# ANALYSIS OF PUPIL PERFORMANCE
## ISC EXAMINATION 2013

# PART II
# SCIENCE & MATHEMATICS

**COUNCIL FOR THE INDIAN SCHOOL CERTIFICATE EXAMINATIONS,**
**NEW DELHI**

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# FOREWORD

This document of the analysis of pupils' performance at the ISC Year 12 and ICSE Year 10 Examination is one of its kind. It has grown and evolved over the years to provide feedback to schools in terms of the strengths and weaknesses of the candidates in handling the examinations.

We commend the work of Mrs. Poonam Sodhi and the ISC Division of the Council who have painstakingly prepared this analysis. We are grateful to the examiners who have contributed through their comments on the performance of the candidates under examination as well as for their suggestions to teachers and students for the effective transaction of the syllabus.

We hope the schools will find this document useful. We invite comments from schools on its utility and quality.

**Gerry Arathoon**
**Chief Executive & Secretary**

**September 2013**

# INTRODUCTION

The Council has consistently been bringing out the "Pupil Performance Analysis" document since 1994. This document is reviewed every year and changes incorporated based on suggestions received from various quarters which include experts in the field of education as well as heads of schools and teachers, in order to make the study more useful and meaningful.

This document comprises of qualitative analysis of performance of pupils at the ISC examinations. Performance Analysis has been carried out for the most popular subjects that are largely ascribed to, by the schools. The purpose of this study is to enable teachers to see at a glance, overall performance of all candidates who have taken the examination and examiners comments on each question. This would enable the teachers to understand the assessment of the ISC examinations better and would help them to guide their students more effectively.

The qualitative analysis details the assessment criteria followed for evaluation of answer scripts. Once the process of evaluation of scripts is over, examiners are requested to give detailed comments on the performance of candidates for each question. This includes the examiners' response on what constitutes a good answer; common errors made by candidates while answering the questions; their popularity with students and overall performance of students.

Mrs. Shilpi Gupta along with Mrs. Desiree Tennent have done commendable work in ensuring that this document is prepared well in time, in order to be of value to you for guiding students who will be appearing for the ISC Examination.

**Poonam Sodhi**
**Deputy Secretary**

**September 2013**

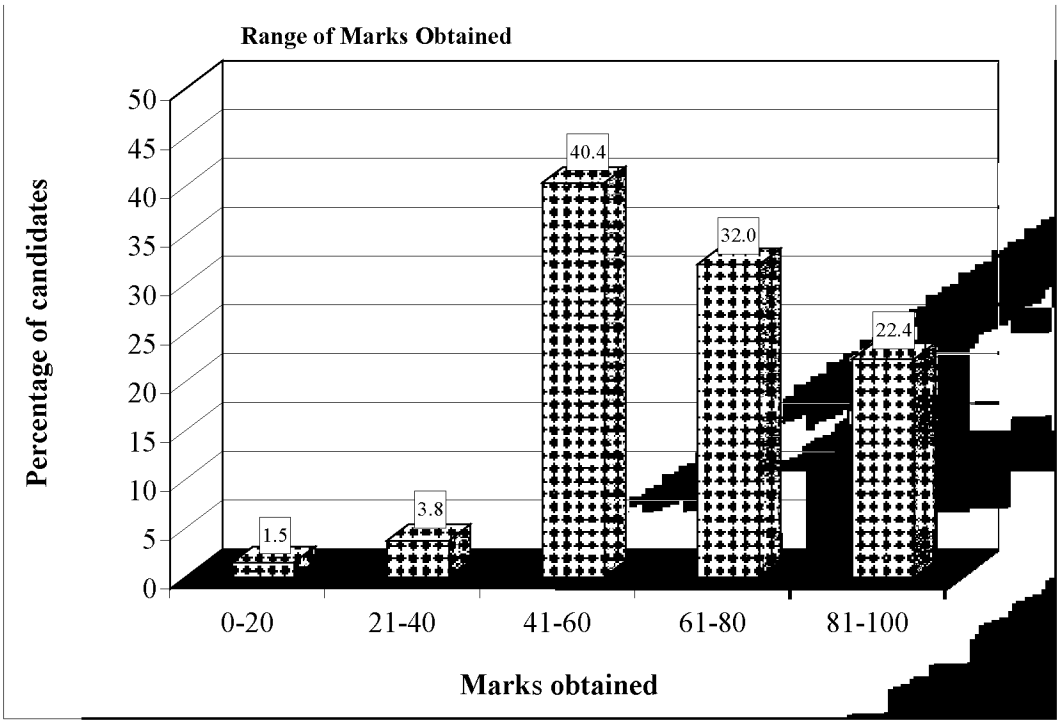
# PHYSICS

## A. STATISTICS AT A GLANCE

| | |
|---|---|
| Total number of students taking the examination | 32,826 |
| Highest marks obtained | 100 |
| Lowest marks obtained | 1 |
| Mean marks obtained | 64.83 |

### Percentage of candidates according to marks obtained

| | Mark Range | | | | |
|---|---|---|---|---|---|
| | ***0-20*** | ***21-40*** | ***41-60*** | ***61-80*** | ***81-100*** |
| Number of candidates | 496 | 1234 | 13250 | 10509 | 7337 |
| Percentage of candidates | 1.5 | 3.8 | 40.4 | 32.0 | 22.4 |
| Cumulative Number | 496 | 1730 | 14980 | 25489 | 32826 |
| Cumulative Percentage | 1.5 | 5.3 | 45.6 | 77.6 | 100 |



## B. ANALYSIS OF PERFORMANCE

**PART I (20 Marks)**

*Answer* **all** *questions.*

**Question 1**

**A.** Choose the correct alternative (a), (b), (c) or (d) for each of the questions given below: **[5]**

(i) Relative permittivity of water is 81. If $\in_w$ and $\in_o$ are permittivities of water and vacuum respectively, then:

(a) $\in_o = 9 \in_w$

(b) $\in_o = 81 \in_w$

(c) $\in_w = 9 \in_o$

(d) $\in_w = 81 \in_o$

(ii) Five resistors are connected as shown in ***Figure 1***.

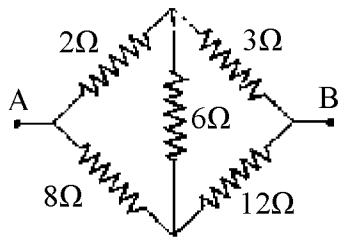



***Figure 1***

The effective resistance i.e. equivalent resistance between the points A and B is:

(a) 4 Ω

(b) 5 Ω

(c) 15 Ω

(d) 20 Ω

(iii) The **Biot Savart's** Law in **vector** form is:

(a) $\overrightarrow{\delta B} = \frac{\mu_o}{4\pi} \frac{dl\left(\vec{I} \times \vec{r}\right)}{r^3}$

(b) $\overrightarrow{\delta B} = \frac{\mu_o}{4\pi} \frac{I\left(\vec{dl} \times \vec{r}\right)}{r^3}$

(c) $\overrightarrow{\delta B} = \frac{\mu_o}{4\pi} \frac{I\left(\vec{r} \times \vec{dl}\right)}{r^3}$

(d) $\overrightarrow{\delta B} = \frac{\mu_o}{4\pi} \frac{I\left(\vec{dl} \times \vec{r}\right)}{r^2}$

(iv) In an astronomical telescope of refracting type:

(a) Eyepiece has greater focal length.

(b) Objective has greater focal length.

(c) Objective and eyepiece have equal focal length.

(d) Eyepiece has greater aperature than the objective.

(v) The particles which cannot be accelerated by a **cyclotron** or a **Van de Graff** generator are:

(a) Alpha particles

(b) Beta particles

(c) Neutrons

(d) Protons

**B.** Answer **all** questions given below briefly and to the point: **[15]**

(i) A large hollow metallic sphere has a positive charge of $35{\cdot}4\,\mu C$ at its centre. Find how much **electric flux** emanates from the sphere.

(ii) A current 'I' flows through a metallic wire of radius 'r' and the free electrons in it drift with a velocity $v_d$. Calculate the drift velocity of the free electrons through the wire of the **same material**, having double the radius , when **same** current flows through it.

(iii) Name **any one** instrument which works on the principle of **tangent law** in magnetism.

(iv) State the SI unit of **magnetic dipole moment**.

(v) Alternating current flowing through a certain electrical device leads over the potential difference across it by $90^o$. State whether this device is a **resistor**, **capacitor** or an **inductor**.

(vi) What is the shape of the wavefront diverging from a **point source of light**?

(vii) The critical angle for a given transparent medium and air is $i_c$ . A ray of light travelling in air is incident on this transparent medium at an angle of incidence equal to the polarising angle $i_p$ . What is the relation between the two angles $i_c$ and $i_p$ ?

(viii) Find the **focal length** and **nature** of a lens whose optical power is – 5D.

(ix) What is **Modulation**? Explain in brief.

(x) What are the **dark lines** seen in the **solar spectrum** called?

(xi) What is the relation between **wavelength** and **momentum** of moving particles?

(xii) Name the series of lines in the hydrogen spectrum which lies in the **ultra-violet** region.

(xiii) Fill in the blank in the given nuclear reaction:

$$\_\_\_\_\_ + {}^{27}_{13}\mathrm{Al} \rightarrow {}^{25}_{12}\mathrm{Mg} + {}^{4}_{2}\mathrm{He}$$

(xiv) Give an example where energy is converted into matter.

(xv) To convert a pure semiconductor into ***n***-type semiconductor, what type of impurity is added to it?

Comments of Examiners

A. (i) Many candidates did not know that relative permittivity = dielectric constant and its value is >1 for all materials.

(ii) A few candidates did not recognise that the given network was a balanced Wheatstone bridge. Evaluation of $R_p$ from $1/R_1 + 1/R_2$ was wrong for many. Some applied Kirchhoff's law unnecessarily and incorrectly.

(iii) Wrong choices were made by several candidates as many did not understand that the expression with cross product and current I is not a vector quantity.

(iv) A number of candidates had no idea of the relative values of the focal lengths of the objective lens and the eyepiece, nor the reason for it. Hence, many wrong choices were made by candidates. In a few cases, aperture and focal length were mixed up.

(v) Wrong options were chosen by some candidates due to lack of understanding of the principle of Cyclotron. Some gave the answer as 'alpha particles' as they are positively charged, not having read 'cannot be accelerated', in the question.

*Suggestions for teachers*

- Stress $\varepsilon_r = k > 1$ for all materials. The value of $\varepsilon_r = k$ is always $> \varepsilon_o$. Point out that $\varepsilon_r = k = \varepsilon_w/\varepsilon_o$. For any medium, $\varepsilon = \varepsilon_r.\varepsilon_o$.
- Teach the condition for a bridge to be balanced.
- It is the current element Idl that is a vector not the current I. The direction of magnetic field vector B is along the cross product dlxr not rxdl. Teach the properties of cross product of vectors very well.
- Point out that magnification $m = f_o/f_e$. So $f_o >> f_e$ for high magnifying power. In the ray diagram, stress this aspect of telescope. Also mention larger aperture of objective enables more light to be gathered-> brighter I.

B. (i) Many candidates gave flux $\varphi = 0$ as they thought $E = 0$ inside a hollow sphere. They did not notice that there was a charge at the centre. Many candidates wrote the unit of electric flux incorrectly.

(ii) Some candidates combined the full formulas, $I = v_d.ena$ and area $a = \pi.R^2$ resulting in unwanted lengthy calculations and mistakes.

(iii) Answers like, cyclotron, galvanometer, moving coil galvanometer, vibration magnetometer and magnetometer were given which were all incorrect.

(iv) Many candidates gave incorrect units: $A/m^2$, $Tesla.m^2$, etc.

(v) Several candidates gave incorrect answers.

(vi) Many candidates gave the shape of the wavefront as 'circle', which was incorrect.

(vii) Many gave the expressions for $i_c(\sin i_c = 1/n)$ and for $i_p(\tan i_p = n)$; but did not connect these, whereas the question asked for the relation between $i_c$ and $i_p$.

(viii) The unit of 'f' was not given by many candidates. In some cases, the nature of the lens was given as convex.

(ix) Most of the candidates did not have a clear idea as to what modulation is, hence they gave different types of modulations.

(x) Many candidates answered this part incorrectly.

(xi) A few candidates gave wrong formulae, such as, $p = h.c/\lambda$

(xii) Some candidates gave the wrong names: Balmer, Pfund, or Brackett series.

(xiii) Many candidates gave wrong names: $(p+n)$, p or ${}_1H^1$.

(xiv) Many candidates gave incorrect answers in this part.

(xv) Some candidates gave the answer as, 'trivalent elements'; some wrote, 'acceptor elements'.

- The working principle and the limitations should be stressed. The what and why should be explained. Point out that Cyclotron can accelerate only charged particles (no neutrons); electrons have relativistic increase in mass violating the resonance condition required.
- Stress upon the correct use of Gauss' theorem, especially that the el flux $\varphi = q/\varepsilon_o$, where q is the *charge enclosed*.
- Explain clearly that Tangent law, $B_2 = B_1 \tan\theta$ has two crossed fields, $B_1$ and $B_2$ perpendicular to each other. So the devices based on tangent law must have two crossed magnetic fields. $B_1$ is usually the horizontal component of earth's field, $B_{EH}$; $B_2$ is the artificial field produced by a bar magnet or a current carrying coil.
- Teach Phasor diagrams in detail, showing R, $X_L$ and $X_C$ along the +X, +Y and –Y directions respectively. Also, $V_R$, $V_L$ and $V_C$.; along with their phase differences.
- Energy from a point source spread out in all direction in 3-dimensional space. The wave front is a sphere, not a circle. Illustrate with example of water wave (circles) in 2-D and sound propagation in 3-D space (spheres).
- Ask students to read the question carefully; note carefully what is asked and answer that specifically.
- Tell students that when power is in D, f is in m (not cm). Always include the correct unit in the final answer. Also, if power or focal length is –ve, it is a concave/diverging lens.

- New topics like modulation should be clearly explained with the help of diagrams and examples.
- Tell students that the names given to the first 3 series should be learned well with the help of energy level diagram.
- Teach the conservation law of Z and A in nuclear reactions. Also, let students learn the names of the first 10 elements with their Z and A values.
- Explain clearly what happens in pair production and mutual annihilation.
- Point out the 'n' in do**n**or, pe**n**tavalent, and **n**-type. Also explain the difference between n-type and p-type semiconductors.

**MARKING SCHEME**

**Question 1.**

**(A)** (i) (d) or $\in_w = 81 \in_o$

(ii) (a) or $4\Omega$

(iii) (b) or $\overrightarrow{dB} = \frac{\mu_o}{4\pi} \frac{I\left(\vec{dl} \times \vec{r}\right)}{r^3}$

(iv) (b) or Objective has greater focal length.

(v) (c) or Neutrons

(b) Beta particles also may be accepted as a special case.

**(B)** (i) $\Phi = \frac{q_{net}}{\in_o} = \frac{35.4 \times 10^{-6}}{8.55 \times 10^{-12}} = 4 \times 10^6$ Vm or C.m.F$^{-1}$ NC$^{-1}$ m$^2$

(ii) $\frac{v_d}{4}$ or 1/4

(iii) Deflection magnetometer OR
Tangent magnetometer OR
Tangent galvanometer. } any one

(iv) $A\ m^2$

(v) Capacitor

(vi) Spherical wavefront OR spherical OR sphere

(vii) $\text{Tan } i_p = \frac{1}{\sin i_c}$ OR its equivalent

(viii) Concave lens, or diverging lens f = -20 cm

(ix) Combining an a.f. signal with a r.f. carrier wave or equivalent statement.

Superposition/overlapping or 3 diagrams

(x) Fraunhofer lines

(xi) $P = \frac{h}{\lambda}$ OR $\lambda = \frac{h}{p}$

(xii) Lyman (series)

(xiii) ${}^{2}_{1}H$ OR ${}^{2}_{1}D$ OR ${}_{1}H^{2}$ OR ${}_{1}D^{2}$ OR ${}^{2}_{1}X$ OR ${}^{2}_{1}Y$

(xiv) Pair production or equivalent $\gamma \rightarrow e^{+} + \bar{e}$ OR $h\nu \rightarrow e^{+} + \bar{e}$

Or labelled diagram

(xv) Pentavalent element or donor impurity or name or element of $5^{th}$ group

## PART II (50 Marks)

*Answer* **six** *questions in this part, choosing* **two** *questions*

*from* ***each*** *of the Sections* ***A, B*** *and* ***C.***

## SECTION A

*Answer any* **two** *questions.*

**Question 2**

(a) (i) Write an expression (**derivation not required**) for intensity of electric field in: **[3]**

(1) Axial position.

(2) Broad side position of an electric dipole, in terms of its length (2a) dipole moment (p) and distance (r).

(ii) What is the ratio of these two intensities i.e. $E_1 : E_2$, for a **short** electric dipole?

(b) Three capacitors $C_1 = 6\,\mu F$, $C_2 = 12\,\mu F$ and $C_3 = 20\,\mu F$ are connected to a 100 V batttery, as shown in ***Figure 2*** below: **[3]**

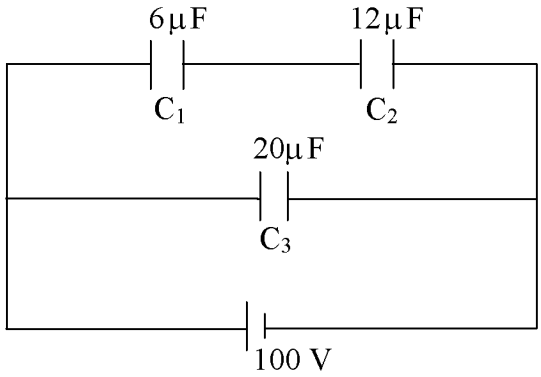



***Figure 2***

Calculate:

(i) Charge on each plate of capacitor $\mathbf{C_1}$

(ii) Electrostatic potential energy stored in capacitor $\mathbf{C_3}$.

(c) 'n' cells, each of emf 'e' and internal resistance 'r' are joined in series to form a row. 'm' such rows are connected in parallel to form a battery of N = mn cells. This battery is connected to an external resistance 'R'. **[3]**

(i) What is the emf of this battery and how much is its internal resistance?

(ii) Show that current 'I' flowing through the external resistance 'R' is given by:

$$I = \frac{Ne}{mR + nr}$$

Comments of Examiners

(a) (i) Many candidates gave the abridged formula for *E* in place of the complete formula required in the question.
(ii) For the ratio $E_1/E_2$ for a short electric dipole, the abridged formula was to be used. Many did not note that and used the un-abridged formula, resulting in clumsy results. Some got E1:E2 = 1:2 which was incorrect.

(b) (i) Many candidates followed very lengthy methods. Some used the reciprocal relation for $C_p$; Some carried $10^{-6}$ for μ in all substitutions. Mistakes were also made in simplifying the exponents.
(ii) Many candidates used wrong formulas. Some did not use $\mu = 10^{-6}$ correctly.

(c) The *emf* of the battery was wrongly given as *ne/m* or *mne*. Total internal resistance and total resistance were also given incorrectly. Some candidates gave total internal resistance r' = r/n instead of n.r/m.

*Suggestions for teachers*

- Instruct students to read the question carefully, noting carefully what exactly is asked and giving just that.
- Explain clearly how the pd and charge combine in series and parallel combination of capacitors. The differences in charge and pd should be well understood.
- Stress upon the importance of the three formulas for U. Solve typical problems.
- The total *emf* for each row is *n.e* and for *m* such rows (battery), the *emf* is the same as for each row, ne. Explain that the internal resistance adds up in each row (nr) and divides for *m* rows (*nr/m*).

**MARKING SCHEME**

**Question 2.**

(a) $E_1 = \frac{1}{4\pi \in_o} \frac{2pr}{\left(r^2 - a^2\right)^2}$

$E_2 = \frac{1}{4\pi \in_o} \frac{p}{\left(r^2 + a^2\right)^{3/2}}$

$E_1 : E_2 = 2 : 1$

(b) (i) $C_{12} = \frac{C_1 C_2}{C_1 + C_2} = \frac{6 \times 12}{6 + 12} = 4\mu F$

$Q_1 = Q_{12} = C_{12}V = 4 \times 10^{-6} \times 100 = 4 \times 10^{-4} C$

$= 400\,\mu C$

OR

$Q = \frac{C_1 C_2}{C_1 + C_2} V$

$= \frac{6 \times 12}{6 + 12} \times 100$

$= 400\ \mu C$

Correct substitution with or

Without (correct) formula

Correct result with proper unit

(ii) $U = \left(\frac{1}{2} CV^2 = \right) \frac{1}{2} \times 20 \times 10^{-6} \times (100)^2$

$= 1 \times 10^{-1}$ J OR

$= 0.1$ J

(c) (i) emf = ne

internal resistance, r' = $\frac{nr}{m}$

(ii) $I = \frac{E}{R + r} = / \frac{ne}{R + \frac{nr}{m}} = mne/(mR+nr) = Ne/(mR+nr)$

**Question 3**

(a) In the circuit shown in ***Figure 3***, $E_1 = 17$ V, $E_2 = 21$ V, $R_1 = 2\Omega$ , $R_2 = 3\Omega$ and $R_3 = 5\Omega$. Using **Kirchoff's laws,** find the currents flowing through the resistors $R_1$, $R_2$ and $R_3$. (Internal resistance of each of the batteries is neglegible.) **[4]**

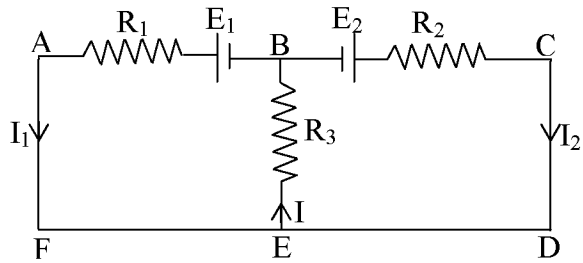



***Figure 3***

(b) You are provided with one low resistance $R_L$ and one high resistance $R_H$ and two galvanometers. One galvanometer is to be converted to an ammeter and the other to a voltmeter. Show how you will do this with the help of simple, labelled diagrams. **[2]**

(c) (i) Plot a labelled graph to show variation of thermo-emf 'e' versus temperature difference '$\theta$' between the two junctions of a thermocouple. Mark 'N' as **neutral temperature** and 'I' as **temperature of inversion**. **[3]**

(ii) What is **Peltier effect**?

Comments of Examiners

(a) The sign convention was applied wrongly by many candidates. In some cases, the solution of the two simultaneous equations was attempted using very lengthy and incorrect methods. Several candidates changed the direction of arrows given in the question paper. Some did not know Kirchhoff's laws or its applications.

(b) Disregarding the given labels, $R_L$ and $R_H$ many candidates used 'S' and 'R' for shunt and series resistors. Others gave detailed derivations of the expressions for S and R which were not asked for.

(c) The shape of the graph was wrong in several cases. The points N and I were marked wrongly by a number of candidates. Many candidates did not know Peltier effect at all.

*Suggestions for teachers*

- Use $\Sigma\varepsilon + \Sigma IR = 0$, (not $\Sigma\varepsilon = \Sigma IR$). Also, take the loop direction against current so that IR is +ve. Explain well what is +ve for *emf* and for p.d = V = I.R.
- Teach students how to solve simultaneous equations in easy steps.
- Tell students not to change symbols and the directions of the arrows given in the diagrams in the question paper.
- Ask students to read the questions very carefully and to follow the directions strictly.
- This simple graph should be taught well, pointing out the correct shape and the location of the points N and I.

**MARKING SCHEME**

**Question 3.**

(a) $I = I_1 + I_2$

$- I \times 5 - 2 I_1 + 17 = 0$

OR

$5I + 2 I_1 = 17$

OR

Equation 1: $7 I_1 + 5 I_2 = 17$

$- I \times 1 - 6 I_2 - 1 I_2 + 10 = 0$

OR

$5I + 3I_2 = 21$

OR

Equation 2: $5I_1 + 8 I_2 = 21$

Solving the two simultaneous equations; show some working

$I_1 = 1$ A

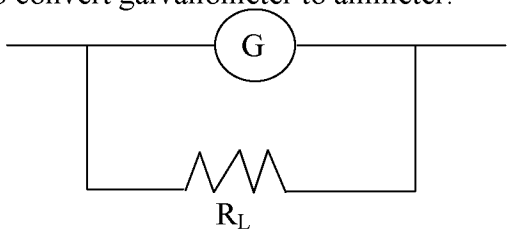
$I_2 = 2$ A

$\therefore \ I = 3$ A

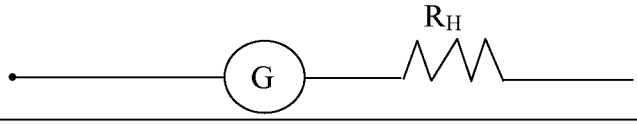
ECF applicable, if one of the equations is wrong.

ECF applicable, if both the equations are wrong.

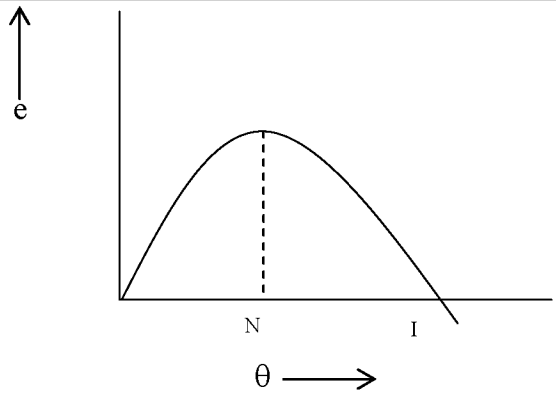
(b) (i) To convert galvanometer to ammeter:




(ii) To convert galvanometer to voltmeter:



(c) (i)




Correct labelling: e on Y axis; θ on x axis.

: **N** for neutral temp.

: **I** or temperature of immersion

Correct shape of the graph

(ii) When a current is passed through a thermo-couple, one of its junctions gets heated whereas the other gets cooled or equivalent.

**Question 4**

(a) ***Figure 4*** below shows two infinitely long and thin current carrying conductors X and Y kept in vacuum, parallel to each other, at a distance 'a'. **[2]**

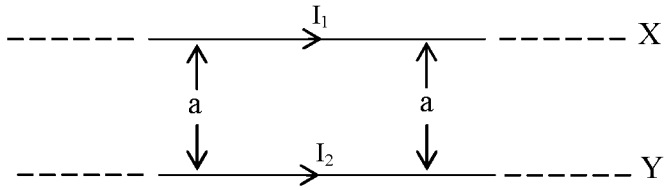



***Figure 4***

(i) How much force per unit length acts on the conductor Y due to the current flowing through X ? Write your answer in terms of $\left(\frac{\mu_o}{4\pi}\right)$, $I_1$, $I_2$, and a.

**(Derivation of formula is not required.)**

(ii) Define **ampere**, in terms of force between two current carrying conductors.

(b) A metallic rod CD rests on a thick metallic wire PQRS with arms PQ and RS parallel to each other, at a distance $l$ = 40 cm, as shown in ***Figure 5***. A uniform magnetic field B = 0·1T acts perpendicular to the plane of this paper, pointing inwards (i.e. away from the reader). The rod is now made to slide towards right, with a constant velocity of $v = 5.0\ ms^{-1}$. **[3]**

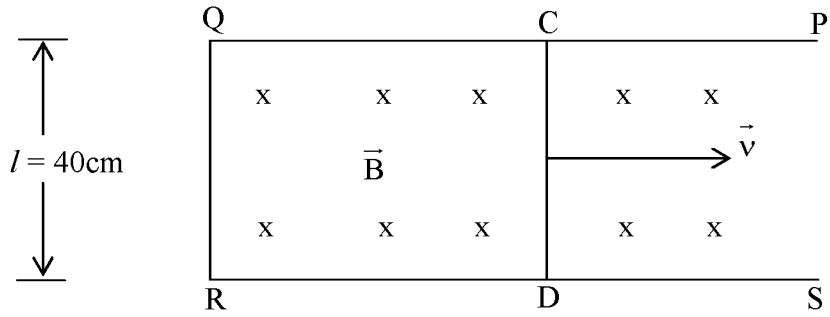



***Figure 5***

(i) How much emf is induced between the two ends of the rod CD ?

(ii) What is the direction in which the induced current flows?

(c) (i) ***Figure 6*** below shows a series **RCL** circuit connected to an ac source which generates an alternating emf of frequency 50 Hz. The readings of the voltmeters $V_1$ and $V_2$ are 80 V and 60 V respectively. **[4]**

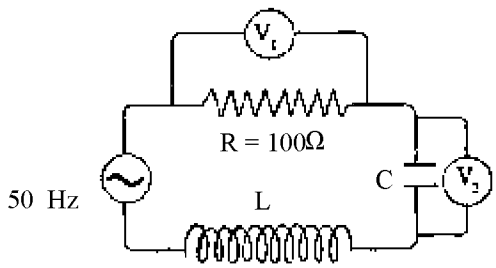



***Figure 6***

Find:

(1) the current in the circuit.

(2) the capacitance C of the capacitor.

(ii) At resonance, what is the relation between impedance of a series LCR circuit and its resistance R?

Comments of Examiners

(a) (i) The expression for $F/l$ was wrong for many candidates. Several candidates derived the formula unnecessarily.
(ii) A number of candidates were not able to define 'Ampere' correctly.

(b) (i) The emf = $B.L.v$ was simple substitution but many candidates did it incorrectly as L = 40 cm was not changed to 0.40 m.
(ii) Direction of induced current was given wrongly by many candidates.

(c) (i) A number of candidates did not recognize $I = V/R$ and made some wrong calculations. Mistakes were also made in simplifying and solving for C from $Xc = 1.\omega C = 1/2\pi fC$.

*Suggestions for teachers*

- Ask students to read the questions very carefully. Tell them to do just what is asked, strictly following the directions.
- Ampere, the base unit of electricity is defined from the expression, $F/l = (\mu_o/2\pi)\, I_1.I_2/a$. So, stress (i) $I_1 = I_2 = I = 1$ A, if a = 1 m, $F/l = 2\text{x}10^{-7}$ N/m, when the conductor is very long and is placed in vacuum.
- Emphasize the unit of each physical quantity. In numerical problems, in most cases, all data should be in SI units.
- Teach carefully, the use of Lenz's law to obtain the direction of the induced current; 'so as to oppose the action which causes it.'
- Help students understand that in an LCR circuit, current, I is the same in all components. So, the simplest formula for I is, I = V/R.

**MARKING SCHEME**

**Question 4.**

(a) (i) $F = \left(\frac{\mu_o}{4\pi}\right)\frac{2I_1 I_2}{a}$ OR $\frac{\mu_o I_1 I_2}{2\pi a}$

(ii) Current flowing through each of the two (infinitely) long (thin) conductors is said to be 1A if they attract or repel each other with a force of $2\times10^{-7}$ $Nm^{-1}$, when they are kept parallel to each other at a distance of 1 m in vacuum.

(must mention $2\times10^{-7}$ and either $Nm^{-1}$ or 1 m accepted)

(b) (i) $e = Blv$

$= 0{\cdot}1 \times 0{\cdot}4 \times 5{\cdot}0$

$e = 0{\cdot}2$ V

Correct substitution or correct formula

Correct result with unit

(ii) From D to C or along DCQR

(c) (i) 1. $I = \frac{V_R}{R} = (\frac{80}{100}) = 0 \cdot 8A$

2. $X_c = \frac{1}{2\pi fC} = \frac{V_C}{I}$ = 75 Ω or implied

$\frac{1}{2\pi \times 50 \times C} = \frac{60}{0 \cdot 8}$ or ω = 2. π.f = 2x3.142x50 = 314.2 rad/s

$\therefore C = 42 \cdot 5\mu F$

$\approx 43\mu F$

Accept C = 42 to 43 μF

(ii) Z = R

## SECTION B

*Answer any* **two** *questions*

### Question 5

(a) (i) In an electromagnetic wave, how are electric vector ($\vec{E}$), magnetic vector ($\vec{B}$) and velocity of propagation of the wave ($\vec{c}$) oriented? **[2]**

(ii) How long would **gamma radiation** take to travel from sun to earth, a distance of $1 \cdot 5 \times 10^{11}$ m?

(b) With the help of a labelled diagram, show that fringe separation β in **Young's double slit** experiment is given by: **[4]**

$$\beta = \frac{\lambda D}{d}$$

where the terms have their usual meaning.

(c) (i) What is the difference between **polarised** light and **unpolarised** light based on the direction of electric vector ($\vec{E}$) ? **[2]**

(ii) What will be the effect on the **width** of the **central bright fringe** in the diffraction pattern of a single slit if:

(1) Monochromatic light of smaller wavelength is used.

(2) Slit is made narrower.

Comments of Examiners

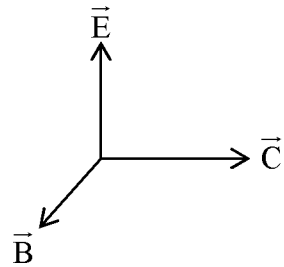
(a) (i) Instead of saying that E, B, and c are mutually perpendicular, many candidates mentioned about planes.
(ii) Some candidates did not know that $v$ = c = 3.0 x $10^8$ m/s. Several candidates made mistakes in simplifying the exponential. At times, the unit was wrong.
(b) Steps were left out by many candidates in this part.
(c) (i)Many candidates did not know the relation between the electric field E and the state of polarization and hence could not answer correctly.
(ii) Several candidates were not able to answer this part correctly.

*Suggestions for teachers*
- Explain to students that the speed of all *e.m.* radiation is c = 3.0 x $10^8$ m/s in vacuum/air. Teach the the rules for simplifying exponents.
- Emphasise the importance of reading questions very carefully.

**MARKING SCHEME**

**Question 5.**

(a) (i) They are mutually perpendicular to each other OR correct diagram.

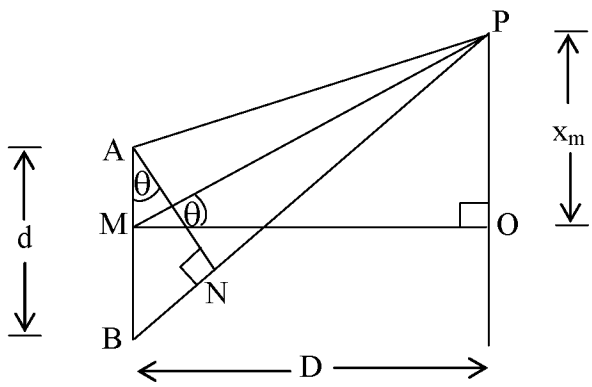



(ii) $t = \frac{S}{C}$

$= \frac{1.5 \times 10^{11}}{3 \times 10^8}$

$= 0.5 \times 10^3$ OR 500 s

(b)




In $\Delta PMO, \tan\theta = \frac{PO}{MO} = \frac{x_m}{D}$

Path differene = BP – AP = BN = AB sin θ = d sin θ

For a bright fringe to be formed at P, $d \sin\theta = m\lambda$

In $\Delta BAN, \text{Sin}\theta = \frac{BN}{AB} = \frac{m\lambda}{d}$

$\tan\theta = \sin\theta$ $\quad\quad\quad\quad$ $\therefore \theta$ is small

$$\therefore \frac{xm}{D} = \frac{m\lambda}{d}$$

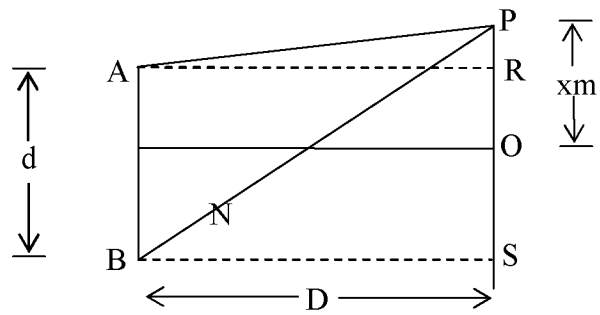
$$\therefore X_m = \frac{m\lambda D}{d}$$

Fringe width $\beta = x_1 = \frac{1.\lambda D}{d}$ $\quad\quad$ OR

Fringe width $\beta = x_m - x_{m-1} = \frac{m\lambda D}{d} - (m-1)\frac{\lambda D}{d}$

$$= \frac{\lambda D}{d}$$

Second method:




$$BP^2 = BS^2 + SP^2$$

$$= D^2 + (x_m + \frac{d}{2})^2$$

$$AP^2 = AR^2 + RP^2$$

$$= D^2 + (x_m + \frac{d}{2})^2$$

$$BP^2 - AP^2 = (x_m + \frac{d}{2})^2 - (x_m + \frac{d}{2})^2$$

$$(BP - AP)(BP + AP) = 2\, x_m \,.\, d$$

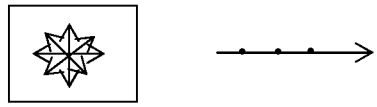
$$(BP - AP)\, \cancel{2}\, D = \cancel{2}\, x_m \,.\, d$$

$$m\lambda \,.D = x_m\, d$$

$$\therefore x_m = \frac{m\lambda D}{d}$$

Fringe width $\beta = x_1 \frac{1\lambda D}{d} = \frac{\lambda D}{d}$

(c) (i) In unpolarised light, electric vector points in all directions or infinite number of directions in a plane, perpendicular to the direction of propogation whereas in polarised light, it points in only one direction which is perpendicular to the direction of propagation of light OR correct diagram.



(ii) (1) decreases

(2) increases

**Question 6**

(a) At what angle, a ray of light should be incident on the first face AB of a regular glass prism ABC so that the emergent ray grazes the adjacent face AC ? **[3]**
See ***Figure 7*** below. (Refractive Index of glass = 1·6)

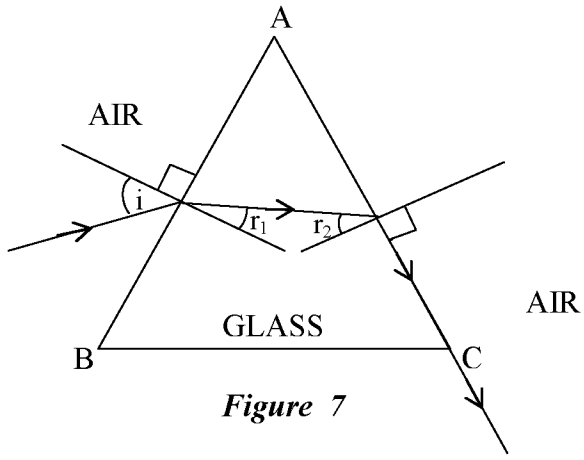



***Figure 7***

(b) A convex lens '**L**' and a plane mirror '**M**' are arranged as shown in ***Figure 8*** below. Position of object pin '**O**' is adjusted in such a way that the inverted image '**I'** formed by the lens mirror combination, coincides with the object pin '**O**'. Explain how and when this happens. **[2]**

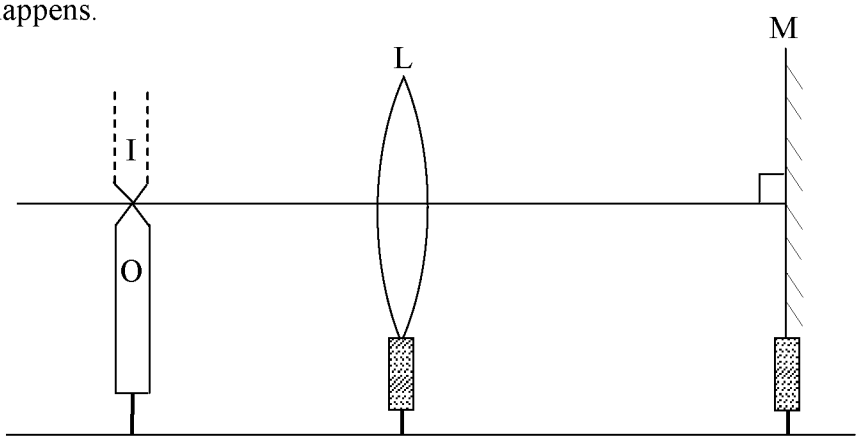



***Figure 8***

(c) Starting with an expression for refraction at a **single spherical surface**, obtain an expression for **lens maker's formula**. **[3]**

Comments of Examiners

(a) Many candidates got confused and used very complicated formulas. Some candiates used the formula for min. deviation.
(b) A number of candidates did not know that the image formation was due to rays returning to O after refraction through the lens and reflection from the mirror. Hence they did not mention the position of the object pin as the focus of the lens. Many wrong answers were given.
(c) Several candidates derived the expression for refraction at a single spherical surface. This was not asked, this was to be assumed. It was clearly given in the question. Candidates also made mistakes in the sign convention used.

*Suggestions for teachers*

- Teach well the concept of critical angle of incidence, with $r$ = 90; grazing angle of incidence, sin c = 1/n; (sin i/sin r)= $n$; $r_1 + r_2 = A = 60^o$etc. Encourage step by step calculation.
- Different cases of the incident rays retracing their path after reflection from (i) a plane mirror and (ii) a convex /concave mirror must be taught with the help of ray diagrams and explanation of the 'why' in each case should be done. Also, do image formation with a combination of lens and mirror.
- Ask students to read the questions very carefully and do just what is asked following the directions given.
- Discourage the learning of derivations by heart. Students should be made to understand the logic behind each step.

**MARKING SCHEME**

**Question 6.**

(a) $r_2 = c = \sin^1\left(\frac{1}{\mu}\right) = \sin^{-1}\left(\frac{1}{1\cdot 6}\right)$

$= 38.7^o$

$^r_1 = A - C$

$= 60^o - 38.7 = 21.3^o$

$\frac{\sin i}{\sin r_1} = \mu$ OR $\sin i = \mu \sin r_1$

$\text{Sin } i = 1.6 \times \sin\left(21.3^o\right)$

$\therefore i = 35.5^o$

(b) This happens when the object pin is kept at the focus of the lens.

Rays of light emerging from the lens become **parallel** to each other and to the principal axis of the lens. These rays fall on the plane mirror **normally** and hence get reflected back. The rays now retrace their path and meet at the focus of the lens, i.e. the image coincides with the object pin. OR ray diagram with f or F marked.

(c) For the refraction at first (convex) spherical surface;

$$\frac{\mu}{v'} - \frac{1}{u} = \frac{(\mu - 1)}{R_1}$$

For refraction at second spherical surface;

$$\frac{1}{v} - \frac{\mu}{v'} = \frac{(\mu - 1)}{R_2}$$

Adding:

$$\frac{1}{v} - \frac{1}{u} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

Correct diagram

**Question 7**

(a) Show that the **axial chromatic aberration** ($f_r - f_v$) for a convex lens is equal to the product of its mean focal length (f) and dispersive power ($\omega$) of its material i.e. Prove: **[3]**

$$f_r - f_v = \omega f.$$

(b) Draw a labelled diagram of an image formed by a **compound microscope**, with the image at **least distance of distinct vision**. Write any one expression for its magnifying power. **[3]**

(c) What is meant by **long-sightedness?** How can this defect be corrected? **[2]**

Comments of Examiners

(a) The starting expression for $1/f = (n-1)(1/R_1 - 1/R_2)$ was given incorrectly by several candidates. The definition of $\omega$ was wrong. Many candidates gave no explanation for the steps.
(b) Many candidates made mistakes in the diagram of compound microscope: $F_1$, $F_2$, *arrows* on rays were not shown; formation of image $I_1$ was not correctly shown. Formation of $I_2$ at D was not correctly shown. In some Expression for *m* was not correct.
(c) Several candidates did not know the meaning of long-sightedness. For correction, some wrote 'concave lens', in place of 'convex lens'.

*Suggestions for teachers*

- Explain the starting equation and the 'why' of each step well. Ask students not to learn derivations by heart.
- In teaching/learning, make sure that 'compound microscope' is not left out or neglected. Draw neat labelled diagrams on the black board; explain the formation of images as well as the magnifying power $m = m_o x m_e$. At least one arrow is a must for each ray.
- Ask students to study carefully the physics behind the defects of the eye and its correction, using neat ray diagrams. Differentiate between long sightedness and short sightedness.

**MARKING SCHEME**

**Question 7.**

(a)

$$\frac{1}{f_r} = (\mu_r - 1)\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

$$\frac{1}{f_v} = (\mu_v - 1)\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

$$\frac{1}{f_v} - \frac{1}{f_r} = (\mu_v - \mu)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{f_r - f_v}{f_r f_v} = (\mu - 1)\left(\frac{\mu_v - \mu_r}{\mu\text{-}1}\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{f} = (\mu - 1)\left(\frac{R}{1} - \frac{R}{2}\right) \qquad \sin\varpi = \frac{\mu_v - \mu_r}{\mu - 1} \quad \text{or implied}$$

$$\frac{f_r - f_v}{f^2} = \omega \cdot \frac{1}{f}$$

$\therefore\ [f_r - f_v = \omega f\ ]$

(b) Two incident rays from an object + objective, with at least one arrow.

Two emergent rays with at least one arrow + eyepiece, with inverted image at D.

$M = M_e M_o$ OR

$$= \left(1 + \frac{D}{f_e}\right)\frac{v_o}{u_o} \ldots \text{OR}$$

$$= \left(1 + \frac{D}{f_e}\right)\left(\frac{v_o}{f_o} - 1\right)$$

(c) (It is that defect of vision)

A person can't see objects at and beyond D (25 cm) upto his near point.

It can be corrected by using a convex lens (of appropriate focal length).

## SECTION C

*Answer any* **two** *questions.*

**Question 8**

(a) (i) What is meant by '**Quantization of charge**'? **[3]**

(ii) In Thomson's experiment, prove that the ratio of **charge to the mass** (e/m) of an electron is given by:

$$\frac{e}{m} = \frac{1}{2V} \cdot \frac{E^2}{B^2}$$

where the terms have their usual meaning.

(b) In a photo-electric cell, a retarding potential of 0·5V is required to block the movement of electrons from the cathode when monochromatic light of wavelength 400 nm is incident on its surface. Find the **work function** of the material of the cathode. **[3]**

(c) Name a **phenomenon** or an **experiment** which proves: **[2]**

(i) Particle nature of electro magnetic radiations.

(ii) Wave nature of particles.

(Description of the phenomenon / experiment is **not** required.)

Comments of Examiners

(a) (i) In place of $Q = ne$, some candidates wrote, Q is a simple multiple of … which is not correct.
(ii) Many candidates were confused between v (velocity) and V (pd).

(b) Some candidates calculated $\lambda_o$ unnecessarily. Many candidates used very lengthy methods in the solution; mistakes were also made by candidates in calculating/ converting energy in joules, not taking common factors, simplifying exponents in the values of h, c and $\lambda$.

(c) (i) For an experiment or phenomenon which proves the particle nature of *em* radiation, some candidates gave Plank's quantum theory or de Broglie equation which was not correct.
(ii) For wave nature of particles, many candidates wrote - reflection, refraction, etc which was incorrect.

*Suggestions for teachers*

- Teach the mathematical statement, $Q = n.e$ where $n$ is an integer and $e$ is the charge on an electron.
- Stress upon the convenience of using eV for energy unit in modern physics problems. The work out is much simpler and easier. Work function is usually given in eV. Also, point out that when retarding/stopping potential V is given, work function in eV is simply = V (numerically).
- Explain the importance/relevance of photoelectric effect and Compton effect. These can be explained only assuming quantum nature of radiation (not its wave nature).

**MARKING SCHEME**

**Question 8.**

(a) (i) The charge on any body is always an /integral multiple of elementary charge ($\pm$ e)

OR

Q = $\pm$ ne where n is an integer.

(ii) $\frac{1}{2}mv^2 = eV$ OR

$\frac{e}{m} = \frac{v^2}{2V}$

$Bev = eE$ OR $v = \frac{E}{B}$

(b) $eVs = \frac{hc}{\lambda} - \omega$

OR

$\omega = \frac{hc}{\lambda} - eV_s$

For $hc/\lambda$ or eVs calculation

$$\omega = \frac{6.63\times10^{-34}\times3\times10^{8}}{400\times10^{-9}} - 0.8\times10^{-19}$$

$= 4.1725\times10^{-19}$ J

OR

$\omega = 2.61$ eV Or may do in eV complete solution

(c) (i) Photo electric effect OR

Compton effect OR

Raman effect.

(ii) Electron diffraction OR

Davisson & Germer's experiment OR

GP Thomsons experiment.

**Question 9**

(a) (i) State the postulate of **Bohr's theory** regarding: **[3]**

(1) Angular momentum of an electron.

(2) Emission of a photon.

(ii) Total energy of an electron orbiting around the nucleus of an atom is always negative. What is the significance of this?

(b) (i) Draw a labelled graph showing variation of relative intensity of X-rays versus their wavelength $\lambda$. Mark $\lambda_{min}$ on the graph. **[3]**

(ii) State how the value of $\lambda_{min}$ can be varied.

(c) **Half life** of a certain radioactive substance is 6 hours. If you had 3·2 kg of this substance in the beginning, how much of it will disintegrate in one day? **[2]**

Comments of Examiners

(a) (i) Some candidates unnecessarily explained the postulates, while only the statement was asked. Emission of electrons was not explained properly by many candidates. Some candidates gave the condition for emission of photoelectrons.
(ii) The significance of –ve energy was not known to many candidates. The word 'significance' was also not understood by some.

(b) (i) The shape of the graph and position of $\lambda_{min}$ were not correct in many cases. At times, the right arm of the graph was shown as coming down steeply. Labelling of axes not correct for some candidates.
(ii) Many candidates mentioned just potential or pd without specifying Anode potential or Tube potential.

(c) Some candidates made very lengthy calculations. Mistakes were also made in simplification.

*Suggestions for teachers*

- Teach the statement of postulates in words and in equation form. $L = n.h/2\pi$ and $\Delta E$ or $(E_f - E_i) = hf = hc/\lambda$.
- Tell students that the kinetic energy is always +ve; but potential energy of electron-proton system (H atom) is always –ve because of the attractive force. Total energy E = U +K is always –ve for a bound system like H atom. This should be explained clearly with numerical values also.
- Explain the difference between anode potential and filament potential.
- Teach the concept of half-life with numerical examples. Explain the difference between the amount which decays and the amount left after decay.

**MARKING SCHEME**

**Question 9.**

(a) (i) 1) Angular momentum of an electron is quantized OR

(Electron revolves around the nucleus in that orbit where) its angular momentum is an integral multiple of $\left(\frac{h}{2\pi}\right)$ or $(t)$ OR

$l = nt$ or $\frac{nh}{2\pi}$

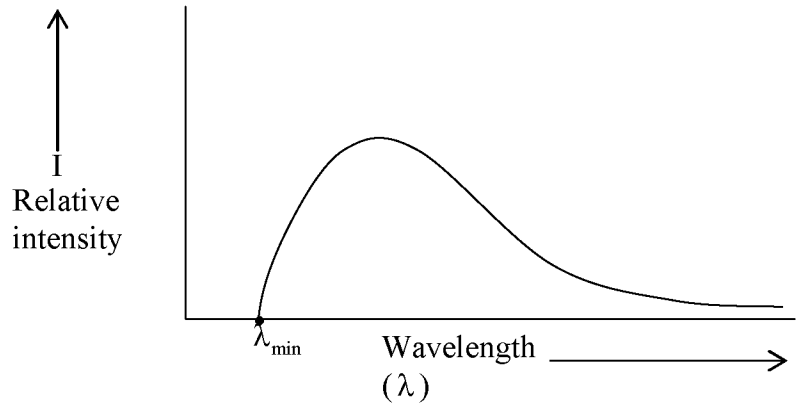
2) An atom emits energy/photon when its electron jumps from higher excited state to a lower excited state or ground state. Or equivalent formula

(ii) It means electron is bound to be nucleus OR

electron can't leave the atom unless it is provided with sufficient / enough energy. OR atom is in abound/stable state. OR

energy is required to remove an electron from an atom.

(b)




(i) Axes correctly labelled

(ii) Correct shape of the graph (with or without peaks/spikes)

With $\lambda_{min}$ marked

$\lambda_{min}$ depends on tube potential i.e. potential difference between

The cathode and the anode.

(c) (1 day = 24 hours = 4T)

3.2 kg $\underset{\rightarrow}{T}$ 1.6kg $\underset{\rightarrow}{2T}$ 0.8kg $\underset{\longrightarrow}{3T}$ 0.4kg

0.4 kg $\rightarrow$ 0.2kg OR using $N = N_0.(1/2)^n$ where $n = t/T$

Amount disintegrated = 3.0 kg

**Question 10**

(a) (i) What is the significance of **binding energy per nucleon** of a nucleus? **[3]**

(ii) In a certain star, three alpha particles undergo **fusion** in a single reaction to form $^{12}_{6}C$ nucleus. Calculate the energy released in this reaction in MeV.

Given : $m(^{4}_{2}He) = 4.002604$ u and $m(^{12}_{6}C) = 12.000000$ u.

(b) Show by drawing labelled diagrams, the nature of output voltages in case of: **[3]**

(i) A half wave rectifier.

(ii) A full wave rectifier.

(iii) An Amplifier.

(In each case, input is an ac voltage)

**Circuit diagrams of these devices are not required**.

(c) Identify the logic gate whose truth table is given below and draw its symbol: **[2]**

| A | B | Y |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

Comments of Examiners

(a) (i) Many candidates gave the definition of BE/nucleon, which was not asked. The 'significance' of BE per nucleon was asked.
(ii) Calculation of mass defect, $\Delta m$ was wrong in several cases, as candidates did not use 3 in 3m(He) or did not subtract correctly. Some candidates wrongly used $E = m.c^2$ with m in u. Some did $E = E_1 - E_2$ which was very lengthy.

(b) Many candidates gave full circuit diagrams which were not asked. Input signal was not asked but many candidates gave that also. Some candidates did not label the axes.

(c) A number of candidates identified it as AND + NOT gate. Some wrote 'AND' gate. Many copied the Truth Table which was not required. The symbol of NAND gate was wrong in a few cases.

*Suggestions for teachers*

- Explain with example that high values of BE/A signifies high stability.
- Teach students to first calculate $\Delta m$ in u only very carefully. To convert the mass defect in u to energy in MeV, use the conversion factor, 1=931 MeV/u. Also, explain that $E=m.c^2$ is valid only with mass m in kg. Here, $c = 3.0 \times 10^8$ m/s.
- Stress upon labelling the axes for graphs. Explain the function and working of each device.
- Ask students to do just what is asked following the directions strictly and not to copy diagrams and tables from the question paper to the answer sheet.

**MARKING SCHEME**

**Question 10.**

(a) (i) It gives us an idea of the relative stability of the nucleus.

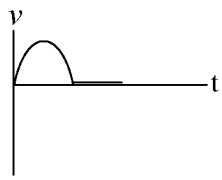
(ii) $\Delta m = \left[3m\left({}^{4}_{2}H_e\right)\right] - \left[m\left({}^{12}_{6}C\right)\right]$

OR

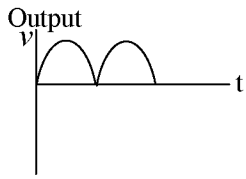
$(3 \times 4002604 - 12.0000)u$
$= 0.007812\ u$

Energy releasd, $E = 0.007812 \times 931)$
$= 7.27$ (MeV)

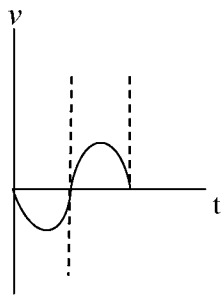
(b) (i) Half wave rectifier.



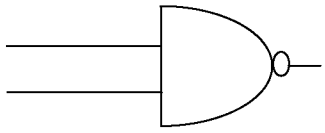

(ii) Full wave rectifier:




(iii) Amplifier:




(c) NAND GATE



**GENERAL COMMENTS:**

**(a) Topics found difficult by candidates in the Question Paper:**

- Correct application of Gauss' law
- Distribution of charge in a network of capacitors.
- Vector form of Biot-Savart Law
- RLC Circuit, voltage across each; $X_c = 1/\omega C$ calculation
- Kirchhoff's Law equations
- Solving simultaneous equations
- Direction of induced current; Lenz's law.
- Derivations: Mixed grouping of cells, Magnetic force between parallel currents, Interference fringe-width formula, and Chromatic aberration formula.
- Relation between angles in the refraction through a prism, including critical angle.
- Compound microscope, ray diagram, magnifying power.
- Particle accelerators.
- Significance of BE/A and negative total energy.

- Conversion of energy into matter; examples.
- Modulation

**(b) Concepts between which candidates got confused:**

- Permittivity and relative permittivity.
- Seebeck effect and Peltier effect.
- Electric and magnetic dipole moments.
- Relative size and focal length of objective and eyepiece in a telescope.
- Long sightedness and short sightedness.
- Polarised light and un-polarised light in terms of electric field vector.
- Emission of photons from (i) H atom (Bohr's theory) and (ii) metals (photo-electric effect).
- Wave nature and particle nature.
- Mass defect, binding energy, energy released, and conversion factor (1 u = 931.5MeV).
- The n-type and p-type semiconductors.
- Amount of radioactive substance decayed/left.

**(c) Suggestions for students:**

- While reading your text, mark important definitions, formulas, vector equations and make a list.
- Prepare notes combining your own reading and class room lecture material. Review the classroom lessons on the same day.
- Learn derivations step by step, understanding the logic of each step; start from defining equations or the given equations. Include diagrams if relevant.
- Work out as many problems as possible related to each topic.
- Practise drawing figures, graphs and circuit diagrams with labels.
- Keep your eyes/mind open for easier, shorter, and faster solutions/derivations.
- Read each question very carefully, underline the data given (if any), and plan out the steps, solution and results **exactly as required in the question**.
- Do not leave out units of final results, and arrows in ray diagrams.
- Try to understand what exactly is asked; do just that and that only.
- Keep your answers neat, legible and well-spaced.
- Keep the length of your answers proportional to the marks allotted.
- Do not copy diagrams, tables etc. from the question paper.
- Practice drawing figures, graphs and circuit diagrams with labels.
- Work systematically, with a definite plan of study and revision.

# PHYSICS PAPER 2 (PRACTICAL)

**Question 1** **[10]**

This experiment determines the focal length of the given convex lens by **no parallax** method.

You are provided with:

(i) A convex lens

(ii) A lens holder

(iii) Two optical pins

(iv) An optical bench.

**Note**: *If an optical bench is not available, the experiment may be performed on a table top, using a metre scale.*

Mount the given convex lens **L** on a lens holder. Keep the object pin **O** to the left and the image pin **I** to the right of the lens (See ***Figure 1***). Adjust their heights till their tips lie on the principal axis of the lens.

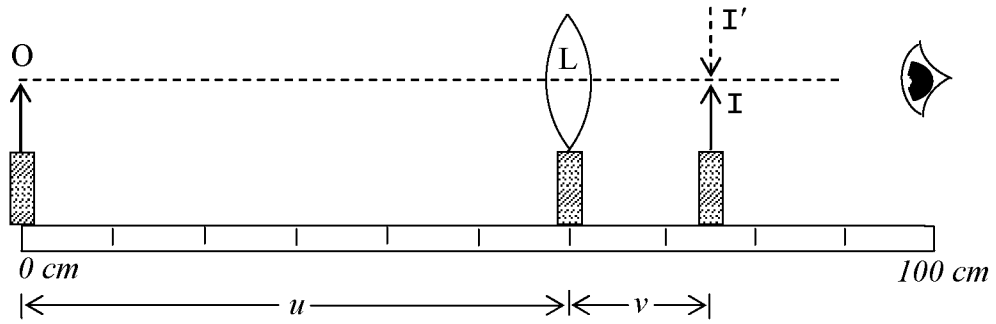



***Figure 1***

Keep the object pin at 0 cm mark and the lens at 60·0 cm mark, so that object distance OL = $u$ = 60·0 cm. Look at the object pin through the lens, from a distance. You should see an **inverted** and **diminished** image I′ of the object pin O. Adjust the position of the image pin I so that there is **no parallax** between I and I′. Ensure that '**tip to tip**' parallax is removed. If required, you may adjust the heights of the two pins O and I. At no parallax, note the position I of the image pin on the metre scale, correct up to **one decimal place**.

Determine the image distance $v$ = LI, correct up to **one decimal place**. Record this value of $v$ in your answer booklet. **Show this reading to the Visiting Examiner.** Calculate **linear magnification** m = $\frac{v}{u}$, correct up to **two decimal places**.

Repeat the experiment for **five more values** of $u$ i.e. $u$ = 50 cm, 40 cm, 30 cm, 20 cm and 15 cm. Each time, remove the parallax and find $v$ and m.

Now, tabulate all **six** sets of values of $u$, $v$ and m with their **units** (if any).

Plot a graph of m vs $v$, taking m on Y axis. Do not choose the origin at (0, 0). Choose the scales such that you use more than half the graph.

Draw the line of best fit. It must be a thin and uniform line. Find its slope **S** using:

$$\mathbf{S} = \frac{\text{change in m}}{\text{change in } v}$$

Record the value of **S**, rounded up to **three significant figures**.

Then, find f , using $f = \frac{1}{S}$

and record its value in your answer booklet, correct up to **one decimal place**, with proper unit.

Comments of Examiners

Record:

- In some cases, the trend( V vs U) was not followed i.e. U increases, V decreases; the Parallax error was not removed completely.
- Many candidates did not express V upto 1dp with unit.
- The calculation of m=v/u upto 2dp after correct rounding-off was not done by many candidates.

Graph:

- Many candidates did not take a uniform scale; kink was taken and origin not marked properly. A few candidates took an inconvient scale such as 15 div = 1unit.
- The understanding of the concept of line of best fit was found to be lacking amongst many candidates.
- For slope calculation, some candidates took plotted points; less than half of the line was taken in some cases. Many candidates did not calculate slope upto 3 significant figures.

Calculation:

- Many candidates did not write the unit of 'f'.

*Suggestions for teachers*

- Explain to students the concept of parallax error and the reason for the same.
- Tell students about the least count of various instruments, significant figures and rules for rounding off the values upto proper decimal place.
- Explain to students the difference between 'significant figures' and 'decimal places'.
- Instruct students to read the question paper properly and to underline the important points.
- Ask students to write the observations in a proper tabular form; tell students that the readings should be consistent with least count; readings should be written with proper unit, and significant figures after rounding off as per the instructions in Question paper.
- Teach students how to draw graphs with proper labeling of the axes, with unit, correct marking of origin without kink.
- Ask students to take a convenient, uniform and wide range scale so that the last plot covers atleast 60% of both the axes.
- Explain to students the concept of the line of best-fit and teach them how to calculate slope.

**MARKING SCHEME**

**Question 1.**

RECORD (R)

(i) Correct set of 5 values of *u* and *v*

*(v* decreases as *u* increases)

*v* recorded up to one decimal place

Unit of *v* (cm) given

(ii) Correct calculation of m upto two decimal places

GRAPH (G)

(i) Axes labelled correctly (interchange of axes and kink not allowed), Scale uniform and consistent, Origin may or may not be (0,0)

(ii) 5 correct plots (a blob is a misplot)

(iii) Line of bestfit (At least line passes very close to the four points or within 5 division or 1cm perpendicular distance on the both sides of the line drawn .

Thin and uniform(the line should be extended on both sides is at least for 4 plotted points)

DEDUCTION (D)

Correct calculation of slope using two distant points (more than 50% of the line drawn) at least one point being an unplotted one. Slope should be calculated up to three significant figures (proper rounding off is necessary).

QUALITY: (Q)

Candidate's f = Supervisor's f ± 2.5cm

**Question 2** **[7]**

This experiment determines the resistance per unit length of the given metallic wire. You are provided with:

(i) A 100 cm long and uniform wire **AB** stretched on a wooden board with a meter scale attached to it.

(ii) A battery eliminator **D** of emf 4V.

(iii) A resistance box **R.B.** of range 0 Ω to 10 Ω.

(iv) A plug key **K**

(v) A jockey **J**

(vi) A fresh dry cell **E** kept in a battery box / holder.

(vii) 0 – 3V voltmeter **V**

(viii) 0 – 1A ammeter **A**

(ix) A central zero galvanometer **G**

(x) Connecting wires

Set up a circuit as shown in ***Figure 2*** below:

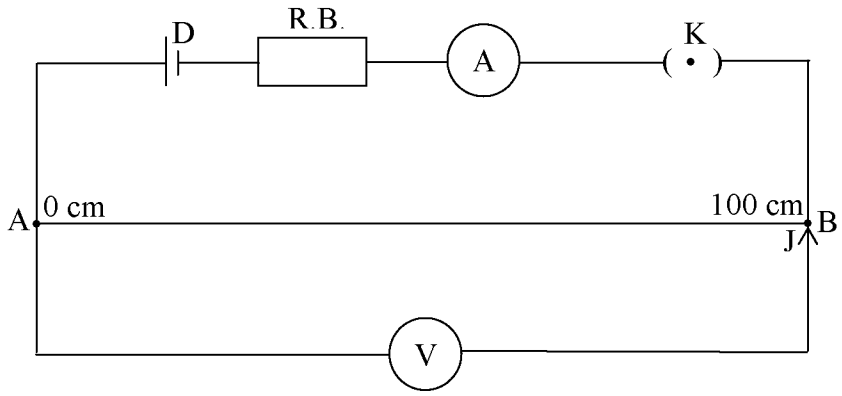



***Figure 2***

Determine and record the least count of the given ammeter and the voltmeter.

Place the jockey gently at the point B of the wire AB. Adjust the resistance R in the resistance box R.B. so that the reading of the voltmeter is maximum and the reading of the ammeter is within its scale. Record in your answer booklet, the readings R, V and I of the **resistance box**, **voltmeter** and **ammeter** respectively.

**Show these readings to the Visiting Examiner**.

By taking different values of resistance R in the resistance box, repeat the experiment to obtain **four more** values of V and I, with the jockey **always touching the point B** of the wire AB.

Tabulate all the **five** sets of values of R, V and I.

Plot a graph of V vs I, taking V on Y axis. Draw the **line of best fit**.

Find its slope S′ using:

$$S' = \frac{\text{change in V}}{\text{change in I}}$$

Calculate r = S′/100 and record its value up to **three significant figures**, with proper unit.

Comments of Examiners

Record:

- Some candidates wrote the least count of Ammeter and Voltmeter without unit or with wrong units.
- A few candidates wrote least count of Ammeter and Voltmeter which did not match with the supplied Ammeter and Voltmeter.
- In many cases, the readings were not consistent with the least counts of Ammeter and Voltmeter. ( e.g. L.C of A=0.05A , the reading recorded 0.9A instead of 0.90A)
- In some cases, proper trend of V and I was not observed with respect to resistance.
- Some candidates recorded absurd values of R, such as, 10.5, 23.5 ohms.

Graph:

- In the graph, the error were repeated, such as, interchange of axes; plotted points taken for slope.

*Suggestions for teachers*

- Make students see various types of ammeters and voltmeters with various ranges and tell them to write the least count and range before starting the experiment.
- Teach students how to record their observations in the observation table.
- For slope calculation, tell students to take two unplotted points on the best-fit line and separated from each other through a distance of more than 50% of the line dawn .

Calculation:

- Calculation of 'r' was not done correctly by many candidates and the value was not recorded up to three significant figures, with proper unit.

**MARKING SCHEME**

**Question 2.**

RECORD (R)

(i) L C of Ammeter with unit

LC of Voltmeter with unit

(ii) Correct sets of 4 values of V and I ($V$ and $I$ decrease as R increases)

Record of V and I must be consistent with least count (at least in 6 values)

GRAPH (G)

(i) Axes labelled correctly

(ii) 4 correct plots

A thin uniform line of best fit, covering extreme plots

DEDUCTION (D)

Correct calculation of S′

**Question 3** **[3]**

This experiment determines emf of the given cell.
Replace the voltmeter in the circuit of ***Figure 2*** with a dry cell **E** and a central zero galvanometer **G** and set up a new circuit as shown in ***Figure 3*** below:

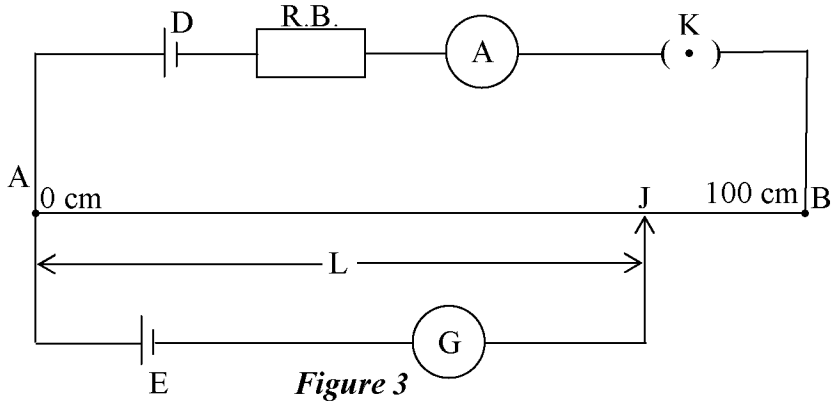



***Figure 3***

Close the key K. Take out 1Ω plug from the resistance box R.B. so that R = 1Ω. Press the jockey J gently on the wire AB such that the galvanometer shows **no deflection**. Read and record the length L= AJ. Also record the ammeter reading $I_0$.
**Show these readings to the Visiting Examiner**.

Determine E = $I_0$rL, correct up to **one decimal place**. **(Use the value of** r **found in Question 2.)**

Repeat the experiment for R = 2 Ω and calculate the new value of E.

Find $\mathbf{E_m}$, the mean value of E and record its value in your answer booklet, correct up to **two decimal places**, with proper unit.

Comments of Examiners

Some common errors made by cadidates are as follows:

- Many candidate did not write the value of Io in consistence with the least count of ammeter; at times, the unit was missing.
- The null point length 'L' was not expressed upto 1dp (e.g. written as 68 instead of 68.0) and without unit.
- In a few scripts the trend of R, Io and L was not observed.
- Some candidats calculated emf E incorrectly and did not express it with 1dp; in a few cases, the unit was missing.
- In some cases, in calculation of emf E, instead of the value 'r' from Question 2, the value of resistance 'R' was taken.
- Several candidates made mistakes in calculation of the average value of emf $E_m$. .
- In a few scripts, the average value of emf $E_m$ obtained was beyond the range.

*Suggestions for teachers*

- Give practice to students in writing related physical quantities like, length, current, voltage, diameter, etc. regularly with the respective least counts of the instruments - metre scale/ optical bench, ammeter, voltmeter, screw guage.
- Ask students to write the sample sets of observations, in consistence with the least count and with correct units.
- Instruction must be given to students to record their own observations from the experiment.
- Give practice in doing correct calculations and expressing the result with proper decimal point or significant figure, after proper rounding off and with unit, as per the instruction given in the Question paper.
- Instruct students to read the question paper thoroughly and to underline important instructions.

**MARKING SCHEME**

**Question 3.**

RECORD (R)

Two Values of L and $I_o$ recorded up to 1 decimal place with unit.

DEDUCTION (D)

Correct calculation of both the values of E and $E_m$

QUALITY (Q)

Candidate's value of $E_m$ = Supervisor's value of emf of dry cell $\pm 0.3$ volt

## GENERAL COMMENTS:

**(a) Topics found Difficult and Confusing by candidates in the question paper:**

- Removal of parallax.
- Finding L.C. of instruments and the correct way of presentation of observations, in consistence with L.C.
- Mentioning the correct unit of the physical quantity measured.
- Difference between decimal place and significant figure.
- Graph: marking of origin, concept of kink, taking a convenient uniform and wide range of scale.
- Drawing the best-fit line.
- Calculation of slope.

**(b) Suggestion for students:**

**Record:**

- Read the question carefully and follow the instructions, using only the formula given in the question paper for all the calculations.
- Ensure that all observations are consistent with L.C. of the measuring instrument and recorded in tabular form with unit. Note down the L.C. of the instruments used before starting the experiment.
- All values calculated should be rounded off to the d.p. asked for the in the question.
- The question paper should be read carefully in the reading time allotted.
- While doing any optical experiment with lens, always record the positions of object pin, image pin and the lens.

**Graph:**

- Scale should be uniform and convenient with axes properly labelled.
- Origin should begin from zero if the intercept is to be found. Co-ordinates of the origin must be given/ marked on graph paper.
- Plots should be small encircled dots, correct to the nearest division of the graph sheet.
- Line of best fit means the aggregate of all plotted points drawn symmetrically and extended on both sides of the last plotted points.
- Slope calculation should be from two widely separated, unplotted points lying on the best fit line.
- The scale of the graph should be such that at least 2/3 of the graph paper is used.

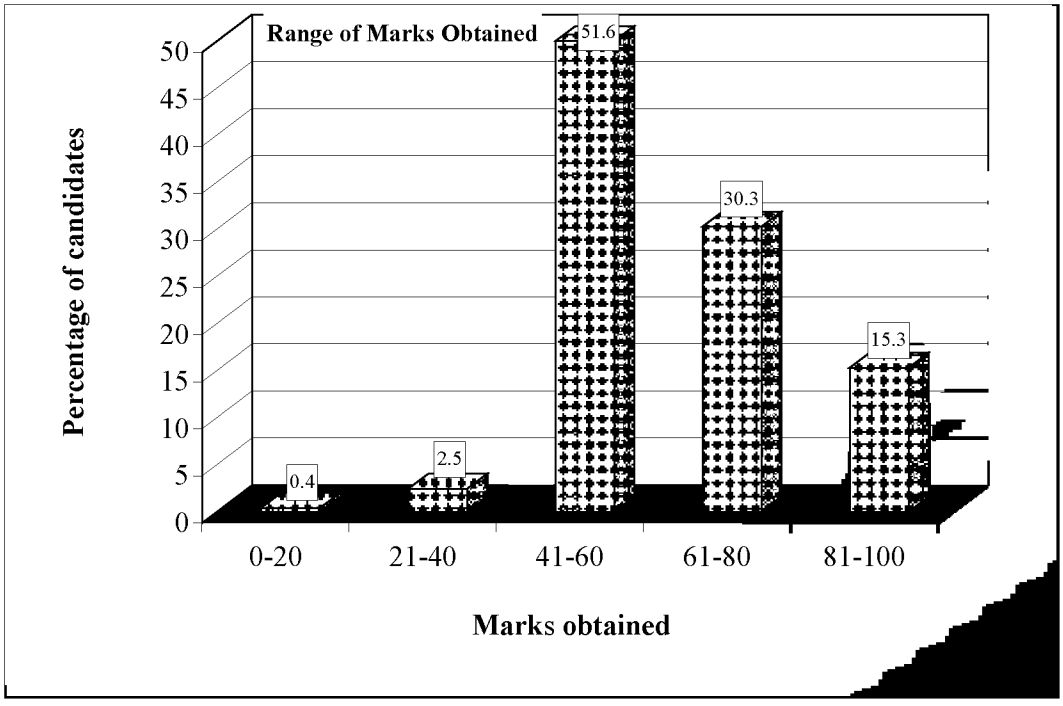
# CHEMISTRY

## A. STATISTICS AT A GLANCE

| | |
|---|---|
| Total number of students taking the examination | 32,711 |
| Highest marks obtained | 100 |
| Lowest marks obtained | 10 |
| Mean marks obtained | 62.43 |

### Percentage of candidates according to marks obtained

| | Mark Range | | | | |
|---|---|---|---|---|---|
| | ***0-20*** | ***21-40*** | ***41-60*** | ***61-80*** | ***81-100*** |
| Number of candidates | 135 | 802 | 16864 | 9907 | 5003 |
| Percentage of candidates | 0.4 | 2.5 | 51.6 | 30.3 | 15.3 |
| Cumulative Number | 135 | 937 | 17801 | 27708 | 32711 |
| Cumulative Percentage | 0.4 | 2.9 | 54.4 | 84.7 | 100 |



## B. ANALYSIS OF PERFORMANCE

## CHEMISTRY PAPER 1 (THEORY)

### PART I (20 Marks)

*Answer **all** questions.*

**Question 1**

(a) Fill in the blanks by choosing the appropriate word/words from those given in the brackets: **[5]**

(zero, first, second, increased, decreased, anode, cathode, active, inactive, potassium cyanide, internal, external, dependent, independent, red, benzoic acid, benzoin, common ion effect, salt hydrolysis, alkali, potassium hydroxide.)

(i) In a galvanic cell, electrons flow from_____ to _____ through the connecting wires.

(ii) Racemic mixtures are optically _____ because of _____ compensation.

(iii) Half life period of a _____ order reaction is _____ of the concentration of the reactant.

(iv) Benzaldehyde when treated with an alcoholic solution of_____ forms _____.

(v) Solubility of calcium oxalate is _____ in the presence of ammonium oxalate because of _____.

(b) Complete the following statements by selecting the **correct alternative** from the choices given: **[5]**

(i) The compound which is optically active is:

(1) 1-butanol

(2) 2-butanol

(3) 1-propanol

(4) 2-methyl-1-propanol

(ii) The salt which will not hydrolyse in aqueous solution is:

(1) Copper sulphate

(2) Sodium sulphate

(3) Potassium cyanide

(4) Sodium carbonate

(iii) Copper has the face centred cubic structure. The coordination number of each ion is:

(1) 4

(2) 12

(3) 14

(4) 8

(iv) For the reaction $2SO_2 + O_2 \square 2SO_3$, the unit of equilibrium constant is:

(1) L $mol^{-1}$

(2) J $mol^{-1}$

(3) mol $L^{-1}$

(4) $[L\ mol^{-1}]^2$

(v) The deficiency of vitamin D causes:

(1) Rickets

(2) Gout

(3) Scurvy

(4) Night blindness.

(c) Answer the following questions: **[5]**

(i) Two metallic elements A and B have the following standard oxidation potentials:

A = 0·40v B = – 0·80v. What would you expect if element A was added to an aqueous salt solution of element B? Give a reason for your answer.

(ii) Two moles of $NH_3$ are introduced into one litre flask in which it dissociates at high temperature as follows: $2NH_3(g) \square N_2(g) + 3H_2(g)$. Determine Kc, if at equilibrium 1 mole of $NH_3$ remains.

(iii) Give balanced equation for the preparation of salicylaldehyde from phenol.

(iv) If the half life period for a first order reaction is 69·3 seconds, what is the value of its rate constant?

(v) Define cryoscopic constant.

(d) Match the following: **[5]**

| | | | |
|---|---|---|---|
| (i) | Colligative property | (a) | Polysaccharide |
| (ii) | Nicol prism | (b) | Osmotic pressure |
| (iii) | Activation energy | (c) | Aldol condensation |
| (iv) | Starch | (d) | Polarimeter |
| (v) | Acetaldehyde | (e) | Arrhenius equation |

Comments of Examiners

(a) (i) Some candidates wrote 'cathode to anode'.
(ii) Many candidates wrote 'active' and 'internal' in place of the correct words.
(iii) Some candidates wrote 'dependent' in place of 'independent'.
(iv) Many candidates wrote 'potassium hydroxide' and 'Benzoic acid' instead of the correct words.
(v) A few candidates wrote 'increased' in place of 'decreased'.

(b) (i) '1-butanal' or 2-methyl propanol was chosen by some candidates.
(ii) 'Potassium cyanide' or 'sodium carbonate' was chosen in some cases.
(iii) Some candidates wrote '4' in place of the correct option.
(iv) Many candidates chose the options (3) and (4).
(v) A few candidates chose 'scurvy' or 'night blindness'.

(c) (i) Candidates were confused with oxidation and reduction potential. Some wrote 'B displaced A' and various other wrong answers and incorrect reasons.
(ii) Most of the candidates calculated $K_e$ for 2 moles of $NH_3$. Unit was wrong in many scripts.
(iii) Wrong reagents were used by many candidates. In some cases, the equation was unbalanced.
(iv) Several candidates used a wrong formula.
(v) Most of the candidates gave the mathematical expression and explained that.

(d) Most of the candidates were able to attempt this part correctly.

*Suggestions for teachers*

- The concept of production of current and flow of electrons in a galvanic cell should be explained clearly.
- The idea of 'internal 'and 'external' compensation should be taught with correct examples.
- Reactions should be practiced in class with correct names of the reactants and products.
- 'Common ion effect' should be taught in class with equations showing the shift of equilibrium.
- The concept of chiral carbon atom should be made clear. Isomerism should the practised with examples.
- The units of $K_e$ should be derived in class taking examples.
- The use of electrochemical series should be taught in details giving its importance in determining the properties and nature of the elements.
- Reactions should be practiced with correct reactions and products in the balanced form.

**MARKING SCHEME**

**Question 1.**

(a) (i) anode, cathode
(ii) inactive, external
(iii) first \ $1^{st}$, independent or zero, dependent or second dependent
(iv) potassium cyanide, benzion/ formula
(v) decreased, common ion effect

(b) (i) 2 butanol / formula
(ii) (1) Sodium sulphate / formula

(iii) (2) 12 /twelve

(iv) (1) L mol-1

(v) (1) Rickets

Answer the following questions:

(c) (i) A displaces B from its salt solution. Standard reduction potential of A is less than standard reduction potential of B or any other explanation.

(ii) $2\,NH_3 \rightleftharpoons N_2 + 3H_2$

Initial 2 0 0

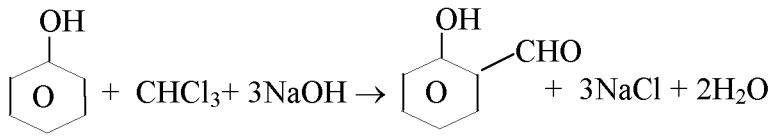
At eqn. 1 $\frac{1}{2}$ $\frac{3}{2}$

$[NH_3] = \frac{1}{1}$ moles per litre $[N_2] = \frac{\frac{1}{2}}{1}$ moles per litre

$[H_2] = \frac{\frac{3}{2}}{1}$ moles per litre

$$K_c = \frac{[N_2][H_2]^3}{[NH_3]^2} = \frac{\left(\frac{1}{2}\right)\left(\frac{3}{2}\right)^3 \text{ mole}^4/\text{litre}^4}{(1)^2 \text{ mole}^2/\text{litre}^2}$$

$$= \frac{27}{16}\text{mole}^2/\text{litre}^2 = 1{\cdot}687\ (\text{mol}/\text{lit})^2$$

(iii) 

(OR with KOH)

(iv) $K = \frac{0.693}{693} = 0.01\,\text{sec}^{-1}$

(v) Depression of freezing point when the molality of the solution is unity / any correct definition.

(d) Match the following:

(i) (b) Osmotic pressure

(ii) (d) Polarimeter

(iii) (e) Arrhenius equation

(iv) (a) Polysaccharide

(v) (c) Aldol condensation

# PART II (50 Marks)

*Answer* **six** *questions choosing* **two** *from* ***Section A,*** **two** *from* ***Section B*** *and* **two** *from* ***Section C.***

## SECTION A

*Answer any* **two** *questions.*

**Question 2**

(a) (i) Ethylene glycol is used as an antifreeze agent. Calculate the amount of ethylene glycol to be added to 4 kg of water to prevent it from freezing at -6°C. ($K_f$ for $H_2O$ = 1·85 K $mole^{-1}$ kg) **[3]**

(ii) The freezing point of a solution containing 0·3gms of acetic acid in 30gms of benzene is lowered by 0·45K. Calculate the Van't Hoff factor. **[2]**
(at. wt. of C = 12, H = 1, O = 16, $K_f$ for benzene = 5·12K kg $mole^{-1}$).

(b) Name the law or principle confirmed by the following observations: **[2]**

(i) When water is added to 0·01M aqueous solution of acetic acid the number of hydrogen ions increase.

(ii) When 96500 coulombs of electricity is passed through acidulated water, 5·6 litres of oxygen at s.t.p. is liberated at the anode.

(c) Arrange Ag, Cr and Hg metals in the increasing order of reducing power. Given: **[1]**

$$E^{o}_{Ag^{+}/Ag} = +0 \cdot 80V$$

$$E^{o}_{cr^{+3}/cr} = -0 \cdot 74V$$

$$E^{o}_{Hg^{+2}/Hg} = +0 \cdot 79V$$

(d) In a first order reaction, 10% of the reactant is consumed in 25 minutes. Calculate: **[2]**

(i) The half life of the reaction.

(ii) The time required for completing 17% of the reaction.

Comments of Examiners

(a) (i) Incorrect formula and substitution was done by many candidates. Some candidates were unable to calculate the molecular weight of glycol.

(ii) Many candidates made wrong calculations due to wrong substitution.

(b) (i) Many candidates gave the answer as, 'dilution law' instead of Ostwald dilution Law.

(ii) Some candidates wrote only 'Faraday's law' but did not mention the '2nd law'.

*Suggestions for teachers*

- More practice should be given in numericals along with correct substitution.
- Important laws and their applications should be taught in class with correct examples.
- Elechochemical series should be taught with reference to the properties of the elements.

(c) Several candidates were confused between 'reduction' and 'reduction potential'. Many candidates arranged the metals in the reverse direction.

(d) (i) Some candidates made calculation errors in this part of the question.

(ii) Incorrect formula was taken by some candidates.

**MARKING SCHEME**

**Question 2.**

(a) (i) $\Delta T_f = K_f \times \frac{w \times 1000}{m \times W}$

$w = \frac{\Delta T_f \times m \times W}{K_f \times 1000}$ [Mol. wt. of $\begin{matrix} CH_2OH \\ | \\ CH_2OH \end{matrix}$ $= 62$ ]

$= \frac{6 \times 62 \times 4 \times 1000}{1 \cdot 85 \times 1000}$

$= 804 \cdot 32$ g

(ii) $\Delta T_f = iK_f \times \frac{w \times 1000}{m \times W}$ – or $\Delta T_f = ik_f x\ m$

$i = \frac{\Delta T_f \times m \times W}{K_f \times w \times 1000}$

$= \frac{0 \cdot 45 \times 60 \times 30}{5 \cdot 12 \times 0 \cdot 3 \times 1000}$

$= 0 \cdot 527$

(b) (i) Ostwald's dilution law

(ii) Faraday's second law

(c) Ag, Hg, Cr

(d) $K = \frac{2 \cdot 303}{t} \log\left(\frac{a}{a-x}\right)$

$K = \frac{2 \cdot 303}{25} \log\left(\frac{100}{90}\right)$

$= 4.215 \times 10^{-3}\ min^{-1}$

Half life ($t_{½}$) $= \frac{0.693}{K} = \frac{0.693}{4.215 \times 10^{-3}} = 164.41$ minutes

$t = \frac{2 \cdot 303}{k} \log\left(\frac{a}{a-x}\right)$

$= \frac{2 \cdot 303}{4.215 \times 10^{-3}} \log\left(\frac{100}{83}\right) = 44.21$ minutes

**Question 3**

(a) Explain giving reasons why (Give equations in support of your answer):

(i) A solution of $NH_4Cl$ and $NH_4OH$ acts as a buffer. **[2]**

(ii) Cu is precipitated as CuS while Zn is not precipitated when $H_2S$ is passed through an acidic solution of $Cu(NO_3)_2$ and $Zn(NO_3)_2$ respectively. **[2]**

(b) (i) What is Schottky defect in a solid? **[1]**

(ii) A bcc element (atomic mass 65) has a cell edge of 420 pm. Calculate its density in $gms/cm^3$. **[3]**

(c) The rate of the reaction $H_2+I_2 \rightleftharpoons 2HI$ is given by: **[2]**

$$\text{rate} = 1{\cdot}7 \times 10^{-19}[H_2][I_2] \text{ at } 25^oC.$$

The rate of decomposition of gaseous HI to $H_2$ and $I_2$ is given by:

$$\text{rate} = 2{\cdot}4 \times 10^{-21}[HI]^2 \text{ at } 25^oC.$$

Calculate the equilibrium constant for the formation of HI from $H_2$ and $I_2$ at $25^oC$.

Comments of Examiners

(a) (i) The definition of Buffer solution was given by many candidates instead of explaining 'Buffer action'.

(ii) Many candidates did not mention the low $K_{sp}$ for CuS and high $K_{sp}$ for ZnS. Some candidates did not mention the suppression of concentration of Sulphide ion in acidic medium.

(b) (i) Many candidates did not mention the missing of both anion and cation in ionic crystals. Some candidates confused it with Frenkel defect.

(ii) Several candidates did not attempt this numerical, while some others did the problem with incorrect formula. In some cases, the value of 'Z' was taken wrongly.

(c) Value of $K_c$ was taken as $rate_1$ / $rate_2$, giving wrong answers.

*Suggestions for teachers*

- The mechanism of buffer action should be explained with reference to the addition of acid, alkali and dilution. Explanation should be given taking correct equation.
- The use of solubility product in salt analysis should be taught with correct examples. Stress should be laid on key words.
- Defects in crystals should be explained diagrammatically.
- Adequate practice should be given in numericals.

**MARKING SCHEME**

**Question 3.**

(a) (i) $NH_4Cl \rightarrow NH_4^+$ (High) + $Cl^-$ (High)

$NH_4OH \rightleftharpoons NH_4^+$ (low) + $OH^-$ (low)

Addition of HCl, $HCl \rightarrow H^+ + Cl^-$

$H^+$ (from HCl) + $OH^-$ (from $NH_4OH$) $\rightarrow H_2O$

$OH^-$ ions are removed from the solution.

In the absence of $OH^-$, $NH_4OH$, dissociates more in giving more $OH^-$ ions. These $OH^-$ ions combines with $H^+$ to form water. Process keeps on happening till all $H^+$ ions are consumed and pH remains constant.

Addition of NaOH:

$NaOH \rightarrow Na^+ + OH^-$

$NH_4^+$ (from $NH_4Cl$) + $OH^-$ (from NaOH) $\rightarrow NH_4OH$

$NH_4OH$ being a weak base dissociates partially and whatever $OH^-$ are released are not sufficient to increase the pH. OR any other explanation.

(ii) $HCl \rightarrow H^+ + Cl^-$ . $H_2S \rightarrow 2H^+ + S^{2-}$

In the presence of HCl, the dissociation of $H_2S$ is suppressed due to common $H^+$ ion and less $S^{2-}$ ions are released in solution.

The $K_{sp}$ of CuS is low and hence $[Cu^{+2}][S^2] > K_{sp}$.

ZnS has a high value of $K_{sp}$ and hence, does not get precipitated with less $S^{2-}$ ions.

(b) (i) Schottky defect – pair of holes exist in the crystal lattice due to one positive ion and one negative ion being absent from the crystal lattice. OR any other definition

(ii) $$\text{Density (P)} = \frac{Z \times M}{N_A \times a^3}$$

$$= \frac{2 \times 65}{6.023 \times 10^{23} \times \left(420 \times 10^{-10}\right)^3}$$

$$= \frac{2 \times 65}{6.023 \times 10^{23} \times 7 \cdot 4 \times 10^{-23}}$$

$$= 2.91 \text{ gms/cm}^3$$

(c) $H_2 + I_2 \rightarrow 2HI$

$K_1 = 1 \cdot 7 \times 10^{-18}$

$K_2 = 2 \cdot 4 \times 10^{-21}$

$$K_c = \frac{K_1}{K_2} = \frac{1 \cdot 7 \times 10^{-18}}{2 \cdot 4 \times 10^{-21}} = 708 \times 10^2$$

**Question 4**

(a) (i) Give Lewis' definition for acids and bases. **[1]**

(ii) The solubility of $Ag_2CrO_4$ at 25°C is $8 \cdot 0 \times 10^{-5}$ moles/litre. Calculate its solubility product. **[1]**

(b) (i) Define molar conductance of a solution. State its unit. How is it related to the specific conductance of a solution? **[2]**

(ii) Calculate the value of $E_{cell}$ at 298K for the following cell: **[3]**

$Al / Al^{3+}$ (0·01M) // $Sn^{2+}$ (0·015M) / Sn

$E^{o}_{Al^{3+}/Al} = -1{\cdot}66$ volt and $E^{o}_{Sn^{2+}/Sn} = -0{\cdot}14$ volt

(c) (i) Calculate the degree of hydrolysis of 0·2(M) sodium acetate solution. **[1]**
(Hydrolysis constant of sodium acetate = $5{\cdot}6\times10^{-10}$ and ionic product of $H_2O = 10^{-14}$ at 25°C)

(ii) Explain why high pressure is used in the manufacture of ammonia by Haber's process. State the law or principle used. **[2]**

Comments of Examiners

(a) (i) Several candidates wrote 'electron acceptor' instead of stating 'electron pair acceptor'.
(ii) Wrong formula was used by some candidates.
(b) (i) Many candidates explained the formula of molar conductance in place of defining it. The unit was given wrongly in many scripts.
(ii) Several candidates calculated $E^{0}_{cell}$ correctly but the calculation of $E_{cell}$ was wrong. Some got the same values for both since they rounded up the value instead of calculating it up to the third place of decimal. Many candidates did wrong substitution in the 'Nernst' equation.
(c) (i) Incorrect formula was used by many candidates.
(ii) The explanation given by many candidates was not clear. In some cases, Le Chatelier's principle was only mentioned but not stated.

*Suggestions for teachers:*

- Lewis definition should be correctly taught with correct examples.
- Derivation of the $K_{sp}$ values of different salts should be done in class.
- 'Nernst equation' should be taught with correct examples and correct substitution.
- Numericals should be practised with correct formula of substitution.
- Le Chaterliers principle should be explained with reference to the equations mentioned in the scope of syllabus.

**MARKING SCHEME**

**Question 4.**

(a) (i) Lewis acid is an electron pair acceptor.

Lewis base is an electron pair donor.

(ii) $Ag_2CrO_4 \rightleftharpoons 2Ag^{+} + CrO_4^{2-=}$

S 2S S

$K_{sp} = [Ag^{+}]^2[CrO_4^{2-}]$

$= (2S)^2 (S) = 4S^3$

$K_{sp} = 4 \times (8\times10^{-5})^3 = 2{\cdot}048\times10^{-12}$

(b) (i) Molar conductance is defined as the conducting power of all the ions produced by dissolving one gm mole of an electrolyte in solution/ any other definition

Its unit is $ohm^{-1}\ cm^2\ mole^{-1}$ or $ohm^{-1}\ m^2\ mole^{-1}$

$$\wedge_m = \frac{1000}{c} \times \wedge_{sp}$$

c = conc. in molarity

(ii) $E^o_{cell} = \left(E^o_{redn}\right)cathode - \left(E^o_{redn}\right)anode$

= (-0·14) – (1·66) volt

= 1·52 volt

$$E_{cell} = E^o_{cell} - \frac{0\cdot05912}{n}\log\frac{[products]}{[Reactants]}$$

$Al - 3e \rightarrow Al^{3+}$ — x (2)

$Sn^{2+} + 2e \rightarrow Sn$ — x (3)

$2Al - 6e \rightarrow 2Al^{3+}$

$3Sn^{2+} + 6e \rightarrow 3\ Sn$

$2Al + 3Sn^{2+} \rightarrow 2Al^{3+} + 3\ Sn$

$$E_{cell} = 1\cdot52 - \frac{0\cdot05912}{6}\log\frac{[Al^{3+}]^2[Sn]^3}{[Al]^2[Sn^{2+}]^3}\ volt$$

$$= 1\cdot52 - \frac{0\cdot05912}{6}\log\frac{(0\cdot01)^2(1)^3}{(1)^2(0015)^3}\ volt$$

= (1·52 - 0·0145) volt = 1·5055 volt

(c) (i) $$h = \sqrt{\frac{kw}{ka.c}} = \sqrt{\frac{Kh}{c}}$$

$$= \sqrt{\frac{5\cdot6\times10^{-10}}{0\cdot2}} = 5\cdot29\times10^{-5}$$

(ii) Formation of ammonia takes place with decrease in volume. Hence, the reaction is favoured with high pressure.

Le Chatelier's Principle – when a system at equilibrium is subjected to a stress, the equilibrium shifts in that direction to nullify the effect of the stress OR any other explanation.

## SECTION B

*Answer any* **two** *questions.*

**Question 5**

(a) Give the IUPAC names of the following coordination compounds: **[2]**

(i) $K_2[Zn(OH)_4]$

(ii) $[Co(NH_3)_5(CO_3)]Cl$

(b) For the complex ion $[Fe(CN)_6]^{3-}$ state:

(i) The geometry of the ion. **[1]**

(ii) The magnetic property of the ion.

(c) What type of structural isomers are $[Co(NH_3)_5Br]SO_4$ and $[Co(NH_3)_5SO_4]Br$ ? Give a chemical test to distinguish the isomers. **[2]**

Comments of Examiners

(a) (i) Several candidates wrote 'hydroxy' in place of 'hydroxo'. The valency of Zinc was not given correctly by a number of candidates.

(ii) Several candidates made mistakes in writing the correct name. 'Carbonate' was written instead of 'Carbonato'. The oxidation state of cobalt was given incorrectly by some candidates.

(b) (i) Many candidates wrote 'tetrahedral' or 'bipyramidal'.

(ii) Some candidates gave the answer as 'diamagnetic'.

(c) Many candidates wrote 'linkage isomerism'. Chemical test was not given but the ionisation of the two compounds was shown.

*Suggestions for teachers*

- Many examples of co-ordination complexes should be practised with correct spelling and correct oxidation state.
- Geometry of co-ordination compounds and ions should be explained by drawing the correct structure.
- The relation of the magnetic property with number of unpaired electrons should be explained by writing the electronic configuration in box diagrams.

**MARKING SCHEME**

**Question 5.**

(a) (i) potassiumtetrahydroxo zincate(II)

(ii) pentaamminecarbonatocobalt(III) chloride

(b) (i) Octahedral, Paramagnetic

(ii) Ionisation isomerism.

$[Co(NH_3)_5Br]SO_4$ gives white ppt with $BaCl_2$ solution, but $[Co(NH_3)_5 SO_4]Br$ does not give white ppt. with $BaCl_2$ solution OR any other test.

(c) Type of structural isomers and correct chemical test.

**Question 6**

(a) For the molecule $XeF_2$ : **[2]**

(i) Draw the structure of the molecule indicating the lone pairs.

(ii) State the hybridisation of the central atom.

(iii) State the geometry of the molecule.

(b) Give balanced chemical equations for the following reactions: **[3]**

(i) Fluorine treated with dilute sodium hydroxide solution.

(ii) Hydrogen sulphide treated with concentrated sulphuric acid.

(iii) Potassium iodide treated with acidified potassium permanganate solution.

Comments of Examiners

(a) (i) Proper orientation of the orbitals around the Xenon atom was not shown by many candidates. Lone pair of electrons was missing in some cases.

(ii) The hybridisation was given incorrectly by many candidates.

(iii) Some candidates gave the answer as 'T' shaped. The word 'linear' was missing in many answers.

(b) In this part, many candidates wrote unbalanced and incorrect equations.

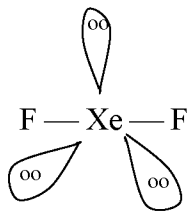
*Suggestions for teachers*

- Structures of the compounds should be explained by drawing and showing the lone pair of electrons.
- The correct hybridisation should be taught by writing the electronic configuration in box diagrams.
- The geometry of the molecules should be explained on the basis of hybridisation.
- Students should be given practice in writing correct balanced equations.

**MARKING SCHEME**

**Question 6.**

(a)




$sp^3d$, linear.

(b) (i) $2F_2 + 2NaOH \rightarrow F_2O + 2NaF + H_2O$

(ii) $H_2S + H_2SO_4 \rightarrow 2\ H_2O + SO_2 + S$

(iii) $2KMnO_4 + 8H_2SO_4 + 10\ KI \rightarrow 6K_2SO_4 + 2MnSO_4 + 8H_2O + 5I_2$

**Question 7**

(a) In the extraction of zinc from zinc blende: **[2]**

(i) Give an equation to show how zinc oxide is converted to zinc.

(ii) How is impure zinc finally electro-refined?

(b) Explain why: **[3]**

(i) Transition elements form coloured compounds.

(ii) Interhalogen compounds are more reactive than their constituent elements.

(iii) $Cu^{+}$ is diamagnetic but $Cu^{2+}$ is paramagnetic. (Z = 29)

Comments of Examiners

(a) (i) Some candidates wrote '$CO_2$' in place of 'CO'.
(ii) The electrolyte was given wrongly by many candidates.
(b) (i) The presence of unpaired d-electrons was not mentioned by many candidates.
(ii) The polar nature of the x-y bonds or less overlapping of the orbitals was not mentioned by several candidates.
(iii) The diamagnetic nature of $Cu^{+}$ was not mentioned by several candidates.

*Suggestions for teachers*

- Electrorefining should be taught with correct electrodes and electrolytes.
- The properties of transition metals should be explained with reference to the d-electrons.
- Magnetic nature should be explained in terms of electronic configuration.

**MARKING SCHEME**

**Question 7.**

(a) (i) $ZnO + C \xrightarrow{1673K} Zn + CO$

(ii) Anode – Impure Zn block

Cathode – Thin sheet of pure Zinc

Electrolyte – $ZnSO_4$ solution containing a little dilute $H_2SO_4$

Cathode – $Zn^{2+} + 2e \rightarrow Zn$

Anode – $Zn - 2e \rightarrow Zn^{+2}$

(b) (i) Presence of unpaired electrons in d orbitals/ d-d transition

Electrons absorb radiations of one colour from white light for excitation from one energy level to another within the same d subshell. Hence, transmitted light appears coloured. Or any correct explanation

(ii) x – y bonds are weaker than x – x or y – y bonds.

Polar nature of x-y bond.

Less overlapping of orbitals in x – y bond.

(iii) $Cu^{+1}$ has no unpaired electrons, hence diamagnetic

$Cu^{+2}$ has unpaired electrons, hence paramagnetic

## SECTION C

*Answer any* **two** *questions.*

**Question 8**

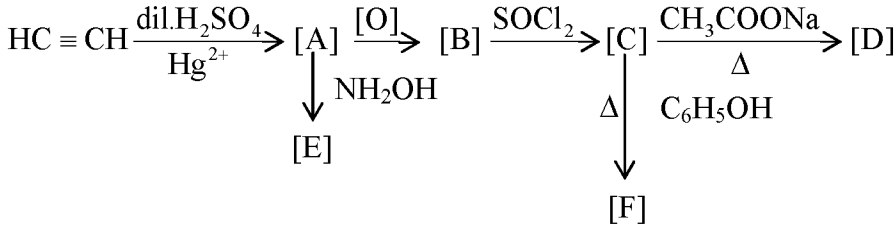
(a) How can the following conversions be brought about:

(i) Nitro benzene to benzene diazoniumchloride. **[3]**

(ii) Propanoic acid to ethylamine. **[2]**

(iii) Benzoic acid to benzaldehyde. **[2]**

(b) Identify the compounds A, B, C, D, E and F: **[3]**




Comments of Examiners

(a) (i) Many candidates used $LiAlH_4$ or $H_2$ /Ni for the reduction of nitrobenzene to aniline. In some cases, reagents and temperature were not mentioned for diazotization.

(ii) Several candidates started the conversion from ethanoic acid in place of propanoic acid. Conversion steps were incorrect in many cases.

(iii) Most of the candidates reduced benzoic acid to benzaldehyde directly by metal / acid.

(b) [E] was identified as methylamine and [F] as ethylacetate by many candidates.

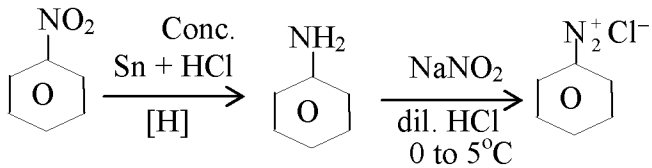
*Suggestions for teachers*

- Reduction of nitrobenzene should be taught with correct reducing agent. Diazotization should be taught with correct reagents and temperature ($0^oC$ – $5^0C$).
- Aliphatic and aromatic conversions should be practiced in class with correct reagents.
- Reactions should be practiced in class with correct reactants and products.

**MARKING SCHEME**

**Question 8.**

(a) (i)




(ii) $CH_3CH_2COOH \xrightarrow[\Delta]{NH_3} CH_3CH_2CONH_2 \xrightarrow{Br_2 / KOH} C_2H_5NH_2$

(iii) $C_6H_5COOH \xrightarrow[PCl_3/PCl_5^-]{SOCl_2} C_6H_5COCl \xrightarrow[BaSO_4]{H_2/Pd} C_6H_5CHO$

(b) [A] → Acetaldehyde or $CH_3CHO$

[B] → Acetic acid or $CH_3COOH$

[C] → Acetyl chloride or $CH_3COCl$

[D] → Acetic anhydride or $(CH_3CO)_2O$

[E] → Acetaldoxime or $CH_3CH=NOH$

[F] → Phenyl acetate or $C_6H_5OCOCH_3$

OR any common name

**Question 9**

(a) Write balanced chemical equations for the following reactions and name the reactions: **[3]**

(i) Acetamide is heated with bromine and sodium hydroxide solution.

(ii) Benzaldehyde is treated with 50% sodium hydroxide solution.

(b) Give one chemical test to distinguish between the following pairs of compounds: **[3]**

(i) Acetone and phenol.

(ii) Formic acid and Acetic acid.

(c) (i) Name the type of isomerism exhibited by the following pairs of compounds: **[2]**

(1) $(C_2H_5)_2NH$ and $CH_3$- NH-$C_3H_7$

(2) 1-butanol and 2 methyl-1-propanol

(ii) Name the type of isomerism that the compound with molecular formula $C_3H_6O_2$ exhibits. Represent the isomers. **[2]**

Comments of Examiners

(a) (i) Only the main product was written by many candidates while the by products were missing. In some cases, the equation was not balanced.

(ii) The name of the reaction was given incorrectly by a number of candidates.

(b) (i) Many candidates gave ferric chloride test for a acetone. Some only mentioned the name of the test without giving the observation.

(ii) Incorrect tests were given by many candidates.

(c) (i) Some candidates gave the answer as 'position isomers'.

(ii) Most of the candidates were able to attempt this part correctly.

*Suggestions for teachers*

- Name equations should be taught in balanced form. Reactants and products should be correctly taught.
- Identification of organic compounds should be done in class with correct tests.
- Isomerism should be explained by drawing the structural formulae of the isomers.

**MARKING SCHEME**

**Question 9.**

(a) (i)

Hoffmann's bromanide or Hofmann's degradation reaction.

(ii) $2C_6H_5 - CHO \xrightarrow{\text{dil. NaOH}} C_6H_5CH_2OH + C_6H_5COONa$

Cannizzaro's reaction

(b)(i) Acetone when treated with $I_2$ + NaOH gives yellow ppt. of $CHI_3$ but phenol with $I_2$ + NaOH gives no such ppt.

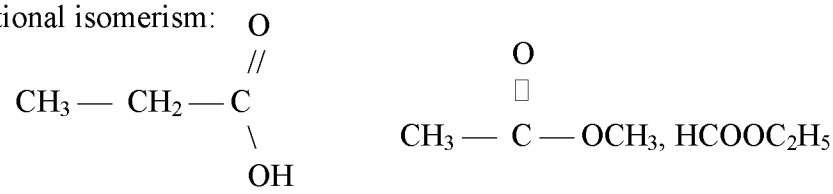
Phenol with neutral $FeCl_3$ solution gives violet colouration but Acetone gives no such observation (Or any correct test)

(ii) Formic acid gives white or grey ppt. with $HgCl_2$ solution but Acetic acid does not give such observation (Or any correct test)b

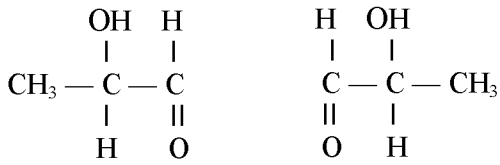
(c) (i) (1) Metamerism

(2) Chain isomerism

(ii) Functional isomerism:



Optical Isomerism:



**Question 10**

(a) Write balanced chemical equations for the following reactions: **[4]**

(i) Oxalic acid is treated with acidified potassium permanganate solution.

(ii) Benzoic acid is treated with a mixture of concentrated nitric acid and concentrated sulphuric acid.

(iii) Methyl magnesium iodide is treated with carbon dioxide and the product hydrolysed in acidic medium.

(iv) Ethylacetate is treated with ammonia.

(b) An organic compound [A] having molecular formula $C_2H_7N$ on treatment with nitrous acid gives a compound [B] having molecular formula $C_2H_6O$. [B] on treatment with an organic compound [C] gives a carboxylic acid [D] and a sweet smelling compound [E]. Oxidation of [B] with acidified potassium dichromate also gives [D]. **[4]**

(i) Identify [A], [B], [C], [D] and [E].

(ii) Write balanced chemical equation of [D] with chlorine in the presence of red phosphorus and name the reaction.

(c) Acetamide is amphoteric in nature. Give two equations to support this statement. **[2]**

Comments of Examiners

(a) (i) A number of candidates wrote incorrect equations.

(ii) Ortho - para benzoic acid was written as the product by several candidates.

(iii) Some candidates wrote wrong products in this part.

(iv) This part was generally done correctly by candidates.

(b) (i) Identification of [C] was incorrectly done by several candidates.

(ii) A number of candidates wrote unbalanced equations.

(c) Many candidates did not attempt this part of the question. Some gave the reaction with NaOH to show the acidic nature of acetamide.

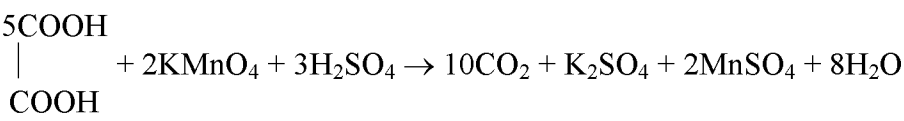
*Suggestions for teachers*

- Equation should be studied by writing the reactants and products with balanced form.
- Organic problems of identification should be given in class.
- The amphoteric nature of acetamide should be taught correctly with proper reactants and products.

**MARKING SCHEME**

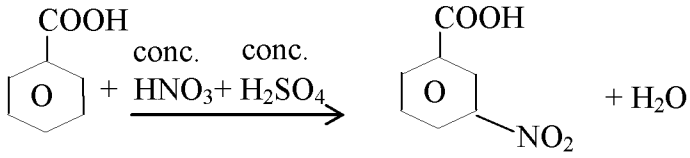
**Question 10.**

(a) (i)



$$\begin{matrix}5COOH\\|\\COOH\end{matrix} + 2KMnO_4 + 3H_2SO_4 \rightarrow 10CO_2 + K_2SO_4 + 2MnSO_4 + 8H_2O$$

(ii)




(iii) $CH_3MgI + O = C = O \rightarrow [IMgO - \overset{CH_3}{\underset{C}{|}} = O] \rightarrow CH_3COOH + MgI(OH)$

(iv) $CH_3COOC_2H_5 + NH_3 \rightarrow CH_3CONH_2 + C_2H_5OH$

(b) (i) [A] → $CH_3CH_2NH_2$ or Ethylamine

[B] → $CH_3CH_2OH$ or Ethanol

[C] → $(CH_3CO)_2O$ or Ethanoic anhydride

[D] → $CH_3COOH$ or Ethanoic acid.

[E] → $CH_3COOC_2H_5$ or Ethyl ethanoate.

(ii) $CH_3COOH + Cl_2 \xrightarrow{Red\ P} CH_2ClCOOH + HCl$

Hell Volhard Zelinsky reaction or

HVZ reaction.

(c) Basic : $CH_3CONH_2 + HCl \rightarrow CH_3CONH_2.HCl$ or $[CH_3CONH_3]^+Cl^-$

Acidic: $CH_3CONH_2 + HgO \rightarrow (CH_3CONH)_2Hg + H_2O$

**GENERAL COMMENTS:**

**(a) Topics found difficult by candidates in the Question Paper:**

- Co-ordination compounds.
- Definitions of different terms and units.
- Isomerism.
- Buffer solution
- Electrochemical cells.
- Geometry and hybridization.
- Inorganic equations.

**(b) Concepts between which candidates got confused:**

- Hydrolysis of salts.
- Catalysts in organic reactions.
- Conversion in Organic Chemistry.
- Numericals in Colligative properties with correct units.

**(c) Suggestions for students:**

- Practice organic conversions.
- Study chemical tests to distinguish between organic compounds.
- Study isomerism by drawing the structural formulae of the isomers.
- Avoid selective studies.
- Practice equations, both inorganic and organic with balanced form and correct condition.
- Practice numericals from all chapters with correct formulae and units.

# CHEMISTRY PAPER 2 (PRACTICAL)

**Question 1** **[8]**

You are provided with two solutions as follows:

- **C-10** is a solution prepared by dissolving 1·85 gms of potassium manganate (VII) $KMnO_4$ per litre.
- **C-11** is a solution prepared by dissolving 22 gms of hydrated ammonium iron (II) sulphate crystals, $(NH_4)_2SO_4.FeSO_4.xH_2O$ per litre.

PROCEDURE:

Rinse and fill the burette with the given solution **C-10** of potassium manganate (VII). Pipette out 20 ml or 25 ml of the solution **C-11** of ammonium iron(II) sulphate solution into a clean conical flask. To this, add 20 ml of **C-12** solution of dilute $H_2SO_4$ specially provided for titration.

Titrate the solution by running solution **C-10** from the burette till one drop of this solution gives a permanent light pink colour to the solution **C-11** in the conical flask. Ensure that the pink colour obtained does not disappear on shaking the contents of the conical flask.

Repeat the above procedure of the titration to get at least two concordant readings.

Tabulate your readings.

State:

(a) The capacity of the pipette used.

(b) The titre value you intend to use in your calculations.

**Show the titre value to the Visiting Examiner.**

The equations for the above reactions are as follows:

$2KMnO_4 + 8H_2SO_4 + 10(NH_4)_2SO_4.FeSO_4.xH_2O \rightarrow K_2SO_4 + 2MnSO_4 + 10(NH_4)_2SO_4 + 5Fe_2(SO_4)_3 + 8H_2O + 10\,x\,H_2O$

OR

$2MnO_4^- + 10\,Fe^{2+} + 16H^+ \rightarrow 2Mn^{2+} + 10Fe^{3+} + 8H_2O$

Relative atomic masses:

K = 39 Fe = 56 S = 32 N = 14 H = 1 Mn = 55 O = 16

**Calculate the following**:

(i) The **molarity** of potassium manganate(VII) solution **C-10**.

(ii) The **molarity** of the hydrated ammonium iron(II) sulphate solution **C-11**.

(iii) The **molecular mass** of hydrated ammonium iron (II) sulphate, deduced from the experimental data.

(iv) The **numerical value** of *x*, i.e. the number of molecule of water of crystallization in $(NH_4)_2 SO_4.FeSO_4.x H_2O$

Comments of Examiners

A number of candidates did not seem to be aware of the significance of tabulating the readings. They did not write initial and final readings. Many just gave one titre value. These candidates had no concept of concordant readings. Some used average value with a difference between two readings of more than 0.2. Several candidates did not read the question paper carefully and used wrong solutions in the burette and pipette. Overwriting in the titre value was also observed.

- Many candidates used wrong formula to calculate molarity of hydrated ferrous ammonium sulphate i.e. gms per litre/molecular weight instead of $M_1 V_1 / M_2 V_2 = n_1/n_2 = 1/5$.
- Some candidates rounded off the value of molarity in questions (i) and (ii) and used only two places after the decimal instead of four.
- Molecular weight of hydrated ferrous ammonium sulphate was incorrectly calculated by many candidates as the question was not read carefully i.e. theoretical value of x was substituted and molecular weight determined.
- In some cases, the numerical value of (x) water of crystallization was reported in fraction and it was not rounded off to the closest whole number.

*Suggestions for teachers*

- Insist that students tabulate the titre value correctly. Teach them the tabular form and explain the significance of each column. Insist on one trial run and two concordant readings. Tell them the average should not be taken and overwriting in the readings should be strictly avoided.
- Give sufficient practice in calculating molarity, percentage purity, water of crystallization for all oxidation/-reduction titration in the syllabus. Students must do the experiments throughout the year under the supervision of the teacher.
- Tell students that it is absolutely imperative to write upto at least four decimal places in the calculation of molarities, and at least two decimal places for molecular weight and percentage purity. They must also round off the value of water of crystallization to the nearest whole number.

- Ask students to read the question paper carefully, refer to the formula of the substances and atomic weights as given in the question paper. They must follow the chemical equation given in the question paper and apply that for the number of moles.
- Explain that for only pure compounds students can use molarity = weight dissolved per liter/ molecular weight.

**MARKING SCHEME**

**Question 1.**

(i) Molarity of C – 10 ($KMnO_4$)

$$\text{Molarity} = \frac{\text{wt. in gms per litre}}{\text{mol. wt.}} = \frac{1{\cdot}85}{158} = 0.0117089\text{M}$$

(ii) Molarity of C-11 (Hydrated ammonium iron(II) sulphate)

$$\frac{M_1V_1}{M_2V_2} = \frac{n_1}{n_2}$$

$M_1$ – Molarity of **C -10**

$V_1$ – Volume of **C-10 (Titre value)**

$M_2$ = Molarity of **C-11**

$V_2$ = Volume of **C-11**

$n_1$ – number of moles of **C-10**

$n_2$ – Number of moles of **C-11**.

Let the titre value be 25·5 ml

$$\frac{0{\cdot}0117089 \times 25.5}{M_2 \times 25} = \frac{2}{10}$$

$M_2 = 0{\cdot}0597$ M

(iii) Mol. Wt. of C-11

$$\text{Mol wt} = \frac{\text{wt. in gms per litre}}{\text{Molarity}(M_2)} = \frac{22}{0.0597} = 368.5$$

(iv) Value of x: $(NH_4)_2SO_4FeSO_4.xH_2O = 368.5$

$368{\cdot}5 = 284 + 18\,x$

$x = 4{\cdot}69 \approx 5$

$x = 5$

**Question 2** **[5]**

This experiment is designed to find out the effect of concentration of the reactants on the rate of a chemical reaction.

You are provided with two solutions:

(a) **C-13** is a solution prepared by dissolving 60gms of sodium thiosulphate crystals ($Na_2S_2O_3.5H_2O$) per litre.

(b) **C-14** is a solution of 1M hydrochloric acid.

PROCEDURE:

Measure out 50 ml of the solution **C-13** ($Na_2S_2O_3.5H_2O$) in a beaker. Place the beaker over a piece of paper with a cross mark on it. Now add 10 ml of the solution **C-14** (HCl) to this solution and start the stop watch at the same time. Look down vertically on to the cross and note the time when the cross becomes invisible. This is due to the formation of colloidal sulphur in the reaction. The reaction is given as:

$Na_2S_2O_3(aq) + 2HCl\ (aq) \rightarrow 2NaCl(aq) + SO_2(g) + H_2O(aq) + S\ (collidal)$.

Repeat the experiment using 40ml, 30ml, 20ml and 10ml of **C-13** solution made upto 50 ml with distilled water in each case and 10 ml of **C-14** according to the following table:

| Expt. no | Volume of the solution **C-13** | Volume of distilled water | Time in seconds |
|---|---|---|---|
| 1. | 50 ml. | 0 ml. | |
| 2. | 40 ml. | 10 ml. | |
| 3. | 30 ml. | 20 ml. | |
| 4. | 20 ml. | 30 ml. | |
| 5. | 10 ml. | 40 ml. | |

Tabulate your results. From your results:

(i) Plot a graph of the concentration of sodium thiosulphate solution (in terms of the volume of sodium thiosulphate taken) against time.

(ii) From the graph find out the time taken for the reaction when 15 ml of the solution **C-13** is used.

(iii) Predict the effect of change in concentration of sodium thiosulphate on the rate of the above reaction from the nature of your graph.

**Show the results as required to the Visiting Examiner.**

Comments of Examiners

A tabular column was provided in the question paper which many candidates did not follow and complete by filling up the time in seconds.

(i) The question said 'plot a graph of the concentration of sodium thiosulphate solution (in terms of the volume) against time'. Several candidates first calculated the molarity of sodium thiosulphate (concentration) which was not required. Only volume was to be used.
Many candidates did not mention what was taken on which axis and units like ml & sec were also missing.
In some cases, the scale for x and y axis was incorrect and haphazard.
In several answer scripts the curve was not hyperbolic. It should have been drawn free-hand, but instead, it was drawn using a ruler by some candidates.

(ii) The time for the reaction when 15 ml of C-13 is used was not interpreted correctly from the graph. Instead, a vague value was reported

(iii) Many candidates used vague, incomplete, and inappropriate language for prediction of the effect of change in concentration of sodium thiosulphate on the rate of reaction.

*Suggestions for teachers*

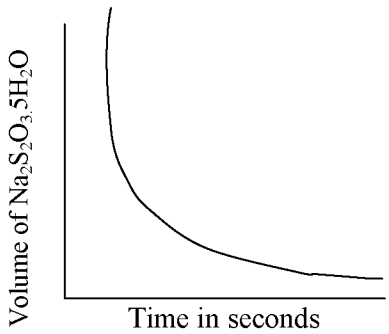
- Insist on reading the experiment carefully. Tabulation must be done correctly in the given format with correct units.
- Give more practice to students in experiments based on rate of reaction.
- Explain to students the selection of axis, choosing an appropriate scale, how and when to join points on a graph, free-hand /use a ruler, depending on the shape of the curve.
- Tell students that interpretation from the graph must be shown on the graph paper, and reported on the answer script as well.

**MARKING SCHEME**

**Question 2.**

Tabulation of time in ascending order.

(i) Graph




Time in seconds along x axis. Volume in ml or concentration in moles per litre/ relative concentration of strength along y axis. Shape of curve (rectangular hyperbole).

(ii) Time required when 15 ml of $Na_2S_2O_3.5H_2O$ solution was taken.

(iii) The rate of reaction decreases with decrease in concentration of sodium thiosulphate or rate of reaction is directly proportional to concentration of sodium thiosulphate.

**Question 3** **[7]**

Analyse qualitatively the substance **C-15** which contains *two* anions and *two* cations. Identify these ions.

(a) While testing for **anions** you must mention:

(i) How the solution/soda extract was prepared.

(ii) How the gases were identified.

(iii) The confirmatory test for each anion.

***Show the results as required to the Visiting Examiner.***

(b) While testing for **cations** you must mention:

(i) How the original solution for group analysis was prepared.

(ii) The formal group analysis with pertinent group reagents.

(iii) The confirmatory test for each cation.

***Show the results as required to the Visiting Examiner.***

**Note:** *Use of qualitative analysis booklet/table is not allowed.*

Comments of Examiners

(a) Wet tests for anions were performed by many candidates using either the aqueous solution or soda extract, instead of neutralized soda extract.
- For the nitrate ion, ferrous sulphate was used which is incorrect. Instead, freshly prepared ferrous sulphate should have been used.
- Alternative test for nitrate ion using salt mixture, concentrated sulphuric acid, copper turning and heat was incorrectly done with salt solution, dilute acid and without heat.
- For the acetate ion, ferric chloride solution was used which is incorrect. Instead, neutral ferric chloride should have been used.
- Alternative test for acetate using salt mixture, ethanol, concentrated sulphuric acid and heat was incorrectly done with salt solution and dilute sulphuric acid.

(b) Preparation for original solution for cation detection was not done correctly by many candidates.
- Most of the candidates did not add concentrated nitric acid in group III.
- The order of preparing the buffer medium in group III was incorrect.

*Suggestions for teachers*
- Teach students the steps for preparing the original solution.
- Insist that the wet tests for the anion be performed with neutralized sodium carbonate extract, even if the salt mixture is more or less soluble in water.
- Concepts of formal group analysis like, common ion, buffer and solubility product must be taught thoroughly before doing salt analysis.
- Practice mixture analysis and guide the student on how to record formal group analysis correctly and meaningfully with pertinent group reagents.
- Explain to the students the importance of adding concentrated nitric acid and boiling to convert ferrous to ferric.

- Absence of group III, IV and V was not reported by several candidates.
- $H_2S$ was not boiled off before group III and V reagents were added.
- The filtrate after group V was not used for detection of group VI. Instead, candidates incorrectly used original solution.
- The precipitate of Group I / Group II was not dissolved correctly in hot water/ concentrated nitric acid respectively.
- In some cases, the reagent for magnesium test was written with a wrong formula.

- Removal of $H_2S$ before Group III and V must be taught clearly.
- Tell students that while reporting the groups which are present, it is equally important to mention groups which are absent so that the analysis is systematic.

**MARKING SCHEME**

**Question 3.**

(a) C-15 is a mixture of Lead acetate and Magnesium nitrate.

Test for $NO_3^-$ :

Neutralise the $Na_2CO_3$ extract with dil. $H_2SO_4$ and add equal volume of freshly prepared solution of ferrous sulphate followed by conc. $H_2SO_4$ from the side of the test tube → Brown Ring forms at the junction of two liquids.

Nitrate confirmed.

OR

Salt mixture + concentrated $H_2SO_4$, heat and add copper turnings or paper balls. Dense brown fumes are observed. Nitrate confirmed.

$CH_3COO^-$

Neutralise the $Na_2CO_3$ extract with dil $HNO_3$. Add neutral $FeCl_3$ solution - a blood red colouration is obtained on heating turns reddish brown ppt. Acetate confirmed.

OR

Salt mixture + concentrated sulphuric acid add ethanol and heat, pleasant fruity odour of ester is obtained. Acetate confirmed.

OS. The salt solution is made in dil. $HNO_3$/ water/ hot dil HCl.

Group I present:

Add dil. HCl to OS - a white ppt. Group I present/Group II may also be accepted. Pass $H_2S$ gas through the filtrate of Group I.

Confirmatory test for $Pb^{2+}$.

If the white precipitate from Group I is taken, dissolve it in hot water. If the black precipitate is taken from Group II, dissolve it in 33 % nitric acid and heat.

Add potassium chromate solution/ KI solution.

A yellow ppt. $Pb^{2+}$ confirmed.

Group VI:

After reporting the absence of III, IV and V groups with pertinent group reagents, the filtrate of group V is taken, add $NH_4OH$ solution and then add Disodium hydrogen phosphate/ Sodium hydrogen phosphate solution. A fine crystalline white precipitate is formed.

Group VI present and $Mg^{++}$ is confirmed.

**GENERAL COMMENTS:**

**(a) Topics found difficult:**

- Concepts of molarity based on (grams/litre)/ molecular weight for pure substances and molarity based on titre value.
- Plotting of graphs in chemical kinetics.
- Principles of formal group analysis.

**(b) Concepts found confusing:**

- Choice of axis, correct scale, joining of points, shape of curve etc. in the graph of chemical kinetic.
- Solubility of mixture/neutralized sodium carbonate extract and carrying out a systemic analysis from Group 0 to Group 6.

**(c) Suggestions for students:**

- Listen to the teacher's instructions carefully, read the experiment thoroughly and then perform them.
- Develop a habit of observation and note them down correctly and to the point.
- Practice makes perfect, hence practice as many salt mixtures as possible.
- Remember to tabulate your readings neatly, keeping in mind concordant readings and avoid overwriting in the tabular column.
- Do not round off molarity values, report to minimum four decimal places.
- Do follow the molecular formula given in the question paper, whether it is hydrated or anhydrous.
- Perform experiments on chemical kinetics carefully after understanding the theoretical concepts. Also practice plotting graphs for these experiments.
- Plan before writing formal group analysis.
- Do not forget the use of concentrated nitric acid in Group III. Also understand why it is being used.
- Test for Group V cations in the order barium, strontium, calcium and show absence of barium before reporting presence of strontium.
- Group VI must be reported with the filtrate after group V is reported absent and not with the original solution.

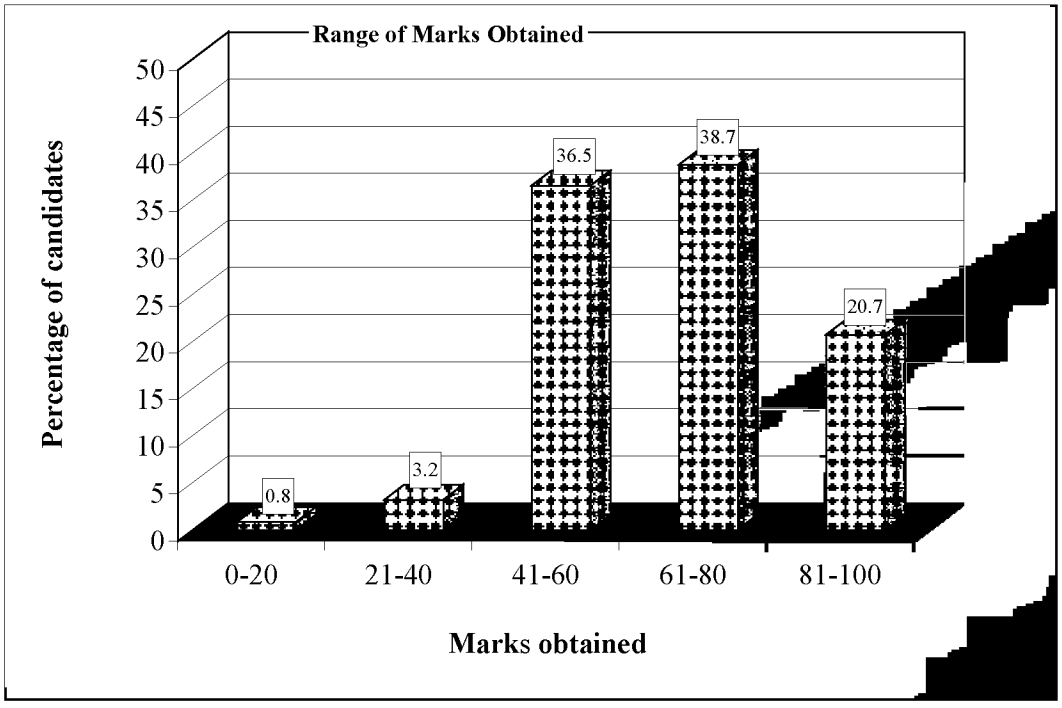
# BIOLOGY

## A. STATISTICS AT A GLANCE

| | |
|---|---|
| Total number of students taking the examination | 11,817 |
| Highest marks obtained | 100 |
| Lowest marks obtained | 10 |
| Mean marks obtained | 66.18 |

### Percentage of candidates according to marks obtained

| | Mark Range | | | | |
|---|---|---|---|---|---|
| | ***0-20*** | ***21-40*** | ***41-60*** | ***61-80*** | ***81-100*** |
| Number of candidates | 98 | 377 | 4317 | 4578 | 2447 |
| Percentage of candidates | 0.8 | 3.2 | 36.5 | 38.7 | 20.7 |
| Cumulative Number | 98 | 475 | 4792 | 9370 | 11817 |
| Cumulative Percentage | 0.8 | 4.0 | 40.6 | 79.3 | 100 |



## B. ANALYSIS OF PERFORMANCE

### PART I (20 Marks)

*Answer* **all** *questions.*

**Question 1**

(a) Give *one* significant difference between each of the following: **[5]**

(i) Implantation and Parturition.

(ii) Active absorption and passive absorption.

(iii) Haemodialysis and Peritoneal dialysis.

(iv) Simple fruit and Aggregate fruit.

(v) Auricles and Ventricles.

(b) Explain what would happen if: **[5]**

(i) Excess fertilizers are added to soil.

(ii) Blood clots in the coronary artery.

(iii) Beta cells in the islets of langerhans are damaged.

(iv) Silicon emulsion is applied over the surface of leaves.

(v) Magnesium element is deficient in the soil.

(c) Each of the following questions / statements have four suggested answers. Rewrite the correct answer in each case: **[3]**

(i) The cell division in the tunica region of shoot apex is:

(A) Periclinal

(B) Horizontal

(C) Anticlinal

(D) Radial

(ii) The dark coloured dead wood present in the central region of old trees is:

(A) Spring wood

(B) Heart wood

(C) Sap wood

(D) Cambium

(iii) Dwarfism accompanied with mental retardation is due to hypo-secretion of:

(A) Growth hormone

(B) Thyroxine hormone

(C) Parathormone

(D) Adrenalin hormone

(iv) Oxygen is released in photosynthesis by:

(A) Photophosphorylation

(B) Photolysis of water

(C) Photorespiration

(D) Photons

(v) The spinal nerve is:

(A) A mixed nerve

(B) A sensory nerve

(C) A motor nerve

(D) A cranial nerve

(vi) The cells of the areolar tissue which produce heparin are:

(A) Fibrocytes

(B) Mast cells

(C) Macrophages

(D) Chondriocytes

(d) Mention the most significant function of the following: **[3]**

(i) Semi circular canals

(ii) Bowman's capsule

(iii) Parenchyma

(iv) Leg haemoglobin

(v) Guard cells

(vi) Alveoli

(e) State the best known contribution of: **[2]**

(i) Munch

(ii) Ronald Ross

(iii) Marshall Hall

(iv) Huxley

(f) Expand the following : **[2]**

(i) ABA

(ii) FSH

(iii) AIDS

(iv) DDT

Comments of Examiners

(a) (i) Instead of blastocyst/embryo, some candidates used words like, zygote, foetus, egg, ovule, etc. Some candidates confused implantation with implants; under parturition, some candidates wrote – 'expelling the child' instead of 'full term foetus'.

(ii) Most of the candidates answered this part correctly. Some wrote opposite answers. A few candidates interpreted the question in terms of water absorption but made no mention of the role of root cells except that roots are 'involved' and 'not involved'.

(iii) Majority of the candidates attempted 'Hemodialysis' correctly but failed to attempt 'Peritoneal Dialysis'.

(iv) Some candidates explained the difference between true and false fruit. The expected single carpel / multi carpellary syncarpous ovary was not mentioned in many answers; in some cases, 'aggregate fruits' were confused with 'multiple fruits'.

(v) Majority of the candidates wrote the answer correctly.

(b) (i) Most of the candidates wrote in terms of toxicity and pollution instead of tonicity. Several candidates wrote 'endosmosis' instead of 'exosmosis'.

(ii) The common term 'heart attack' was used by a number of candidates. Some candidates just wrote that blood supply to the heart stops whereas, reference to supply of blood to the heart muscles was important as the question clearly mentioned 'coronary artery'. Some candidates only wrote, 'heart will stop working', without giving a proper explanation.

(iii) Some candidates wrote the function of α cell instead of β cells. Hence wrote about glucagon instead of insulin.

(iv) Many candidates attempted this question correctly. A few some did not know that silicon emulsion acts as an antitranspirant. They wrote vague answers like, photosynthesis will stop or to increase soil fertility.

(v) Most of the candidates could write this answer correctly; however, very few wrote the technical terms i.e. chlorosis.

*Suggestions for teachers*

- Stress upon using key words in answers.
- Go through the syllabus and scope every year and pay special attention to the topics which have been newly introduced.
- Importance must be given to giving compatible differences.
- The types of fruits and their development should be compared in tabular form.
- The structure of the Heart must be explained with the help of a model or diagrams so that the students have a clear concept of the chambers of the Heart. Auricles are thin walled and ventricles are thick walled – this must be explained with reasoning.
- The concept of coronary artery supplying blood to the Heart muscles should be made clear - technical terms like coronary thrombosis, myocardial infarction should be discussed.
- Fertilisers act as salts which make the soil hypertonic. This should be explained when teaching osmotic relations in a plant cell.
- Different types of Hormones, their source and their functions should be discussed in a tabular form.
- Role and deficiency of elements must be discussed while teaching Mineral Nutrition.
- Photolysis, Photorespiration and Photophosphorylation must be clearly explained along with comparison and differentiation.

(c) (i) Many candidates answered this part correctly.
(ii) This part was generally attempted correctly by most of the candidates. A few candidates got confused with 'sap wood'.
(iii) A few candidates got confused between 'growth hormone' and 'thyroxine'.
(iv) Most of the candidates answered this part correctly.
(v) A few candidates chose 'sensory nerve' instead of 'mixed nerve'.
(vi) Many candidates wrote 'macrophages' instead of 'mast cells'.

(d) (i) A few candidates wrote 'hearing' as the function. Some candidates wrote 'static balance' instead of 'dynamic balance'.
(ii) Some wrote 'excretion/ urine information' instead of 'ultrafiltration'. Some only wrote 'glomerular filtration'.
(iii) This part was generally well attempted. A few candidates wrote about sclerenchyma instead of parenchyma.
(iv) Most of the candidates answered this part correctly. Some confused 'leg haemoglobin' with 'haemoglobin' and wrote anemia.
(v) Some candidates only mentioned the shape and turgid condition, but did not mention the role of Guard cells.
(vi) Most of the candidates attempted this part correctly. Some candidates gave the answer as 'respiration' instead of 'exchange of respiratory gases'.

(e) (i) Most of the candidates wrote the role correctly. Some wrote the answer as 'Munch Hypothesis' instead of 'Mass flow Hypothesis'.
(ii) Most candidates were able to attempt this part correctly.
(iii) This part was mostly answered correctly. A few candidates wrote 'reflex arc' instead of 'reflex action'.
(iv) Most of the candidates were able to attempt this part correctly.

(f) (i) Spelling errors were made by several candidates while expanding the abbreviation
(ii) Some candidates mentioned 'Follicular' instead of 'Follicle' and 'Stimulation' instead of 'Stimulating'.
(iii) Some candidates made mistakes and spelling errors in expansion.
(iv) DDT was expanded as 'tetra- chloro' and as 'ethene' or 'ethylene' by some candidates.

- Functions of different parts of the ear must be explained clearly. Difference between static balance and dynamic balance must be highlighted.
- Functions of individual parts of the nephron should be discussed separately.
- Parenchyma and their types should be discussed along with their functions.
- The process of nitrogen fixation should be discussed in detail mentioning the role of different microbes. Importance of leghemoglobin should be discussed as oxygen scavenger for action of nitrogenase enzyme.
- Importance of correct spellings should be emphasised.

**MARKING SCHEME**

**Question 1.**

| | | | |
|---|---|---|---|
| (a) | (i) | Implantation<br>– After 7 days/1 week of fertilisation<br>– Attachment of blastocyst/embryo to the uterine wall/endometrium | Parturition<br>– After 280 days / 40 weeks of fertilisation<br>– Act of expelling the full term young one at the end of gestation/ child birth/ delivery of foetus |
| | (ii) | Active absorption<br>– Requires carrier molecules<br>– Against concentration gradient/ Low concentration to high conc. / Energy required/ ATP required<br>– Slow transpiring<br>– Forces activity of root | Passive absorption<br>– Does not require carrier molecules<br>– Along concentration gradient/ High conc. to low conc./ Energy not required<br>– Fast transpiring<br>– Forces activity of shoot |
| | (iii) | Hemodialysis<br>– Man-made membrane / dialiser to filter wastes and remove extra fluid from the blood/ artificial kidney.<br>– Needs hospitalization. | Peristoneal dialysis<br>– Uses the lining of abdominal cavity / Peritoneal membrane and a solution dialysate to remove wastes and extra fluid.<br>– Does not need hospitalization. |
| | (iv) | Simple fruit<br>– From a single carpel or more than one fused carpels / multicarpellary syncarpous flower/ ovary | Aggregate fruit<br>– From many carpels / multicarpellary apocarpous ovary |
| | (v) | Auricles<br>– Thin walled<br>– Receiving chambers<br>– Upper chamber of heart | Ventricles<br>– Thick walled<br>– Distributing chambers<br>– Lower chamber of heart |

(b) (i) Root hair will be killed due to exosmosis/plasmolysis/flaccid/soil becomes hypertonic/loses osmotic balance.

(ii) Coronary thrombosis/heart attack/myocardial infarc/ ischemia.

(iii) Diabetes mellitus/no insulin/sugar in urine and blood/hyperglycemia/glycosuria.

(iv) Silicon emulsion application reduces the rate of transpiration (acts as antitranspirant) and hence the leaves remain distended and their cells are turgid for a long time.

(v) Chlorosis/decrease synthesis of chlorophyll/yellowing of leaves.

(c) (i) Anticlinal

(ii) Heart wood

(iii) Thyroxin

(iv) Photolysis

(v) A mixed nerve

(vi) Mast cells

(d) (i) Balance/ dynamic equilibrium/ angular acceleration.

(ii) Ultra filtration.

(iii) Storage of food/ mechanical support/ seat of metabolic activities / conduction of water/ photosynthesis/ buoyancy.

(iv) Oxygen scavenger (action of nitrogenase enzyme)/ Nitrogen fixation/ protects nitrogenase. Maintains anaerobic conditions for nitrogenase / attachment of nitrogen.

(v) Regulate the opening and closing of stomata/regulates transpiration.

(vi) Exchange of (respiratory) gases.

(e) (i) Mass flow hypothesis/ Pressure flow hypothesis/ turgor pressure flow/ translocation of photosynthetates/food/organic solutes.

(ii) Malarial parasite (life cycle in mosquitoes)/ Malaria.

(iii) Reflex action/ simple reflex/ physiology of circulation.

(iv) Sliding filament theory/Synthetic Theory of Evolution/ protoplasm is the physical basis of life.

(f) (i) Abscissic acid

(ii) Follicle Stimulating Hormone

(iii) Acquired Immuno Deficiency Syndrome

(iv) Dichloro di phenyl tri chloro ethane.

# PART II (50 Marks)

## SECTION A

*Answer any **three** questions.*

**Question 2**

(a) Give *four* differences between *root apex* and *shoot apex*. **[4]**

(b) Explain the development of the different types of endosperms in angiosperms. **[3]**

(c) Explain briefly: **[3]**

(i) Capillary water

(ii) Osmosis

(iii) Aeroponics

Comments of Examiners

(a) Some candidates wrote very general differences like, root apex below the ground and shoot apex above the ground. Actual valid differences were missed in many answers.

(b) Several candidates mentioned the names of different types of endosperms correctly but failed to give correct explanation. Some described double fertilization. Some wrote intermediate type of endosperm which is correct for mode of development but not as a type.

(c) (i) Many candidates attempted this part correctly but some confused 'capillary water' with 'ground water'.
(ii) Many candidates went wrong in explaining 'Osmosis', as the concept of concentration was not understood clearly by them.
(iii) Many candidates wrote about 'hydroponics' instead of 'aeroponics'. Candidates did not mention about nutrient mist which is a must.

*Suggestions for teachers*

- Comparison between root and shoot and root apex and shoot apex should be discussed simultaneously to make the concept clear.
- Teaching should be accompanied by diagrams to give a clear understanding.
- Different types of soil water must be discussed in detail.
- That a highly concentrated solution will have less concentration of water must be explained. The importance of semipermeable membrane should also be highlighted.

**MARKING SCHEME**

**Question 2.**

(a)

| Root Apex | Shoot Apex |
|---|---|
| – Sub-terminal | Terminal |
| – Protected by root cap | Protected by apical bud/leaf primordia/leaf appendages |
| – Has no nodes and internodes | Has nodes and internodes |
| – Does not bear any appendages | Bears lateral appendages/ leaf primordial |
| – Has a quiescent center | No quiescent center |
| – Cells non-green/ non-photosynthetic | green/photosynthetic |
| – No changes at the time of flowering | Changes seen |
| – Positively geotropic | Positively phototropic |
| – Not differentiated into tunica and corpus | Differentiated |

(b) Nuclear Endosperm – In polypetalous dicotyledons

- First few divisions not accompanied by cell wall formation.
- Nuclei produced remain free in the cytoplasm.

(Self-explanatory diagram also accepted).

Cellular Endosperm - In gamopetalous dictoyledons

- wall formation occurs with first division of primary endosperm nucleus
- endosperm tissue cells do not show regular arrangement.

Helobial Endosperm:

- Intermediate between nuclear and cellular type.
- First division of primary endosperm nucleus accompanied by formation of transverse wall
- Divides embryo sac unequally into small chalazal chamber and large micropylar chamber.

(c) (i) Water held between soil particles by capillary force/ only water available to plants.

(ii) Movement of water molecules from their higher concentration to their lower concentration/dilute to concentrated solution through a semi-permeable membrane.

(iii) Aeroponics – plants are grown with their roots placed in nutrient mist /aerosol.

**Question 3**

(a) Explain the $C_4$ cycle of photosynthesis. **[4]**

(b) State *three* advantages and *three* disadvantages of vegetative reproduction. **[3]**

(c) Mention *one* role and *one* deficiency symptom of the following elements in plant nutrition: **[3]**

(i) Phosphorus

(ii) Iron

(iii) Chlorine

Comments of Examiners

(a) The correct sequence was not followed by some candidates. Mesophyll chloroplasts and bundle sheath chloroplasts were not specified. Reactants and co-factors eg. $CO_2$, $NADPH_2$ and ATP were not shown at the required steps by some candidates. In some cases, the enzymes were not mentioned.

(b) Some candidates took 'vegetative reproduction' as 'self-pollination' and mentioned differences between self and cross pollination. Many candidates did not write the disadvantages. In many answers there were repetitive points.

(c) (i) Many candidates wrote the role correctly but went wrong in writing the function.

(ii) Most of the candidates attempted this part correctly. Some candidates mentioned the use in synthesis of hemoglobin which is a respiratory pigment found in animals.

(iii) The correct role of chlorine was not mentioned by several candidates.

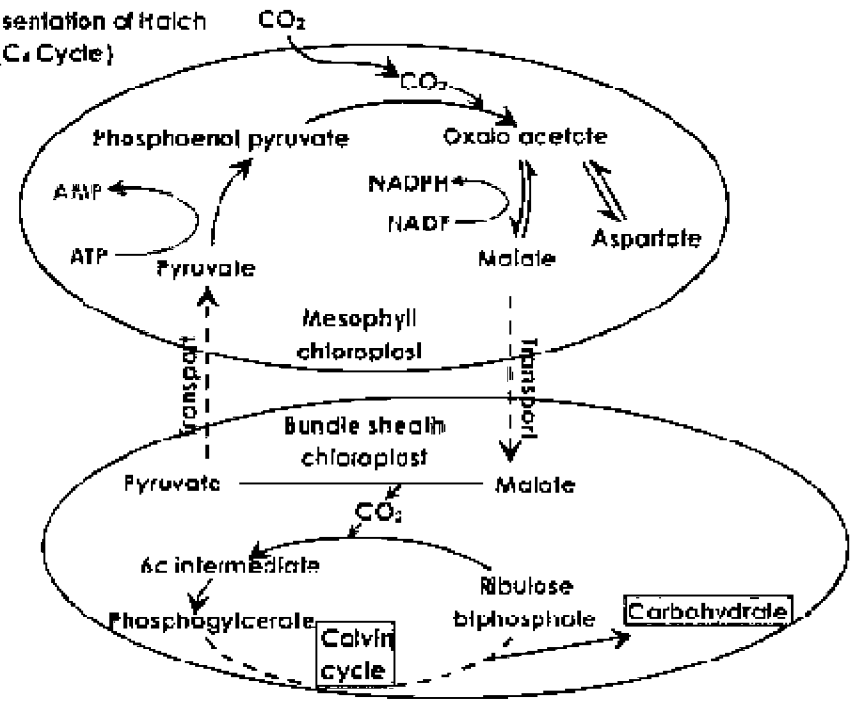
*Suggestions for teachers*

- The teachers should insist that students mention the site as well as the correct carbon dioxide acceptors. The correct sequence should be given importance.
- Advantages and disadvantages of vegetative reproduction as well as sexual reproduction should be compared and contrasted for clear understanding. This will help them to avoid repetitions.

**MARKING SCHEME**

**Question 3.**

(a) The schematic representation of Hatch and Slack pathway ($C_4$ Cycle)




(b) Advantages:

- More rapid
- Cheaper
- Preservation of desirable characteristics
- Possible to raise a large stock of selected strains
- Propagation of ornamental plants
- Sure/certain
- Plants which do not produce viable seeds can be propagated
- Mastery of their surrounding

*(any three)*

Disadvantages:

- Unwanted characters cannot be eliminated
- Fall in vigour and vitality due to lack of sexual stimulus
- No variations
- Low yield
- Overcrowding

*(any three)*

| (c) | | | Role | Deficiency |
|---|---|---|---|---|
| | (i) | Phosphorus | Constituent of cell membrane / nuclear acid /nucleotides / coenzymes / ATP / nitrogen metabolism / phosphorylation of sugar in respiration | – Stunted growth / premature leaf fall<br>– development of anthocyanin pigment /chlorosis<br>– brown necrotic areas/necrosis<br>– Restricted root and shoot gr.<br>– Delayed flowering. |
| | (ii) | Iron | Synthesis of chlorophyll, formation of carotenoids constituent of cytochromes<br>Electron carrier formation of ferredoxin<br>Activates number of enzymes/ catalases. | Interveinal chlorosis<br>Localised or generalized necrosis |
| | (iii) | Chlorine | Transfer of electrons from $OH^-$ ions to photoexcited chlorophyll/ photolysis<br>Ionic equilibrium<br>Proper working of PS II | Wilted leaves/ stunted growth/ chlorosis/ necrosis<br>Reduced fruiting. |

**Question 4**

(a) What are *tropic hormones*? Describe the feedback control of tropic hormones with an example. **[4]**

(b) Explain the conduction of nerve impulse through a nerve fibre. **[3]**

(c) Draw a labelled diagram of the T.S. of bone. **[3]**

Comments of Examiners

(a) Most of the candidates failed to write that tropic hormones regulate other endocrine glands. Many candidates gave wrong examples for tropic hormones. Clear examples of positive and negative feedback were not given. After explaining positive feedback, some candidates wrote that the opposite happens in negative feedback, which was an incomplete statement.

*Suggestions for teachers*

– Tropic Hormones should be explained with reference to hypothalamus and pituitary. Both positive and negative feedback should be clearly explained with examples.

(b) The stages were mentioned but not discussed in proper sequence by some candidates. In some cases, wrong description was given. Most candidates mentioned - inner more negative and outer more positive.

(c) Most of the candidates drew the correct diagram but did not label correctly. Some candidates lost marks as they drew the L.S. of bone instead of T.S of bone.

- Resting Potential should be explained with reference to ionic equilibrium, axolemma permeability and the role of Na Pump. For generation of action potential threshold stimulus is a must.
- Students should be explained the difference between T.S, L.S & V.S.
- The importance of correct labelling should be stressed upon. Arrows of labels should not intersect each other.

**MARKING SCHEME**

**Question 4.**

(a) Tropic hormones – Hormones which stimulate other endocrine glands to release their hormones.

- They are subject to feedback inhibition.
- At the pituitary / hypothalamic level.
- When the blood level of Adreno cortico steroids/ sex steroids/ thyroid hormones becomes high they inhibit release of their respective tropic hormone.
- If it falls more tropic hormones are released.
- Thus maintaining level of hormones in blood.
- Role of releasing factor.

(b) In the resting state

- Na pump/normal polarized state/$Na^+$ ions move outside and $K^+$ ions move inside
- Energy supplied by ATP
- Axon membrane inside electronegative (less electropositive) and outside electropositive (more electropositive)

Reverse potential/reverse polarization

- Na pump stops/$Na^+$ ions from exterior into axoplasm/ Na influx
- Axon membrane gets depolarized/interior of axon becomes positive to that of outside
- When stimulus is strong depolarization spreads throughout the nerve fibre

Repolarisation

- No more Na can enter/axon membrane totally impermeable
- $K^+$ ions diffuse in axoplasm and $Na^+$ ions diffuse in interstitial fluid
- Na pump starts functioning

(c) T.S. of Bone – Diagram with correct labeling.

**Question 5**

(a) Explain the role of pancreas in digestion of various food materials. **[4]**

(b) Briefly describe the stages in clotting of blood. **[3]**

(c) Define: **[3]**

(i) Reparative regeneration

(ii) Capacitation

(iii) Menarchy

Comments of Examiners

(a) Most of the candidates could not write the complete reactions with correct names of substrates, enzymes and products. Very few candidates could write the end products correctly.

(b) The correct sequence was not followed by many candidates. Several candidates did not start the answer with the release of thromboplastin. Some candidates did not show the involvement of calcium ions at relevant steps.

(c) (i) Most of the candidates were able to attempt this part well. Some candidates confused 'reparative regeneration' with 'restorative regeneration'.

(ii) The question was well attempted. Some candidates confused 'capacitation' with 'spermatogenesis'. A few explained it as - changes in the uterus to accept a sperm.

(iii) Most of the candidates attempted this part correctly. Some confused 'menarche' with 'menopause'. Others defined 'puberty'.

*Suggestions for teachers*

- The role of pancreatic enzymes for carbohydrates, proteins and lipids digestion should be dealt with separately with reference to Substrate (enzyme, pH), Product.
- The importance of writing the correct sequence must be told to students.
- Types of regeneration should be explained with examples.
- Different terms associated with spermatogenesis and fertilisation should be explained clearly.
- The difference between menarche and menopause should be explained.

**MARKING SCHEME**

**Question 5.**

(a) Role of Pancreas in digestion of various food materials:

- Produces pancreatic juice consisting of $NaHCO_3$ and $Na_2HPO_4$ which makes the juice alkaline. Juice contains:
- Trypsin/ chymotrypsin/ Carboxypeptidase → converts proteins to simple peptides and AAS
- Amylase(Amylopsin) → starch to maltose
- Phospholipase/ Lipase (steapsin) → Fatty emulsions to fatty acid and glycerol.
- RNA se/DNA ase → RNA/DNA to simple nucleotides
- Elastase → elastin to AAs

(b) The stages in clotting of blood:

- Platelets release thromboplastin / F3/thrombokinase
- Acts on prothrombin in pr of $Ca^{++}$ ions
- Converts to active thrombin
- Thrombin acts on fibrinogen
- Converts to fibrin
- Fibrin + dead cells → clot

(c) (i) Repair/healing of injuries takes place by proliferation of localized cells and migration

(ii) Changes/activation in a sperm for fertilization

(iii) Onset of menstruation.

**Question 6**

(a) State *four* differences between *transpiration* and *guttation*. **[4]**

(b) Give an account of the secretory phase of menstrual cycle. **[3]**

(c) Define: **[3]**

(i) Radial vascular bundle

(ii) Rigor mortis

(iii) Root pressure

Comments of Examiners

(a) This part was mostly well attempted. A few candidates could not write compatible differences. Some wrote about 'bleeding'. In some cases, points were repeated.

(b) Some candidates described vague points or wrote about the menstrual phase. Important points were missing in many answers. Several candidates could not correlate the changes in the uterus with the hormonal changes in ovary/ pituitary.

(c) (i) Most of the candidates attempted this part correctly. Some candidates confused 'radial bundle' with 'collateral bundle'.
(ii) Some candidates could not define 'rigor mortis' correctly as stiffening of muscles after death or, sustained contraction.
(iii) A few candidates did not write the complete definition. They defined 'root pressure' as 'pressure created in roots'.

*Suggestions for teachers*

- Transcription, guttation and bleeding should be discussed with comparison and contrast.
- Different phases of the menstrual cycle should be explained with reference to the pituitary, ovary and uterine endometrium.
- Types of vascular bundles should be explained with the help of diagrams.
- Students should be explained the difference between 'sperm' and 'rigor mortis'.
- Definitions should be taught with key words.

**MARKING SCHEME**

**Question 6.**

(a) Differences between Transpiration and Guttation

| | Transpiration | Guttation – exudation of water |
|---|---|---|
| – | Occurs during the day | At night / early morning |
| – | Water lost in the form of water vapour | In the form of liquid droplets |
| – | Through stomata/aerial parts, lenticels and cuticle | Through hydathodes |
| – | Under dry conditions | Under humid conditions |
| – | Pure water | Dissolved salts |
| – | Cooling effect | Rid of excess water / No such effect |
| – | No root pressure | Root pressure involved |

(b)
- High LH causes ovulation/rupture of follicle
- Ruptured follicle changes into corpus luteum
- Secretes progesterone
- Endometrium thickens
- Richly supplied with blood vessels
- Corkscrew shaped uterine glands / pendulus/ more active
- Uterine movements are reduced
- Uterine milk secreted
- Arteries become coiled
- Glycogen content of the endometrial epithelium increases
- If ovum is not fertilized the corpus luteum degenerates / formation of corpus albicans
- Progesterone level decreases

(c)
(i) Xylem alternates with phloem (found in roots) lying on separate radii

(ii) Stiffening of muscles after death/sustained contraction/irreversible contraction

(iii) Pressure created in the roots which takes the water into the xylem.

## SECTION B

*Answer any **two** questions.*

**Question 7**

(a) Differentiate between *apes* and *man* with respect to the following characteristics: **[4]**

(i) Posture

(ii) Cranium

(iii) Brow ridges

(iv) Locomotion

(b) Define: **[3]**

(i) Vestigeal organs

(ii) Variations

(iii) Neo-Darwinism

(c) Give *three* differences between *Natural Selection* and *Artificial Selection.* **[3]**

Comments of Examiners

(a) (i) Most of the candidates gave correct differences.
(ii) Some candidates wrote the cranial capacity incorrectly.
(iii) Some candidates wrote 'flat face' but made no mention of 'brow ridges'. Some wrote, 'brow ridges absent in man'.
(iv) Many candidates mentioned 'arboreal' for apes but did not mention the use of the limbs for locomotion. Some wrote, 'walking with knuckles' to describe locomotion in apes.

(b) (i) Some candidates wrote incomplete definitions - e.g. Non - functional organs, without mentioning 'ancestors'.
(ii) Many candidates answered this part correctly.
(iii) Some candidates only explained 'Darwinism'.

(c) In many cases, the differences given by candidates were not compatible. Most of the candidates could write only one valid difference between natural and artificial selection.

*Suggestions for teachers*

- Differences and similarities between man and ape should be done under separate headings, like, anatomical, morphological and genetic.
- A collection of important definitions from each chapter should be given to students Relevant key words should be stressed upon.
- The factors responsible for and the consequences of variations should be discussed. Definitions should be learnt thoroughly.
- Darwinism and neo Darwinism should be clearly explained with examples for a proper understanding.

**MARKING SCHEME**

**Question 7.**

(a)

| | | Apes | Man |
|---|---|---|---|
| (i) | Posture | Slight bent/ semi erect/ stooping | Erect |
| (ii) | Cranium | Small/sloping/flattened/650cc or less | Large/rounded/vaulted/1450cc |
| (iii) | Brow Ridges | Heavy and protruded/ prominent/dense | Thin and not protruded/inconspicuous/ less dense |
| (iv) | Locomotion | Soles do not touch the ground/sub-plantigrade/ quadrapedal | Touch except bridge of feet/ plantigrade/bipedal. |

(b) (i) Poorly developed non functional organs which were well developed and functional in ancestors.

(ii) Variations: Differences in individuals (which make them more adapted to the changing environment).

(iii) Units of evolution are not individuals but the population as a whole. It explains the role of variations/genetic drift

Population is the unit of evolution

Modified form of Darwinism.

(c)

| Natural selection | Artificial selection |
|---|---|
| Only the fittest survive rest are eliminated | Selected variety and natural variety both co-exist. |
| Exerted by nature | Exerted by man |
| Random | Selective |
| Slow process | Fast process |
| Tough competition | No competition |
| Led to great diversity in nature | Led to evolution of a few economically important plants and animals only |
| Causes evolution of new species | No new species formed |

**Question 8**

(a) State *four* characteristics of the Cromagnon man. **[4]**

(b) Explain the basic postulates of Darwinism. **[3]**

(c) *Archaeopteryx is a connecting link between reptiles and birds*. Justify the statement by giving *two* characteristics of each group. **[3]**

Comments of Examiners

(a) Majority of the candidates could score well in this part. Some candidates wrote the features of Apes instead of Cro-Magnon man.
(b) Some candidates did not seem to understand the question. Others explained the elongation of giraffe's neck as evidence in favour of Darwinism.
(c) Both avian and reptilian characteristics were expected in the answer. Some candidates wrote only avian or only reptilian characteristics, whereas some wrote general characteristics without the specific characteristics of Archaeopteryx.

*Suggestions for teachers*

- Features of different ancestors of present day man should be explained, showing the kind of change the ancestors have undergone during the course of evolution.
- The basic postulates of Lamarckism and Darwinism should be explained clearly and students should be asked to write them in logical sequence.
- Archaeopteryx should be explained as a connecting/ missing link between birds and reptiles. Avian features and reptilian features should be discussed separately.

**MARKING SCHEME**

**Question 8.**

(a)
- About 1.8m tall
- Head large with flat forehead
- Perfect erect posture
- Body was less hairy
- Chin prominent and nose narrow and elevated
- Face was prognathous
- Cranial capacity was 1660 cc
- Ability to make tools and ornaments
- Cave dwellers
- Lived in families
- Buried the dead
- Omnivorous
- Used fire
- Swift runner
- Intelligent hunter

– Teeth closely placed
– Wisdom tooth present
– Cave paintings
– Covered body with skin of animals

(b) – Enormous power of fertility
– Struggle for existence/competition
– Variations and heredity
– Survival of the fittest/Natural selection
– Origin of species

[*any four*]

(c) Reptilian characters:
- Presence of teeth in jaws
- Not pneumatic
- Long tail with caudal vertebra
- Weak keel less sternum
- Clawed digits *(any two)*

Avian characters:
- Feathers on the body
- Forelimbs modified into wings
- Four toes in foot adapted for perching
- Presence of beak *(any two)*

**Question 9**

(a) *Persons suffering from G6PD deficiency are resistant to malaria.* Explain. **[4]**

(b) Define: **[4]**

(i) Genetic Erosion

(ii) Bioinsecticides

(iii) Antigen

(iv) Psychosis

(c) Define *Biofortification.* **[2]**

Comments of Examiners

(a) Several candidates did not attempt this part correctly. Some candidates did not write the full form of G6PD. They did not mention its role in the metabolism. Very few candidates discussed natural selection with reference to G6PD deficiency. Some candidates wrote about sickle cell anemia.

(b) (i) Some candidates wrote about loss of genes but made no mention of 'gene pool' and Population.
(ii) This part was not attempted well. Candidates did not seem to have an understanding of Bioinsecticides. Vague definitions like, 'use of biological agents to kill insects' or 'use of chemicals from biological agents to kill insects', were given by candidates.
(iii) Candidates were confused between 'antigen' and 'pathogen'. Mostly candidates explained 'Antigen' as, 'disease causing agents' or as 'foreign substances which enter our body', without mentioning the stimulation of the immune system or production of antibodies.
(iv) Some candidates defined 'Psychosis' as a mental illness but the type was not mentioned. Several candidates were confused between 'psychosis' and 'neurosis'. Some simply defined it as 'madness' without giving the key words.

(c) 'Bio fortification' was confused with 'Bio magnification' by some candidates. It appeared that candidates were not aware of this term.

*Suggestions for teachers*

- G6PD should be discussed as an example of natural selection. Its role in the metabolism of parasite and the effect of $H_2O_2$ on RBC membrane should be linked.
- Key words should be given importance in definitions.
- Bio insecticides must be explained with examples.
- Types of mental illnesses should be discussed in detail describing their characteristics.

**MARKING SCHEME**

**Question 9.**

(a) Persons suffering from G6PD deficiency are resistant to Malaria because:
- G6PD – glucose 6 phosphate dehydrogenase
- Decomposes $H_2O_2$ formed during metabolism
- When persons suffering from malaria are given primaquin/any anti-malarial drug, causes hemolysis as $H_2O_2$ is not decomposed
- RBCs are deformed so malarial parasite fails to multiply
- Such people are favoured by natural selection.

(b) (i) Loss of genes from the gene pool.
(ii) The living organisms employed to destroy the undesirable organisms.
(iii) Any protein/substance that triggers the production of antibodies/stimulates the immune system.
(iv) Severe type of mental illness in which the victim forgets everything/loses touch with reality.

(c) Biofortification

It is a method of breeding/ use of recombinant DNA technology in crops to increase their nutritional value.

**Question 10**

(a) List the activities of Community Health Services. **[4]**

(b) Give *three* early diagnostic symptoms of cancer. **[3]**

(c) Define: **[3]**

(i) Carrying capacity

(ii) Implant

(iii) Carcinoma

Comments of Examiners

(a) A number of candidates wrote anything and everything related with Health and Community. Valid points were found to be missing in many answers.

(b) This part was attempted well by many candidates but some wrote general points like, fever and weight loss when key words were rapid/ unexplained weight loss, persistent cough, etc.

(c) (i) 'Carrying capacity' was confused with 'Population density' or 'Biotic potential' by several candidates. The word 'maximum' which was the key word was missing in many answers.

(ii) Some candidates could not differentiate between implant/ transplant/ Prosthesis and hence wrote a vague definition.

(iii) Several candidates defined 'carcinogen' instead of 'carcinoma'. Some just defined it as 'type of cancer', without specifying skin/epithelial tissue.

*Suggestions for teachers*

- Teachers should stress on valid points even in general topics.
- Precise symptoms need to be given. At least four correct symptoms should be learnt.
- Exact definition with key words should be given importance.
- Must insist on writing cancer of epithelial tissue/ skin.

**MARKING SCHEME**

**Question 10.**

(a)
- Maintaining sanitation of the environment by providing pure and safe drinking water/ collection of vital statistics/ proper disposal of sewage/ medical care.
- Providing facilities for prevention & control of communicable diseases.
- Providing maternity & child health services.
- Providing school education/ community health education/ nutrition education/ family welfare/ rehabilitation of drug addicts/ alcoholics.

(b)
- Lump of hard tissue in the breast or throat or any area
- Persistent cough
- Change in the nature of mole/wart
- Unexplained weight loss
- Wound does not heal

- Prolonged hoarseness
- Excess loss of blood from any open wound
- Change in bowel movement

(c) 1) Carrying capacity – it is the maximum number of individuals which the environment can support or sustain.

2) Implant – A tissue or organ/artificial device inserted surgically into the human body to replace a defective one.

3) Carcinoma – malignant growth of epithelial tissue or skin.

**GENERAL COMMENTS:**

**(a) Topics found difficult by candidates in the Question Paper:**

- Peritoneal Dialysis
- Natural and Artificial selection.
- Contribution of Ronald Ross.
- Definition of Aeroponics, Root pressure, Bio fortification.
- Feedback control of tropic hormones.
- Role of Pancreas in digestion of various food materials.
- G6PD deficiency in relation to malaria.
- Neo Darwinism.

**(b) Concepts between which candidates got confused:**

- Hemodialysis and Peritoneal Dialysis, Darwinism and Neo Darwinism.
- Advantages and disadvantages of Vegetative Reproduction.
- Differences between apes and man with respect to (a) brow ridges (b) locomotion
- Antigen and Pathogen.
- L.S and T.S of Bone.
- Bio fortification and Bio magnification.

**(c) Suggestions for students:**

- Learn definitions with the key words.
- Learn compatible differences.
- Study should be accompanied by appropriate diagrams for proper understanding.
- Answers should be precise and written in the correct sequence.
- Learning must be done on a day to day basis to avoid bulk study at the end.
- While writing abbreviations, take care of spellings.
- Read the question proper very carefully.
- Diagrams should be shaped correctly and correct labelling should be done.

# BIOLOGY PAPER 2 (PRACTICAL)

**Question 1** **[5]**

(a) Examine carefully the flower specimens **D41** and **D42** provided. Describe the floral characteristics of each in semi-technical terms. (Details of individual whorls are not required.)

(b) Cut a longitudinal section of the specimen **D41** with a sharp razor blade. Arrange one of the cut surfaces on a moist filter paper. Draw a neat and labelled diagram of this cut surface.

(c) Similarly, with the help of a sharp razor blade, cut a longitudinal section of the specimen **D42**. Arrange one of the cut surfaces on a moist filter paper. Draw a neat and labelled diagram of this cut surface, highlighting the essential whorls.

(d) Observe the cut surfaces of **D41** and **D42** and record the following features in a tabular form as given below:

| **Androecium** | | **D41** | **D42** |
|---|---|---|---|
| (i) | Relation of stamens to each other | -- | -- |
| (ii) | Attachment of anther to filament | -- | -- |
| **Gynoecium** | | | |
| (i) | Nature of stigma | -- | -- |
| (ii) | Structure of placenta | -- | -- |

(e) Take a fresh specimen of **D41.** With the help of a forceps, remove the whorls one by one, till you reach the gynoecium. With the help of a sharp razor blade, cut a transverse section of the ovary. Draw a neat and labelled diagram of the transverse section.

(f) Name the families to which **D41** and **D42** respectively belong.

(g) Write *one* characteristic of each family named by you in (f).

(h) Draw the floral diagram of specimen **D42**.

(i) Write the floral formulae of **D41 and D42**.

(j) Mention *one* economically important plant belonging to each family mentioned in (f) above. (Write the botanical name only.)

Comments of Examiners

(a) Several candidates did not mention all the technical terms. Spelling errors were made by many candidates in writing semi-technical terms. A few candidates, who could not comprehend the meaning of semi-technical terms, described all the four individual whorls. Some candidates used two terms like, regular/ actinomorphic for one expression.

(b) In some cases, the epicalyx and sepals were not drawn in the correct position (for D41).

(c) For D42, the gamopetalous and epipetalous conditions were not clear in some diagrams. The bifid stigma was not shown and at many times, the ovules were not attached with the placenta. Mistakes were also made by candidates in labelling – 'calyx' was written in place of 'sepals', 'corolla' in place of 'petal'.

(d) (i) Many candidates did not follow the instruction of recording the features in a tabular form. Some did not use the term 'monadelphous' for D-41. For D-42 many candidates were confused between 'polydelphous' and 'polyandrous'.

(ii) Many candidates were not clear about the terms 'basifixed' and 'dorsifixed'. Spelling errors were also observed. The term 'axile' placentation was misspelt by many candidates as 'axial' or 'exile'.

(e) Some of the mistakes made by candidates in the diagram were: the five locules were not drawn; two ovules in each locule were not drawn; the ovules were not attached to the placenta; some candidates drew the L.S instead of the T.S.

(f) The names of the families were misspelt by some candidates.

(g) Many candidates wrote general characteristics of the family. They ignored the most significant features of the family.

(h) In many cases, the position of the mother axis was incorrect, as a result, the orientation of the whorls was wrong; epipetalous condition, obliquely placed ovary and swollen placenta was not shown by many candidates.

(i) In some cases, the number of episepals was given in a range (5-7); punctuation was used in the floral diagram. Signs of epipetalous condition and superior ovary were ignored by many candidates.

(j) The rules of binomial nomenclature were not followed by many candidates. Spelling errors were common.

*Suggestions for teachers*

- A list of common semi-technical terms must be given to the students. They should then be trained to write the terms with correct spellings.
- Students should be encouraged to draw from the cut surface of a fresh specimen and not to copy from a book. Diagrams must be proportionate and correctly labelled. Fixation must be clear.
- Students must be encouraged to read the question paper and follow the instruction given.
- Types of fixation must be taught using fresh specimen.
- Students should be encouraged to prepare their own temporary slides of the T.S of ovary, view under microscope and then draw. Insist on labelling all the parts.
- Emphasise and point out the most significant feature of the family while teaching.
- Explain the significance and relevance of the mother axis and positioning of the whorls according to it.
- Draw the floral diagram and write the flora formula on the board and explain clearly. Lab manuals must be checked regularly.
- Ensure that scientific names are always written according to the rules of Binomial nomenclature.

**MARKING SCHEME**

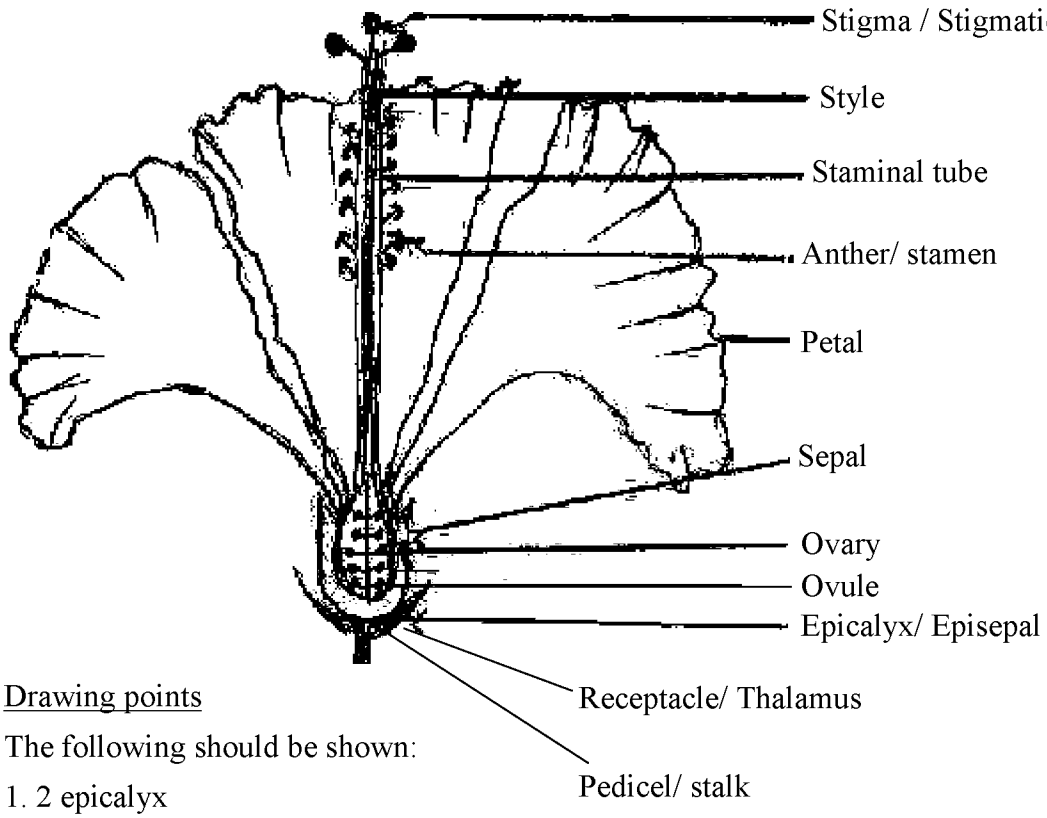
**Question 1.**

(a) D-41: Hibiscus: Pedicillate, ebracteate, bracteolate/ with epicalyx, complete, actinomorphic/ regular, cyclic bisexual / hermaphrodite, pentamerous, hypogynous

D-42: Dhatura: Ebracteate, pedicillate, cyclic, pentamerous, actinomorphic/ regular, bisexual / hermaphrodite, hypogynous, infundibuliform/ bell/ funnel/ campanulate, complete.

Petunia: Ebracteate, pedicillate, cyclic, hypogynous, actinomorphic/ regular, bisexual / hermaphrodite, complete, pentamerous, infundibuliform/ bell/ funnel

(b) Drawing: L.S. of flower (D-41)

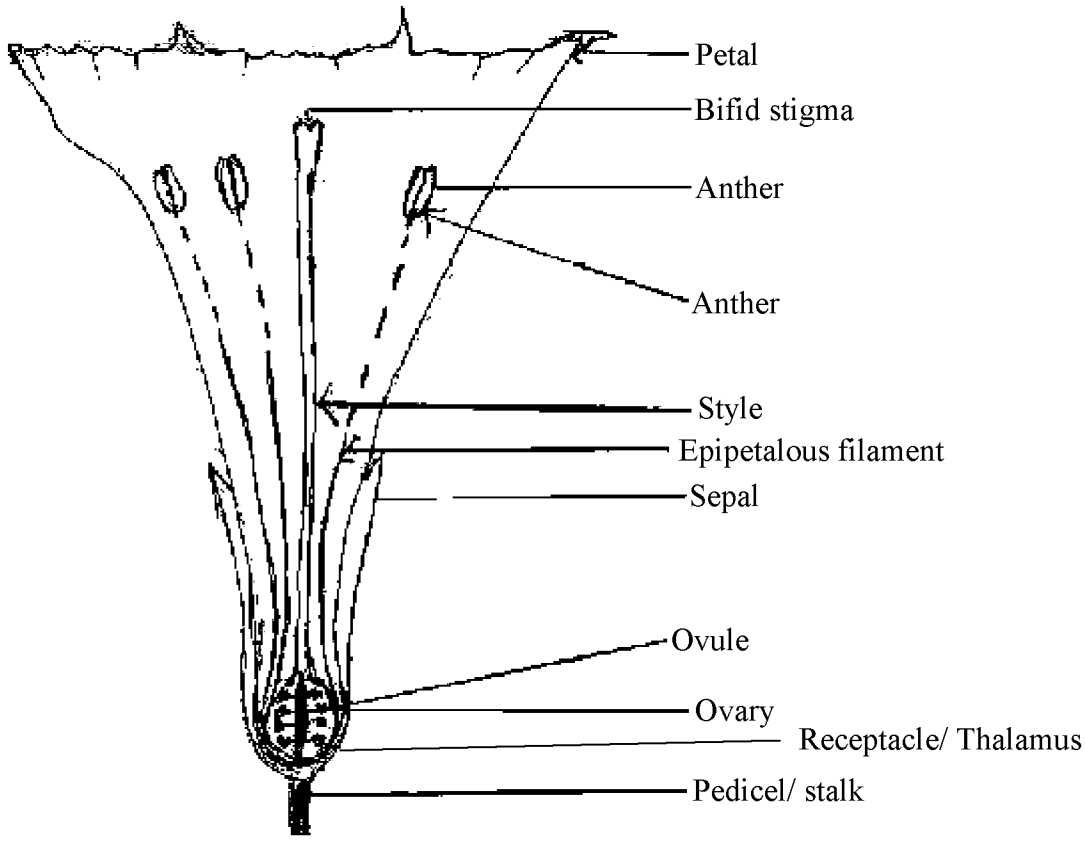



Drawing points

The following should be shown:

1. 2 epicalyx
2. 2 sepals
3. 2-3 free petals
4. Staminal tube
5. Thin long style (passing through the staminal tube)
6. Many (4-6) reniform anthers attached to the staminal tube
7. 2-3 capitate stigma
8. 2 locules visible in the ovary
9. 2 rows of ovules attached to the placenta

(c) Drawing: L.S. of flower (D-42)




Drawing points

The following should be shown:

1. 2 sepals (long)
2. 2-3 gamopetalous (bell shaped) petals
3. 2-3 epipetalous stamens
4. Long and basifixed anther
5. Prominent style with bifid stigma
6. Style shorter than the petals
7. 2 locules visible in the ovary
8. 2 rows of ovules attached to the placenta

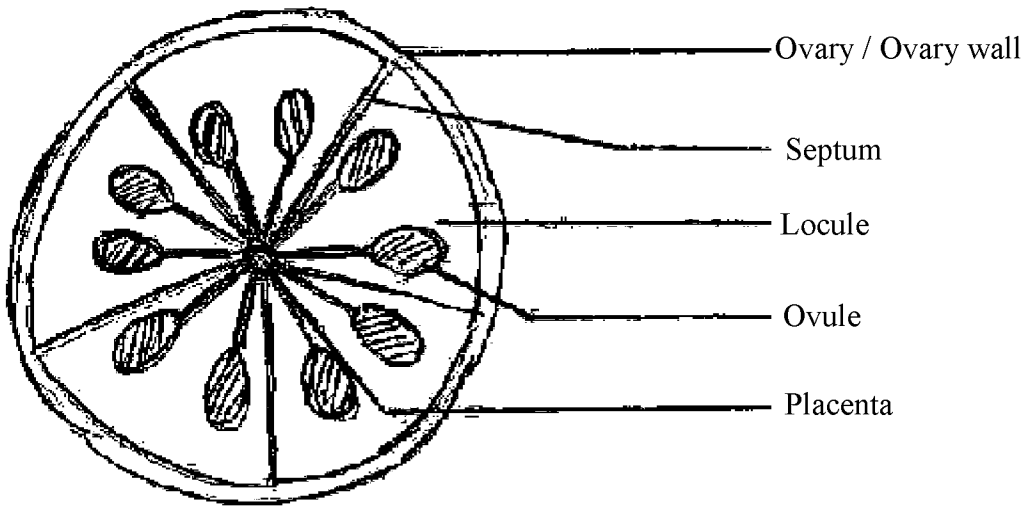
(d)

| | **D-41** | **D-42** |
|---|---|---|
| **ANDROECIUM** | | |
| i) Relation of stamens to each other | Monadelphous | Polyandrous |
| ii) Attachment of anther to filament | Dorsifixed/Basifixed | Basifixed |

**GYNOECIUM**

| | | |
|---|---|---|
| i) Nature of stigma | Capitate/pentafid/five stigmatic lobe | Bifid |
| ii) Structure of placenta | Thin/regular/axile | Swollen/oblique/thick/axile |

(e) Diagram: T.S. of ovary of D-41




Drawing points

The following should be shown:

1. 5 locules
2. 2 ovules in each locule
3. ovules attached to the placenta
4. ovary wall
5. axile placentation

(f) D-41 Malvaceae

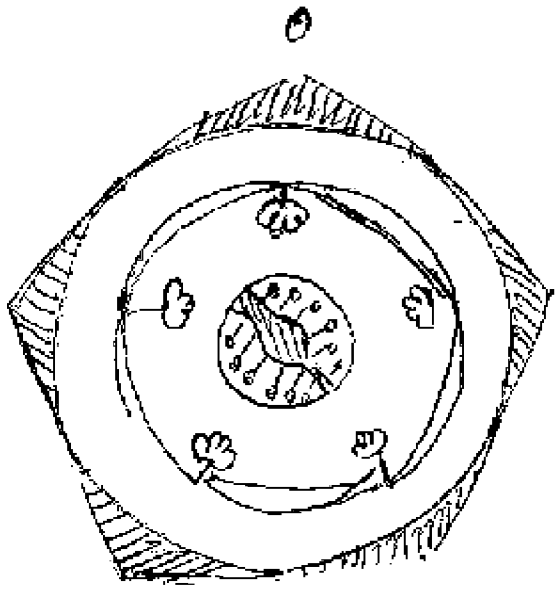
D-42 Solanaceae

(g) Family characteristics

D-41 - Monadelphous stamen / reniform anther / mucilaginous flower / style passes through staminal tube / epicalyx present.

D-42 - Obliquely placed ovary / swollen placenta / bifid stigma / epipetalous stamen

(h) Floral diagram of D-42

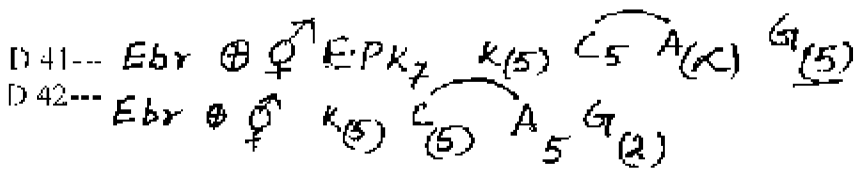


Drawing points

The following should be shown:

1. Mother axis
2. 5 joined sepals with correct orientation
3. 5 joined petals with correct orientation
4. epipetalous stamen alternating to petals
5. bilocular ovary obliquely placed/ tetralocular
6. swollen placenta
7. axile placentation

(i)




(j) **D-41:**

1. Gossypium arboreum
2. Hibiscus rosa sinensis
3. Althea rosea
4. Hibiscus cannabinus

**D-42:**

1. Solanum tuberosum
2. Solanum melanogena
3. Nicotina tabacum
4. Alotropa belladonna

**Question 2** **[5]**

(a) Measure and pour 20 ml of solutions $S_1$, $S_2$ and $S_3$ into three separate petri dishes. Label the petri dish with solution $S_1$ as A, with solution $S_2$ as B and with solution $S_3$ as C. Cover the three petri dishes.

(b) You are provided with a potato, specimen **D43**. Peel the potato. With the help of a knife, cut three rectangular pieces, each measuring approximately 4cms × 0·5cm × 0·5cm in length, width and thickness respectively.

(c) Place the potato pieces on a moist filter paper to prevent drying. Measure and record the exact length of each piece.

Fully immerse one piece in solution $S_1$, in petri dish A. Similarly, immerse the second piece in solution $S_2$, in petri dish B and the third piece in solution $S_3$, in petri dish C.

(d) Cover the petri dishes and leave them as such for 30 minutes.

**Show the set up to the Visiting Examiner**.

(e) After 30 minutes, remove the potato piece from dish A. Dry it on a filter paper and measure it. Record the length. Repeat the procedure with the pieces from petri dishes B and C.

(f) Record the length of each piece in a tabulated form as shown below:

| Length of rectangular potato piece | | At the beginning | After 30 minutes |
|---|---|---|---|
| (i) | In $S_1$ solution - petri dish A | | |
| (ii) | In $S_2$ solution - petri dish B | | |
| (iii) | In $S_3$ solution - petri dish C | | |

(g) Explain the observation of each potato piece in petri dishes A, B and C as recorded by you in (f) above.

(h) With the help of forceps pick up the potato piece from petri dish A. Place it on a dry filter paper. Touch it and feel it. Write your observation regarding any change you have noticed.

Repeat the process with potato pieces from petri dishes B and C.

(i) Explain the changes (if any) observed by you in (h) above.

(j) Name and define the process that led to the changes (if any) observed in (h) above.

(k) Comment on the tonicity of the solutions $S_1$, $S_2$, and $S_3$.

(l) What do you think would happen if a red blood corpuscle is placed in solution $S_1$?

(m) Give an example of a similar observation seen in a plant body as that observed in petri dish C due to occurrence of the same phenomenon.

Comments of Examiners

(a) Some of the candidates did not use the solutions in perfect amount. Observations made by candidates revealed that either solutions S1, S2 and S3 were not taken in proper petri dishes A, B, C, respectively, or they were confused while marking.

(b) From the answer scripts it appeared that many candidates did not cut the photo according to the dimensions mentioned in the question paper.

(f) The unit of measurement was not mentioned by many candidates; some did not write the observation in the tabular form. Many candidates did not mention the initial measurement in the Column after 30 minutes.

(g) The observation of each potato piece in petri dishes A, B, and C was not written separately in some cases; in other cases, the explanation lacked keywords and the process involved.

*Suggestions for teachers*

- Ask students to follow the instructions accurately.
- Emphasise the use of "Keywords".
- Help students understand the concepts of osmosis, plasmolysis and deplasmolysis. Emphasise that osmosis in the movement of solvent only.
- Provide a clear understanding of words like hypertonic, hypotonic and isotonic.
- Train students to answer logically to a specific question.

(h) Many candidates ignored 'touch it and feel it' part of the question. Most observations were recorded on the basis of the alteration of the length of the pieces and not on the basis of how it felt when touched.

(i) In several cases, the explanation given by candidates lacked the key words. Many failed to explain the changes correctly.

(j) Many candidates were unable to name and define the process involved. Candidates did not have a clear concept of terms like Plasmolysis and Osmosis. They defined Plasmolysis and deplasmolysis instead of Exosmosis and Endosmosis.

(k) The concept of tonicity was not clear to many candidates.

(l) The term 'crenation' was not used by a number of candidates. Many used wrong terms like - plasmolysed, turgid, etc.

(m) Many candidates gave wrong examples in this part.

**MARKING SCHEME**

**Question 2.**

(f)

| | Length of the piece of D-43 | At the beginning | After 30 minutes |
|---|---|---|---|
| 1. | In $S_1$ – Petridish A | 4 cms | Decreased / 3.7 |
| 2. | In $S_2$ – Petridish B | 4 cms | No change / 4 |
| 3. | In $S_3$ – Petridish C | 4 cms | Increased / 4.3 |

(g) $S_1$ – solution is hypertonic, exosmosis occurs, potato piece becomes smaller.

$S_2$ – solution is isotonic, exosmosis/endosmosis does not occur, potato piece size remains the same.

$S_3$ – solution is hypotonic, endosmosis occurs, potato size increases.

(h) $S_1$ – Potato piece is soft and limp.

$S_2$ – Potato piece appears same as before/ no change.

$S_3$ – Potato piece is stiff and hard.

(i) $S_1$ – As the potato piece was kept in hypertonic solution it lost water through exosmosis due to which it became soft and decreased in size.

$S_2$ – Solution is isotonic as a result the potato piece showed no change.

$S_3$ – Solution is hypotonic as a result the potato piece increased in size due to endosmosis and became stiff.

(j) Endosmosis - movement of solvent molecules from the surrounding into the cell sap due to difference in tonicity, i.e. from hypo to hyper.

Exosmosis – movement of solvent molecules from the cell sap to the surrounding.

(k) Tonicity of solutions:

$S_1$ – Hypertonic

$S_2$ – Isotonic

$S_3$ – Hypotonic

(l) RBC would shrink due to exosmosis and may get crenated.

(m) Absorption of water by root from the soil.

Opening of stomata.

Turgidity of leaf.

**Question 3** **[5]**

(a) With a sharp razor blade, cut several transverse sections of the specimen **D44** provided. Select a good section and stain with safranin. Mount it in glycerine.

**Show your slide to the Visiting Examiner under low power of Microscope**.

(b) Draw a neat labelled diagram of the mount as seen under the microscope. (Microscopic details are not required.)

(c) Identify the given specimen.

(d) Write *three* characteristic features of this specimen.

Comments of Examiners

(a) Candidates of certain centres were unable to prepare the slide properly- sections were oblique, overstained or understained.

(b) Microscopic details were drawn by some candidates, which were not required. A few candidates drew only one or two bundles, as a result, the 'scattered' condition was not clear. The conjoint, collateral and closed nature of the vascular bundles was not clear. In a number of cases, the labelling was incomplete.

(c) By and large this part was answered correctly. A few candidates identified the specimen as 'dicot stem' or 'dicot root'.

(d) Instead of writing the key identifying features, some candidates wrote general characteristics. Some candidates were confused between the terms 'endarch' and 'exarch'.

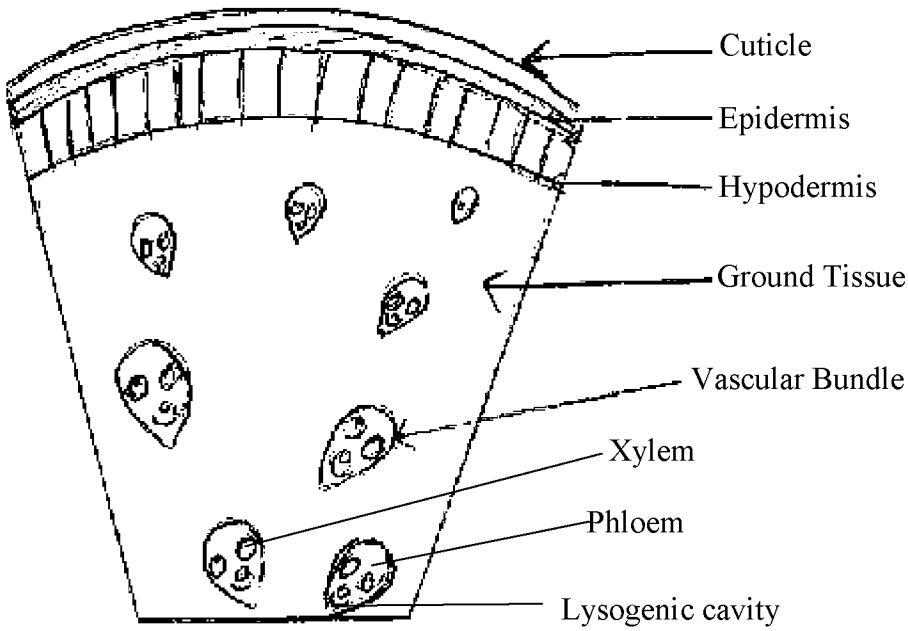
*Suggestions for teachers*

- Sufficient practice needs to be given in slide preparation. Oblique sections must be rejected.
- Students must be trained to draw outline diagrams and to show the structure of vascular bundles clearly. All parts must be labelled. The difference in the size of vascular bundles must be emphasised.
- Train students to observe the most distinctive features under the microscope.

**MARKING SCHEME**

**Question 3.**

(b)




Drawing points:

1. Vascular bundles are conjoint, collateral and closed
2. Vascular bundles are scattered
3. Y shaped arrangement of xylem vessels
4. Pith is indistinct

5. Vascular bundles are of different sizes, smaller ones are seen towards the periphery and the larger ones towards the centre
6. Cuticle/ hypodermis present
7. Lysogenous cavity

(c) (T.S.) monocotyledonous stem

(d)
1. Vascular bundles are conjoint, collateral and closed.
2. Vascular bundles are scatterd in the ground tissue.
3. Hypodermis is sclrenchymatous.
4. Pith is indistinct.
5. Vacular bundles are of various sizes.
6. Y shaped arrangement of xylem.
7. Lysogenous cavity
8. Endarch Xylem

*(Points 1 or 2 must be mentioned and any two from the rest)*

**Question 4** **[5]**

Identify the given specimens A to E. Give *two* reasons to support your answer in each case. Draw a neat labelled diagram of each specimen. You are not allowed to spend more than three minutes for each spot.

**Note**: *Hand over your continuation sheets to the Supervising Examiner after you finish answering this question.*

Comments of Examiners

**Spot A:** Incomplete identification was done by many candidates. Several candidates omitted to write 'T.S' or 'mammalian ovary'; the different follicular stages were not shown in some cases; a few candidates labelled 'primordial follicle' as 'primary follicle'; in some cases, Graffian follicle not drawn correctly. The key identifying features were not written correctly by many candidates.

**Spot B:** This was wrongly identified as 'germinating pollen tube', or 'germinating seed'. In other cases, 'rough exine' was not drawn; the germ pore was not labelled; the two nuclei were not labelled correctly.

**Spot C:** While identifying the spot, several candidates failed to write 'T.S'. In other cases, unicellular root hair not drawn; the radial arrangement was not clear; proto and metaxylem were of same size; pith was made distinct; endodermis and pericycle were wrongly labelled.

*Suggestions for teachers*

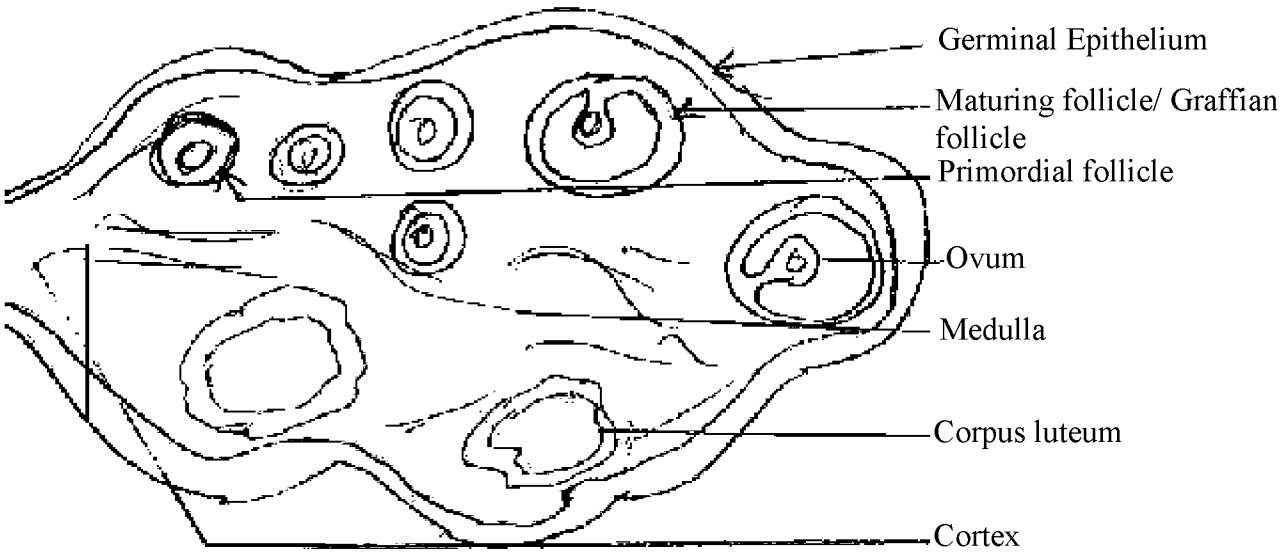
- Give regular training to students so that they can make correct observations, within the given time. The drawings should highlight the specific features.
- Insist that the diagram drawn is clear and correctly labelled. Identifying features must be given importance.
- Insist on correct diagram and complete labelling. Cellular details are not required in spotting.
- In the physiological set up a complete statement should be given for identification.

**Spot D:** Incomplete or incorrect identification was made by many candidates, i.e. the word 'Model' was missing. Some candidates identified the spot as, 'synovial joint' or 'hinge joint'.
**Spot E:** Incomplete identification was done by many candidates. In some cases, only 'photosynthesis' was mentioned. Some identified it as, 'Process of Transpiration'. In the diagrams drawn by several candidates, the leaf was not attached to the plant; the flask was not balanced; source of light was not shown; instead of a complete leaf, only a part of the leaf was inserted in the flask.

**MARKING SCHEME**

**Question 4.**

SPOT A: Identification – T.S. of Ovary of mammal



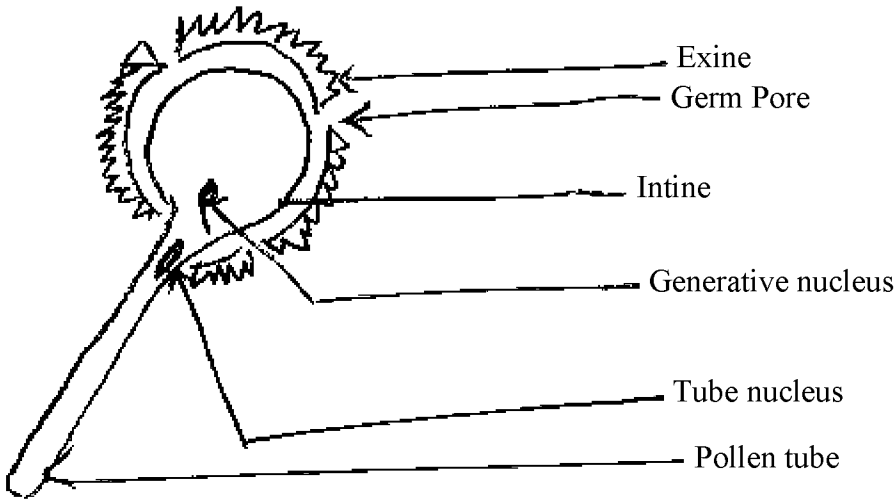

Drawing points:

1. Follicles of different sizes shown.
2. Germinal epithelium present.
3. Ovum seen in mature follicle.
4. Empty follicle visible.
5. More follicles in the cortex.

Reason:

1. Many ovarian follicles of different sizes seen.
2. Germinal epithelium visible.
3. Matured follicle has ovum in it.
4. Corpus Luteum visible.

SPOT B: Identification – Germinating pollen grain



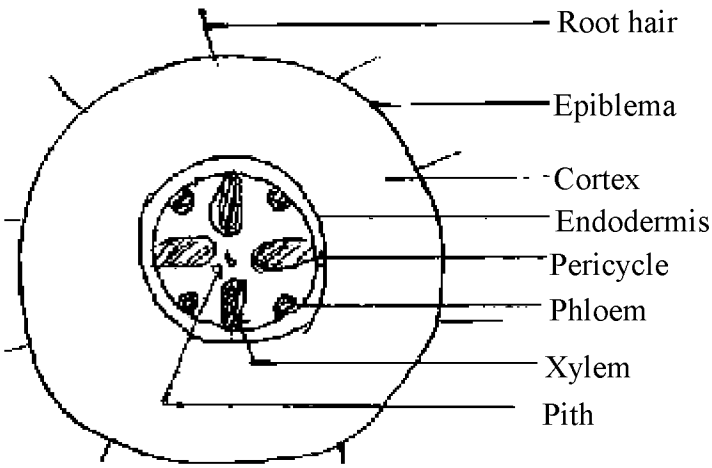

Drawing points:

1. Rough exine visible.
2. Germ pore shown.
3. (Smooth) intine extends as pollen tube.
4. Two nuclei shown.

Reason:

1. (Rough) exine attached with germ pore.
2. Pollen tube projecting out of a germ pore.
3. 2 nuclei visible.
4. Intine present.
5. Germ pore is present

SPOT C: Indentification – T.S. of dicotyledonous root



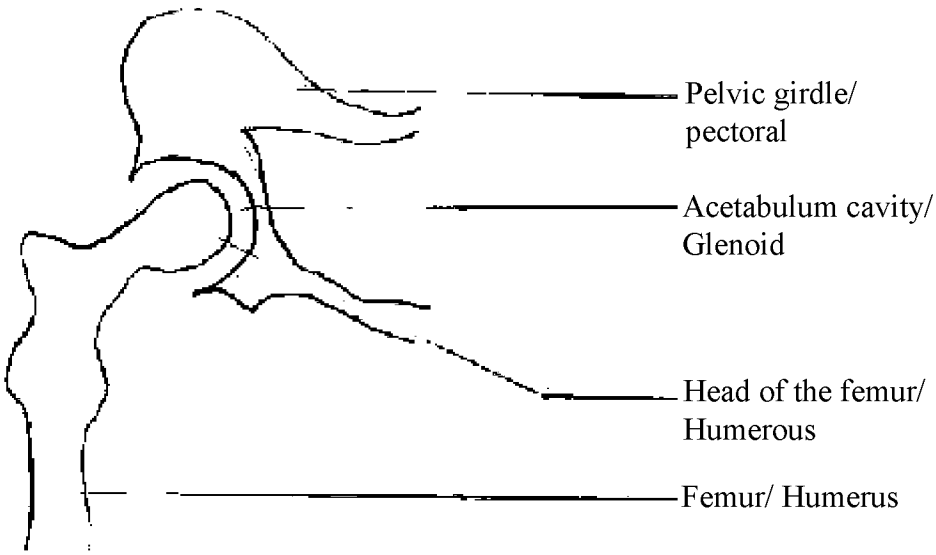
Drawing points:

1. Unicellular root hair shown.
2. Radial vascular bundles (3 – 6).
3. Xylem exarch.
4. Pith indistinct.

Reason:

1. Vascular bundles are radial and exarch.
2. Number of vascular bundles 6 or less.
3. Pith is indistinct.
4. Xylem is exarch.

SPOT D: Identification – Model of Ball and Socket Joint



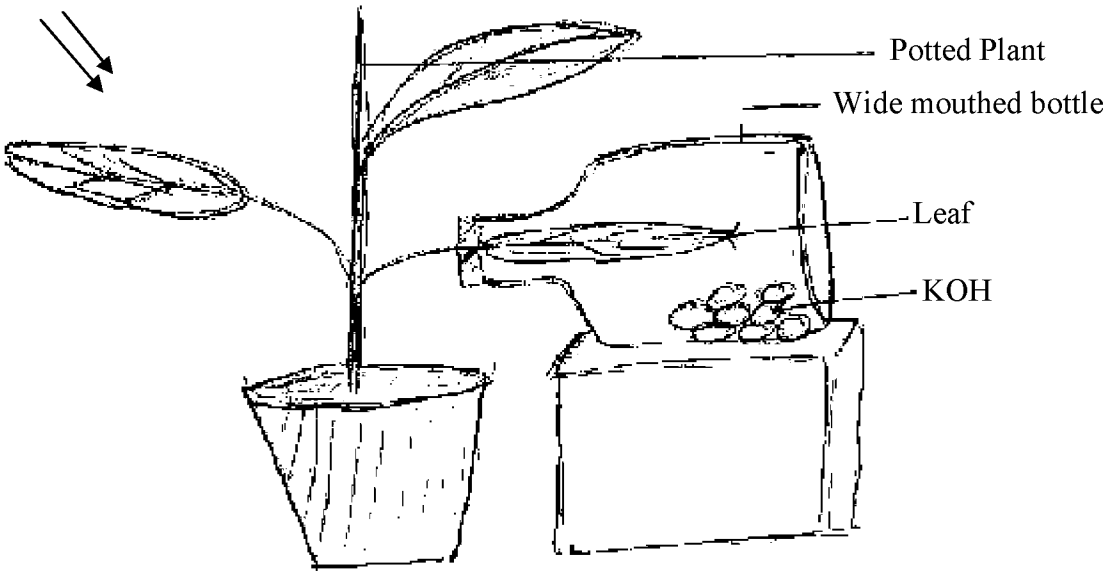

Drawing points:

1. Acetabulum cavity of pelvic girdle / glenoid cavity of pectoral girdle shown.
2. Head of the femur is fitted into the acetabulum cavity / head of the humerus fitted into the glenoid cavity.
3. Femur/Humerus drawn.

Reason:

1. Depressed cavity/socket is clearly visible (any girdle).
2. Head of the long bone (name) is within the socket and allows free movement.

SPOT E: Identification – Experimental setup to show that carbon dioxide is necessary for photosynthesis




Drawing points:

1. Leaf is connected to the potted plant.
2. One leaf is inside the bottle.
3. KOH is present inside the bottle.
4. Bottle is balanced.
5. Light rays are shown.

Reason:

1. Leaf present in the bottle does not receive cardon dioxide as KOH absorbs it.
2. As a result experimental leaf cannot carry out photosysthesis and would give negative result for the starch test.

## GENERAL COMMENTS:

**(a) Topics found difficult by candidates in the Question Paper:**

- Using of semi technical terms with correct spelling.
- Tabulating the information.
- Floral formula and Floral diagram.
- Correct spelling of scientific names.
- Concept of tonicity.
- Interpretation of observation in the physiology experiment.

**(b) Concepts between which candidates got confused:**

- Staminal tube and style.
- Monadelphous and polyandrous condition.
- Concept of endarch and exarch xylem.
- Concept of conjoint, collateral and closed vascular bundles.
- Tonicity of the solutions.
- Concept of osmosis- (endosmosis and exosmosis) and plasmolysis

**(c) Suggestions for students:**

- Given importance to practical classes.
- Do not compartmentalize theory and practical classes, both complement each other.
- Observe specimens and physiological setup keenly.
- Follow instructions given in the question.
- Reading the question paper carefully to understand the scope of the question.
- Use the keywords in the answer and be precise.
- Focus the slide correctly.
- Practice diagrams and their labelling regularly.
- Be through with the semi technical terms.
- Learn the most significant features for identification.

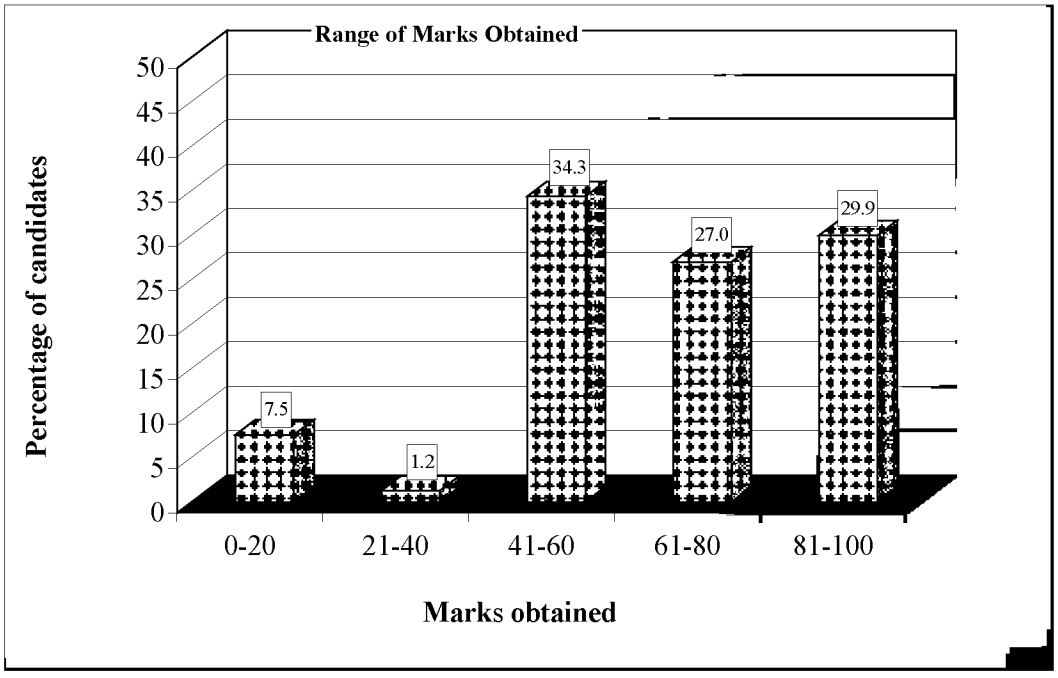
# MATHEMATICS

## A. STATISTICS AT A GLANCE

| | |
|---|---|
| Total number of students taking the examination | 41,537 |
| Highest marks obtained | 100 |
| Lowest marks obtained | 0 |
| Mean marks obtained | 65.85 |

### Percentage of candidates according to marks obtained

| | Mark Range | | | | |
|---|---|---|---|---|---|
| | ***0-20*** | ***21-40*** | ***41-60*** | ***61-80*** | ***81-100*** |
| Number of candidates | 3128 | 513 | 14265 | 11197 | 12434 |
| Percentage of candidates | 7.5 | 1.2 | 34.3 | 27.0 | 29.9 |
| Cumulative Number | 3128 | 3641 | 17906 | 29103 | 41537 |
| Cumulative Percentage | 7.5 | 8.8 | 43.1 | 70.1 | 100 |



## B. ANALYSIS OF PERFORMANCE

### SECTION A

**Question 1** **[10 × 3]**

(i) If (A – 2 I) (A – 3 I) = 0, where A = . $\begin{pmatrix} 4 & 2 \\ -1 & x \end{pmatrix}$. and I = $\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$, find the value of $x$.

(ii) Find the value(s) of $k$ so that the line $2x + y + k = 0$ may touch the hyperbola $3x^2 - y^2 = 3$.

(iii) Prove that: $\tan^{-1}\frac{1}{4} + \tan^{-1}\frac{2}{9} = \frac{1}{2}\sin^{-1}\frac{4}{5}$

(iv) Using L'Hospital's Rule, evaluate:

$$Lim_{x\to 0}\left(\frac{e^x - e^{-x} - 2x}{x - \sin x}\right)$$

(v) Evaluate: $\int \frac{1}{x + \sqrt{x}}\,dx$

(vi) Evaluate: $\int_0^1 \log\left(\frac{1}{x} - 1\right)dx$

(vii) Two regression lines are represented by $4x + 10y = 9$ and $6x + 3y = 4$.
Find the line of regression of $y$ on $x$.

(viii) If 1, $w$ and $w^2$ are the cube roots of unity, evaluate $(1 - w^4 + w^8)(1 - w^8 + w^{16})$

(ix) Solve the differential equation:

$$log\left(\frac{dy}{dx}\right) = 2x - 3y$$

(x) If two balls are drawn from a bag containing three red balls and four blue balls, find the probability that:

(a) They are of the same colour.

(b) They are of different colours.

Comments of Examiners

(i) Errors were made by candidates while multiplying matrices because of carelessness. Some could not equate the Left Hand Matrix with Null Matrix.

(ii) Mistakes were made while expressing the given hyperbola in the standard form (i.e., $\frac{x^2}{a_2} - \frac{y2}{b2} = 1$) and values of $a^2$, $b^2$ are incorrect. Some candidates used the wrong formula for condition of tangency of a line with hyperbola.

(iii) After obtaining tan-1 $\left(\frac{1}{2}\right)$ on the Left Hand Side many could not proceed further.

(iv) Some candidates used U/V rule instead of L' Hospital's Rule, as required. Derivative of $e^{-x}$ was wrongly taken as $e^{-x}$ instead of $-e^{-x}$.

(v) Errors were made by some candidates while using inappropriate substitutions. Some used rationalization of the denominator process and then tried to decompose in to partial Fractions without success.

(vi) Use of the property $\int_0^a f(x)dx = \int_0^a f(a-x)dx$, as not made by many. Some used the method of integration by parts but this involved complicated steps which many could not handle.

(vii) Many candidates solved the equations unnecessarily and tried to identify $b_{yx}$ arbitrarily. The condition for the two equations to represent regression lines and the tests for identifying them were not used by some.

(viii) Some candidates expanded directly but failed to simplify $w^3$ and higher degrees into simplest form before proceeding. Also use of $1+w+w^2= 0$ was not made by some.

(ix) Several candidates substituted √=2x-3y and thus made things more complicated. Some could not get $\frac{dy}{dx} = e^{2x-3y}$ from the given, $\log\left(\frac{dy}{dx}\right) = 2x-3y$. Separation of variables hence or otherwise was incorrect.

*Suggestions for teachers*

- Basic operations with Matrices need to be explained. Difference between Matrix and Determinant should be made clear by discussing separately with sufficient practice. The concept of equality of matrices and taking of only those values of the unknown variable that satisfy all conditions must be clear.
- If hyperbola is $\frac{x^2}{1} - \frac{y^2}{3} = 1$, then $a^2=1$, $b^2=3$
  Condition for the line y = mx + c, to be a tangent to the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$, is, C = $\pm\sqrt{a^2m^2 - b^2}$.
  These basics have to be taught clearly.
- Conversion of inverse circular functions (one to another) needs to be explained clearly to students. Plenty of practice is required to understand the applications of the laws, especially double angle laws.
- Applications of L'Hospital's Rule for calculating Limits of Indeterminate Forms $\left(\frac{0}{0} or \frac{\infty}{\infty}\right)$ should be taught well. In the rule the numerator and denominator need to differentiated separately till $\frac{0}{0}$ is removed.
- Teach properties of definite integrals well and see that the students learn to apply them appropriately. Properties when correctly used reduce cumbersome calculations into simple ones.

(x) Addition property was not used by some candidates. The probability of drawing 2 balls of the same colours implies the case of both being red and both being blue. Some failed to take these cases.

Some took the probability of different colours as $\frac{3}{7}\times\frac{4}{7}$ instead of $\left(\frac{{}^{3}c_1\cdot{}^{4}c_1}{{}^{7}c_2}\right)$ or $\left(\frac{3}{7},\frac{4}{6}+\frac{4}{7},\frac{3}{6}\right)$.

**MARKING SCHEME**

**Question 1.**

(i) $A=\begin{pmatrix}4 & 2\\ -1 & x\end{pmatrix}$, $I=\begin{pmatrix}1 & 0\\ 0 & 1\end{pmatrix}$, $A-2I=\begin{pmatrix}2 & 2\\ -1 & x-2\end{pmatrix}$ $A-3I=\begin{pmatrix}1 & 2\\ -1 & x-3\end{pmatrix}$

$$(A-2I)\cdot(A-3I)=\begin{pmatrix}2 & 2\\ -1 & x-2\end{pmatrix}\begin{pmatrix}1 & 2\\ -1 & x-3\end{pmatrix}=\begin{pmatrix}0 & 2x-2\\ -x+1 & x^2-5x+4\end{pmatrix}$$

(A – 2I) (A– 3I) = 0 , hence $2x-2=0 \therefore x=1$

(ii) $3x^2-y^2=3$

$$\frac{x^2}{1}-\frac{y^2}{3}=1$$

$a^2=1,\ b^2=3$

$y=-2x-k$

$m=-2,\ c=-k$

Condition for tangency:

$c^2=a^2m^2-b^2$

$\Rightarrow k^2=4-3=1$

$k=\pm1$

(iii) LHS $=\tan^{-1}\frac{1}{4}+\tan^{-1}\frac{2}{9}=\tan^{-1}\left(\frac{\frac{1}{4}+\frac{2}{9}}{1-\frac{1}{4}\cdot\frac{2}{9}}\right)$

$$=\tan^{-1}\frac{1}{2}=\frac{1}{2}\left(2\tan^{-1}\frac{1}{2}\right)$$

$$=\frac{1}{2}\cdot\sin^{-1}\frac{2\left(\frac{1}{2}\right)}{1+\left(\frac{1}{2}\right)^2}=\frac{1}{2}\sin^{-1}\frac{4}{5}$$

= RHS

(iv) $\underset{x\to 0}{Lim}\dfrac{e^x-e^{-x}-2x}{x-\sin x}\left(\dfrac{0}{0}\right)=\underset{x\to 0}{Lim}\dfrac{e^x+e^{-x}-2}{1-\cos x}\left(\dfrac{0}{0}\right)$

$=\underset{x\to 0}{Lim}\dfrac{e^x-e^{-x}}{\sin x}\left(\dfrac{0}{0}\right)=\underset{x\to 0}{Lim}\cdot\dfrac{e^x+e^{-x}}{\cos x}=2$

(v) $\int\dfrac{1}{x+\sqrt{x}}dx$

$=\dfrac{1}{\sqrt{x}\left(\sqrt{x}+1\right)}dx$ Put $t=\sqrt{x}+1$

$\text{dt}=\dfrac{1}{2\sqrt{x}}dx$

$=\int\dfrac{2dt}{t}$

$=2\log|t|+c$

$=2\log\left|\sqrt{x}+1\right|+c$

(vi) $\text{I}=\int_0^1\log\left(\dfrac{1-x}{x}\right)dx$

$=\int_0^1\log\dfrac{x}{1-x}dx$

$2\text{I}=\int_0^1\left[\log\left(\dfrac{1-x}{x}\right)+\log\left(\dfrac{x}{1-x}\right)\right]dx$

$2\text{I}=\int_0^1\log(1)dx$

$=0$

$\therefore I=0$

(vii) Let the line of regression of y on x be

$4\text{x}+10\text{y}=9$

$\therefore y=\dfrac{-4}{10}x+\dfrac{9}{10}$

$\therefore b_{yx} = \frac{-4}{10}$

The line of regression of x on y be

$6x + 3y = 4$

$x = -\frac{1}{2}y + \frac{2}{3}$

$\therefore b_{xy} = -1/2$

$\therefore r^2 = \frac{-4}{10} \times \frac{-1}{2} = \frac{1}{5} < 1$

$\therefore$ the line of regression of y on x is $4x + 10y = 9$

(viii) $(1 - w^4 + w^8)(1 - w^8 + w^{16})$

$= (1 - w + w^2) \cdot (1 - w^2 + w)$

$= (-2w)(-2w^2)$

$= 4w^3 = 4$

(ix) $\log\left(\frac{dy}{dx}\right) = 2x - 3y$

$\frac{dy}{dx} = e^{2x-3y}$

$\therefore \frac{dy}{dx} = e^{2x} \times e^{-3y}$

$\Rightarrow \int e^{3y} dy = \int e^{2x} dx$

$\frac{e^{3y}}{3} = \frac{e^{2x}}{2} + c \quad \therefore 2e^{3y} - 3e^{2x} = k$

(x) $P(both\ red) = \frac{3C_2}{7C_2}$, $P(both\ blue) = \frac{4C_2}{7C_2}$

(a) $P(both\ same\ colour) = \frac{3C_2}{7C_2} + \frac{4C_2}{7C_2} = \frac{3+6}{21} = \frac{3}{7}$

(b) $P(both\ different\ colour) = \frac{3C_1 \times 4C_1}{7C_2} = \frac{12}{21} = \frac{4}{7}$

**Question 2**

(a) Using properties of determinants, prove that: **[5]**

$$\begin{vmatrix} x & y & z \\ x^2 & y^2 & z^2 \\ y+z & z+x & x+y \end{vmatrix} = (x-y)(y-z)(z-x)(x+y+z)$$

(b) Find $A^{-1}$, where $A = \begin{bmatrix} 4 & 2 & 3 \\ 1 & 1 & 1 \\ 3 & 1 & -2 \end{bmatrix}$ **[5]**

Hence, solve the following system of linear equations:

$4x + 2y + 3z = 2$

$x + y + z = 1$

$3x + y - 2z = 5$

Comments of Examiners

(a) Errors were made by many candidates in use of Determinant properties (e.g. $C_1$ - $C_2$ and then $C_2$ - $C_3$ cannot be followed up by $C_3$ - $C_1$ with original elements of $C_1$).
Common factors in a line were not extracted by some.
Several candidates expanded directly. At times, correct cofactors are not used.

(b) Errors were made by several candidates while calculating the cofactors of the elements of 'A' and hence or otherwise the value of determinant of 'A'.
For finding the unknown matrix X, some candidates used post-multiplication with inverse of A. A few candidates solved using Cramer's Rule.

*Suggestions for teachers*

- Determinant expansion needs to be explained well. Students must be shown how to use the properties correctly. Use of properties and extraction of common factors when they appear, help in simplifying the determinant to make the final expansion easy.
- Instil the basics with regards to cofactors of elements, obtaining adjoint and inverse and meaning of pre– and post– multiplication of matrices; e.g. if AX=B then $X=A^{-1}B$ and not BA as multiplication of matrices is not commutative.

**MARKING SCHEME**

**Question 2.**

(a) $R_3 \rightarrow R_3 + R_1$

$$\Delta = \begin{vmatrix} x & y & z \\ x^2 & y^2 & z^2 \\ y+z & z+x & x+y \end{vmatrix} = \begin{vmatrix} x & y & z \\ x^2 & y^2 & z^2 \\ x+y+z & x+y+z & x+y+z \end{vmatrix}$$

$$= (x+y+z)\begin{vmatrix} x & y & z \\ x^2 & y^2 & z^2 \\ 1 & 1 & 1 \end{vmatrix}$$

$$= (x+y+z)\begin{vmatrix} x-y & y-z & z \\ x^2-y^2 & y^2-z^2 & z^2 \\ 0 & 0 & 1 \end{vmatrix} \qquad \begin{matrix} c_1 \rightarrow c_1 - c_2 \\ c_2 \rightarrow c_2 - c_3 \end{matrix}$$

$$= (x+y+z)(x-y)(y-z)\begin{vmatrix} 1 & 1 & z \\ x+y & y+z & z^2 \\ 0 & 0 & 1 \end{vmatrix}$$

$$= (x+y+z)(x-y)(y-z)(\cdot z-x)$$

(b) $$|A| = \begin{vmatrix} 4 & 2 & 3 \\ 1 & 1 & 1 \\ 3 & 1 & -2 \end{vmatrix}$$

$$= 4(-2-1) - 2(-2-3) + 3(1-3)$$

$$= -12 + 10 - 6 = -8$$

co factors of row 1 : $-3,\ 5,\ -2$

co factors of row 2 : $7,\ -17,\ 2$

co factors of row 3 : $-1,\ -1\ ,\ 2$

$$\text{Adj } A = \begin{bmatrix} -3 & 5 & -2 \\ 7 & -17 & 2 \\ -1 & -1 & 2 \end{bmatrix}^1$$

$$= \begin{bmatrix} -3 & 7 & -1 \\ 5 & -17 & -1 \\ -2 & 2 & 2 \end{bmatrix}$$

$$\therefore A^{-1} = \frac{Adj\ A}{|A|} \qquad = -\frac{1}{8}\begin{bmatrix} -3 & 7 & -1 \\ +5 & -17 & -1 \\ -2 & 2 & 2 \end{bmatrix}$$

For the given system of equations

$$\text{AX} = \text{B}, \quad \text{where} \quad \text{X} = \begin{bmatrix} x \\ y \\ z \end{bmatrix} \quad and \quad B = \begin{bmatrix} 2 \\ 1 \\ 5 \end{bmatrix}$$

$$\therefore X = A^{-1} B$$

$$\text{X} = \frac{-1}{8}\begin{bmatrix} -3 & 7 & -1 \\ 5 & -17 & -1 \\ -2 & 2 & 2 \end{bmatrix}\begin{bmatrix} 2 \\ 1 \\ 5 \end{bmatrix}$$

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \frac{-1}{8}\begin{bmatrix} -4 \\ -12 \\ 8 \end{bmatrix} = \begin{bmatrix} 1/2 \\ 3/2 \\ -1 \end{bmatrix}$$

$$\therefore x = \frac{1}{2}, y = \frac{3}{2}, z = -1$$

**Question 3**

(a) Solve for $x$: $\sin^{-1} \text{x} + \sin^{-1}(1 - \text{x}) = \cos^{-1} \text{x}$ **[5]**

(b) Construct a circuit diagram for the following Boolean Function: **[5]**

(BC+A)(A′B′+C′) + A′B′C′

Using laws of Boolean Algebra, simplify the function and draw the simplified circuit.

Comments of Examiners

(a) Generally, the formula for $\sin^{-1}x + \sin^{-1}y$ was correctly applied on the LHS. Errors were made by candidates while squaring, simplifying and solving higher degree algebraic equations. Some candidates converted all terms into $\tan^{-1}$ form but could not handle the resulting bulky fractions.

(b) Errors were made by some candidates in drawing the circuit. Boolean Algebra laws were generally well applied but some candidates erred using the distributive property and so failed to simplify (A+A'B') as (A+B').

*Suggestions for teachers*

- ICF laws need to be taught thoroughly for full understanding by the students. The applications need to be illustrated with copious examples. Inter conversion of functions is to be done if it helps the simplification process.

– Laws of Boolean Algebra need to be properly understood by all concerned. Different circuits for union and intersection need to be understood. Distributive property of 'union' over 'intersection' is unique to Boolean Algebra (sets) as, a+b.c = (a+b). (a+c) is not true in any other mathematical systems.

**MARKING SCHEME**

**Question 3.**

(a) $\sin^{-1}x + \sin^{-1}(1-x) = \cos^{-1}x$

$$\Rightarrow \sin^{-1}x + \sin^{-1}(1-x) = \frac{\pi}{2} - \sin^{-1}x$$

$$\sin^{-1}(1-x) = \frac{\pi}{2} - 2\sin^{-1}x$$

Let $\sin^{-1}x = y \;\; \therefore x = \sin y$

$$\therefore \sin^{-1}(1-x) = \frac{\pi}{2} - 2y$$

$$1-x = \sin\left(\frac{\pi}{2} - 2y\right)$$

$$1-x = \cos(2y)$$

$$1-x = 1-2\sin^2 y$$

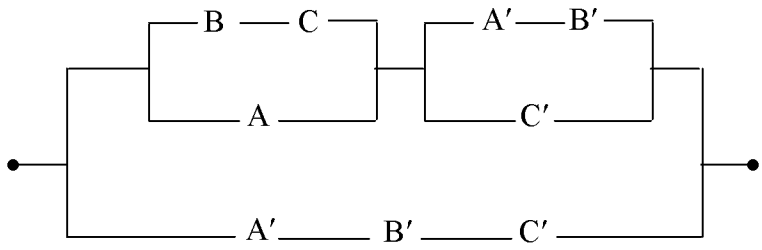
$$1-x = 1-2x^2$$

$$2x^2 - x = 0$$

$$x(2x-1) = 0$$

$$x=0, \frac{1}{2}$$

(b)




$(BC + A)\cdot(A'B'+C') + A'B'C'$

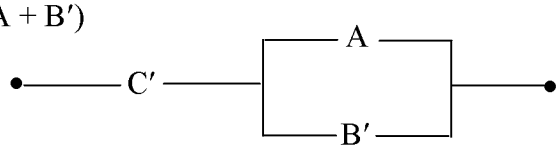
$= BCA'B' + BCC' + AA'B + AC' + A'B'C'$

$= 0 + 0 + 0 + AC' + A'B'C'$

$= C'(A+A'B')$

$= C'(A+A')\ (A + B')$

$= C'\ (A + B')$




**Question 4**

(a) Verify Lagrange's Mean Value Theorem for the function f($x$) = $\sqrt{x^2 - x}$ in the interval [1, 4]. **[5]**

(b) From the following information, find the equation of the Hyperbola and the equation of its Transverse Axis: **[5]**

Focus: (–2, 1), Directrix: $2x - 3y + 1 = 0$, e = $2/\sqrt{3}$

Comments of Examiners

(a) While defining the criteria for Lagrange's Mean Value Theorem, many candidates were unable to correctly attach the "closed interval" and "open interval" option with the relevant criterion. Some also differentiated $\sqrt{x^2 - x}$ incorrectly. That the value of 'C' must belong to the "open interval" was not found or stated by some.

(b) The fundamental relation PS = e.PM was reversed by some into PM = e.PS. Several candidates failed to use the value of 'e'. Errors also occurred while squaring and simplifying. Some candidates forgot to find the equation of the transverse axis.

*Suggestions for teachers*

- The different criteria for Rolle's and Lagrange's Mean Value theorems need to be understood and differentiated. Difference between 'closed' and 'open' intervals requires explanation. For Lagrange's Mean Value theorem $f'(c) = \frac{f(b) - f(a)}{b - a}$, and C has to be found in the open interval and so stated.
- Conics and their equations need to be thoroughly explained separately as well as jointly. Something as basic as axis and directrix of a conic cannot be forgotten, mistaken or ignored. Fundamental algebraic operations such as squaring of binomials or trinomials, simplification, solution etc. require plenty of practice.

**MARKING SCHEME**

**Question 4.**

(a) Given:

$f(x) = \sqrt{x^2 - x}, x \in [1,4]$

(i) f(x) is continuous in [1, 4]

(ii) f(x) is differentiable in (1, 4)

$\therefore f'(x) = \frac{1}{2\sqrt{x^2 - x}} \times (2x-1)$

$f(4) = \sqrt{16-4} = \sqrt{12}$

$f(1) = \sqrt{1-1} = 0$

Therefore all the conditions of Lagrange's Mean Value theorem are satisfied.

$\therefore f'(c) = \frac{f(b) - f(a)}{b-a}$

$\Rightarrow \frac{2c-1}{2\sqrt{c^2-c}} = \frac{\sqrt{12}-0}{4-1} = \frac{\sqrt{12}}{3}$

Squaring both sides

$\frac{(2c-1)^2}{4(c^2-c)} = \frac{12}{3} = 4$

$\Rightarrow 3(4c^2 - 4c + 1) = 16(c^2 - c)$

$\Rightarrow 12c^2 - 12c + 3 = 16c^2 - 16c$

$\Rightarrow 4c^2 - 4c - 3 = 0$

$\Rightarrow 4c^2 - 6c + 2c - 3 = 0$

$\therefore (2c+1)(2c-3) = 0$

$c = -\frac{1}{2}$ or $c = \frac{3}{2}$

Clearly c = $\frac{3}{2}$ lies between 1 and 4.

$\therefore$ Lagrange's Mean Value theorem is verified.

(b) Let P(x, y) be a point on the conic, then

PS = e . PM i.e. $\sqrt{(x+2)^2 + (y-1)^2} = \frac{2}{\sqrt{3}}\left(\frac{2x-3y+1}{\sqrt{4+9}}\right)$

$\Rightarrow 39(x^2 + y^2 + 4x - 2y + 5) = 4(4x^2 + 9y^2 + 1 - 12xy + 4x - 6y)$

i.e. $23x^2 + 48xy + 3y^2 + 140x - 54y + 191 = 0$ is the required hyperbola.

Transverse axis passes through (–2, 1) and is perpendicular to Directrix,

$2x - 3y + 1 = 0$

TA: $3x + 2y + c = 0$ where $-6 + 2 + c = 0$, $c = 4$; TA: $3x + 2y + 4 = 0$

**Question 5**

(a) If $y = \left(\cot^{-1} x\right)^2$, *show that* $\left(1 + x^2\right)^2 \frac{d^2y}{dx^2} + 2x\left(1 + x^2\right)\frac{dy}{dx} = 2$ **[5]**

(b) Find the maximum volume of the cylinder which can be inscribed in a sphere of radius $3\sqrt{3}\,cm$. (Leave the answer in terms of $\pi$) **[5]**

Comments of Examiners

(a) Some candidates took the derivative of $\cot^{-1} x$ as $\left(\frac{1}{1+x^2}\right)$ instead of $-\left(\frac{1}{1+x^2}\right)$ Use of the rule for composite function as well as chain rule was forgotten by several candidates.

(b) Volume of the cylinder had to be expressed in terms of a single variable (either r or h). Many candidates failed in this basic step. Also, second order derivative needs to be shown as negative for maximum volume. Some candidates were not able to do this.

*Suggestions for teachers*

- Derivatives of all forms of functions require continuous practice and review from time to time. Sufficient time needs to be spent on this topic.
- Students need to familiarise themselves with the area, perimeter, surface and volume of 2-Dimensional and 3-Dimensional figures in the syllabus. The function to be optimised needs to be expressed in terms of a single variable by using the given data. For maximum value $f'(x)=0$ and $f''(x) < 0$. This needs to be taught well.

**MARKING SCHEME**

**Question 5.**

(a) $y = \left(\cot^{-1} x\right)^2$

$$\therefore \frac{dy}{dx} = 2\cot^{-1} x \cdot \left(\frac{-1}{1+x^2}\right)$$

ie, $$\left(1 + x^2\right)\cdot\frac{dy}{dx} = -2\cot^{-1} x$$

$$\Rightarrow \left(1+x^2\right)\frac{d^2y}{dx^2} + 2x\frac{dy}{dx} = -2\left(\frac{-1}{1+x^2}\right)$$

ie, $\left(1+x^2\right)^2 \cdot \frac{d^2y}{dx^2} + 2x\left(1+x^2\right)\frac{dy}{dx} = 2$

(b) $V = \pi r^2 (2h)$

$= 2\pi h\left(27 - h^2\right)$

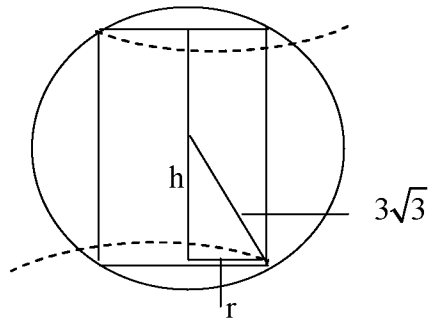
$= 54\pi h - 2\pi h^3$

$\frac{dv}{dh} = 54\pi - 6\pi h^2$

$\frac{dv}{dh} = 0 \Rightarrow h = 3$

Also, $\frac{d^2v}{dh^2} = -12\pi h\left(negative\right) : Hence \max . V$

$\therefore V_{\max} = 2\pi.3\left(27-9\right) = 108\pi$ cubic units.




**Question 6**

(a) Evaluate: $\int \frac{\cos^{-1} x}{x^2} dx$ **[5]**

(b) Find the area bounded by the curve $y = 2x - x^2$, and the line $y = x$. **[5]**

Comments of Examiners

(a) Some candidates attempted product rule of integration directly without any substitution and could not proceed beyond the first stage. Some took the $\int \frac{dx}{x\sqrt{1-x^2}}$ as $\sec^{-1}x$ which is incorrect.

A number of candidates who used an appropriate substitution did not give the final answer in terms of $x$ but left it in terms of the new variable.

(b) Some candidates found $\int (y_1)\, dx$ or $\int (y_1 - y_2)\, dx$ within the wrong intervals (0, 2) where the curve cuts the $x$ – axis.

*Suggestions for teachers*

– Integration by parts with all relevant substitutions and necessary changes needs good grounding and plenty of practice. If, cos Z = $x$ and the integral reduces to $\int \text{SecZ.dz}$, then the answer should not be left in terms of Z as log $\left|\sec Z + \tan Z\right|$ + c but given in terms of x as log $\left|\frac{1}{x} + \frac{\sqrt{1-x^2}}{x}\right| + c$.

– Sketching of curves may not be necessary always but a rough sketch will always help the student to understand the requirements, the area required to be found, the points of intersection and the limits of the definite integral. Since the functions given are usually simple algebraic or trigonometric functions, the integration of such functions will not cause problems and the solution can be easily found.

**MARKING SCHEME**

**Question 6.**

(a) Let

$$I = \int \frac{\cos^{-1} x}{x^2} dx$$

Put $\cos^{-1} x = t$

$x = \cos t$

$dx = \sin t\, dt$

$$I = -\int \frac{t \sin t}{\cos^2 t} dt$$

$$= -\int t\left(\sec t \tan t\right) dt$$

$$= -\left[t \sec t - \int 1 \cdot \sec t\, dt\right]$$

$$= -t \sec t + \log\left|\sec t + \tan t\right| + c$$

$$= -\frac{1}{x}\cos^{-1} x + \log\left|\frac{1}{x} + \frac{\sqrt{1-x^2}}{x}\right| + c$$

$$= -\frac{1}{x}\cos^{-1} x + \log\left|\frac{1+\sqrt{1-x^2}}{x}\right| + c$$

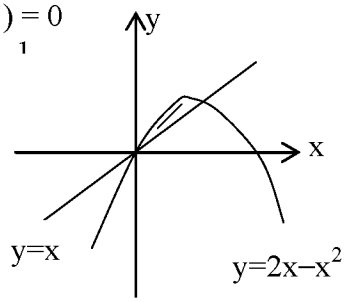
(b) Solving, $x = y$, $y = 2x - x^2$,

$2x - x^2 = x$

$x^2 - x = 0$

$x(x-1) = 0$

$x = 0, 1$




Required area $= \int_0^1 (y_1 - y_2)dx$

$= \int_0^1 \{(2x - x^2) - x\}dx$

$= \int_0^1 (x - x^2)dx$

$= \left[\frac{x^2}{2} - \frac{x^3}{3}\right]_0^1$

$= \left(\frac{1}{2} - \frac{1}{3}\right) - (0) = \frac{1}{6}$ sq. units

**Question 7**

(a) Find the Karl Pearson's co-efficient of correlation between $x$ and $y$ for the following data: **[5]**

| $x$ | 16 | 18 | 21 | 20 | 22 | 26 | 27 | 15 |
|---|---|---|---|---|---|---|---|---|
| $y$ | 22 | 25 | 24 | 26 | 25 | 30 | 33 | 14 |

(b) The following table shows the mean and standard deviation of the marks of Mathematics and Physics scored by the students in a school: **[5]**

| | Mathematics | Physics |
|---|---|---|
| Mean | 84 | 81 |
| Standard Deviation | 7 | 4 |

The correlation co-efficient between the given marks is 0·86. Estimate the likely marks in Physics if the marks in Mathematics are 92.

Comments of Examiners

(a) Since the means $\bar{x}$ and $\bar{y}$ are not whole numbers, use of the formula $\frac{\sum(dxdy)}{\sqrt{\sum dx^2}\sqrt{\sum dy^2}}$ by some candidates, taking approximate whole number values of the means was incorrect. Several candidates solved the problem using Spearman's method.
(b) Several candidates used incorrect formula. Some used the equation for the regression line of 'x on y' instead of 'y on x" to find y when x was given.

*Suggestions for teachers*

- Plenty of practice is required in order to solve problems on correlation.
- Teachers are to make sure the students understand the need for the appropriate formula at appropriate situations.

**MARKING SCHEME**

**Question 7.**

(a)

| x | y | dx=x-20 | dy=y-25 | $dx^2$ | $dy^2$ | dx×dy |
|---|---|---|---|---|---|---|
| 16 | 22 | –4 | –3 | 16 | 9 | 12 |
| 18 | 25 | –2 | 0 | 4 | 0 | 0 |
| 21 | 24 | 1 | –1 | 1 | 1 | –1 |
| 20 | 26 | 0 | 1 | 0 | 1 | 0 |
| 22 | 25 | 2 | 0 | 4 | 0 | 0 |
| 26 | 30 | 6 | 5 | 36 | 25 | 30 |
| 27 | 33 | 7 | 8 | 49 | 64 | 56 |
| 15 | 14 | –5 | –11 | 25 | 121 | 55 |
| | | 5 | –1 | 135 | 221 | 152 |

$$\therefore r = \frac{n\sum(dx\cdot dy)-\sum dx\times\sum dy}{\sqrt{n\sum dx^2-\left(\sum dx\right)^2}\sqrt{n\sum dy^2-\left(\sum dy\right)^2}}$$

$$= \frac{8\times152-(5\times-1)}{\sqrt{8\times135-5^2}\times\sqrt{8\times221-(-1)^2}}$$

$$= \frac{1216+5}{\sqrt{1080-25}\sqrt{1768-1}} = 0.894$$

(b) Let Mean marks in mathematics $\left(\bar{x}\right) = 84$

Mean marks in Physics $\left(\bar{y}\right) = 81$

$\sigma_x = 7$ , $\sigma_y = 4$

r = 0.86

$b_{yx} = r \times \frac{\sigma_y}{\sigma_x}$

$= 0{\cdot}86 \times \frac{4}{7} = 0{\cdot}49$

or 86/175

$\therefore$ Regression hne of y on x be $y - \bar{y} = b_{yx}\left(x - \bar{x}\right)$

y – 81 = 0.49(x–84)

y = 0.49x – 41.16 + 81

y = 0.49x + 39.84

whereas x = 92, y = 0.49 ×92 + 39.84

y = 84.92

**Question 8**

(a) Bag A contains three red and four white balls; bag B contains two red and three white balls. If one ball is drawn from bag A and two balls from bag B, find the probability that: **[5]**

(i) One ball is red and two balls are white;

(ii) All the three balls are of the same colour.

(b) Three persons, Aman, Bipin and Mohan attempt a Mathematics problem independently. The odds in favour of Aman and Mohan solving the problem are 3:2 and 4:1 respectively and the odds against Bipin solving the problem are 2:1. Find: **[5]**

(i) The probability that all the three will solve the problem.

(ii) The probability that problem will be solved.

Comments of Examiners

(a)(i) & (ii) The product and summation laws of probability and their application was not clear to many candidates. Both parts (i) and (ii) required the application of these laws jointly.
Students failed to identify or exhaust all possible cases.
(b)(i) The concept of odds in favour or against was not clear to several candidates. Some candidates took the probability of all three solving as $P_1+P_2+P_3$ instead of $P_1xP_2xP_3$.
(ii) Some candidates failed to realise that 'the probability that the problem will be solved', means, the probability that at least one solves the problem which is, 1–P.

*Suggestions for teachers*

- Explain the probability laws correctly. Students need to understand the problem and identify the cases that satisfy the situation.
- Students need to know how to obtain probabilities from odds stated, e.g. if the odds one m:n in favour, then probability of occurrence is $\frac{m}{m+n}$ . The rest of the problem follows the usual combination of sum and product laws.

**MARKING SCHEME**

**Question 8.**

(a) (i) P(1 red ball from A and 2 white from B)= $\frac{3C_1}{7C_1}\cdot\frac{3C_2}{5C_2}=\frac{9}{70}$

P(1W from A and R & W from B) = $\frac{4C_1}{7C_1}\cdot\frac{2C_1\cdot 3C_1}{5C_2}=\frac{24}{70}$

$\therefore P(one\,\text{Red}\,\&\,two White)=\frac{9}{70}+\frac{24}{70}=\frac{33}{70}$

(ii) P(all same colour) = P(all three red)+P(all three white)

$$=\frac{3C_1}{7C_1}\cdot\frac{2C_2}{5C_2}+\frac{4C_1}{7C_1}\cdot\frac{3C_2}{5C_2}$$

$$=\frac{3}{7}\cdot\frac{1}{10}+\frac{4}{7}\cdot\frac{3}{10}$$

$$=\frac{15}{70}or\frac{3}{14}\text{ or }0.21$$

(b) $P(E_1)=\frac{3}{5},P(E_2)=\frac{1}{3},P(E_3)=\frac{4}{5}$

(i) $P(E_1\cap E_2\cap E_3)=P(E_1)\cdot P(E_2)\cdot P(E_3)$

$$=\frac{3}{5}\cdot\frac{1}{3}\cdot\frac{4}{5}=\frac{4}{25}$$

(ii) P(at least one solves) = $1 - P\left(\overline{E_1} \cap \overline{E_2} \cap \overline{E_3}\right)$

$$= 1 - \frac{2}{5}\cdot\frac{2}{3}\cdot\frac{1}{5} = 1 - \frac{4}{75} = \frac{71}{75}$$

**Question 9**

(a) Find the locus of the complex number $z = x + iy$, satisfying relations $\arg(z-1) = \pi/4$ and $|z-2-3i| = 2$. Illustrate the locus on the Argand plane. **[5]**

(b) Solve the following differential equation: **[5]**

$ye^y\,dx = (y^3 + 2xe^y)\,dy$, given that $x = 0,\ y = 1$.

Comments of Examiners

(a) Sketching of loci was inaccurate in several cases. Some candidates were confused about locus satisfying both conditions and failed to find the points of intersection.
Sketching was done on separate axes by several candidates, instead of the same axes and graph.
(b) A number of candidates could not write the given equation in the standard form: $\frac{dx}{dy} + P\cdot x = Q$ (where P, Q are functions in y). Some, who managed, took 'P' as $\frac{2}{y}$ instead of $-\frac{2}{y}$. This resulted in incorrect Integrating Factor.

*Suggestions for teachers*
- Sketching of straight lines and curves (circle, conics etc.) should be practiced regularly.
- Post differentiation and integration solving of differential equations needs a lot of practice.

**MARKING SCHEME**

**Question 9.**

(a) Let $z = x + iy$

$\arg(z-1) = \frac{\pi}{4}$

$\arg(x + iy - 1) = \frac{\pi}{4}$

$\tan^{-1}\frac{y}{x-1} = \frac{\pi}{4}$

$\frac{y}{x-1} = 1 \quad \therefore y = x - 1 ----(i)$

$|z-2-3i| = 2$

$\Rightarrow |x+iy-2-3i| = 2$

$(x-2)^2 + (y-3)^2 = 4$

$(x-2)^2 + (x-1-3)^2 = 4$ $(from\,(i)\ y = x-1)$

$x^2 - 4x + 4 + x^2 - 8x + 16 = 4$

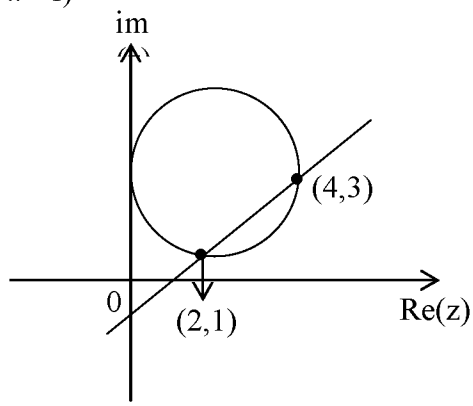
$2x^2 - 12x + 16 = 0$

$x^2 - 6x + 8 = 0$

$(x-4)(x-2) = 0$

$x = 4$ or $2$

$y = 3$ or $1$




$\therefore$ the locus will be points (2, 1) and (4, 3)

$\therefore x = [v^2(e^{-1} - e^{-y})$

## SECTION B

**Question 10**

(a) If $\vec{a}$ and $\vec{b}$ are unit vectors and $\theta$ is the angle between them, then show that **[5]**
$|\vec{a} - \vec{b}| = 2\sin\frac{\theta}{2}$.

(b) Find the value of $\lambda$ for which the four points A, B, C, D with position vectors **[5]**
$-\hat{j} - \hat{k}$; $4\hat{i} + 5\hat{j} + \lambda\hat{k}$; $3\hat{i} + 9\hat{j} + 4\hat{k}$ and $-4\hat{i} + 4\hat{j} + 4\hat{k}$ are coplanar.

Comments of Examiners

(a) Many candidates who attempted this part, failed to convincingly prove the rider. Those who erred did so mainly in converting 1 - cosθ, into $2\text{Sin}^2\left(\frac{\theta}{2}\right)$. Vector notations were also not used by several candidates.

(b) Some candidates erred in finding vectors $\overrightarrow{AB} \cdot \overrightarrow{AC}$, or $\overrightarrow{AD}$. Scalar triple product as a determinant was incorrectly expanded by some candidates.

*Suggestions for teachers*

- Vector notations, usage, dot and cross products in terms of the vectors or their components need to be taught well and in detail. Basic rules of trigonometry need to be revised.
- The students must understand that $\overrightarrow{AB}$ = Position vector of B – Position vector of A.

– The fact that the scalar Triple Product of three co-initial vectors gives the volume of the parallelopiped with these vectors as the edges, needs explanation. If this Determinant (i.e. Volume) is zero, the conclusion that the vectors are coplanar is evident.

**MARKING SCHEME**

**Question 10.**

(a) $\left|\vec{a}-\vec{b}\right|^2 = |\vec{a}|^2 - 2|\vec{a}|\cdot|\vec{b}|\cos\theta + |\vec{b}|^2$

$\vec{a}, \vec{b}$ are unit vectors $\Rightarrow |\vec{a}| = |\vec{b}| = 1$

$$|\vec{a}-\vec{b}|^2 = 1 - 2\cos\theta + 1$$
$$= 2 - 2\cos\theta$$
$$= 2(1-\cos\theta)$$
$$= 2 \times 2\sin^2\frac{\theta}{2}$$

$$\left|\vec{a}-\vec{b}\right| = 2\sin\left(\theta/2\right)$$

(b) $\overrightarrow{AB} = (4i+5j+\lambda k)-(-j-k) = 4i+6j+(\lambda+1)k$

$\overrightarrow{AC} = (3i+9j+4k)-(-j-k) = 3i+10j+5k$

$\overrightarrow{AD} = (-4i+4j+4k)-(-j-k) = -4i+5j+5k$

$\because$ Vectors are coplanar, $\left[\overrightarrow{AB}\ \overrightarrow{AC}\ \overrightarrow{AD}\right] = 0$

ie. $\begin{vmatrix} 4 & 6 & \lambda+1 \\ 3 & 10 & 5 \\ -4 & 5 & 5 \end{vmatrix} = 0$

ie $4(50-25)-6(15+20)+(\lambda+1)(15+40) = 0$

$55(\lambda+1) = 110 \ \therefore \lambda = 1$

**Question 11**

(a) Find the equation of a line passing through the point (−1, 3, −2) and perpendicular to the lines: $\frac{x}{1}=\frac{y}{2}=\frac{z}{3}$ and $\frac{x+2}{-3}=\frac{y-1}{2}=\frac{z+1}{5}$. **[5]**

(b) Find the equations of planes parallel to the plane $2x - 4y + 4z = 7$ and which are at a distance of five units from the point (3, −1, 2). **[5]**

Comments of Examiners

(a) Candidates who attempted by vector method got confused between equation of a line and equation of a plane in vector form. Some candidates did not use the cross-product of perpendicular vectors correctly.
(b) The distance formula of a point from a plane did not include the modulus symbol in several cases. Hence only one value of '$\lambda$' was obtained, whereas two were required (i.e. two planes).
Some candidates also concluded that if $(18+\lambda)^2=900$, then $18+\lambda = 30$, whereas it should be $\pm 30$.

*Suggestions for teachers*

- Use of Cartesian and vector methods for solving must be separately explained and compared for complete understanding.
- Distance of point from point, point from line, point from plane as well as the shortest distance between two lines are topics that need careful study and understanding.

**MARKING SCHEME**

**Question 11.**

(a) The direction vector of the required line is cross product of the direction vectors of the given lines.

$$\therefore \vec{p}=\begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ 1 & 2 & 3\\ -3 & 2 & 5\end{vmatrix}$$

$$=\hat{i}(10-6)-\hat{j}(5+9)+\hat{k}(2+6)$$

$$=4\hat{i}-14\hat{j}+8\hat{k}$$

$$\therefore \text{equation of the required line is } \frac{x+1}{4}=\frac{y-3}{-14}=\frac{z+2}{8}$$

$$\Rightarrow \frac{x+1}{2}=\frac{y-3}{-7}=\frac{z+2}{4}$$

(b) Equation of the plane parallel to the given plane is

$2x-4y+4z+\lambda=0$. This plane is at the distance of five units from the point (3, –1, 2) if

$$\left|\frac{6+4+8+\lambda}{\sqrt{4+16+16}}\right|=5$$

$$\frac{|18+\lambda|}{\sqrt{36}}=5$$

$$(18+\lambda)^2=25\times 36$$

$$18+\lambda=\pm 30$$

$$\lambda=12,-48$$

Equations of the required plane are:

$2x - 4y + 4z + 12 = 0$

and $2x - 4y + 4z - 48 = 0$

or $x-2y + 2z + 6 = 0$

and $x - 2y + 2z - 24 = 0$

**Question 12**

(a) If the sum and the product of the mean and variance of a Binomial Distribution are 1·8 and 0·8 respectively, find the probability distribution and the probability of at least one success. **[5]**

(b) For A, B and C, the chances of being selected as the manager of a firm are 4 : 1 : 2, respectively. The probabilities for them to introduce a radical change in the marketing strategy are 0·3, 0·8 and 0·5 respectively. If a change takes place; find the probability that it is due to the appointment of B. **[5]**

Comments of Examiners

(a) From the given, np + npq = 1.8 and np.(npq) = 0.8, some candidates could not solve for n, p, q.
The probability distribution was not correctly expressed by many candidates. Some candidates did not know how to find the probability of at least one successful outcome.
(b) Many candidates used Baye's theorem correctly but took the probabilities of A, B, C, as 4, 1, 2, instead of fractions $\frac{4}{7}, \frac{1}{7}, \frac{2}{7}$.
Some candidates did not implement the theorem correctly.

*Suggestions for teachers*

- Students must be made to revise standard deviation or variance. While solving for n, p, q it must be noted that p+q=1. Practice in solving equations in two or three unknowns is a must.
- Probabilities are ratios and not numbers – this must be made clear. P(E/A) = P(E). P(A/E) must be explained as well as the implementation of Baye's theorem.

**MARKING SCHEME**

**Question 12.**

(a) Mean = np variance = npq

$np + npq = 1.8$ ..... (i)

$np\,(npq) = 0.8$ ..... (ii)

Solving, $q = \frac{4}{5}$ $\therefore p = \frac{1}{5}, n = 5$

$\therefore$ Distributionis : $(q+p)^n$ ie. $\left(\frac{4}{5}+\frac{1}{5}\right)^5$

P(at least one success) = $1 - \left(\frac{4}{5}\right)^5 = 1 - \cdot 33$

= 0.67 or 2101/3125

(b) Let events be

$E_1$ = A is selected as manager

$E_2$ = B is selected as manager

$E_3$ = C is selected as manager

E = radical change in the marketing strategy

$P(E_1) = 4/7,\ P(E_2) = \frac{1}{7},\ P(E_3) = 2/7$

By Baye's theorem

$$P(E_2/E) = \frac{P(E_2)P(E/E_2)}{(P(E_1)P(E/E_1) + P(E_2)P(E/E_2) + P(E_3)P(E/E_3)}$$

as $P\left(\frac{E}{E_1}\right) = 0.3,\ P\left(\frac{E}{E_2}\right) = 0\cdot 8$ and $P\left(\frac{E}{E_3}\right) = 0\cdot 5$

Applying Baye's theorem

$$P(E_2/E) = \frac{(1/7 \times 0\cdot 8)}{(4/7 \times 0\cdot 3 + 1/7 \times 0\cdot 8 + 2/7 \times 0\cdot 5)}$$

$$P(E_2/E) = \frac{4}{15}$$

## SECTION C

**Question 13**

(a) If Mr. Nirav deposits ₹250 at the beginning of each month in an account that pays an interest of 6% per annum compounded monthly, how many months will be required for the deposit to amount to at least ₹6,390 ? **[5]**

(b) A mill owner buys two types of machines A and B for his mill. Machine A occupies 1000 sqm of area and requires 12 men to operate it; while machine B occupies 1200 sqm of area and requires 8 men to operate it. The owner has 7600 sqm of area available and 72 men to operate the machines. If machine A produces 50 units and machine B produces 40 units daily, how many machines of each type should he buy to maximise the daily output? Use Linear Programming to find the solution. **[5]**

Comments of Examiners

(a) Some candidates took Amount for Immediate Annuity formula $\frac{A}{i}\left\{(1+i)^n - 1\right\}$ instead of Annuity Due formula: $\frac{A}{i}(1+i)\left\{(1+i)^n - 1\right\}$. Some substitutions were also not correct.

(b) In some cases, all the constraints were not stated or used and hence coordinates of all feasible points were not obtained.

*Suggestions for teachers*

- Help students to distinguish between Amount of Annuity, Present Value of Annuity, Immediate Annuity and Annuity Due. Also, the reasons for the different formulae must be explained.
- The optimum function and all possible constraints in the form of inequations have to be put down from what is stated in the problem. Students must be made to solve the constraints equations in pairs to obtain all feasible points leading to maximum or minimum value of desired function.

**MARKING SCHEME**

**Question 13.**

(a) $a = 250, \quad i = \frac{6}{12 \times 100} = 0.005$ *and* $n = 12m$ months

$$S = \frac{a}{i}(1+i)\{(1+i)^n - 1\}$$

$$6390 = \frac{250}{0.005}(1.005)\{(1.005)^{12m} - 1\}$$

$$6390 = \frac{250}{0.005}(1.005)\{(1.005)^{12m} - 1\}$$

$$0.1271 = \{(1.005)^{12m} - 1\}$$

$$1.1271 = (1.005)^{12m}$$

$$\log_e 1.1271 = \log_e (1.005)^{12m}$$

$$\frac{\log_e 1.1271}{\log_e (1.005)} = 12m$$

$$12m = 23.98 \approx 24$$

23.98 or 24 months

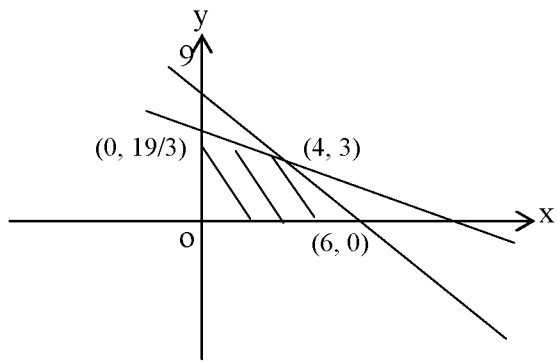
(b) Let there be x machines of type A and y machines of type B. Daily output, Z = 50x + 40y.

Constraints are:

$1000x + 1200y \leq 7600$

$12x + 8y \leq 72$

$x \geq 0, y \geq 0$




Feasible points are (6, 0), (4, 3), (0, 19/3)

At (6, 0), Z = 300

At (4, 3), Z = 320

$\therefore$ for maximum output there should be 4 machines and 3 machines respectively of type A and B.

**Question 14**

(a) A bill of ₹60,000 was drawn on 1st April 2011 at 4 months and discounted for ₹58,560 at a bank. If the rate of interest was 12% per annum, on what date was the bill discounted? **[5]**

(b) A company produces a commodity with ₹24,000 fixed cost. The variable cost is estimated to be 25% of the total revenue recovered on selling the product at a rate of ₹8 per unit. Find the following: **[5]**

(i) Cost function

(ii) Revenue function

(iii) Breakeven point.

Comments of Examiners

(a) Some candidates omitted to include the Days of Grace and so got the wrong value of 'n'. Some candidates used True Discount formula instead of Banker's Discount or relevant formula. Several candidates had no idea how to get the Date of Discounting.
(b) (i) In some cases, variable cost was incorrectly calculated and hence the total cost.
(ii) Some candidates erred in obtaining Revenue function.
(iii) The condition for Breakeven point was forgotten by several candidates.

*Suggestions for teachers*

- All relevant terms and formulae need to be taught well for complete understanding. Legal due date includes three days of grace.
- While using any formula using n, it should be made clear that it does not stand for the entire period but only for the unexpired period from Date of Discounting to Legal Due Date.

**MARKING SCHEME**

**Question 14.**

(a) Banker's Discount, B.D = 60,000 – 58560 = Rs 1440

Let t be unexpired period in years

B.D = Ani

$$1440 = \frac{60000(12)t}{100} \Rightarrow t = \frac{1}{5} \text{ year or } \frac{1}{5} \times 365 = 73 \text{ days}$$

Legal due date of bill

1st April 2011 + 4 months +3 days of grace = 4th August 2011

The bill was cashed 73 days before 4th August.

04 days in August

31 days in July

30 days in June

08 days in May which comes to 23rd May 2011 as the date.

(b) Let x be the number of units produced and sold.

Price per unit = Rs. 8

Revenue function =R (x)= 8x

Variable cost of the x units = 25% of 8x

= Rs. 2x

Total cost =c (x)= fixed cost + variable cost

Total cost= c (x) =24000 + 2x At break even point : R(x) = c(x)

∴ 8x =24000+2x

x= 4000…

**Question 15**

(a) The price index for the following data for the year 2011 taking 2001 as the base year was 127. The simple average of price relatives method was used. Find the value of $x$: **[5]**

| Items | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| Price (₹ per unit) in year 2001 | 80 | 70 | 50 | 20 | 18 | 25 |
| Price (₹per unit) in year 2011 | 100 | 87·50 | 61 | 22 | $x$ | 32·50 |

(b) The profits of a paper bag manufacturing company (in lakhs of rupees) during each month of a year are: **[5]**

| Month | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Profit | 1·2 | 0·8 | 1·4 | 1·6 | 2·0 | 2·4 | 3·6 | 4·8 | 3·4 | 1·8 | 0·8 | 1·2 |

Plot the given data on a graph sheet. Calculate the four monthly moving averages and plot these on the same graph sheet.

Comments of Examiners

(a) Errors were committed by several candidates as the instructions were not followed. Instead of using Price-relatives, some candidates used simple aggregate of prices method.
(b) Moving averages were mostly correctly calculated but for plotting, centred moving averages were required. Some candidates did not use the centred averages. In some cases, the graphs were not neat.

*Suggestions for teachers*

– Moving Averages need to be calculated correct to two decimal places. For plotting, centred averages correct to one decimal place is sufficient. The axes should be labelled, plotting and sketching should be as neat as possible and the graph should be given a caption.

**MARKING SCHEME**

**Question 15.**

(a) Using simple average of price relatives, the price index for 2011 taking 2001 as base year, was 127 from the following data find the value of x:

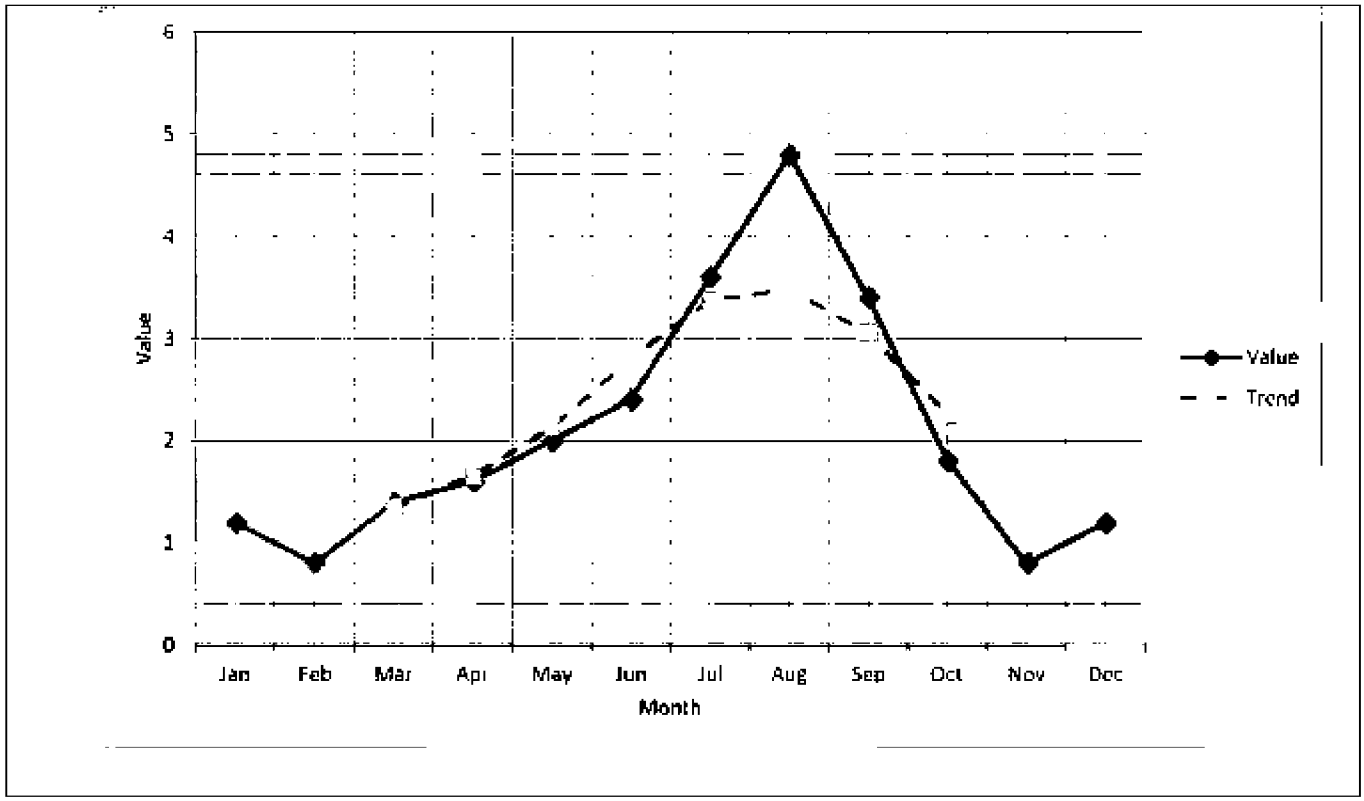
| | | | | | | |
|---|---|---|---|---|---|---|
| $P_0$ | 80 | 70 | 50 | 20 | 18 | 25 |
| $P_1$ | 100 | 87.50 | 61 | 22 | X | 32.50 |
| PR | 125 | 125 | 122 | 110 | $\frac{100x}{18}$ | 130 |

$$\frac{\sum PR}{N} = 127$$

i.e. $612+\frac{100x}{18}=127\times 6 \ \therefore \ x=27$

(b)

| Months | profit | 4 monthly total | 4 monthly average | 4 monthly centred moving average |
|---|---|---|---|---|
| JAN | 1.2 | - | - | - |
| FEB | 0.8 | - | - | - |
| | | 5 | 1.25 | |
| MAR | 1.4 | | | 1.35 |
| | | 5.8 | 1.45 | |
| APR | 1.6 | | | 1.65 |
| | | 7.4 | 1.85 | |
| MAY | 2.0 | | | 2.125 |
| | | 9.6 | 2.4 | |
| JUN | 2.4 | | | 2.8 |
| | | 12.8 | 3.2 | |
| JULY | 3.6 | | | 3.375 |
| | | 14.2 | 3.55 | |
| AUG | 4.8 | | | 3.475 |
| | | 13.6 | 3.4 | |
| SEP | 3.4 | | | 3.05 |
| | | 10.8 | 2.7 | |
| OCT | 1.8 | | | 2.25 |
| | | 7.2 | 1.8 | |
| NOV | 0.8 | | | - |
| | | - | - | |
| DEC | 1.2 | | | - |




**GENERAL COMMENTS:**

**(a) Topics found difficult by candidates in the Question Paper:**

- Indefinite Integrals (use of substitution or integration by parts)
- Definite Integrals – use of properties.
- Inverse Circular Functions (formulae and relations)
- Differential Equations (solving Linear Differential Equations)
- Vectors – in general
- Annuity (use of appropriate formula)
- Conics in general (Hyperbola in particular)
- Probability – use of sum and product laws and identifying all cases.
- Maxima and Minima (expressing volume of cylinder in terms of r or h only)

**(b) Concepts between which candidates got confused:**

- For $\int_o^a f(x)\,dx$, obtaining f(a-x) from f(x).
- Regression lines: y on x and x on y
- Sum and product laws of probability
- 3 – D: parallel planes and perpendicular forms.
- Conditional probability property in Baye's theorem.
- Price Index by aggregate and Price Relative methods.
- Differences between and usage of formulae for BD, TD, BG, DV etc.

**(c) Suggestions for students:**

- Study the entire syllabus thoroughly and revise from time to time. Concepts of Class XI must be revised and integrated with the Class XII syllabus.
- Develop logical and reasoning skills to have a clear understanding.
- Revise all topics and formulae involved and make a chapter wise or topic-wise list of these.
- Make wise choices from the options available in the question paper.
- Be methodical and neat in your working.

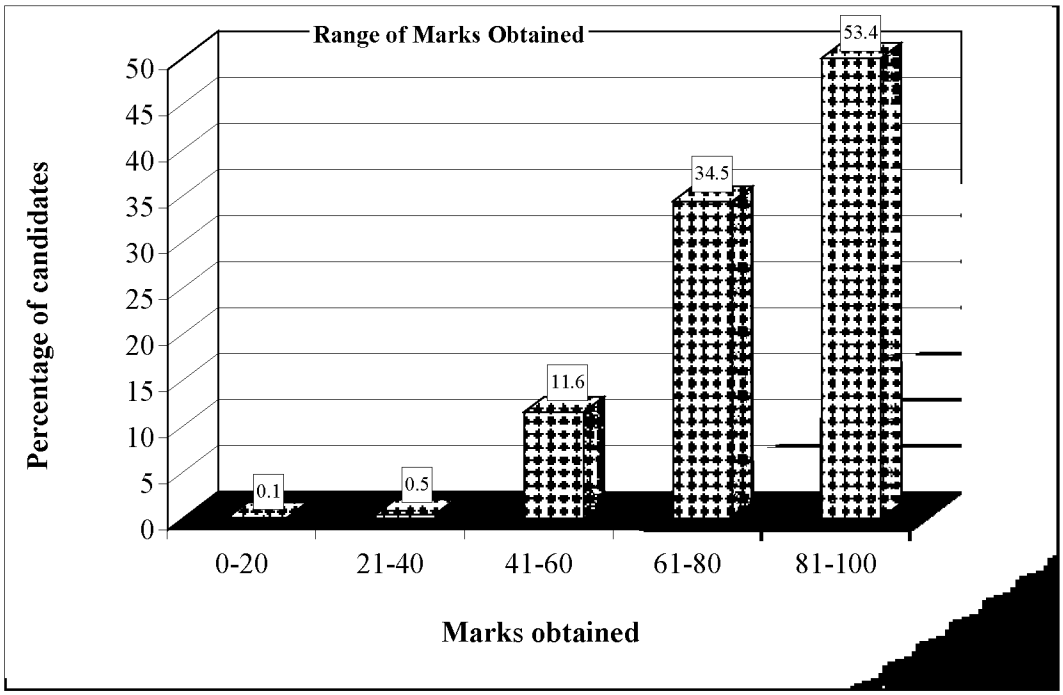
# COMPUTER SCIENCE

## A. STATISTICS AT A GLANCE

| | |
|---|---|
| Total number of students taking the examination | 16,574 |
| Highest marks obtained | 100 |
| Lowest marks obtained | 2 |
| Mean marks obtained | 80.22 |

### Percentage of candidates according to marks obtained

| | Mark Range | | | | |
|---|---|---|---|---|---|
| | ***0-20*** | ***21-40*** | ***41-60*** | ***61-80*** | ***81-100*** |
| Number of candidates | 16 | 80 | 1918 | 5712 | 8848 |
| Percentage of candidates | 0.1 | 0.5 | 11.6 | 34.5 | 53.4 |
| Cumulative Number | 16 | 96 | 2014 | 7726 | 16574 |
| Cumulative Percentage | 0.1 | 0.6 | 12.2 | 46.6 | 100 |



## B. ANALYSIS OF PERFORMANCE

### PART I

*Answer* **all** *questions.*

***While answering questions in this Part, indicate briefly your working and reasoning, wherever required.***

**Question 1**

(a) State the Principle of Duality. Write the dual of: **[2]**

$(P+Q').R.1 = P.R + Q'.R$

(b) Minimize the expression using Boolean laws: **[2]**

$F = (A + B').(B + CD)'$

(c) Convert the following cardinal form of expression into its canonical form: **[2]**

$F(P,Q,R) = \pi(1,3)$

(d) Using a truth table verify: **[2]**

$(\sim p \Rightarrow q) \wedge p = (p \wedge \sim q) \vee (p \wedge q)$

(e) If A = 1 and B = 0, then find: **[2]**

(i) $(A' + 1).B$

(ii) $(A + B')'$

Comments of Examiners

(a) This part was well answered by most of the candidates. Some candidates did not give the definition, but wrote the dual correctly. Some did not bracket the terms for the dual equation. Interchanging of signs '+' to '-'and 1's to 0's was not mentioned in some cases. A few candidates did not mention that the complements do not change.

(b) Some candidates confused it with De Morgan's Law and reduced the expression incorrectly. Some did not change the signs when complements were taken.

(c) The terms 'Cardinal' and 'Canonical' were confusing to a number of candidates. Several candidates wrote the SOP expression instead of POS as they were confused with the symbols $\sum$ and $\Pi$.

*Suggestions for teachers*

- Practice should be given to candidates to find the dual of equations and also the application of Principle of duality in Boolean equations. Importance of brackets must be explained. Differences between complementation and duality must be clarified.
- More practice should be given to candidates to minimize a Boolean expression using Boolean laws. Each and every law must be practiced with examples.

(d) Most of the candidates answered this part well. Some were not clear with the terms and symbols (=>, A, V, ~ ) used in a Proposition.

(e) (i) Most of the candidates were able to answer this part correctly. Only a few did not show the working and wrote the answer directly. Some represented the values but did not find the final result.

(ii) A few candidates did not show the working and wrote the answer directly.

- Inter conversion of canonical and cardinal expression must be given more practice. The terms along with definition must be explained with examples. The representation of the symbols $\sum$ and $\Pi$ should be explained.
- Proposition logic should be taught using all the terms that are required. All the symbols related to propositional logic must be explained in detail.
- More practice should be given in solving such type of Boolean expressions. Importance of the word 'find' in a question must be emphasized.
- More practice should be given in solving such type of Boolean expressions.

**MARKING SCHEME**

**Question 1.**

(a) To every Boolean equation there exists another equation which is dual to the previous equation. This is done by changing AND's to OR's and vice-versa, 0's to 1's and vice-versa, complements remain unchanged.

Dual : $(P \cdot Q') + R + 0 = (P + R) \cdot (Q' + R)$

(b) $F = (A + B') \cdot (B + CD)'$

$F = (A + B') \cdot (B' \cdot (CD)')$

$F = AB' + B'B' \cdot (C' + D')$

$F = B' \cdot (C' + D')$

(c) $F(P,Q,R) = \pi(1, 3)$

$= 001, 011$

$= (P + Q + R') \cdot (P + Q' + R')$

(d) $(\sim p \Rightarrow q) \wedge p = (p \wedge \sim q) \vee (p \wedge q)$

| p | q | ~p | ~q | ~p => q | L.H.S | p Λ ~q | p Λ q | R.H.S |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 |

(e) (i) (A' + 1) . B

= ( 0 + 1 ) . 0 = 0

(ii) (A + B' ) '

= ( 1 + 1 )' = (1)' = 0

**Question 2**

(a) Differentiate between *throw* and *throws* with respect to exception handling. **[2]**

(b) Convert the following infix notation to its postfix form: **[2]**

E* (F / (G – H) * I) + J

(c) Write the algorithm for push operation (to add elements) in an array based stack. **[2]**

(d) Name the File Stream classes to: **[2]**

(i) Write data to a file in binary form.

(ii) Read data from a file in text form.

(e) A square matrix M [ ][ ] of size 10 is stored in the memory with each element requiring 4 bytes of storage. If the base address at M [0][0] is 1840, determine the address at M [4][8] when the matrix is stored in **Row Major Wise**. **[2]**

Comments of Examiners

(a) Most of the candidates were not aware of the term 'throw'. They wrote about 'throws' with respect to exceptional handling. Some used examples while others explained in their own words.

(b) Most candidates were able to solve this problem correctly. Some candidates wrote the correct answer without showing the working. Brackets were ignored as operator precedence was not clear in some cases. Some applied the postfix correctly, but could not derive the final answer.

(c) Some candidates wrote the function with syntax while others wrote in their own language. Stack overflow condition was not mentioned in some cases. Important steps were missing which includes the increment of the top pointer variable.

(d) (i) Several candidates found it difficult to recollect the exact file stream class and gave various answers related to file handling.
(ii) Same as above

(e) Candidates who had the knowledge of the formula to find the address of a cell in an array could solve and get the correct answer. Others answered vaguely. Some calculated using memory cell diagram.

*Suggestions for teachers*

- Exceptional handling should be covered widely with all types of exceptions and emphasis should be laid on its use in programming using the terms 'throw' and 'throws' with examples.
- Examples need to be practiced with conversion of Infix to Postfix notation, the order of precedence; also, the Polish stack method should be taught.
- Candidates should be given more practice to write algorithms in any form i.e. pseudo codes, standard form etc. Checking for overflow for push operation and underflow for pop operation (LIFO / FIFO) must be explained.
- File handling should be taught using a tabular / chart form including the various types of files and their streams required

- Practice should be given in understanding the formula using row major and column major and to make the subject of formula that is required in the question. Diagrammatical explanation of row and column major with respect to two dimensional array must be practiced.

**MARKING SCHEME**

**Question 2.**

(a) Throw : - used to explicitly raise a exception within the program, the statement would throw new exception.

Throws : - this clause is used to indicate the exception that are not handled by the method.

(b) E * ( F / ( G – H ) * I ) + J

E * ( F / G H – * I ) + J

E * F G H – / I * + J

E F G H – / I * * J +

(c) Step 1 : Start

Step 2 : if top >= capacity then OVERFLOW, Exit

Step 3 : top = top+1

Step 4 : Stack[top] = value

Step 5 : Stop

(d) (i) FileOutputStream / DataOutputStream/ FileWriter/ OutputStream

(ii) FileReader / DataInputStream/ InputStream/ FileInputStream

(e) Row Major address formula : **M[i][j] = BA + W [(i – lr) * column + (j – lc)]**

BA = 1840, lr = 0 , lc = 0 , W = 4 , rows = 10 , column = 10 , i = 4 , j = 8

M[4][8] = 1840 + 4 [ ( 4 - 0 ) x 10 + ( 8 – 0 ) ]

= 1840 + 192

= **2032**

**Question 3**

(a) The following function **Recur ( )** is a part of some class. What will be the output of the function **Recur** ( ) when the value of n is equal to 10. Show the dry run / working. **[5]**

```
void Recur (int n)
{   if (n > 1 )
      {   System.out.print ( n + " " );
          if (n%2 !=0)
          {
              n = 3 * n+1;
              System.out.print(n + " ");
           }
          Recur (n/2);
       }
}
```

(b) The following function is a part of some class. Assume 'n' is a positive integer. Answer the given questions along with dry run / working.

```
int unknown (int n)
{
   int i, k;
   if (n%2==0)
   {   i = n/2;
       k=1;
    }
    else
    {
       k=n;
       n– –;
       i=n/2;
    }
    while (i > 0)
    {
       k=k*i*n;
       i– –;
       n– –;
    }
    return k;
}
```

(i) What will be returned by unknown(5)? **[2]**

(ii) What will be returned by unknown(6)? **[2]**

(iii) What is being computed by unknown (int n)? **[1]**

Comments of Examiners

(a) Most of the candidates answered this part correctly. Some candidates were not clear with the concept of recursive technique. A few did not show the working / dry run. Some were confused with the odd and even numbers and solved only half the output i.e. incomplete answer. A few candidates were not able to solve the back tracking part (LIFO). In several cases, the output was shown vertical instead of horizontal. A few candidate gave the answer in reverse order.

(b) (i) Most of the candidates answered well and scored full credit. Some did not show the working and wrote the answer directly. Some could not calculate properly and lost track after the first step.

(ii) Same as above

(iii) This part was answered correctly by most of the candidates.

*Suggestions for teachers*

- Various techniques relating to problem solving using recursion should be given more practice. Output programs must be explained using diagrams for each function call. Memory blocks can be used to represent each function call.
- Practice should be given on program using conditions / looping and other output related programs. Teachers should show the dry run/ working of program and emphasize that working is necessary to get full credit. Working should be done in a tabular form, calculating the values of each variable after each iteration.

**MARKING SCHEME**

**Question 3.**

(a)
```
Recur ( 10 )
10  Recur ( 5 )
        5
        16  Recur ( 8 )
              8  Recur ( 4 )
                    4  Recur ( 2 )
                          2  Recur ( 1 )
```

**OUTPUT : 10 5 16 8 4 2**

(b) (i) 120

(ii) 720

(iii) calculate factorial/ product

## PART – II

*Answer **seven** questions in this part, choosing **three** questions from Section A, **two** from Section B and **two** from Section C.*

## SECTION - A

*Answer any **three** questions.*

**Question 4**

(a) Given the Boolean function: **F(A,B,C,D) = Σ (0, 2, 4, 5, 8, 9, 10, 12, 13)**

(i) Reduce the above expression by using 4-variable K-Map, showing the various groups (i.e. octal, quads and pairs). **[4]**

(ii) Draw the logic gate diagram of the reduced expression. Assume that the variables and their complements are available as inputs. **[1]**

(b) Given the Boolean function: **F(P,Q,R,S) = π (0, 1, 3, 5, 7, 8, 9, 10, 11, 14, 15)**

(i) Reduce the above expression by using 4-variable K-Map, showing the various groups (i.e. octal, quads and pairs). **[4]**

(ii) Draw the logic gate diagram of the reduced expression. Assume that the variables and their complements are available as inputs. **[1]**

Comments of Examiners

(a) (i) Many candidates answered this question correctly. Some candidates made errors in place value and putting variables in K-Map. In some cases, the groups were reduced by laws. Several candidates drew the K-Map incorrectly. Some marked the group as pairs instead of quads. A number of candidates included the redundant group in the final expression
(ii) Several candidates drew the logic circuit using NAND gates while some others drew vague diagrams. In some cases, the gates were not in proper shape and the logic diagram was not labeled.

(b) (i) Several candidates were not able to draw the K-Map for the POS expression correctly. For a number of candidates, the 'Map rolling' concept was not very clear. Some converted the canonical form to cardinal form and then reduced it.
(ii) Many candidates drew the logic circuit using NOR gates while some others drew vague diagrams.

*Suggestions for teachers*

- Emphasize on arranging the variables in proper order and the importance of cell values corresponding with the variables. Explain clearly how the groups are framed and reduced with the highest reducing group marked first. Redundant groups are not to be included in the final reduced expression.
- More and more practice should be given in drawing logic circuits using basic gates and also with universal gates,
- Make students reduce POS and SOP expressions using K-Map simultaneously.

**MARKING SCHEME**

**Question 4.**

(a) $F(A,B,C,D) = \Sigma\ (0, 2, 4, 5, 8, 9, 10, 12, 13)$

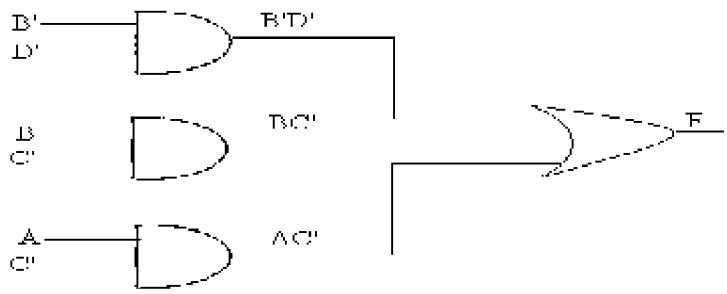
| | **C'D'** | **C'D** | **CD** | **CD'** |
|---|---|---|---|---|
| **A'B'** | 0 **1** | 1 0 | 3 0 | 2 **1** |
| **A'B** | 4 **1** | 5 **1** | 7 0 | 6 0 |
| **AB** | 12 **1** | 13 **1** | 15 0 | 14 0 |
| **AB'** | 8 **1** | 9 **1** | 11 0 | 10 **1** |

There are three quads:

Quad1 $(m_0 + m_2 + m_8 + m_{10})$ = B'D' Quad2 $(m_4 + m_5 + m_{12} + m_{13})$ = BC'

Quad3 $(m_8 + m_9 + m_{12} + m_{13})$ = AC'

**Hence F (A, B, C, D) = B'D' + BC' + AC'**



(b) F(P,Q,R,S) = **π ( 0, 1, 3, 5, 7, 8, 9, 10, 11, 14, 15 )**

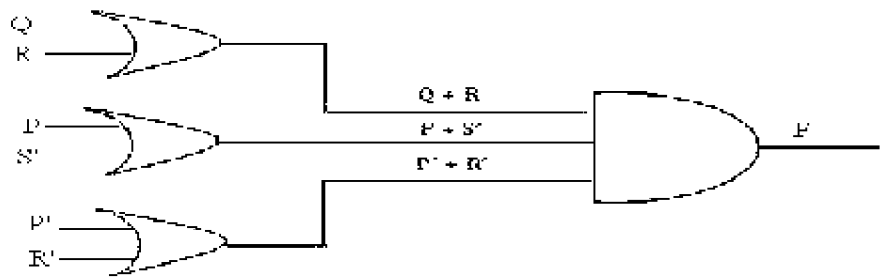
| | R+S | R+S' | R'+S' | R'+S |
|---|---|---|---|---|
| P+Q | 0 **0** | 1 **0** | 3 **0** | 2 1 |
| P+Q' | 4 1 | 5 **0** | 7 **0** | 6 1 |
| P'+Q' | 12 1 | 13 1 | 15 **0** | 14 **0** |
| P'+Q | 8 **0** | 9 **0** | 11 **0** | 10 **0** |

There are three quads:

Quad 1 ( $M_0 M_1 M_8 M_9$ ) = Q + R  Quad 2 ( $M_1 M_3 M_5 M_7$ ) = P + S'

Quad 3 ( $M_{10} M_{11} M_{14} M_{15}$ ) = P' + R'

**Hence F(P,Q,R,S) = ( Q + R ) . ( P + S' ) . ( P' + R' )**




**Question 5**

A Football Association coach analyzes the criteria for a win/draw of his team depending on the following conditions.

- If the Centre and Forward players perform well but Defenders do not perform well.

**OR**

- If Goal keeper and Defenders perform well but the Centre players do not perform well.

**OR**

- If all the players perform well.

The inputs are :

| INPUTS | |
|---|---|
| **C** | Centre players perform well. |
| **D** | Defenders perform well. |
| **F** | Forward players perform well. |
| **G** | Goalkeeper performs well. |

( In all of the above cases 1 indicates yes and 0 indicates no)

Output: **X** - Denotes the win/draw criteria [1 indicates win/draw and 0 indicates defeat in all cases.]

(a) Draw the truth table for the inputs and outputs given above and write the **POS** expression for X(C, D, F, G). **[5]**

(b) Reduce **X ( C, D, F, G )** using Karnaugh's Map. **[5]**
Draw the logic gate diagram for the reduced **POS** expression for X ( C, D, F, G ) using AND and OR gate. You may use gates with two or more inputs. Assume that the variable and their complements are available as inputs.

Comments of Examiners

(a) While a number of candidates answered well, some did not mention the final expression. Several candidates were confused with the POS expression and took the output with 1's instead of 0's. Some took 0's as outputs but wrote the minterms instead of maxterms.

(b) Some candidates were not able to draw the K-Map for the POS expression correctly. Some drew the K-Map of SOP, but grouping and reducing was done in POS. For a number of candidates the "Map rolling" concept was not very clear. Several candidates converted the canonical form to cardinal form and then reduced it. Some candidates did not draw the logic circuit.

*Suggestions for teachers*

- Student should be told to read the question carefully and answer accordingly so that no part is left unanswered. More practice should be given to derive SOP and POS expression from any given truth table (i.e. Minterms and Maxterms).
- Make students reduce POS and SOP expressions using K-Map simultaneously. Students should be asked to read the question carefully (i.e. SOP or POS) and not to include the redundant group in the final expression.

**MARKING SCHEME**

**Question 5.**

(a)

| C | D | F | G | X |
|---|---|---|---|---|
| Centre players perform well | Defenders perform well | Forward players perform well | Goalkeeper perform well | **OUTPUT** |
| 0 | 0 | 0 | 0 | **0** |
| 0 | 0 | 0 | 1 | **0** |
| 0 | 0 | 1 | 0 | **0** |
| 0 | 0 | 1 | 1 | **0** |
| 0 | 1 | 0 | 0 | **0** |
| 0 | 1 | 0 | 1 | 1 |
| 0 | 1 | 1 | 0 | **0** |
| 0 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 | **0** |
| 1 | 0 | 0 | 1 | **0** |
| 1 | 0 | 1 | 0 | 1 |
| 1 | 0 | 1 | 1 | 1 |
| 1 | 1 | 0 | 0 | **0** |
| 1 | 1 | 0 | 1 | **0** |
| 1 | 1 | 1 | 0 | **0** |
| 1 | 1 | 1 | 1 | 1 |

$X(A,B,C,D) = \pi(0, 1, 2, 3, 4, 6, 8, 9, 12, 13, 14)$

(b)

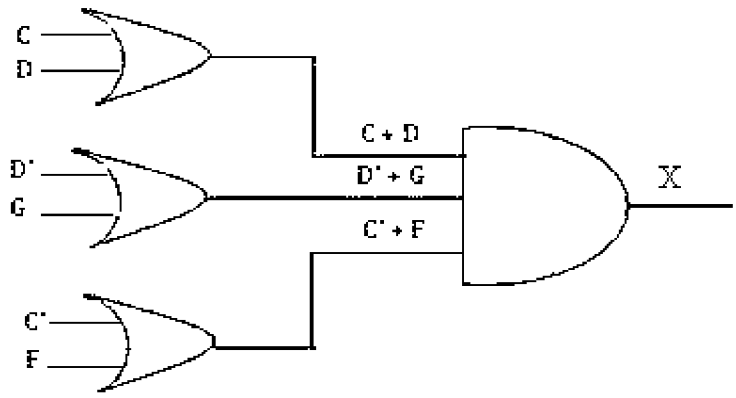
| | **F + G** | **F + G'** | **F' + G'** | **F'+G** |
|---|---|---|---|---|
| **C + D** | 0 **0** | 1 **0** | 3 **0** | 2 **0** |
| **C + D'** | 4 **0** | 5 1 | 7 1 | 6 **0** |
| **C'+ D'** | 12 **0** | 13 **0** | 15 1 | 14 **0** |
| **C'+ D** | 8 **0** | 9 **0** | 11 1 | 10 1 |

There are three quads:

Quad 1 $(M_0\ M_1\ M_2\ M_3) = C + D$ Quad 2 $(M_4\ M_6\ M_{12}\ M_{14}) = D' + G$

Quad 3 $(M_8\ M_9\ M_{12}\ M_{13}) = C' + F$

**Hence X (C, D, F, G) = ( C + D ) . ( D' + G ) . ( C' + F )**




**Question 6**

(a) In the following truth table x and y are inputs and B and D are outputs: **[3]**

| INPUT | | OUTPUT | |
|---|---|---|---|
| x | y | B | D |
| 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 1 |
| 1 | 1 | 0 | 0 |

Answer the following questions:

(i) Write the SOP expression for D.

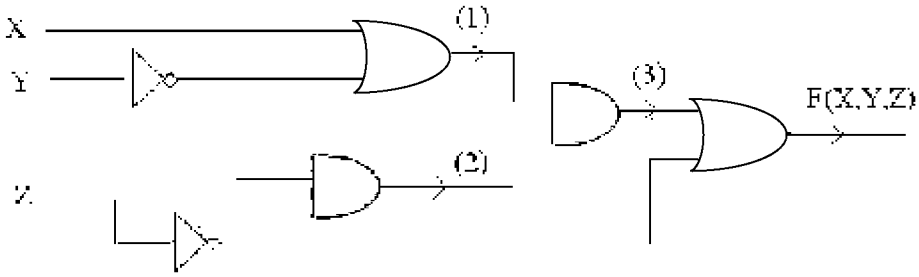
(ii) Write the POS expression for B.

(iii) Draw a logic diagram for the SOP expression derived for D, using only NAND gates.

(b) Using a truth table, verify if the following proposition is valid or invalid: **[3]**

$(a => b) \wedge (b => c) = (a => c)$

(c) From the logic circuit diagram given below, name the outputs (1), (2) and (3). Finally derive the Boolean expression and simplify it to show that it represents a logic gate. Name and draw the logic gate. **[4]**




Comments of Examiners

(a) (i) Some candidates wrote the POS expression for D. Some interchanged 0's with 1's and wrote the minterms for all outputs.
(ii) This part was answered correctly by most of the candidates. A few candidates wrote the SOP expression for B. Some gave the incomplete expression.
(iii) Most of the candidates answered this part correctly barring a few who drew vague diagram. Some candidates drew the logic diagram with multiple use of NAND gates.

(b) Most of the candidates answered this part well except for a few who were not aware of proposition statements and the terms and symbols used in proposition. Some candidates tried to make it equal and wasted time.

(c) The first three sub parts were answered correctly by almost all the candidates, but the final expression and its reducing was confusing to some. Some candidates were not able to arrive at the final expression and reduce it. The final gate symbol for the reduced expression (x + z') was not clear / ambiguous to some of the candidates.

*Suggestions for teachers*

- Deriving both SOP and POS expressions from truth table should be given more practice. Students should be told that 0(zero) output columns are for Maxterms and 1(one) output columns are for Minterms..
- More practice should be given to draw logic circuits using Universal gates (NOR and NAND). Teach students that in SOP expression the logic diagram drawn with basic gates (AND, OR, NOT) can be replaced by NAND gates and in POS expression the basic gates can be replaced by NOR gates directly.
- Propositional logic should be taught using all types of symbols, terms etc. that are used to solve a proposition and to state its validity
- Deriving expression from a logic diagram and reducing it must be given more practice. The basic gates i.e. AND, OR and NOT gate must be explained in detail.

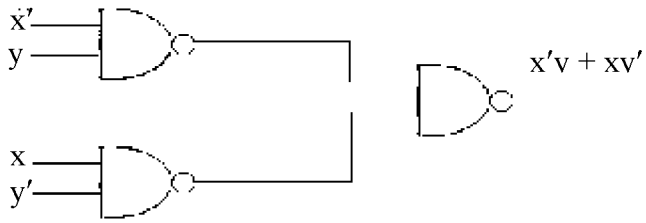
**MARKING SCHEME**

**Question 6.**

(a) (i) $D(x,y) = x'y + xy'$ OR $D(x,y) = \sum(1,2)$ OR $X \oplus Y$

(ii) $B(x,y) = (x+y)\cdot(x'+y)\,(x'+y')$ OR $B(x,y) = \pi\,(0,2,3)$

(iii)




(b) **( a => b ) Λ ( b => c ) = (a => c )**

| a | b | c | a => b | b => c | L.H.S. | a => c |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| 0 | 1 | 0 | 1 | 0 | 0 | 1 |
| 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 |

The proposition is **invalid**

(c) (1) X + Y'

(2) X.Z

(3) ( X + Y' ) . XZ

Final Expression F( X,Y,Z) = ( X + Y' ) . XZ + Z'

= XZ + XY'Z + Z'

= XZ ( 1 + Y' ) + Z'

= XZ + Z'

= (X+Z')·(Z+Z')

= X + Z'

The gate is OR gate.

**Question 7**

(a) What are Decoders? How are they different from Encoders? **[2]**

(b) Draw the truth table and a logic gate diagram for a 2 to 4 Decoder and briefly explain its working. **[4]**

(c) A combinational logic circuit with three inputs P, Q, R produces output 1 if and only if an odd number of 0's are inputs. **[4]**

(i) Draw its truth table.

(ii) Derive a canonical SOP expression for the above truth table.

(iii) Find the complement of the above derived expression using De Morgan's theorem and verify if it is equivalent to its POS expression.

Comments of Examiners

(a) The term 'combinational circuit' was not used in the definition by many candidates. Some were able to give suitable examples of their uses / applications / differences. In some cases, the differences were given but no definition of decoder was given. Several candidates explained the multiplexer instead of decoders.

(b) The logic diagram was well answered. Some candidates drew the OR gate instead of AND gate. Some used the OR gate to combine parallel lines to a single serial line which was not required. There was no labeling in some cases. The working / explanation was not shown in some of the cases.

(c) (i) This part was well answered by most of the candidates. A few candidates drew the wrong truth table with improper combinations.
(ii) Several candidates gave incomplete expression. Some wrote the minterms for all outputs.
(iii) Some candidates were confused as the complement was not equal / equivalent to its POS expression and wasted time in proving it unnecessarily.

*Suggestions for teachers*

- Encourage students to write the correct definition along with their use.
- The differences between encoders, decoders and multiplexers must be explained clearly.
- Practice should be given in drawing the decoders along with the expression, truth table and logic circuit / diagram.
- Candidates should be asked to read the question carefully and answer accordingly.
- Practice should be given in drawing 3-variable and 4-variable truth table combinations according to the gray coding. Odd and even parity must be explained in detail.
- More practice should be given in deriving the SOP and POS expression from the truth table.
- Complement of an expression should be taught in detail. Differences between duality and complementation must be explained with examples.

**MARKING SCHEME**

**Question 7.**

(a) Decoders are combinational circuit which inputs 'n' lines and outputs $2^n$ or fewer lines.

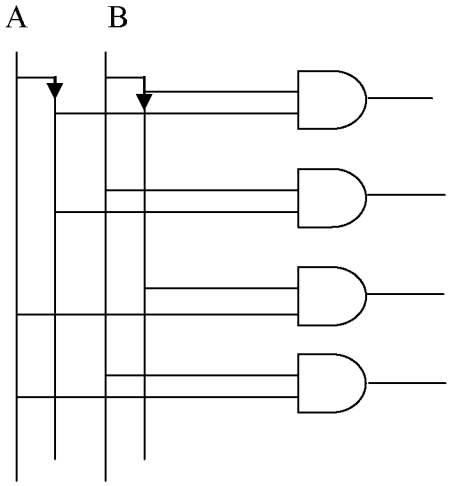
Encoders convert HLL to LLL i.e. Octal, Decimal and Hexadecimal to binary where as

Decoders convert LLL to HLL i.e. Binary to Octal, Decimal and Hexadecimal.

(b)

| Inputs | | Outputs | | | | X |
|---|---|---|---|---|---|---|
| A | B | $d_0$ | $d_1$ | $d_2$ | $d_3$ | |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 | 0 | 1 |
| 1 | 0 | 0 | 0 | 1 | 0 | 2 |
| 1 | 1 | 0 | 0 | 0 | 1 | 3 |

Truth Table for 2 to 4 decoder




Cicuit diagram for 2 to 4 decoder

Working : If any number is required as output then the inputs should be the binary equivalent. For example, if the input is 01 ( A'.B) then the output is 1 and so on.

(c) (i)

| P | Q | R | X (OUTPUT) |
|---|---|---|---|
| 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 0 |

(ii) X (P,Q,R) = P'Q'R' + P'QR + PQ'R + PQR'

(iii) Complement of X (P,Q,R) = (P+Q+R) . (P+Q'+R') . (P'+Q+R') . (P'+Q'+R) which is not equal to POS expression for the above Truth Table.

## SECTION – B

*Answer any **two** questions.*

*Each program should be written in such a way that it clearly depicts the logic of the problem. This can be achieved by using mnemonic names and comments in the program.*

(Flowcharts and Algorithms are **not** required.)

**The programs must be written in Java.**

**Question 8**

An emirp number is a number which is prime backwards and forwards. Example: 13 and 31 are both prime numbers. Thus, 13 is an emirp number. **[10]**

Design a class **Emirp** to check if a given number is Emirp number or not. Some of the members of the class are given below:

| | | |
|---|---|---|
| **Class name** | : | **Emirp** |
| **Data members/instance variables:** | | |
| n | : | stores the number |
| rev | : | stores the reverse of the number |
| f | : | stores the divisor |
| **Member functions**: | | |
| Emirp(int nn) | : | to assign n = nn, rev = 0 and f = 2 |
| int isprime(int x) | : | check if the number is prime using the **recursive technique** and return 1 if prime otherwise return 0 |
| void isEmirp( ) | : | reverse the given number and check if both the original number and the reverse number are prime, by invoking the function isprime(int) and display the result with an appropriate message |

Specify the class **Emirp** giving details of the **constructor(int), int isprime(int)** and **void isEmirp( ).** Define the **main( )** function to create an object and call the methods to check for Emirp number.

Comments of Examiners

Common errors made by candidates were: the concept of recursion was not clear to some candidates; some took the parameter 'x' as the number while some assumed it as a factor. The data member 'f' was declared as double and extra data members were included. Some wrote the function isprime() without using the recursive technique. Several candidates did not invoked the function isprime() to check for prime in the method isEmirp(). The object creation in the main() function was incorrect in some cases. The other function including the constructor as well answered. A few candidates did not write the main() function.

*Suggestions for teachers*

- More practice should be given in solving programs using recursive techniques. Much attention should be paid by the teachers towards recursion and its techniques with examples. Knowledge of base case and recursive case should be given to the students for every program using recursive technique. Invoking function within another function should be given more practice. It should be emphasized that constructors are invoked automatically and cannot return any value.

**MARKING SCHEME**

**Question 8.**

```
import java.util.Scanner;
public class Emirp
{
  int n,rev,f;
  Emirp(int nn)
  {   n=nn;
      rev=0;
      f=2;
   }
  int isprime(int x)
  {
      if(n==x)
        {
           return 1;
        }
      else if(n%x==0 ||n==1)
       {
          return 0;
       }
      else
        return isprime(x+1);
  }
  void isEmirp( )
  {
```

```
    int x=n;
    while(x!=0)
    {
       rev=(rev*10) + x%10;
       x=x/10;
     }
    int ans1=isprime(f);
    n=rev;
    f=2;
    int ans2=isprime(f);
    if(ans1==1 && ans2==1)
      System.out.println(n+ "  is an Emirp number");
    else
      System.out.println(n+ "  is not an Emirp number");
   }
  public static void main()
  {  Scanner sc=new Scanner(System.in);
     System.out.println("\n Enter a number " );
     int x=sc.nextInt();
    Emirp obj = new Emirp(x);
    obj.isEmirp();
  }
}
```

**Question 9**

Design a class **Exchange** to accept a sentence and interchange the first alphabet with the last alphabet for each word in the sentence, with single letter word remaining unchanged. The words in the input sentence are separated by a single blank space and terminated by a full stop. **[10]**

Example: Input: It is a warm day.

Output: tI si a marw yad

Some of the data members and member functions are given below:

| | | |
|---|---|---|
| **Class name** | : | **Exchange** |
| **Data members/instance variables:** | | |
| sent | : | stores the sentence |
| rev | : | to store the new sentence |
| size | : | stores the length of the sentence |
| **Member functions:** | | |
| Exchange( ) | : | default constructor |
| void readsentence( ) | : | to accept the sentence |

| | | |
|---|---|---|
| void exfirstlast( ) | : | extract each word and interchange the first and last alphabet of the word and form a new sentence rev using the changed words |
| void display( ) | : | display the original sentence along with the new changed sentence. |

Specify the class **Exchange** giving details of the **constructor( ), void readsentence( ), void exfirstlast( )** and **void display( )**. Define the **main( )** function to create an object and call the functions accordingly to enable the task.

Comments of Examiners

Most of the candidates answered correctly. Different methods / logic were used to extract the words from the sentence. Some used String tokenizer while others used the split function and charArray to separate words from the sentence. In some cases, the words were exchanged / reversed instead of exchanging the first and last alphabet. Reframing the sentence after exchanging the first and last character was not done properly in several cases. A number of candidates did not define the default constructor. Some used the replace() function which was incorrect. A few candidates did the entire program without answering the exfirstlast() function. The main() function and constructor were not answered by a number of candidates.

*Suggestions for teachers*

- Practice should be given in extracting characters from words, words from sentences and sentences from paragraphs. Different methods /logic should be adopted so that wider exposure to string manipulation related programs is given to the candidates. Knowledge of constructors to initialize a string and other data members should be given.

**MARKING SCHEME**

**Question 9.**

```
import java.util.*;
public class Exchange
{
 String sent,rev;
 int size;
 Exchange()
 { sent=null;
   rev="";
 }
 void readsentence()
 {  Scanner sc=new Scanner(System.in);
    System.out.print("\n Enter a sentence  ");
    sent=sc.nextLine();
    size=sent.length();
 }
 void exfirstlast()
 {
```

```
    int p=0; char ch; String b;
    for(int i=0;i<size;i++)
     { ch=sent.charAt(i);
       if(ch ==' '||ch =='.')
        {  b=sent.substring(p,i);
           if(b.length() != 1)
            { rev += b.charAt(b.length()-1);
              rev = rev + b.substring(1,b.length()-1);
              rev += b.charAt(0);

            }
           else
               rev = rev + b;
          rev = rev + " ";
          p=i+1;
        }
     }
   }
   void display()
   { System.out.print("\n  Input:  " + sent);
     System.out.print("\n Output:  " + rev );
   }
   public static void main()
   { Exchange obj = new Exchange();
     obj.readsentence();
     obj.exfirstlast();
     obj.display();
   }
}
```

**Question 10**

A class **Matrix** contains a two dimensional integer array of order [m × n]. The maximum value possible for both 'm' and 'n' is 25. Design a class **Matrix** to find the difference of the two matrices. The details of the members of the class are given below: **[10]**

| | | |
|---|---|---|
| **Class name** | : | **Matrix** |
| **Data members/instance variables:** | | |
| arr[ ][ ] | : | stores the matrix element |
| m | : | integer to store the number of rows |
| n | : | integer to store the number of columns |

**Member functions:**

| | | |
|---|---|---|
| Matrix (int mm, int nn) | : | to initialize the size of the matrix m = mm and n = nn |
| void fillarray( ) | : | to enter the elements of the matrix |
| Matrix SubMat(Matrix A) | : | subtract the current object from the matrix of parameterized object and return the resulting object |
| void display( ) | : | display the matrix elements |

Specify the class **Matrix** giving details of the **constructor(int,int), void fillarray( ), Matrix SubMat(Matrix)** and **void display**. Define the **main( )** function to create objects and call the methods accordingly to enable the task.

Comments of Examiners

Common errors made by candidates while attempting this question were: (i) passing objects to the function and accessing its members by the dot operator (ii) creating a new local object and returning the object. Several candidates re-declared and created the array in the constructor. In some cases, 3 different arrays were created instead of creating objects. Some candidates used the same object to store the answer without creating a local object. Printing of the array in matrix form was not done properly in a number of cases. The main() function was incomplete in some cases as the objects were not created nor the function was called properly.

*Suggestions for teachers*

- Passing objects to functions must be explained clearly.
- It must be emphasized that only the mentioned technique should be written.
- More practice should be given in writing the main function with each and every program. Practice should be given in both single and double dimension programs.
- Instruct the students to read the question properly and answer accordingly.

**MARKING SCHEME**

**Question 10.**

```
import java.util.Scanner;
public class Matrix
{    static Scanner sc=new Scanner(System.in);
     int arr[][]=new int[25][25];
     int m,n;
     Matrix(int mm,int nn)
     { m=mm;
       n=nn;
     }
     void fillarray()
     {   System.out.print("\n Enter elements of array  ");
```

```
        for(int i=0;i<m;i++)
         { for(int j=0;j<n;j++)
               arr[i][j]=sc.nextInt();
          }
    }

    Matrix SubMat(Matrix A)
    {
      Matrix B=new Matrix(m,n);
      for(int i=0;i<m;i++)
        { for(int j=0;j<n;j++)
            B.arr[i][j]= arr[i][j] - A.arr[i][j];
          }
        return B;
       }
    void display()
    { for(int i=0;i<m;i++)
      { System.out.println();
         { for(int j=0;j<n;j++)
             System.out.print(arr[i][j] + " \t ");
         }      }    }
    public static void main()
    {   System.out.print("\n Size of array " );
       int x=sc.nextInt();
       int y=sc.nextInt();
       Matrix A=new Matrix(x,y);
       Matrix B=new Matrix(x,y);
       Matrix C=new Matrix(x,y);
       A.fillarray();
       B.fillarray();
       C=A.SubMat(B);
       C.display();
    }
}
```

## SECTION – C

*Answer any **two** questions.*

*Each program should be written in such a way that it clearly depicts the logic of the problem stepwise. This can be achieved by using comments in the program and mnemonic names or pseudo codes for algorithms. The programs must be written in Java and the algorithms must be written in general / standard form, wherever required / specified.*

(Flowcharts are **not** required.)

**Question 11**

A super class **Perimeter** has been defined to calculate the perimeter of a parallelogram. Define a subclass **Area** to compute the area of the parallelogram by using the required data members of the super class. The details are given below: **[10]**

| | | |
|---|---|---|
| **Class name** | : | **Perimeter** |
| **Data members/instance variables:** | | |
| a | : | to store the length in decimal |
| b | : | to store the breadth in decimal |
| **Member functions:** | | |
| Perimeter(...) | : | parameterized constructor to assign values to data members |
| double Calculate( ) | : | calculate and return the perimeter of a parallelogram as 2 * (length + breadth) |
| void show( ) | : | to display the data members along with the perimeter of the parallelogram |
| **Class name** | : | **Area** |
| **Data members/instance variables:** | | |
| h | : | to store the height in decimal |
| area | : | to store the area of the parallelogram |
| **Member functions:** | | |
| Area(...) | : | parameterized constructor to assign values to data members of both the classes |
| void doarea( ) | : | compute the area as (breadth * height) |
| void show( ) | : | display the data members of both classes along with the area and perimeter of the parallelogram. |

Specify the class **Perimeter** giving details of the **constructor(...), double Calculate( )** and **void show( ).** Using the **concept of inheritance**, specify the class **Area** giving details of the **constructor(... ), void doarea( )** and **void show( ).**

**The main function and algorithm need not be written.**

Comments of Examiners

The concept of Inheritance was not clear to several candidates. The keywords 'extends' and 'super' was missing in many answers. Constructor with inheritance was not answered correctly. Accessing the members of the super class by the derived class was not clear to some of the candidates. Several candidates declared the base class data members as private. Double data members were not declared properly by some candidates. Invoking the show() function in the derived class was not answered properly. In some cases, the algorithm was written instead of a program. The rest of the functions were well answered.

*Suggestions for teachers*

- Practice should be given on inheritance to students. Use of constructor using the base class member should be made clear. The different visibility modes and their accessing capability should be made clear. Knowledge of calling the member function from the super class to the derived class must be clarified. Function overriding concept must be clearly explained and given more practice.

**MARKING SCHEME**

**Question 11.**

```
import java.util.*;
class Perimeter
{
   protected double a,b;
   Perimeter(double aa,double bb)
   {
       a=aa;
       b=bb;
    }
   double Calculate()
   {
        return (2*(a+b));
    }
   void show()
   {
         System.out.print("\n Length = " + a);
         System.out.print("\n Breadth = " + b);
         System.out.print("\n Perimeter =" + Calculate());
   }
}

import java.util.*;
class Area extends Perimeter
{
     double h;
     double area;
  Area(double aa, double bb, double cc)
  {
```

```
      super(aa,bb);
       h=cc;
   }
  void doarea()
  {
     area=super.b*h;
  }
  void show()
  {
       super.show();
       System.out.print("\n Height =  " + h);
       System.out.print("\n Area =  " + area);
  }

}
```

**Question 12**

A doubly queue is a linear data structure which enables the user to add and remove integers from either ends, i.e. from front or rear. Define a class **Dequeue** with the following details: **[10]**

| | | |
|---|---|---|
| **Class name** | : | **Dequeue** |
| **Data members/instance variables:** | | |
| arr[ ] | : | array to hold up to 100 integer elements |
| lim | : | stores the limit of the dequeue |
| front | : | to point to the index of front end |
| rear | : | to point to the index of the rear end |
| **Member functions:** | | |
| Dequeue(int l) | : | constructor to initialize the data members lim=1; front=rear=0 |
| void addfront(int val) | : | to add integer from the front if possible else display the message ("Overflow from front") |
| void addrear(int val) | : | to add integer from the rear if possible else display the message ("Overflow from rear") |
| int popfront( ) | : | returns element from front, if possible otherwise returns - 9999 |
| int poprear( ) | : | returns element from rear, if possible otherwise returns - 9999 |

Specify the class **Dequeue** giving details of the **constructor(int), void addfront(int), void addrear(int), int popfront( )** and **int poprear( ).**

**The main function and algorithm need not be written.**

Comments of Examiners

The concept of dequeue was not clear to most of the candidates. Common errors made by candidates were: (i) the condition / logic for underflow and overflow was not answered correctly (ii) increment / decrement of front and rear index was not done properly. Some candidates did not return values from popfront() and poprear() functions. Some wrote the queue program instead of dequeue. The methods addfront() and poprear() were found to be difficult by several candidates. Different approaches / methods / logic was used to solve the dequeue concept. The class declaration and constructors was well answered.

*Suggestions for teachers*

- More practice should be given in data structure programs like the stacks, queues, dequeues etc.
- Working must be shown as to how the stack or a queue performs (examples can be supportive ).
- The concept of LIFO and FIFO must be explained to the students with lively examples related to real world. Implementation of stacks, queues and dequeues using arrays should be emphasized. Only the concept has to be explained taking the base as an array. It should be made clear to students that it is not an array related program which can be manipulated by shifting / inserting or initializing by any value since these data structures require pointers and pointers are not supported in java. So, the array is used to show the working of a stack, queue or a dequeue.

**MARKING SCHEME**

**Question 12.**

```
public class Dequeue
{
   int arr[] = new int[100];
   int lim,front,rear;
   Dequeue(int l)
   {
      lim=l;
      front=0;
      rear=0;
      arr=new int[lim];
   }
   void addfront(int val)
   {
       if(front>0)
           arr[front--]=val;
       else
           System.out.print("\n Overflow from front ");
```

```
    }
    void addrear(int val)
    {
        if(rear<lim-1)
            arr[++rear]=val;
        else
            System.out.print("\n Overflow from rear ");
    }
    int popfront()
    {
         if(front!=rear)
              return arr[++front];
         else
              return -9999;
    }
    int poprear()
    {
         if(front!=rear)
             return arr[rear--];
         else
             return -9999;
    }
}
```

**Question 13**

(a) A linked list is formed from the objects of the class, **[4]**

```
class Node
  {
    int item;
    Node next;
   }
```

Write an *Algorithm* **OR** a *Method* to count the number of nodes in the linked list. The method declaration is given below:

**int count(Node ptr_start)**

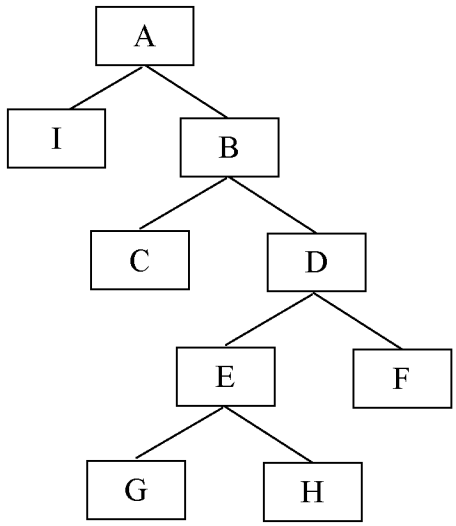
(b) What is the Worst Case complexity of the following code segment: **[2]**

(i)
```
for (int p = 0; p < N; p++)
    {
    for (int q=0; q < M; q++)
        {
          Sequence of statements;
        }
```

```
    }
for (int r = 0; r < X; r++)
    {
        Sequence of statements;
    }
```

(ii) How would the complexity change if all the loops went upto the same limit N?

(c) Answer the following from the diagram of a Binary Tree given below: **[4]**




(i) Preorder Transversal of tree.

(ii) Children of node E.

(iii) Left subtree of node D.

(iv) Height of the tree when the root of the tree is at level 0.

Comments of Examiners

(a) This part was well answered by most of the candidates. A few candidates had problem in moving the pointer to the next node and checking for null. Some wrote the algorithm in simple English language covering all the main steps.

(b) (i) A number of candidates were able to answer this part well. Some candidates did not mention the symbol 'O' in the final answer. A few candidates wrote only the definition of complexity while others mentioned (m*n) as dominant term instead.

*Suggestions for teachers*

- More programs / algorithms should be practiced with link list and binary tree data structure.
- Definition of complexities / big 'O' and the three cases of complexities must be explained in detail along with examples. The role of the dominant term in complexities must be explained.

(ii) Some candidates did not reduce the complexity by taking the dominant term. Some calculated correctly, but represented incorrectly. Candidates were not clear with the dominant term

(c) (i) Some candidates gave incomplete answers. Some were confused with Preorder and Inorder.

(ii) This part was well answered by most of the candidates.

(iii) Sub tree not clear as compared to nodes and only one tree child was mentioned in some cases.

(iv) Different answers were given by the candidates i.e. height of the tree can be 4 or 5.

- Explain binary tree with the different parts like root, nodes(internal and external), height, depth, level, size, tree traversal (preorder, inorder and postorder) etc.
- Candidates should be taught that height and level of a tree is same when the root is at level 0

**MARKING SCHEME**

**Question 13.**

(a) **Algorithm to count the number of nodes in a linked list.**

**Steps :**

1 - Start

2 - Set temporary pointer to first node and counter to 0.

3 - Repeat steps 4 and 5 until the pointer reaches null

4 - Increment the counter

5 - move temporary pointer to the next node

6 - Return the counter value

7 - End

**Method to count for the number of nodes in a linked list**

```
int count ( Node ptr_start )
{
      Node a = new Node(ptr_start);
      int c=0;
      while (a!=null )
       {   c++;
           a=a.next;
         }
       return c;

}
```

(b) (i) O(N x M) + O(X) **OR** O( NM + X )

(ii) $O(N^2)$ **OR** $O(N^2 + N) = O(N^2)$

( by taking the dominant term)

| | | |
|---|---|---|
| (c) | (i) | A, I, B, C, D, E, G, H, F |
| | (ii) | G and H |
| | (iii) | E G H |
| | (iv) | 4 |

**GENERAL COMMENTS:**

**(a) Topics found difficult by candidates in the Question Paper:**

- Canonical and Cardinal form of expressions and inter conversion.
- Keywords 'throw' and 'throws' with respect to Exceptional Handling.
- File Stream classes (both reading and writing data to files).
- K-MAPS (Grouping , map-rolling , place value)
- Redundant groups in K-Maps
- Passing objects to functions.
- Functions exfirstlast( ) and SubMat(Matrix A)
- Recursive technique and invoking function within another function (Nesting of functions).
- Dequeue operations for adding in front and removing from rear.

**(b) Concepts between which candidates got confused:**

- Canonical and Cardinal form of expression
- Difference between 'throw' and 'throws'.
- File handling stream classes
- Symbols of propositional logic
- Duality and complementation
- Deriving POS expression from Truth table
- Representing a single gate after reducing a logic circuit diagram.
- Passing of objects to functions.
- Invoking function within function.
- Written algorithms for inheritance program.
- Dominant term in complexity.

**(c) Suggestions for Candidates:**

- Prepare summary for each chapter or use high lighters to recognize the important terms and definitions.
- Answers and definitions should be short and precise and according to marks intended.
- Read the question properly and answer accordingly.
- Working should be shown at the side of each question wherever required.
- Laws must be mentioned while reducing a Boolean Expression.
- Practice one form of K-Map with proper place value for both SOP and POS.
- In programming documentation is compulsory and should be mentioned with each program.
- Declare the class with data members and member functions. Expand or define each function according to the instructions given by the side of each function.
- Do not memorize the program, try to understand the logic.
- Practice constructors with every program. Treat each function of a class as separate program.