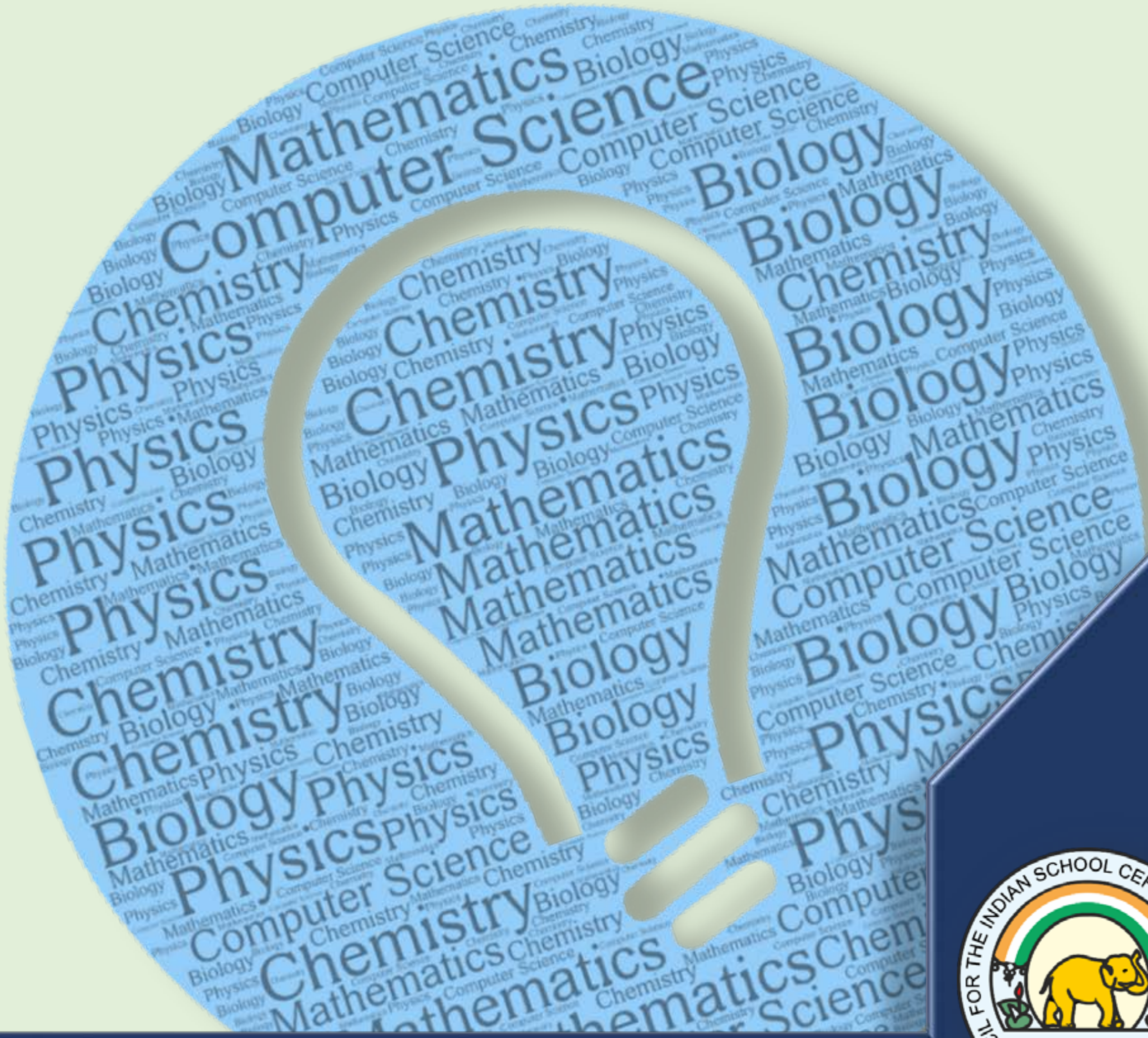
Analysis of Pupil Performance

ISC Year 2017 Examination

Sciences & Mathematics

PHYSICS



Research Development and Consultancy Division

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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. Shilpi Gupta (Deputy Head) and the Research Development and Consultancy Division (RDCD) 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

November 2017

PREFACE

The Council has been involved in the preparation of the ICSE and ISC Analysis of Pupil Performance documents since the year 1994. Over these years, these documents have facilitated the teaching-learning process by providing subject/ paper wise feedback to teachers regarding performance of students at the ICSE and ISC Examinations. With the aim of ensuring wider accessibility to all stakeholders, from the year 2014, the ICSE and the ISC documents have been made available on the Council's website www.cisce.org.

The document includes a detailed qualitative analysis of the performance of students in different subjects which comprises of examiners' comments on common errors made by candidates, topics found difficult or confusing, marking scheme for each answer and suggestions for teachers/ candidates.

In addition to a detailed qualitative analysis, the Analysis of Pupil Performance documents for the Examination Year 2017 have a new component of a detailed quantitative analysis. For each subject dealt with in the document, both at the ICSE and the ISC levels, a detailed statistical analysis has been done, which has been presented in a simple user-friendly manner.

It is hoped that this document will not only enable teachers to understand how their students have performed with respect to other students who appeared for the ICSE/ISC Year 2017 Examinations, how they have performed within the Region or State, their performance as compared to other Regions or States, etc., it will also help develop a better understanding of the assessment/ evaluation process. This will help them in guiding their students more effectively and comprehensively so that students prepare for the ICSE/ ISC Examinations, with a better understanding of what is required from them.

The Analysis of Pupil Performance document for ICSE for the Examination Year 2017 covers the following subjects: English (English Language, Literature in English), Hindi, History, Civics and Geography (History & Civics, Geography), Mathematics, Science (Physics, Chemistry, Biology), Commercial Studies, Economics, Computer Applications, Economics Applications, Commercial Applications.

Subjects covered in the ISC Analysis of Pupil Performance document for the Year 2017 include English (English Language and Literature in English), Hindi, Elective English, Physics (Theory and Practical), Chemistry (Theory and Practical), Biology (Theory and Practical), Mathematics, Computer Science, History, Political Science, Geography, Sociology, Psychology, Economics, Commerce, Accounts and Business Studies.

I would like to acknowledge the contribution of all the ICSE and the ISC examiners who have been an integral part of this exercise, whose valuable inputs have helped put this document together.

I would also like to thank the RDCD team of Dr. Manika Sharma, Dr. M.K. Gandhi, Ms. Mansi Guleria and Mrs. Roshni George, who have done a commendable job in preparing this document. The statistical data pertaining to the ICSE and the ISC Year 2017 Examinations has been provided by the IT section of the Council for which I would like to thank Col. R. Sreejeth (Deputy Secretary - IT), Mr. M.R. Felix, Education Officer (IT) – ICSE and Mr. Samir Kumar, Education Officer (IT) - ISC.

Shilpi Gupta
Deputy Head - RDCD

November 2017

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INTRODUCTION

This document aims to provide a comprehensive picture of the performance of candidates in the subject. It comprises of two sections, which provide Quantitative and Qualitative analysis results in terms of performance of candidates in the subject for the ISC Year 2017 Examination. The details of the Quantitative and the Qualitative analysis are given below.

Quantitative Analysis

This section provides a detailed statistical analysis of the following:

- Overall Performance of candidates in the subject (Statistics at a Glance)
- State wise Performance of Candidates
- Gender wise comparison of Overall Performance
- Region wise comparison of Performance
- Comparison of Region wise performance on the basis of Gender
- Comparison of performance in different Mark Ranges and comparison on the basis of Gender for the top and bottom ranges
- Comparison of performance in different Grade categories and comparison on the basis of Gender for the top and bottom grades

The data has been presented in the form of means, frequencies and bar graphs.

Understanding the tables

Each of the comparison tables shows N (Number of candidates), Mean Marks obtained, Standard Errors and t-values with the level of significance. For t-test, mean values compared with their standard errors indicate whether an observed difference is likely to be a true difference or whether it has occurred by chance. The t-test has been applied using a confidence level of 95%, which means that if a difference is marked as 'statistically significant' (with * mark, refer to t-value column of the table), the probability of the difference occurring by chance is less than 5%. In other words, we are 95% confident that the difference between the two values is true.

t-test has been used to observe significant differences in the performance of boys and girls, gender wise differences within regions (North, East, South and West), gender wise differences within marks ranges (Top and bottom ranges) and gender wise differences within grades awarded (Grade 1 and Grade 9) at the ISC Year 2017 Examination.

The analysed data has been depicted in a simple and user-friendly manner.

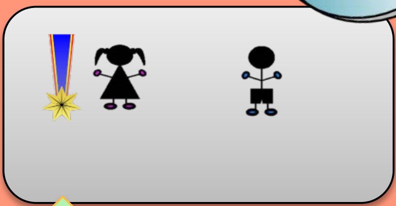
Given below is an example showing the comparison tables used in this section and the manner in which they should be interpreted.

Comparison on the basis of Gender

Gender	N	Mean	SE	t-value
Girls	2,538	66.1	0.29	
Boys	1,051	60.1	0.42	

*Significant at 0.05 level

Girls performed significantly better than boys.



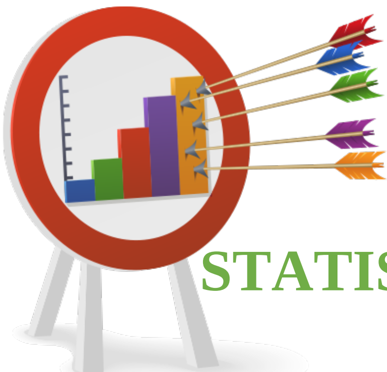
The results have also been depicted pictographically. In this case, the girls performed significantly better than the boys. This is depicted by the girl with a medal.

The table shows comparison between the performances of boys and girls in a particular subject. The t-value of 11.91 is significant at 0.05 level (mentioned below the table) with a mean of girls as 66.1 and that of boys as 60.1. It means that there is significant difference between the performance of boys and girls in the subject. The probability of this difference occurring by chance is less than 5%. The mean value of girls is higher than that of boys. It can be interpreted that girls are performing significantly better than boys.

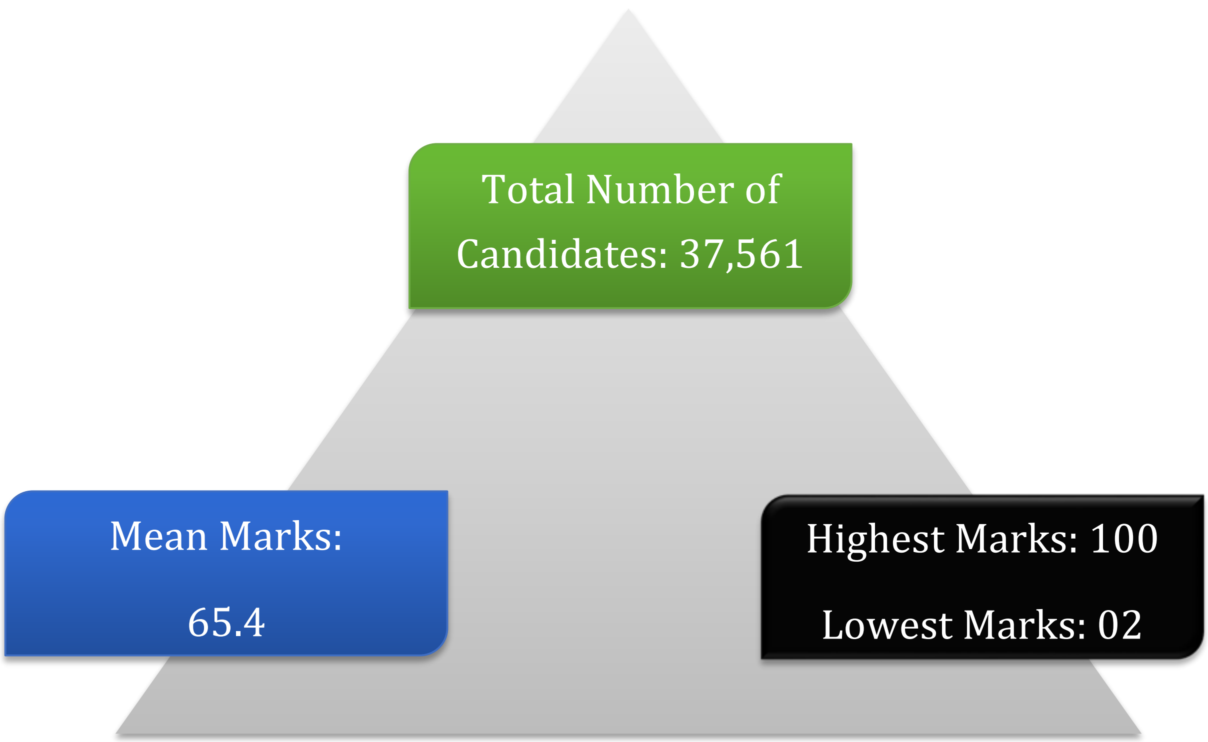
Qualitative Analysis

The purpose of the qualitative analysis is to provide insights into how candidates have performed in individual questions set in the question paper. This section is based on inputs provided by examiners from examination centres across the country. It comprises of question wise feedback on the performance of candidates in the form of *Comments of Examiners* on the common errors made by candidates along with *Suggestions for Teachers* to rectify/ reduce these errors. The *Marking Scheme* for each question has also been provided to help teachers understand the criteria used for marking. Topics in the question paper that were generally found to be difficult or confusing by candidates, have also been listed down, along with general suggestions for candidates on how to prepare for the examination/ perform better in the examination.

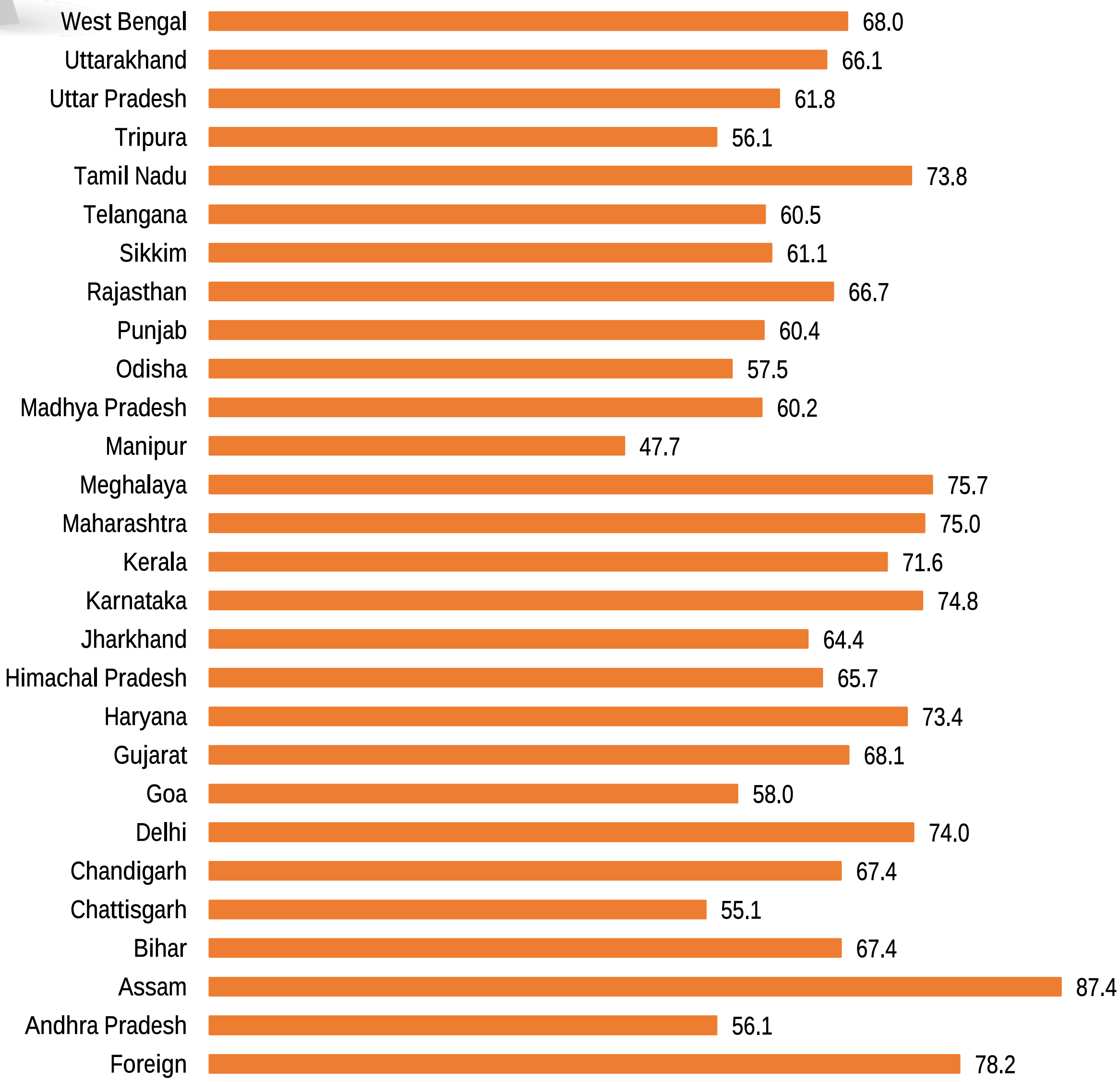
QUANTITATIVE ANALYSIS



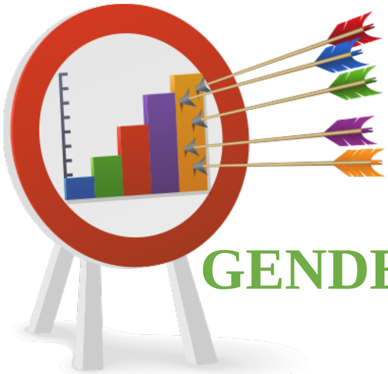
STATISTICS AT A GLANCE



PERFORMANCE (STATE-WISE & FOREIGN)



The States of Assam, Meghalaya and Maharashtra secured highest mean marks. Mean marks secured by candidates studying in schools abroad were 78.2.



GENDER-WISE COMPARISON

GIRLS

Mean Marks: 65.6

Number of Candidates: 14,773

BOYS

Mean Marks: 65.3

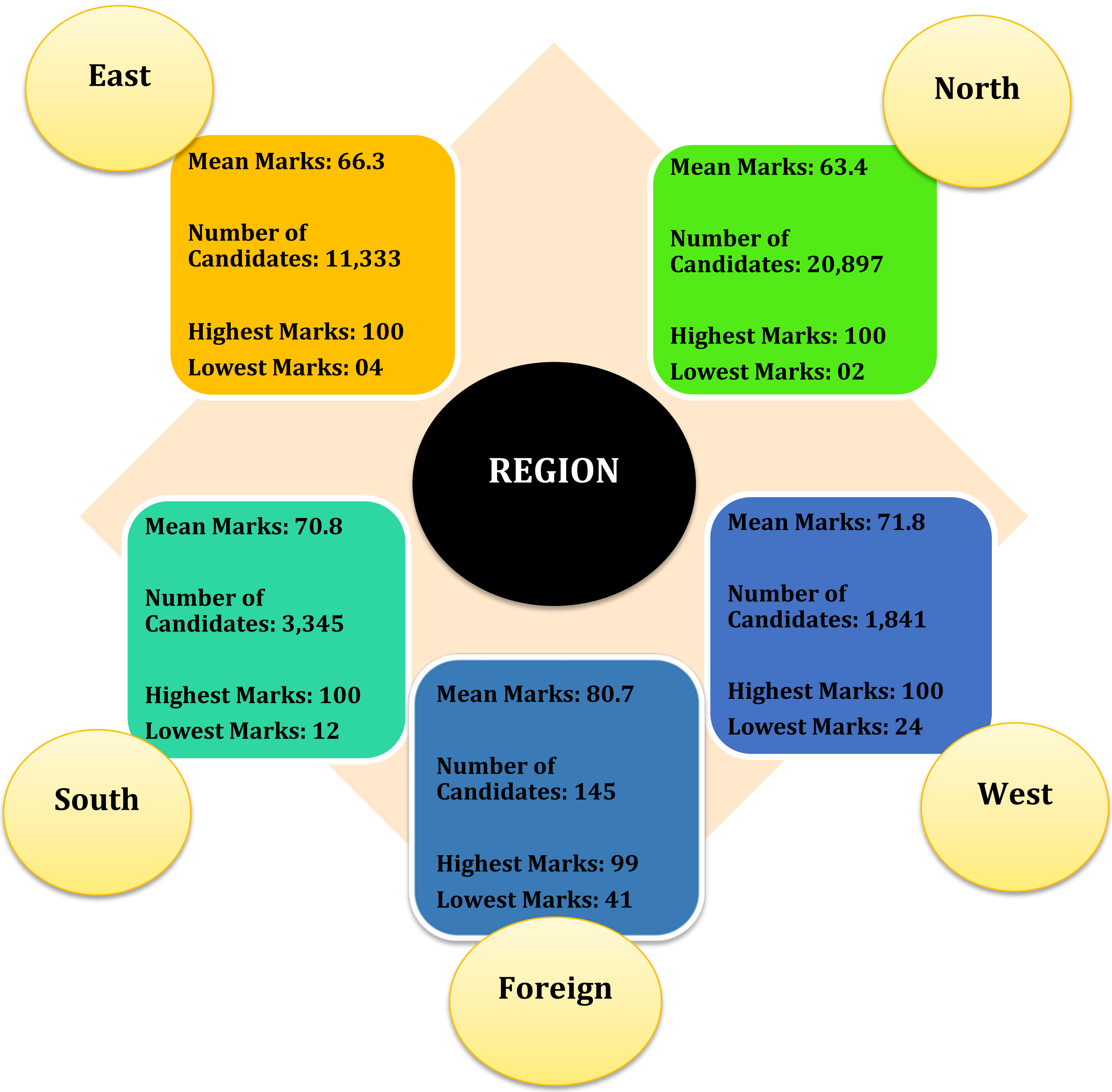
Number of Candidates: 22,788

Comparison on the basis of Gender

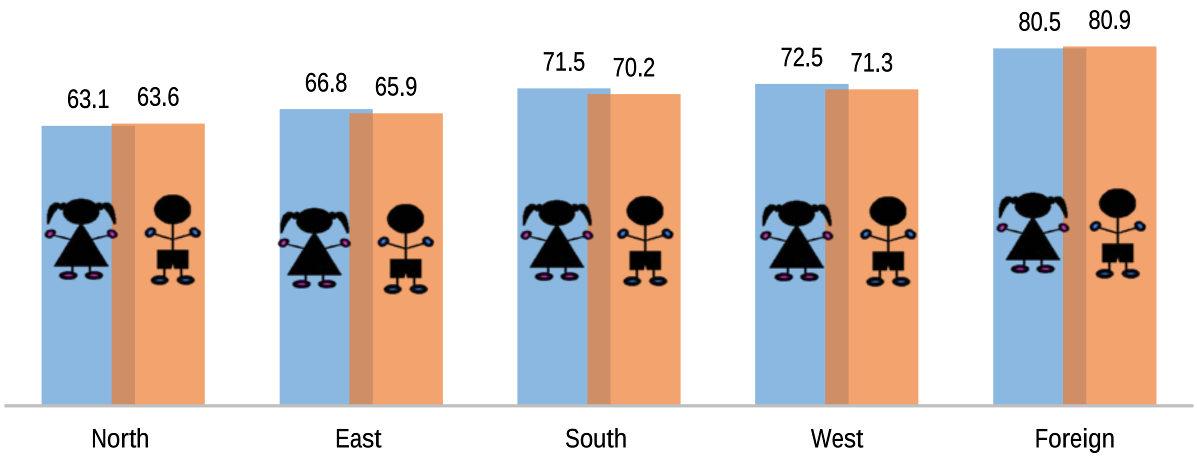
Gender	N	Mean	SE	t-value
Girls	14,773	65.6	0.16	1.79
Boys	22,788	65.3	0.13	

No significant difference was observed between the average performance of girls and boys.

REGION-WISE COMPARISON



Mean Marks obtained by Boys and Girls-Region wise

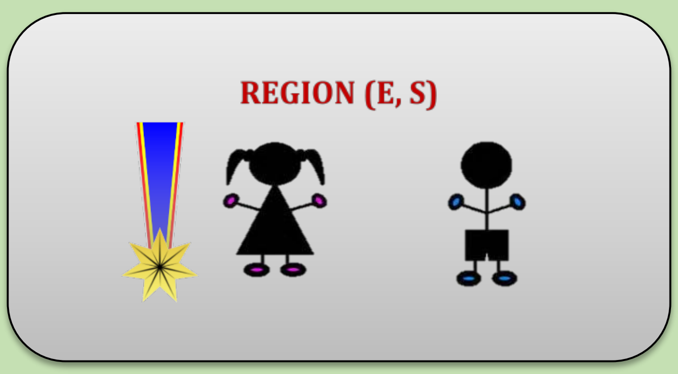


Comparison on the basis of Gender within Region

Region	Gender	N	Mean	SE	t-value
North (N)	Girls	8,000	63.1	0.21	-1.63
	Boys	12,897	63.6	0.17	
East (E)	Girls	4,484	66.8	0.28	2.48*
	Boys	6,849	65.9	0.23	
South (S)	Girls	1,498	71.5	0.45	2.17*
	Boys	1,847	70.2	0.43	
West (W)	Girls	732	72.5	0.70	1.28
	Boys	1,109	71.3	0.59	
Foreign (F)	Girls	59	80.5	1.99	-0.15
	Boys	86	80.9	1.65	

*Significant at 0.05 level

The performance of girls was significantly better than that of boys in the eastern and southern region. In other regions no significant difference was observed.

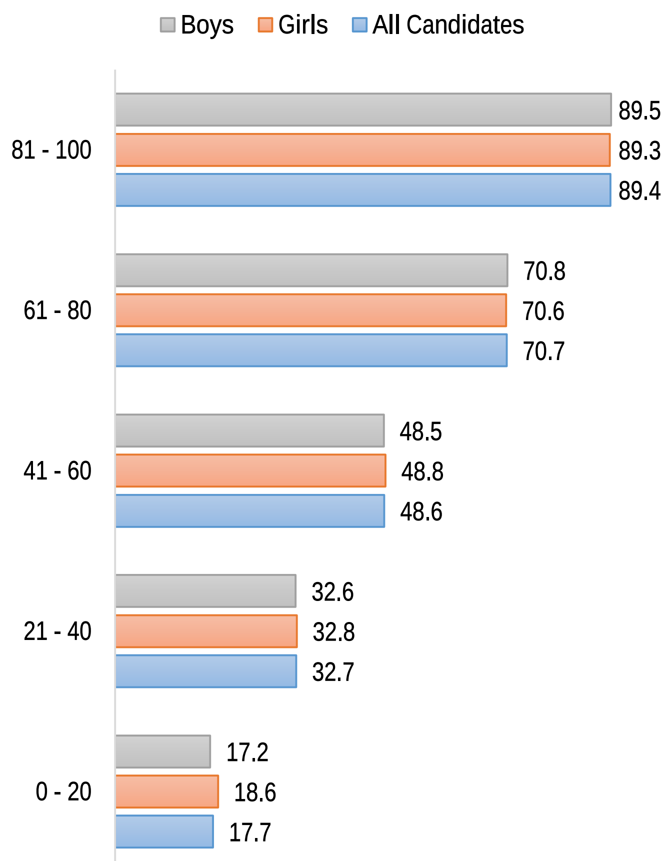


MARK RANGES : COMPARISON GENDER-WISE

Comparison on the basis of gender in top and bottom mark ranges

Marks Range	Gender	N	Mean	SE	t-value
Top Range (81-100)	Girls	4,030	89.3	0.08	-1.32
	Boys	6,335	89.5	0.07	
Bottom Range (0-20)	Girls	28	18.6	0.57	1.93
	Boys	53	17.2	0.48	

No significant difference was found in the performance of girls and boys in the marks range of (81-100) and (0-20).

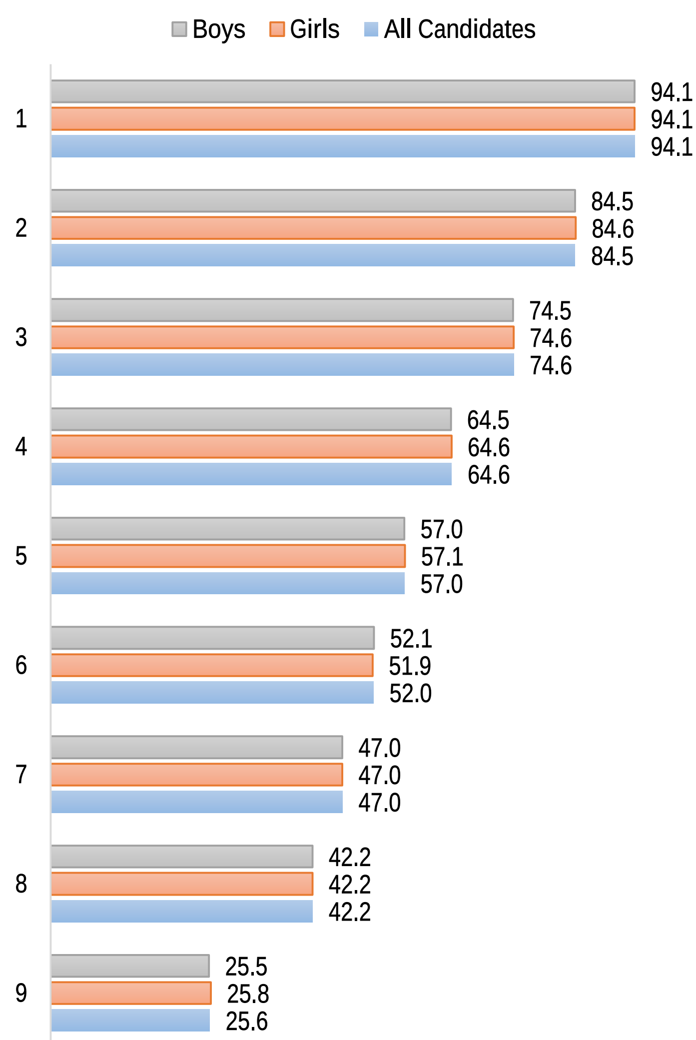


GRADES AWARDED : COMPARISON GENDER-WISE

Comparison on the basis of gender in Grade 1 and Grade 9

Grades	Gender	N	Mean	SE	t-value
Grade 1	Girls	1,897	94.1	2.16	-0.01
	Boys	3,094	94.1	1.69	
Grade 9	Girls	419	25.8	1.26	0.17
	Boys	822	25.5	0.90	

In Grade 1 and Grade 9 no significant difference was observed between the average performance of girls and boys.



QUALITATIVE ANALYSIS

THEORY (PAPER-1)

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) The electrostatic potential energy of two point charges, 1 μC each, placed 1 meter apart in air is:

(a) 9×10^3J
(b) 9×10^9J
(c) 9×10^{-3}J
(d) 9×10^{-3}eV

(ii) A wire of resistance 'R' is cut into 'n' equal parts. These parts are then connected in parallel with each other. The equivalent resistance of the combination is:

(a) nR
(b) R/n
(c) n/R^2
(d) R/n^2

(iii) Magnetic susceptibility of platinum is 0·0001. Its relative permeability is:

(a) 1·0000
(b) 0·9999
(c) 1·0001
(d) 0

(iv) When a light wave travels from air to glass:

(a) its wavelength decreases.
(b) its wavelength increases.
(c) there is no change in wavelength.
(d) its frequency decreases.

(v) A radioactive substance decays to $1/16^{th}$ of its initial mass in 40 days. The half life of the substance, in days, is:

(a) 20

(b) 10

(c) 5

(d) 2·5

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

(i) **Maximum** torque acting on an electric dipole of moment 3×10^{-29} Cm in a uniform electric field E is 6×10^{-25} Nm. Find E.

(ii) What is meant by **drift speed** of free electrons?

(iii) On which conservation principle is **Kirchoff's Second Law** of electrical networks based?

(iv) Calculate magnetic flux density of the magnetic field at the centre of a circular coil of 50 turns, having radius of 0·5m and carrying a current of 5 A.

(v) An a.c. generator generates an emf 'ε' where $\varepsilon = 314\ Sin(50\pi t)\ volt.$ Calculate the **frequency** of the emf ε.

(vi) With what type of source of light are **cylindrical** wave fronts associated?

(vii) How is fringe width of an interference pattern in **Young's double slit experiment** affected if the two slits are brought closer to each other?

(viii) In a **regular** prism, what is the relation between angle of incidence and angle of emergence when it is in the **minimum deviation** position?

(ix) A converging lens of focal length 40 cm is kept in contact with a diverging lens of focal length 30 cm. Find the focal length of the combination.

(x) How can the **spherical aberration** produced by a lens be minimised?

(xi) Calculate the **momentum** of a **photon** of energy 6×10^{-19}J.

(xii) According to **Bohr**, 'Angular momentum of an orbiting electron is quantised'. What is meant by this statement?

(xiii) Why nuclear fusion reaction is also called **thermo-nuclear** reaction?

(xiv) What is the **minimum** energy which a gamma ray photon must possess in order to produce **electron-positron** pair?

(xv) Show the variation of voltage with time, for a **digital** signal.

Comments of Examiners

A. (i) Some candidates selected option (d), which was similar to the correct option (c), except for the unit.

(ii) A few candidates chose option (b), instead of correct option (d).

(iii) Some candidates selected option (b) in place of correct option (c). It was due to confusion in the relation between χ and μ_r.

(iv) Many candidates selected incorrect option in this question, in place of correct option (a).

(v) Some candidates selected (d) = 2.5 as an option, in place of correct option (b) = 10 days.

B. (i) Some candidates did not express the electric field with unit. Some gave incorrect unit of E. A few candidates could not recall the correct formula, while a few made incorrect calculation of E.

(ii) Many candidates could not write the definition correctly. Key words like *constant* or *average velocity* or *on application of electric field* were missing.

(iii) Some candidates got confused between Kirchhoff's 1st law and II law and hence, wrote *conservation of charge* in place of *conservation of energy*.

(iv) Some candidates used incorrect formula of magnetic flux density B. They did not write unit of B. They got confused between magnetic flux ϕ and wrote magnetic flux density, B. Hence, expressed incorrect unit of B.

(v) Some candidates did not know the correct formula of instantaneous emf $e=e_o \sin(\omega t)$ Some of them did not know the relation between ω and *f*.

(vi) Many candidates answered this question incorrectly.

(vii) Some candidates wrote that there is no change in fringe-width whereas some answered it correctly. Some answered, 'Intensity of bright fringes increases.'

Suggestions for teachers

- Train students to use given data in a numerical in SI unit, otherwise convert the final answer in the SI unit, if required.
- The concept of resistors in series and parallel must be developed in students with proper explanation, followed by numerical problems.
- After explaining the meaning of magnetic susceptibility and relative permeability, ask them to learn formulae by heart.
- While teaching refraction of light, explain to them the effect on the speed of light on changing the medium.
- The concept of half-life should be clarified to students, with the help of numerical problems.
- Emphasize that proper unit must be given to a physical quantity.
- Advise students to learn definitions, laws, principles in Physics, by heart and practise writing them.
- While teaching Kirchhoff's laws of electrical networks, explain the difference between the two laws.
- In magnetism, explain magnetic flux and magnetic flux density clearly.
- While teaching wave optics, explain the meaning and importance of the term wave front, types of wave fronts and types of sources of light which produce these wave fronts.
- Factors affecting fringe-width must be discussed specially after deriving the expression.
- Train students to read the questions heedfully and write answer in brief and to the point.

(viii) Some candidates drew the diagram of a prism, showing various angles. They used the formula $i = A + \delta m$

(ix) Some candidates did not take focal length of concave lens as negative and hence, got incorrect answers.
A few of them did not write the unit of F.

(x) A few candidates got confused between *spherical aberration* and *chromatic aberration*. Hence, they wrote about achromatic doublet instead of writing the way of minimising spherical aberration produced by a lens.

(xi) Some candidates used the incorrect formula to calculate the momentum of a photon. Several candidates did not write the unit of p, and a few wrote incorrect unit of p.

(xii) A few candidates wrote $mnr = h/2\pi$ but did not write what 'n' stands for. Some stated that 'angular momentum' is an integral multiple of $h/2$, in place of $h/2\pi$.

- Familiarise the students with the Cartesian sign convention and train them to solve a few numerical problems.
- Explain spherical and chromatic aberrations thoroughly.
- While teaching pair production, give students an idea of energy of gamma rays which can produce electron positron pair with numerical problems.
- Teach the types of signals which are used in the field of electronics. Draw labelled V-t graphs for them.

(xiii) Many candidates got this question incorrect because they wrote 'Heat energy is produced/released in this reaction', instead of writing 'heat energy is required to bring about nuclear fusion'.

(xiv) A few candidates wrote 1.02 eV, in place of 1.02 MeV. Some wrote a statement, instead of giving the value i.e. 1.02 MeV.

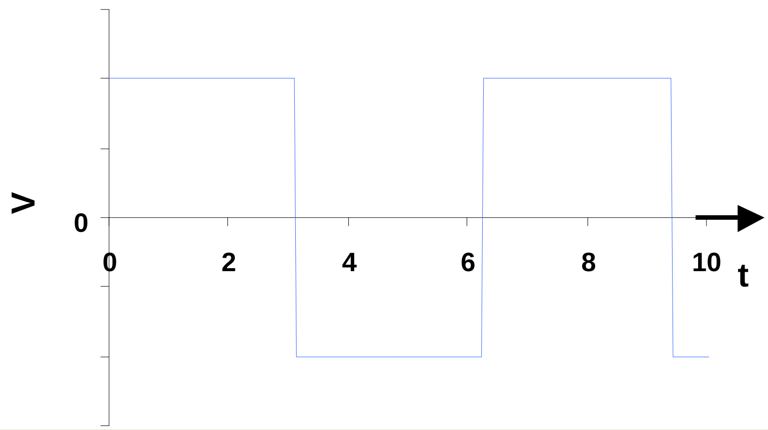
(xv) A number of candidates did not know the correct V-t graph for a digital signal. They drew a sine curve. Some did not label the axes.

MARKING SCHEME

Question 1

A. (i)	(c) OR 9×10^{-3}J
(ii)	(d) OR R/n^2
(iii)	(c) OR 1·0001
(iv)	(a) OR Its wavelength decreases.
(v)	(b) OR 10 days
B. (i)	$E = \frac{\tau}{P} = \frac{6\times10^{-25}}{3\times10^{-29}} = \mathbf{2\times10^4\ Vm^{-1}}$ or answer expressed with any alternate correct unit.
(ii)	It is the mean distance travelled by a free electron per unit time (second) when an external electric field is applied. Or constant/average speed/velocity on application of potential difference/electric field or voltage or opposite to current or towards +ve terminal.

(iii)	Energy
(iv)	B = $\left(\frac{\mu_o}{4\pi}\right)\frac{2\pi NI}{R}$ = $10^{-7} \times \frac{2\pi\times50\times5}{0\cdot5}$ = $\pi\times10^{-4}$ = $3\cdot14\times10^{-4}$ T or answer expressed with any alternate correct unit.
(v)	$\omega = 50\pi t$ or $2\,\pi f = 50\,\pi$ $\therefore f = 25$ Hz
(vi)	Line source/ linear
(vii)	Fringe width increases
(viii)	They are equal, i.e. $\angle i = \angle e$
(ix)	$\frac{1}{F} = \frac{1}{40} + \frac{1}{-30} = \frac{3-4}{120} = -\frac{1}{120}$ $\therefore F = -120\,cm\ \ Or\ \ F = -1\cdot2\,m$
(x)	By using plano-convex / concave lenses OR With the help of stops. (A diagram showing a lens and a stop is also acceptable)
(xi)	P = $\frac{E}{c} = \frac{6\times10^{-19}}{3\times10^{8}}$ = 2×10^{-27} kg m s^{-1} or answer expressed with any alternate correct unit. Alternate method is also **acceptable**.
(xii)	It means angular momentum is an integral multiple of $\hbar$ OR $\frac{h}{2\pi}$ OR $l = n\hbar = \frac{nh}{2\pi}$ where n is an integer. OR $mvr = \frac{nh}{2\pi}$
(xiii)	This is because a lot of heat energy is required to bring about nuclear fusion. OR A very high temperature is required to bring about nuclear fusion.
(xiv)	1·02 MeV OR 1.632 x 10^{-13}J.

(xv)	

PART II (50 Marks)

Answer ten questions in this part, choosing four questions from Section A, three questions from Section B and three questions from Section C.

SECTION A

Answer any four questions.

Question 2

(a) Show that **electric potential** at a point P, at a distance 'r' from a fixed point charge Q, is given by: **[4]**

$$V = \left(\frac{\mathbf{1}}{\mathbf{4}\boldsymbol{\pi}\boldsymbol{\epsilon}_{\mathbf{0}}}\right)\frac{Q}{r}.$$

(b) Intensity of electric field at a perpendicular distance of 0·5 m from an infinitely long line charge having linear charge density (λ) is $3{\cdot}6\times10^{3}$ Vm^{-1}. Find the value of λ. **[1]**

Comments of Examiners

(a) Many candidates could not draw the correct diagrams required for this derivation. Majority of candidates did not use limits for integration. Many of them used incorrect limits. Some could not perform integration. A few missed out negative sign in work done *dw*.

(b) Some candidates did not know the correct formula for intensity due to a long line charge. Some either wrote incorrect unit of λ or didn't write unit of λ.

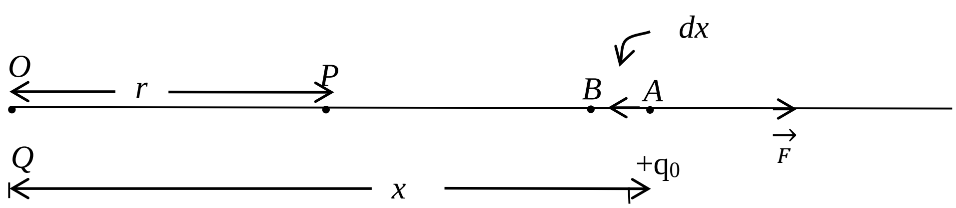
Suggestions for teachers

- Explain the role of integral calculus in Physics specially the meaning of definite integral i.e. the meaning of limits.
- Advise students to study and practise diagrams, along with learning of derivations.
- Prepare a list of formulae in each chapter of Physics and ask students to learn these formulae by heart and practise. A few numerical problems of different types, based on each formula must be solved in class, for clear understanding.

MARKING SCHEME

Question 2

(a)



$F = \frac{1}{4\pi\varepsilon 0}\frac{Qq0}{x^2}$

$dw = -F\,dx$

$\int dw = \int_{\infty}^{r} -F\,dx$

$W = -\int_{\infty}^{r} \frac{\mathbf{1}}{\mathbf{4\pi\epsilon_0}}\frac{Qq0}{x^2}dx$

$V = W/q_0 = \frac{\mathbf{1}}{\mathbf{4\pi\epsilon_0}}Q/r$

So, $V = \left(\frac{1}{4\pi\epsilon_0}\right)\frac{Q}{r}$

Alternate methods are also acceptable.

(b)

i.e. $E = \left(\frac{\mathbf{1}}{\mathbf{4\pi\epsilon_0}}\right)\frac{\mathbf{2\lambda}}{\mathbf{r}}$

	$3{\cdot}6 \times 10^3 = 9 \times 10^9 \times \frac{2\times\lambda}{0{\cdot}5}$ $\therefore \boldsymbol{\lambda} = 1\times10^{-7}$ C m^{-1} Correct substitution with or without formula and correct answer with unit.

Question 3

(a) Three capacitors C_1 = 3μF, C_2 = 6μF and C_3 = 10μF are connected to a 50 V battery as shown in the ***Figure 1*** below: **[3]**

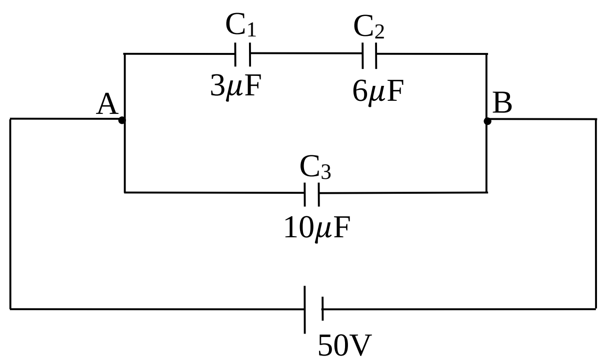


Figure 1

Calculate:

(i) The equivalent capacitance of the circuit between points A and B.

(ii) The charge on C_1.

(b) Two resistors R_1= 60 Ω and R_2 = 90 Ω are connected in **parallel**. If electric power consumed by the resistor R_1 is 15 W, calculate the power consumed by the resistor R_2. **[2]**

Comments of Examiners

(a) (i) After using correct formula for equivalent capacitance of a series combination i.e $1/C_4$ =1/2, a few candidates forgot to find C_4. Some of them did not write the unit of C.

(ii) A few candidates answered this part incorrectly as they used incorrect value of C, i.e. C_1 in place of C_4.

(b) Some candidates found out current in R_1 and used the same current for R_2. They got confused whether current is same or potential difference is same in parallel combination. Some candidates used the incorrect formula for the power consumed by the resistor R_2.

Suggestions for teachers

- Give practice in solving a few numerical problems on capacitors connected in a circuit in series and in parallel combination, clearly explaining the status of charge on each capacitor and potential difference across each capacitor. Make use of equivalent circuits.
- Explain how to calculate the power developed in a resister with different type of numerical problems.

MARKING SCHEME

Question 3

(a)	(i)	$C_4 = \frac{C_1 C_2}{C_1+C_2}$ *or* $\frac{3\times6}{3+6} = 2\mu F$ Correct substitution with or without formula and correct answer. *or* $C = C_4 + C_3$ $= 2 + 10$ $= 12\ \mu F$
	(ii)	$Q_4 = C_4V = 2\times50 = 100\ \mu C$
(b)		$V^2 = P_1R_1 = 15\times 60 = 900\ (\text{volt})^2$ [Unit $(\text{volt})^2$ not necessary.] $\therefore P_2 = \frac{V^2}{R_2} = \frac{900}{90} = 10\text{W}$ Alternate correct methods are also acceptable.

Question 4

(a) ***Figure 2*** below shows two resistors R_1 and R_2 connected to a battery having an emf of 40V and negligible internal resistance. A voltmeter having a resistance of 300 Ω is used to measure potential difference across R_1. Find the reading of the voltmeter. **[3]**

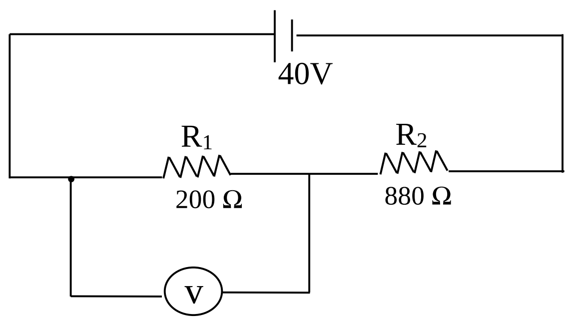


Figure 2

(b) A moving coil galvanometer has a coil of resistance 59Ω. It shows a full-scale deflection for a current of 50 mA. How will you convert it to an **ammeter** having a range of 0 to 3A? **[2]**

Comments of Examiners

(a) Many candidates were unable to calculate equivalent resistance of the circuit correctly and hence got incorrect value of current. Some got the correct value of current but used incorrect value of resistance, hence, got incorrect answers.

(b) Many candidates used the formula of conversion of galvanometer to voltmeter, rather than galvanometer to ammeter. A few didn't state that the calculated resistance should be connected in parallel with the galvanometer.

Suggestions for teachers

- Explain to students, the correct concept and treatment of resistances in series and parallel combination. More practice should be given in solving circuit problems in the class. Encourage the habit of drawing equivalent circuits.
- Encourage students to solve as many numerical problems as possible. Train them to express answers with units, direction, etc.

MARKING SCHEME

Question 4

(a) Equivalent resistance R_3 of R_1 and V is:

$$R_3 = \frac{R_1 \times R_v}{R_1 + R_v} \text{ or } \frac{200\times300}{200+300}$$

$$= 120\ \Omega$$

Then, $R = 120 + 880$

$$= 1000\ \Omega$$

$$I = \frac{\varepsilon}{R} = \frac{40}{1000} = 0{\cdot}04 \text{ A}$$

$$V = I\,R_3$$

$$= 0{\cdot}04 \times 120$$

$$= 4{\cdot}8 \text{ V}$$

(b)

$$S = \frac{I_g G}{I - I_g}$$

or $\therefore S = \frac{50\times10^{-3}\times59}{(3-0{\cdot}05)}$

$$= \frac{50\times59\times10^{-3}}{2{\cdot}95}$$

$\therefore S = 1\ \Omega$ in parallel or shunt of 1Ω or $1\ \Omega$ shunt shown in diagram.

Question 5

(a) In a meter bridge circuit, resistance in the left hand gap is 2 Ω and an unknown resistance X is in the right hand gap as shown in ***Figure 3*** below. The null point is found to be 40 cm from the left end of the wire. What resistance should be connected to X so that the new null point is 50 cm from the left end of the wire? **[3]**

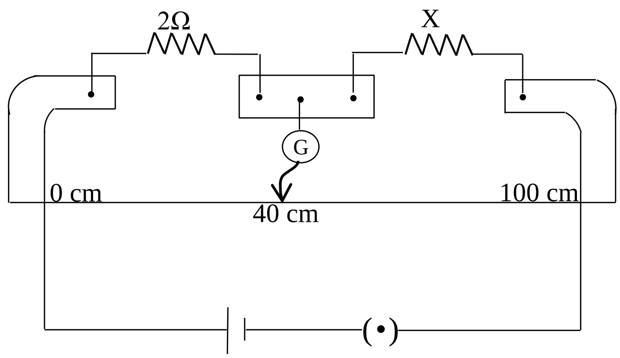


Figure 3

(b) The horizontal component of earth's magnetic field at a place is $\frac{1}{\sqrt{3}}$ times the vertical component. Determine the **angle of dip** at that place. **[2]**

Comments of Examiners

(a) Some candidates did not understand this numerical on meter bridge. It involved three steps: Calculations of X, resistance to be connected to X and hence the required resistance. Many found out X and left it as answer. A few candidates did not know that metre bridge works on the principle of Wheatstone bridge.

(b) Some candidates did not know the relation between B_H, B_V and δ. Hence, they obtained incorrect results. A few did not write the unit of angle of dip θ.

Suggestions for teachers

- Explain meter bridge based numerical problems in the laboratory when students perform experiments. It would give them better understanding of Wheatstone bridge principle. A few numerical problems must be solved on Wheatstone bridge as well as Meter bridge.
- Train the students to read questions carefully and write the data. Then, they must recall the correct formula on which it is based. Finally, answer must be given with proper unit.

MARKING SCHEME

Question 5

(a)	$\frac{2}{X} = \frac{40}{60}$ $\therefore \quad x = 3\Omega$ When balancing length becomes 50 cm: $\frac{y}{2} = \frac{50}{50}$ i.e. $y = 2\Omega$ Now, $\frac{1}{3} + \frac{1}{z} = \frac{1}{2}$ $\frac{1}{z} = \frac{1}{2} - \frac{1}{3}$ $\frac{1}{z} = \frac{1}{6}$ $\therefore \quad \boldsymbol{z = 6}\ \Omega$ In parallel with X.
(b)	$B_H = \frac{1}{\sqrt{3}}\ B_V$ $\frac{B_V}{B_H} = \sqrt{3}$ $\tan \boldsymbol{\delta} = \sqrt{3}$ $\therefore\ \boldsymbol{\delta} = 60^o$

Question 6

(a) Using **Ampere's circuital law**, obtain an expression for the magnetic flux density 'B' at a point 'X' at a perpendicular distance 'r' from a **long** current carrying conductor. (*Statement of the law is not required*). **[3]**

(b) PQ is a long straight conductor carrying a current of 3A as shown in ***Figure 4*** below. An electron moves with a velocity of 2×10^7 ms^{-1} parallel to it. Find the force acting on the electron. **[2]**

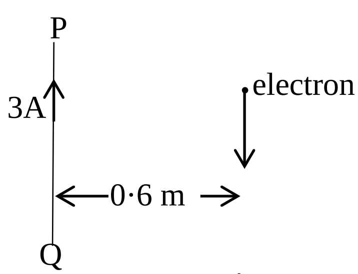


Figure 4

Comments of Examiners

(a) A few candidates applied *Biot Savarts law*, in place of *Ampere Circuital law*. Many could not draw correct diagrams required for this derivation, specially dl and B. They did not use the correct symbol of integration. Some did not use the vector notation with B and dl. Some did not solve B.dl

(b) A number of candidates did not understand the numerical problems. Some could not get the correct formula to calculate force on the moving electron. Others could not substitute the given values correctly and hence got incorrect answers.

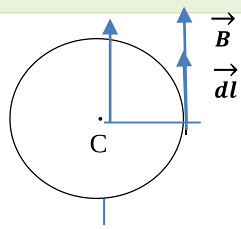
Suggestions for teachers

- Explain Ampere circuital law comprehensively Ask students to practise diagrams, along with derivations.
- Train students to solve numerical problems interrelated with different topics.

MARKING SCHEME

Question 6

(a)



$$\int \vec{B}.\vec{dl} = \mu_o \ I$$

$$\int B \ \ dl \ \cos\theta = \mu_o \ I$$

As θ = 90, cos 90 = 1

$$\int B \ dl = \mu_o \, I$$

$$or \ \ B \int dl \ = \mu_o \ I$$

B. $2\pi r$ = $\mu_o \ I$

$\therefore \qquad B = \frac{\mu_o \, I}{2\pi r}$

(b)

$$B = \frac{\mu_o}{4\pi} \frac{2I}{a}$$

or $\quad = \frac{10^{-7} \times 2 \times 3}{0 \cdot 6}$

= 1×10^{-6} T

F = Bev

= $1 \times 10^{-6} \times 1 \cdot 6 \times 10^{-19} \times 2 \times 10^{7}$

= $3 \cdot 2 \times 10^{-18}$ N

Alternate correct methods are acceptable.

Question 7

(a) (i) AB and CD are two parallel conductors kept 1 m apart and connected by a resistance R of 6 Ω, as shown in ***Figure 5*** below. They are placed in a magnetic field B = 3×10^{-2} T which is perpendicular to the plane of the conductors and directed into the paper. A wire MN is placed over AB and CD and then made to slide with a velocity 2 ms^{-1}. (Neglect the resistance of AB, CD, and MN.) **[3]**

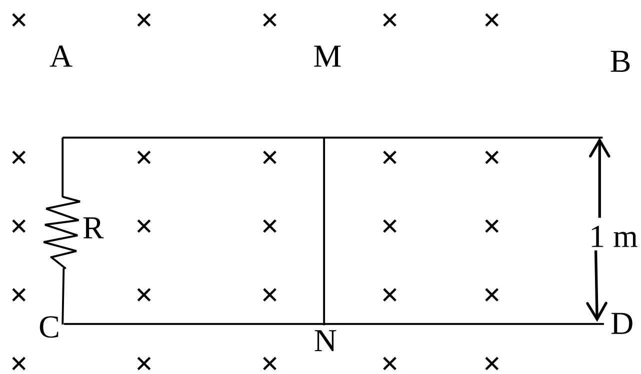


Figure 5

Calculate the induced current flowing through the resistor R.

(ii) In an **ideal** transformer, an output of 66 kV is required when an input voltage of 220 V is available. If the **primary** has 300 turns, how many turns should the **secondary** have?

(b) In a series LCR circuit, obtain an expression for the **resonant frequency**. **[2]**

Comments of Examiners

(a)(i) Some candidates calculated *emf* and not the induced current, as was required. A few candidates did not write the unit of current.

(ii) Some candidates used incorrect formula. A few candidates did not convert output given in kV to volt.

(b) A number of candidates obtained the relation for ω instead of frequency *f*. Some of them could not derive this simple expression, possibly they had no idea of resonant frequency.

Suggestions for teachers

- Train students to read questions carefully. They should pause and think over the relevant answer.
- While explaining working of a transformer, give students all the relations/ratios. Encourage them to practice numerical problems based on these formulae.

MARKING SCHEME		
Question 7		
(a)	(i)	e = Blv Correct substitution with or without formula $= 3\times10^{-2}\times1\times2$ $= 6\times10^{-2}$ V $I = \frac{e}{R}$ $= \frac{6\times10^{-2}}{6}$ $= 1\times10^{-2}$ A Alternate correct methods are acceptable.
	(ii)	$\frac{e_s}{e_p} = \frac{n_s}{n_p}$ $\frac{66000}{220} = \frac{n_s}{300}$ $\therefore\ n_s = \frac{\overset{300}{\cancel{66000}}\times300}{\cancel{220}}$ $= 90000$
(b)	$X_L = X_C$ or $\omega L = 1/\omega C$ $2\pi f L = \frac{1}{2\pi f C}$ $f^2 = \frac{1}{4\pi^2 LC}$ $\therefore f = \frac{1}{2\pi\sqrt{LC}}$	

SECTION B

Answer any three questions

Question 8

(a) (i) State any one property which is **common** to all **electromagnetic** waves. **[3]**

(ii) Arrange the following electromagnetic waves in increasing order of their frequencies (i.e. begin with the lowest frequency):

Visible light, γ rays, X rays, micro waves, radio waves, infrared radiations and ultraviolet radiations.

(b) (i) What is meant by **diffraction** of light? **[2]**

(ii) In **Fraunhofer diffraction**, what kind of source of light is used and where is it situated?

Comments of Examiners

(a)(i) While many candidates wrote that all electromagnetic waves travel with the same speed (of light), 'in vacuum' was missing in many answers. A few candidates wrote, 'they all behave like particles.'

(ii) Some candidates arranged electromagnetic waves in incorrect / reverse order.

(b)(i) Many candidates got confused between refraction of light and diffraction. They did not mention 'bending of light around edges of obstacles'.

(ii) Most of the candidates were unable to answer this question. They did not mention where the source was placed.

Suggestions for teachers

- A clear understanding of properties of electromagnetic waves is called for.
- Arrange them in increasing order of wavelength and tell students that the order will reverse in case of frequencies.
- Explain with the help of wave theory, how light waves spread around edges of opaque bodies to enter geometrical shadow region.
- Discuss Fraunhofer diffraction in detail in the class.

MARKING SCHEME

Question 8

(a)	(i)	- All electromagnetic waves can travel through vacuum/ free space. - They all have $\underset{E}{\rightarrow}$, $\underset{B}{\rightarrow}$ and $\underset{C}{\rightarrow}$ mutually perpendicular to each other. - Transverse in Nature - The do not require a material medium for propagation. - They can be reflected. - All waves are produced by accelerated charged particles/oscillating charged particles. *(any one)* Any other correct property is **also acceptable**.
	(ii)	Correct order is: Radio waves, Micro waves, Infra-red radiations, visible light, ultra violet radiations, X-rays and γ rays.
(b)	(i)	Spreading or bending of light waves around the edges of an opaque aperture/obstacle/corner/around a body is called 'diffraction' of light.
	(ii)	Monochromatic source of light and it is situated far away. (i.e. at infinity)

Question 9

(a) In **Young's double slit experiment** using monochromatic light of wavelength 600 nm, 5^{th} bright fringe is at a distance of 0·48 mm from the centre of the pattern. If the screen is at a distance of 80 cm from the plane of the two slits, calculate: **[3]**

(i) Distance between the two slits.

(ii) Fringe width, i.e. fringe separation.

(b) (i) State **Brewster's** law. **[2]**

(ii) Find **Brewster's** angle for a transparent liquid having refractive index 1·5.

Comments of Examiners

(a) (i) Many candidates did not understand this numerical problem i.e. they could not understand what was given in the question. Some of them used incorrect formula.

(ii) Some of the candidates did not convert unit *nm* Some did not write the unit of fringe width.

(b) (i) Many candidates wrote, 'At polarising angle, reflected ray is perpendicular to refracted ray'. Some of them could not write the statement of Brewster's law.

(ii) Some candidates wrote tan i_p = 1.5 or i_p

Suggestions for teachers

- Give ample practice on numerical problems based on Young's double slit experiment.
- Give them correct statements of laws, principle, etc and tell them to revise frequently.

MARKING SCHEME

Question 9

(a)	(i)	$x_n = \frac{n\lambda D}{a}$ *where* $n = 5$ $y_5 = \frac{5\lambda D}{a}$ $\therefore\ a = \frac{5\lambda D}{y_5}$ $\therefore a = \frac{5\times600\times10^{-9}\times0{\cdot}8}{0{\cdot}48\times10^{-3}}$ $= \frac{5\times480\times10^{-6}}{0{\cdot}48}$ $\therefore\ a = 5\times10^{-3}$m
	(ii)	$\beta = \frac{\lambda D}{a} = \frac{1}{5}y_5 = \frac{0{\cdot}48}{5}\ mm$ = 0·096 mm Alternate correct methods are acceptable.

(b)	(i)	When ordinary (unpolarised) light is incident on a transparent medium at an angle of $\tan^{-1}(\mu)$, the reflected light is completely polarised.
	(ii)	$\theta_P = \tan^{-1}(1{\cdot}50)$ $= 56{\cdot}3^{\circ}$.

Question 10

(a) Find critical angle for glass and water pair, given refractive index of glass is 1·62 and that of water is 1·33. [2]

(b) Starting with an expression for refraction at a single spherical surface, obtain Lens **Maker's Formula**. [3]

Comments of Examiners

(a) Many candidates did not know how to find out ${}_g\mu_w$. Some did not know the relation sin c= ${}_g\mu_w$. A few candidates rounded off the value in the intermediate step and got a different answer.

(b) Many candidates could not draw the correct diagram; arrows were found to be missing in may diagrams. Some candidates got confused between this derivation and that of refraction at a single spherical surface. Many used the lens formula directly to obtain lens maker's formula.

Suggestions for teachers

- Teach the concept of relative refractive index ${}_1\mu_2$ or ${}_g\mu_w$ etc and show its application by solving a few numerical problems. Stress upon the fact that in a numerical problem the intermediate step should not be rounded off. Advise them to do this in the final step only.
- In Geometrical optics (or Ray optics) emphasise on drawing correct ray diagrams Arrows must be given to straight lines to indicate the path of light. Both diagrams and derivations must be practised till they are perfect.

MARKING SCHEME

Question 10

(a)	Sin c = ${}_g\mu_w = {}_a\mu_w/{}_a\mu_g$ = 1.33/1.62 cosec $i_c = {}_w\mu_g = \frac{1.62}{1.3}$ $= 0 \cdot 8210$ $\therefore\ c = 55 \cdot 2^{o}$

(b)	Correct diagram showing object O, intermediate image I', final image I, u, v_1, and v. For first spherical surface: $\frac{\mu}{v_1} - \frac{1}{u} = \frac{\mu-1}{R_1}$ For second spherical surface: $\frac{1}{v} - \frac{\mu}{v_1} = \frac{\mu-1}{-R_2}$ Adding, $\frac{1}{v} - \frac{1}{u} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ When $u = \infty,\ v = f$ $\therefore\ \frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ or $(\mu_2 - \mu_1)/\mu_1 \left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ Alternate correct methods are acceptable.

Question 11

(a) A compound microscope consists of two convex lenses of focal length 2 cm and 5 cm. When an object is kept at a distance of 2·1 cm from the objective, a virtual and magnified image is formed 25 cm from the eye piece. Calculate the **magnifying power** of the microscope. **[3]**

(b) (i) What is meant by **resolving power** of a telescope? **[2]**

(ii) State any one method of increasing the **resolving power** of an astronomical telescope.

Comments of Examiners

(a) Many candidates did not write the unit of Vo. Some did not know which lens is the objective and which one is the eye piece. Some of them did not know the correct formula for magnifying power of compound microscope. Some used incorrect sign convention and got incorrect answers.

(b)(i) Most of the candidates did not mention 'far off' i.e. 'distant objects', in the definition. A few candidates defined 'magnifying power' instead of resolving power of a telescope.

(ii)Most of the candidates wrote 'increasing the objective' but did not mention what was to be increased.

Suggestions for teachers

- Train students to draw rough diagrams before solving numerical problems on compound microscope /telescope because these problems are simply based on lenses in combination. Drill them to apply any one sign convention correctly and illustrate it by solving a few numerical problems in the class.
- Adequate practise should be given to students for learning/understanding various terms and related aspects in Physics correctly.

MARKING SCHEME

Question 11

(a)	For objective: $$\frac{1}{u_o}+\frac{1}{v_o}=\frac{1}{f_o}$$ $$\frac{1}{2\cdot 1}+\frac{1}{v_o}=\frac{1}{2\cdot 0}$$ $$\frac{1}{v_o}=\frac{1}{2}-\frac{1}{2\cdot 1}=\frac{105-100}{210}$$ $$\frac{1}{v_o}=\frac{5}{210}$$ $$v_0=\frac{210}{5}=42\ cm$$ $$M = Vo/U_o\left(1+\frac{D}{f_e}\right)$$ $$=\frac{42}{2\cdot 1}\left(1+\frac{25}{5}\right)$$ $$=20\left(1+\frac{25}{5}\right)$$ M = 120 Alternate correct solutions are acceptable.

(b)	(i)	It is the ability of a telescope to form separate images of two distant objects. (close to each other.)
	(ii)	By increasing the diameter or aperture of the objective.

SECTION C
Answer any three questions.

Question 12

(a) (i) Plot a **labelled** graph of $|V_s|$ where V_s *is* **stopping potential** versus frequency ***f*** of the incident radiation. **[3]**

(ii) State how will you use this graph to determine the value of **Planck's** constant.

(b) (i) Find the de **Broglie** wavelength of electrons moving with a speed of 7×10^6 m s^{-1}. **[2]**

(ii) Describe in brief what is observed when moving electrons are allowed to fall on a thin graphite film and the emergent beam falls on a fluorescent screen.

Comments of Examiners

(a)(i) Many candidates did not draw the graph correctly. A few did not label the axes/ interchanged the axes.

(ii) Some candidates wrote the slope of the graph as Planck's constant.

(b)(i) A few candidates did not know the correct formula to find de Broglie wavelength. Some did not write the unit of λ.

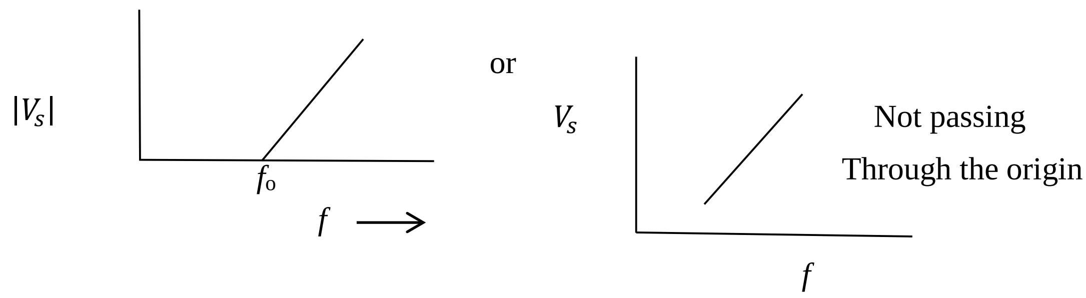
(ii) Most of the candidates could not write the correct answer though many alternate options were considered.

Suggestions for teachers

- Students must be taught how to draw correct and labelled graphs.
- Ask students to learn all the formulae in Physics, with proper understanding of symbols and to practice numerical problems.
- Electrons diffraction should be explained to students with the help of diagrams, photographs, etc.

MARKING SCHEME

Question 12

(a)	(i)	
	(ii)	$eV_s = hf + (-\Phi w)$ $V_s = \left(\frac{h}{e}\right) f + \left(\frac{\Phi w}{e}\right)$ $\therefore$ slope of the line = $\frac{h}{e}$ Or h = slope of the line × e
(b)	(i)	$\lambda = \frac{h}{mv} = \frac{6.6\times10^{-34}}{9.1\times7\times10^{6}\times10^{-31}} \simeq 1\cdot0\times10^{-10}$ m
	(ii)	Alternate bright and dark Circular fringes Diffraction is seen/ alternate dark and bright figure /scintillation Or any correct alternative answer.

Question 13

(a) Draw energy level diagram for hydrogen atom, showing first four energy levels corresponding to n=1, 2, 3 and 4. Show transitions responsible for: **[3]**

(i) Absorption spectrum of **Lyman** series.

(ii) Emission spectrum of **Balmer** series.

(b) (i) Find maximum frequency of X-rays produced by an X-ray tube operating at a tube potential of 66 kV. **[2]**

(ii) State any one difference between **characteristic** X-rays and **continuous** X-rays.

Comments of Examiners

(a)(i) Many candidates could not draw energy level diagrams correctly, some started with n=0, whereas some showed equal spacing between all energy levels.

(ii) Many candidates did not show arrows/transitions correctly. They showed downward transition to all levels. Some showed formation of other series, which were not asked for. A few candidates drew (circular) orbits, instead of energy levels.

(b)(i) Some candidates calculated wave length λ_{min} instead of frequency. Others did not know the correct formula. A few of them did not convert potential of the tube from kV to volt.

(ii) Most of the candidates were unable to answer this question correctly. They wrote about hard X rays and soft X rays.

Suggestions for teachers

– Teach them how to draw energy level diagram of H atom, correctly and the method to mark for the absorption spectrum and the emission spectrum.

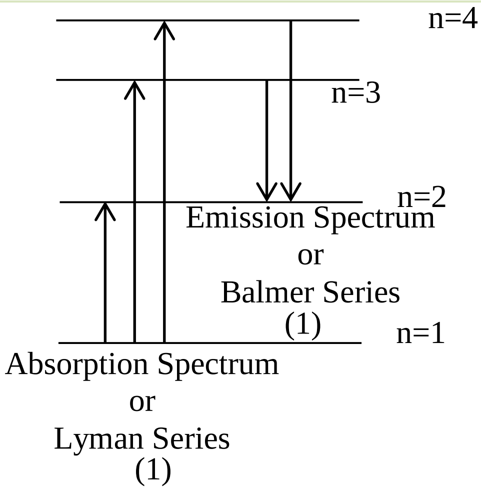
– Ask students to read questions carefully and to answer only as per the question. Before substituting in a formula, all quantities must be converted to SI systems.

\- Differences between continuous X rays and characteristic X rays must be highlighted while teaching X rays.

MARKING SCHEME

Question 13

(a)



(b) (i)

$$\nu_{\max} = \frac{eV}{h} \; or \; \frac{1{\cdot}6\times10^{-19}\times66\times10^{3}}{6{\cdot}6\times10^{-34}}$$

$\nu_{\max} = 1{\cdot}6\times10^{19}$ Hz

Or any alternative correct method to calculate $\nu_{\max}$.

(ii)

1. Characteristic X rays are characteristic of the material of the target whereas continuous X rays are not.
2. Characteristic X rays are fewer in number whereas continuous X rays are infinite in number.

		3. Continuous X rays have lower intensities whereas characteristic X rays have higher intensities. 4. λ_{min} of continuous X rays depends on applied voltage whereas λ of characteristic X-rays does not. (any one)

Question 14

(a) Obtain a relation between **half life** of a radioactive substance and **decay constant** (λ). [2]

(b) Calculate **mass defect** and **binding energy per nucleon** of ${}^{20}_{10}\boldsymbol{Ne}$, given [3]

Mass of ${}^{20}_{10}\boldsymbol{Ne} = \mathbf{19 \cdot 992397}\ \boldsymbol{u}$

Mass of ${}^{1}_{1}\boldsymbol{H} = \mathbf{1 \cdot 007825}\ u$

Mass of ${}^{1}_{0}\boldsymbol{n} = \mathbf{1 \cdot 008665}\ u$

Comments of Examiners

(a) Many candidates wrote t for half-life instead of $t_{1/2}$ or T. A few of them did not write:

At t=T, N=$\frac{1}{2}$ N_o

Some candidates wrote the final relation without giving the in between steps.

(b) Many candidates calculated binding energy but not binding energy per nucleon. Quite a few candidates did not know how to calculate mass defect ($\Delta \boldsymbol{m}$) and binding energy.

Suggestions for teachers

- Advise students to use standard symbols and notations. Teach them the concept of half-life, mean life and disintegration constant and method to obtain relations between them.
- Adequate practise should be given to students in solving numerical problems on mass defect, binding energy and binding energy per nucleon.

MARKING SCHEME

Question 14

(a)	$\boldsymbol{N_t = N_o\, e^{-\lambda t}}$ When t = T, N = $\frac{1}{2}\boldsymbol{N_o}$ T = $\frac{ln2}{\lambda}$ =$\frac{0.693}{\lambda}$ (with working)

(b)	$\{\Delta \boldsymbol{m} = \boldsymbol{Z}\boldsymbol{M}_{\boldsymbol{H}} + (\boldsymbol{A}-\boldsymbol{Z})\boldsymbol{M}_{\boldsymbol{N}}\} - \left\{{}_{\boldsymbol{Z}}^{\boldsymbol{A}}\boldsymbol{X}\right\}$ $= \{10\times1\cdot007825+10\times1\cdot008665\} - \{19\cdot992397\}$ $= \{10\cdot07825 + 10\cdot08665\} - \{19\cdot992397\}$ $\Delta \boldsymbol{m} = \boldsymbol{0}\cdot\boldsymbol{1725}\ \boldsymbol{u}$ or $2.8635 \times \mathbf{10^{-28}}$ kg B.E. $= \Delta \boldsymbol{m} \times \mathbf{931}$ MeV $= 0\cdot1725\times931$ $= 160\cdot6$ MeV or $2.5696 \times \mathbf{10^{-11}}$J B.E./nucleon $= \frac{\mathbf{160\cdot6}}{\mathbf{20}}$ or $= 8\cdot03$ MeV or $1.2848 \times \mathbf{10^{-12}}$J

Question 15

(a) With reference to a semi-conductor diode, what is meant by: **[3]**

(i) Forward bias

(ii) Reverse bias

(iii) Depletion region

(b) Draw a diagram to show how **NAND** gates can be combined to obtain an **OR** gate. (Truth table is not required). **[2]**

Comments of Examiners

(a)(i) A few candidates were confused between forward bias and reverse bias. Some candidates used incorrect terms like *P type diode* and *N type diode*.

(ii) Some candidates wrote incorrect statements e.g. "P region is connected to positive terminal of the battery in reverse bias" while some did not mention the N region.

(iii) Many candidates could not write the meaning of *depletion region* correctly or completely.

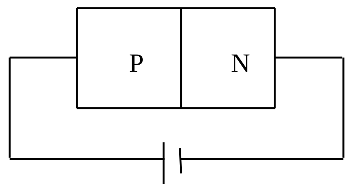
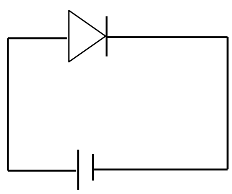
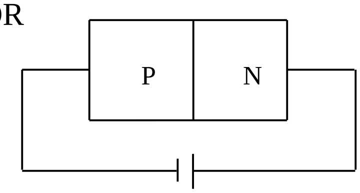
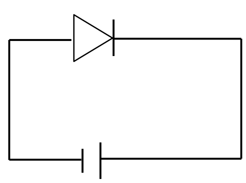
(b) A few candidates used the incorrect symbol of NAND gate. Some showed one input to the NAND gate. A few of them drew the complete diagram but forgot to join the input terminals. Some candidates gave TRUTH Table, which was not required.

Suggestions for teachers

- Ensure that students understand the terms pertaining to semiconductor diode viz. potential barrier, depletion region, drift current and diffusion current, forward bias and reverse bias etc. Tell them to practice drawing labelled diagrams.
- Explain to students the Logic Gates and their combinations to obtain all basic gates.

MARKING SCHEME

Question 15

(a)	(i)	Forward bias: It means *p* region is connected to positive terminal and *n* region is connected to negative terminal of a cell / battery. OR  OR 
	(ii)	Reverse bias: It means p region is connected to negative terminal and n region is connected to positive terminal of a cell/battery OR  OR 
	(iii)	Depletion region is a charge free region between p and n regions of a semi-conductor diode.

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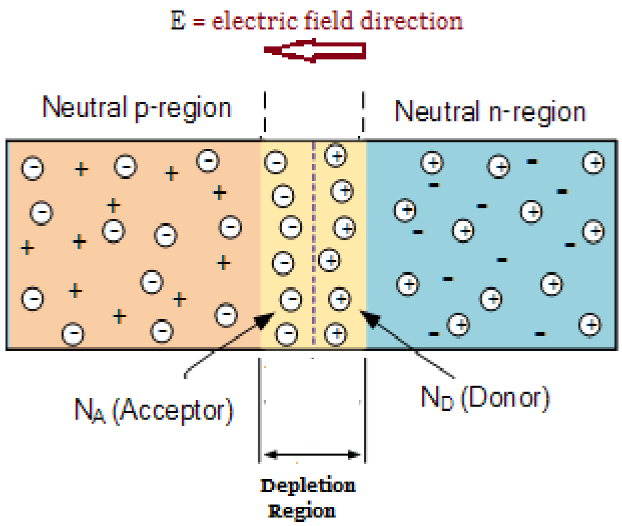
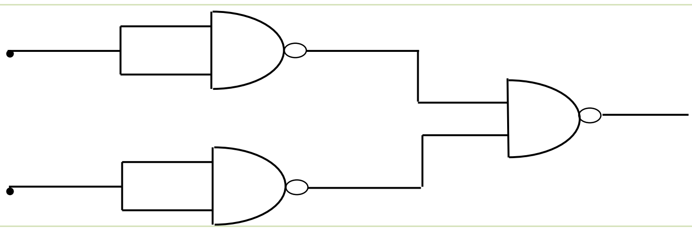
<tr><td></td><td></td><td>

It is a narrow space (region) between p and n regions which does not contain charge carriers (i.e. electrons and holes).</td></tr>
<tr><td>(b)</td><td colspan="2"></td></tr>
</table>

Note: For questions having more than one correct answer/solution, alternate correct answers/solutions, apart from those given in the marking scheme, have also been accepted.

GENERAL COMMENTS

Topics found difficult by candidates

- Capacitors in series and parallel.
- Derivation of electric potential at a point.
- Resistors in series and parallel.
- Numerical problems on electric circuits, voltmeter, meter bridge, etc.
- Angle of dip.
- Ampere circuital law: applications.
- Derivation of lens maker's formula.
- Resolving power of a telescope.
- Energy level diagram of H atom.
- Depletion region

Concepts in which candidates got confused

- Kirchoff's 1st law and II law.
- Biot Savart's law and Ampere's circuital law.
- Spherical aberration and chromatic aberration.
- Lens formula and lens maker's formula.
- Arranging electro-magnetic waves according to their frequencies.
- Emission spectrum and absorption spectrum of hydrogen atom.
- Characteristic X rays and continuous X rays.
- B.E and Binding Energy per nucleon.
- Forward bias and reverse bias of a junction diode.
- Frequency (f) and angular frequency (ω).

Suggestions for candidates

- Study regularly.
- Practise conversion of one system of unit to other system of unit.
- Prepare a list of formulae, definitions, laws, derivations, etc from each chapter.
- Learn the laws, principles, definitions, etc by heart. Focus on key words and terminology.
- Learn all the formula with meaning of each and every term involved. Learning with proper understanding is more important than just learning by rote.
- Try to understand various concepts involved in Physics.
- Refer to different text books, encyclopaedia etc, for reference.
- Practise derivations and numerical problems regularly.
- Practise drawing diagrams, ray diagrams, circuit diagrams, etc regularly.
- Solve past years' question papers and sample paper of ISC.
- During examination read every question carefully and answer to the point.
- Draw labelled diagrams. In Ray optics, don't forget to put arrows to the rays.
- While solving numerical, read the question carefully and write the given data. Before substituting in a relevant formula, ensure that all the given quantities are in SI units. Make proper conversions (if required). Be careful with units like mm, cm, nm, A, μC and μF, electron volt etc. These must be converted to SI units.
- Write complete answer with unit and direction (if it's a vector quantity).
- Don't spend too much time on any one question.
- Write only what is asked for. Write in brief and to the point, rather than beating around the bush.

QUALITATIVE ANALYSIS

PRACTICAL (PAPER-2)

Answer all questions.
You should not spend more than one and a half hours on each question.

Question 1

[9]

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

You are provided with:

(a) An optical bench

(b) A lens holder

(c) A convex lens

(d) Two optical pins

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

(i) Determine the approximate focal length f of the given convex lens by projecting the image of a distant object formed by the lens on a wall or a screen.

Record the value of f in cm correct upto **one decimal place**.

(ii) Arrange the object pin **O**, the image pin **I** and the lens **L** on the optical bench or table top as shown in ***Figure 1*** below. Adjust the height of the object pin **O** and that of the image pin **I** so that the tips of **O** and **I** lie on the principal axis of the lens.

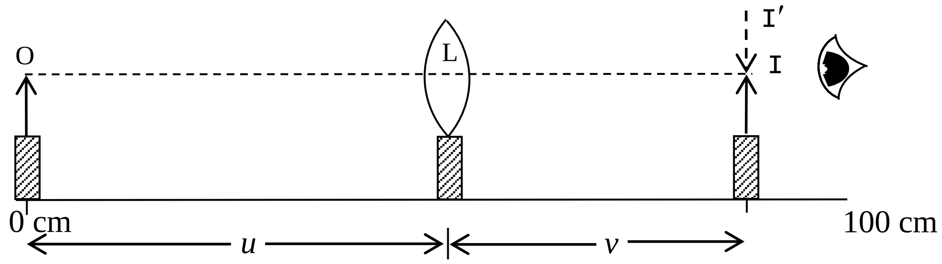


Figure 1

(iii) Place the object pin **O** at the 0 cm mark and the lens **L** at the 70·0 cm mark so that the object distance u = 70.0 cm (i.e. the distance between **L** and **O**)

(iv) Look at the tip of the object pin **O** through the lens from a distance so that you see an inverted image (say I′) of the object pin.

(v) Now, adjust the position of the image pin I in such a way, that there is no parallax between I and I′. Ensure that **tip to tip** parallax is removed.

(vi) At no parallax, note the position of the image pin **I** and measure the image distance v = LI (i.e. the distance between the lens and the image pin) in cm, correct upto **one decimal place**.

(vii) Repeat the experiment for **four** more values of u, i.e. 60·0 cm, 50·0 cm, 40·0 cm and 30·0 cm.

(viii) For each value of u, calculate $\boldsymbol{x} = \frac{u+v}{100}$ and $\boldsymbol{y} = \frac{uv}{10}$.

(ix) Tabulate all **five** sets of u, v, x and y with their units.

(x) **Show the image position when the parallax has been removed, in any one of the readings in (ix) above, to the Visiting Examiner**.

(xi) Plot a graph of y *vs* x. Draw the line of best fit. Calculate its slope **m** using, $\mathbf{m} = \frac{change\ in\ y}{change\ in\ x}$ and record its value, correct upto **three significant figures**.

(xii) Find **F** using, $\mathbf{F} = \frac{m}{10}$ and record its value with proper unit, correct upto **one decimal place**.

Comments of Examiners

Record

- Many candidates did not express the approximate focal length of the convex lens up to 1 decimal place with unit.
- A few candidates did not express the image distance 'v' up to 1 decimal place.
- Many candidates wrote the position as "L" of the lens but not write the object distance OL = u.
- In several cases, candidates showed $x = \frac{u+v}{10}$ instead of $x=\frac{u+v}{100}$ and $y=\frac{uv}{100}$ instead of $y = \frac{uv}{10}$.
- In a number of cases, units of u, v, x and y were not written or the values of x and y were not rounded off properly.

Graph

- Many candidates did not take a uniform scale from the origin. In a few cases, the scale was not written.
- Many candidates took kink on the graph.
- In some cases, the scale taken was inconvenient.
- Many candidates tended to plot the points as blobs; at times, discontinuous lines were drawn, while a few candidates took fake points to get a straight line.

Suggestions for teachers

- Explain the theoretical aspects related to each experiment. Help students to make meaningful observations.
- In optics practicals, explain about the parallax error and how to eliminate it.
- Tell students about the trend of the experiment (for record mark) such as, u increases, v should decrease.
- Give practice to students in finding the least count of different instruments and their ranges.
- Give practice in correct rounding off up to various d.p. and significant figures.
- Instruct students to read the question paper properly.
- Tell students to write observations in a tabular form with unit, decimal place and significant figures, asked as per the question.
- Graph: give enough practice for development of graphical skills (such as labelling, taking a uniform convenient scale, correct plotting, concept of best fit line, finding slope taking other than plotted points separated by more than 50% of the line drawn and correct calculation of slope).

Deduction

For slope "m" plotted points were taken in several cases. In some cases, less than half or 50% of the line was taken; many candidates did not express 'm' in three significant figures.

Calculation

Many candidates calculated f = $\frac{m}{10}$ without decimal place or unit or both. In some cases, 'F' was out of range.

MARKING SCHEME

Question 1

RECORD (R)	
A.	Approximate focal length of the lens (1dp/unit) - unit should be in c.m.
	4 Correct sets of *u* and *v*
	Correct calculation of x and y at least in six values
	Note: (i) Correct set means *v* increases as *u* decreases (ii) Proper unit should be used at least in one place i.e. in u/v/x/y and three values of v should be up to 1dp
GRAPH (G)	
A.	(i) Axes labelled correctly. The scale should be convenient, uniform starting from the origin. [If the scale taken is uniform on both the axes, without the origin marked, it can be considered correct] Origin may be shifted. (ii) Inter change of axes are permitted (iii) Kink is not allowed. (iv) Last plot must cover 50% of either axes.
B.	At least four points plotted correctly
	Note: (i) Correct plot means, plotted points may be ± 50% of 1 division on both sides from the actual point to be plotted. (ii) Points must be thin and encircled (optional) (Like, x) . (iii) A blob is not a point.
C.	Best fit line: (i) Thin and uniform and passes through at least four points (even for blobs) or within five divisions / 1cm. perpendicular distance of both side of the line drawn. (ii) The line must be extended on either side with respect to any four plots.
DEDUCTION (D)	
	(i) Correct calculation of slope (m) of the best fit line using two distant points separated by 50% of the line considered, taking at least one unplotted point. Δy & Δx can be read out directly from the graph (ii) Slope m = $\frac{\Delta y}{\Delta x}$ (Fractional value may be considered)
QUALITY	
	Correct calculation of F using candidate's m should lies within the range of 7.5cm. to 12.5cm. (F must be expressed correct upto 1d.p. with proper unit). Unit should be in cm

Question 2

[4+2]

This experiment determines the potential gradient (K) of a potentiometer wire.

You are provided with:

(a) A 100 cm long and uniform metallic wire **AB** attached to a metre scale on a wooden board. It is provided with connecting terminals at its ends.

(b) A 4 V d.c. source **E**.

(c) A dry cell ε.

(d) An ammeter **A** of range 0 - 1 A.

(e) A voltmeter **V** of range 0 - 3 V.

(f) A galvanometer **G**.

(g) A plug key **K**.

(h) A jockey **J**.

(A) (i) Determine and record the least count of the given ammeter and voltmeter.

(ii) Arrange the circuit as shown in ***Figure 2(a)*** below. Make sure that all connections are tight.

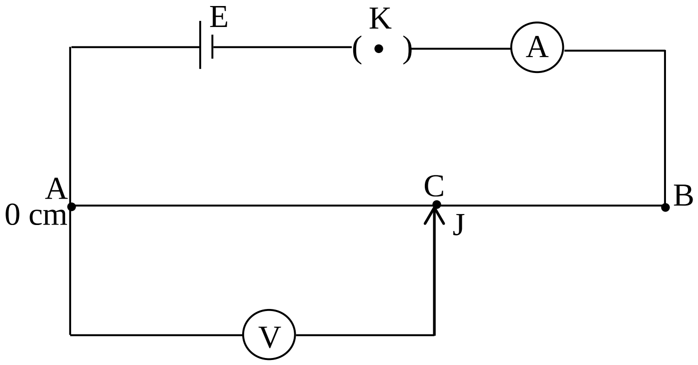


Figure 2(a)

(iii) Keep the value of E at about 3·5V to 4V.

(iv) Close the key **K**. Record the ammeter reading **I**, in your answer booklet.

(v) Place the jockey **J** at a point C on the wire AB such that AC = 20·0 cm. Note and record the reading of the voltmeter.

(vi) Repeat the experiment to obtain **four more values** of l, i.e. **AC** = 40·0 cm, 60·0 cm, 80·0 cm and 100·0 cm. Each time, note and record the reading of the voltmeter.

(vii) For **each value** of V, calculate $K = \frac{V}{l}$ correct upto **three decimal places**.

(viii) Tabulate **all five** sets of values of V, l, and K with their units.

(ix) **Show any one of the readings in (viii) above, to the Visiting Examiner.**

(x) Find K_0, the mean of **all the five** values of K and record its value with unit, in your answer booklet.

(B) This part of the experiment determines the emf of the given dry cell ε.

(i) Replace the voltmeter in the ***Figure2(a)*** with a dry cell ε and a central zero galvanometer **G** and set up a new circuit as shown in ***Figure 2(b),*** below:

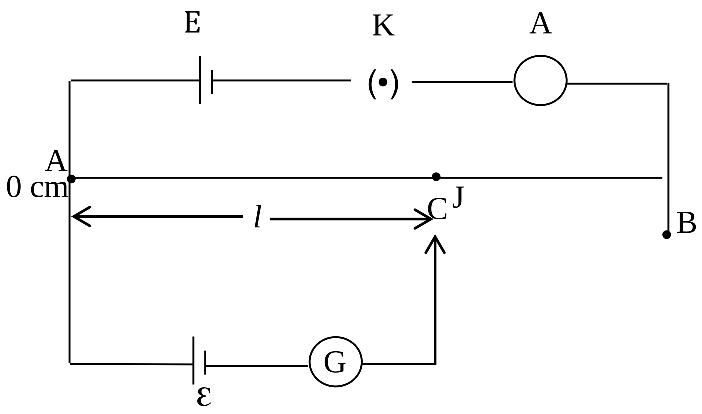


Figure 2(b)

(ii) Close the key **K**, touch the jockey **J** near the ends of **A** and **B** of the wire **AB**. The galvanometer needle must show deflection in the opposite directions.

(iii) Place the jockey gently at different points on the wire **AB** till at a certain point **C**, the galvanometer **G** shows **no deflection**. Note the length **AC** = l.

(iv) Now calculate emf of dry cell ε. $\varepsilon = K_0 l$ where K_0 is the mean value obtained in Question 2(A).

(v) Record the value of ε correct upto **two decimal places** with its unit, in your answer booklet.

Comments of Examiners

(i) Many candidates did not write the least count of the ammeter and voltmeter with unit; in some cases, the least count written did not match with the supplied least count of ammeter and voltmeter. The voltmeter readings were not consistent with the least count of voltmeter in many cases;

(ii) Proper trend between v and l was not observed.

(iii) Average value of k as k_o was not calculated or calculated incorrectly. In a few cases, the units k or k_o were written as volt per meter (Vm^{-1}) instead of volt per cm (Vcm^{-1}).

(iv) Many candidates did not express the value of e.m.f 'ε' correct up to two decimal places with unit.

Suggestions for teachers

- Give practice in finding the least count of different instruments such as the ammeter, voltmeter, meter scale, etc.) and recording them with proper practical units.
- Provide students different types and ranges of ammeters and voltmeters and give them enough practice in writing the least count with units and their ranges.
- Tell students the trend of each experiment mathematically.
- Give practice to students in connection of the circuit as per the diagram given.
- The concept of potential gradient must be explained along with its proper unit.

MARKING SCHEME

Question 2

RECORD (R)	
(A) (a)	L.C. of ammeter and voltmeter with their units
(b)	Three correct sets of l and V
Note: Correct set means:	
(i)	As l increases, V increases
(ii)	V recorded correctly with or without unit but in multiple of L.C. of V. (at least in 3 values)
(iii)	Any values of l can be taken within 0cm to 100cm
DEDUCTION (D)	
Correct calculation of potential gradient K in at least three sets with unit.((Vcm^{-1}, or Vm^{-1}) either in K or K_0	
(B) (i)	Record of balance length l
(ii)	Correct calculation of $\varepsilon = K_0 l$ (Correct upto 2 dp with proper rounding off, with unit)
Note: the value of K_0 must be taken from Q2(A). If mean value K_0 is not calculated, then any recorded value of K can be taken.	

GENERAL COMMENTS

Topics found difficult by candidates

- Removal of parallax error
- Concept of significant figures.
- Proper rounding off of any value up to 1 d.p., 3 d.p, or significant figures.
- Record of readings in consistence with the least count of instruments.
- In graph: marking of origin, choosing proper uniform and convenient scale, concept of best fit line, finding of slope from best fit line.

Concepts in which candidates got confused

- Concept of significant figures
- Concept of convenient scale
- Concept of best fit line
- Finding slope (taking 2 plotted points separated more than the 50% of the best fit line drawn)
- Proper choice of scale
- Least Count of instruments

Suggestions for candidates

- Read the question carefully and follow the instructions, using only the formula given in the question paper for all the calculations.
- Do not waste time by writing unwanted things like apparatus required, theory, circuit diagram, etc.
- Understand the theoretical concepts behind the experiment and understand the trend of the two variables in the experiment.
- Learn the correct use of instruments such as, meter scale, optical bench, Vernier callipers, screw gauge, ammeter, voltmeter and galvanometer;
- 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 calculated upto the decimal place or significant figures asked for the in the question.
- Scale should be uniform and convenient with axes properly labelled.
- 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.