ISC Class 12 Physics Question Paper Solution 2019

THEORY (PAPER 1)

SECTION A

*Answer **all** questions*

Question 1

(A) Choose the correct alternative (a), (b), (c) or (d) for each of the questions given below: [5×1]

(i) A closed surface in vacuum encloses charges –q and +3q. The total electric flux emerging out of the surface is:

(a) Zero

(b) $2q/\epsilon_o$

(c) $3q/\epsilon_o$

(d) $4q/\epsilon_o$

(ii) What is the angle of dip at a place where the horizontal component (B_H) and vertical component (B_V) of earth's magnetic field are equal:

(a) 130^o

(b) 60^o

(c) 45^o

(d) 90^o

(iii) A beam of light is incident at the polarizing angle of 35^o on a certain glass plate. The refractive index of the glass plate is:

(a) sin 35^o

(b) tan 35^o

(c) tan 55^o

(d) sin 55^o

(iv) In a gamma ray emission from nucleus:

(a) only the number of protons change.

(b) the number of protons and neutrons, both change.

(c) there is no change in the number of protons and the number of neutrons.

(d) only the number of neutrons change.

(v) The energy associated with light of which of the following colours is minimum:

(a) violet

(b) red

(c) green

(d) yellow

(B) Answer the following questions briefly and to the point. [7×1]

(i) Define **equipotential** surface.

(ii) Calculate the net emf across A and B shown in ***Figure 1*** below:

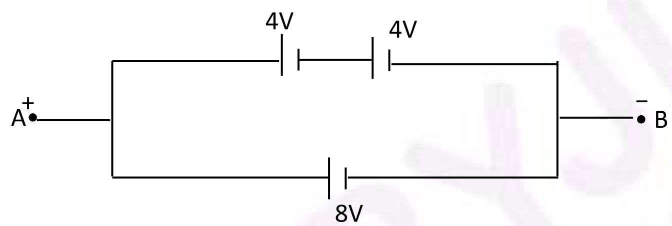

Figure 1

(iii) Why are the pole pieces of a horseshoe magnet in a **moving coil galvanometer** made cylindrical in shape?

(iv) What is the value of **power factor** for a pure resistor connected to an alternating current source?

(v) What should be the path difference between two waves reaching a point for obtaining constructive interference in **Young's Double Slit** experiment?

(vi) Define **critical angle** for a given medium.

(vii) Name the series in the atomic spectra of the hydrogen atom that falls in the ultra violet region.

Comments of Examiners

A (i) Many candidates wrote zero as the answer. Some candidates added the enclosed charges in vacuum in closed surface ignoring the sign.

(ii) Several candidates wrote the angle of dip as 90^0 which was the angle between B_H and B_V.

(iii) Majority of the candidates chose the incorrect alternatives.

(iv) Though it was answered correctly by most candidates, a few candidates wrote change in number of protons and number of neutrons as it was emission from nucleus.

(v) Many candidates wrote the energy associated with light of violet colour is minimum.

B (i) Most candidates attempted this subpart of the question correctly. However, a few candidates, instead of potential wrote potential energy / potential difference.

(ii) Majority of candidates did not write the correct answer. Several candidates added potential like resistances.

(iii) This sub part was not answered correctly by majority of the candidates.

(iv) Many candidates wrote the value of **power factor** for a pure resistor connected to an alternating current source as 90^0 instead of 0^0 as they were confused with the value of cos θ.

(v) Many candidates wrote the expression for fringe or fringe width instead of writing the path difference between two waves reaching a point for obtaining constructive interference in **Young's Double Slit** experiment. Several candidates did not define n after writing n λ.

(vi) Many candidates did not write denser to rarer medium in defining **critical angle** for a given medium. Several candidates missed out angle of incidence in a denser medium.

(vii) Majority of the candidates were unable to answer this question. Most candidates wrote Balmer. Several candidates misspelt Lymen.

Suggestions for teachers

- Lay stress on real-life application of Gauss theorem not just the statement/derivation.
- Train the students on the algebraic addition of charges with examples and diagrams.
- Clarify the components of Earth's magnetic field with different positions and situations through diagrammatic representation.
- Explain Brewster's law with the help of a diagram and give ample practice to students by discussing conceptual / numerical problems in the class to develop understanding of the law.
- Emphasise the nuclear changes taking place during alpha, beta and gamma emissions from a nucleus.
- Besides frequency and wavelength interpret electromagnetic spectrum with energy scale also.
- Point out the difference between potential and potential difference through their definition and properties to the students.
- Illustrate the series and parallel combination of cells and resistances.
- Delineate the cylindrical shape of the pole pieces of a horseshoe magnet in a moving coil galvanometer.
- Explain the term power factor to the students giving adequate practice through conceptual/numerical problems.
- Explain interference thoroughly with both phase and path difference.
- Elucidate the significance of the pair of two optical mediums in defining critical angle.
- Teach the students the three regions - UV, visible and IR with the help of a diagram.
- Emphasise on the correct spellings of various series in the atomic spectra.

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MARKING SCHEME

Question 1

(A)	Choose the correct alternative (a), (b), (c) or (d) for each of the questions given below:	
	(i)	(b) or $\frac{2q}{\epsilon_0}$
	(ii)	(c) or 45^o
	(iii)	(b) or (tan 35)
	(iv)	(c) or No change in the number of protons and the number of neutrons
	(v)	(b) or Red light
(B)	Answer the following questions briefly and to the point.	
	(i)	It is the locus of points having the same potential due to a given charge distribution. OR Any surface on which the electric potential is the same everywhere is called equipotential surface. *(Or any alternate correct definition.)*
	(ii)	$8V$
	(iii)	To obtain radial field or $\theta = 90^0$
	(iv)	One or $\cos 0^0$
	(v)	$n\lambda$, where n = 0,1, 2, 3…… **or** integral multiple of λ
	(vi)	Critical angle is that angle of incidence in a denser medium, for which the angle of refraction in the rarer medium is 90^o.
	(vii)	Lyman

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SECTION B

*Answer **all** question.*

Question 2

[2]

In a potentiometer experiment, the balancing length with a resistance of 2Ω is found to be 100 cm, while that of an unknown resistance is 500 cm. Calculate the value of the unknown resistance.

Comments of Examiners

Majority of the candidates did not solve this question correctly.

Suggestions for teachers

Teach application of potentiometer with examples, giving adequate practice to the students in solving conceptual/numerical problems based on it.

MARKING SCHEME

Question 2

$\frac{X}{R} = \frac{l_2}{l_1}$ **OR**

$X = \frac{l_2}{l_1} \times R$

$X = \frac{500}{100} \times 2$

$X = 10\ \Omega$

(Any alternate correct method)

Question 3

[2]

A rectangular loop of area $5m^2$, has 50 turns and carries a current of 1 A. It is held in a uniform magnetic field of 0·1T, at an angle of 30°. Calculate the torque experienced by the coil.

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Comments of Examiners

Several candidates did not write the correct formula to calculate the torque experienced by the coil. Some candidates did incorrect substitution in the formula. Some did not mention the unit in the answer.

Suggestions for teachers

- Clarify the concept of the torque experienced by a rectangular current carrying coil placed in a uniform magnetic field.
- Advise students to express every physical quantity with proper unit.

MARKING SCHEME

Question 3

τ = NIA B sin θ OR

$\tau = 50 \times 1 \times 5 \times 0.1 \sin 30 / \cos 60$

τ = 12.5 N m

OR

$\tau = 50 \times 5 \times 0.1 \times 1 \sin 60 / \cos 30$

τ = 21.65 N m

(Any alternate correct method)

Question 4

[2]

(a) An electric current I flows through an infinitely long conductor as shown in ***Figure 2(a)*** below. Write an **expression** and **direction** for the magnetic field at point P.

Figure 2(a)

OR

(b) An electric current I flows through a circular loop as shown in ***Figure 2(b)*** below. Write an **expression** and **direction** for the magnetic field at the centre of the loop at point P.

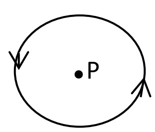

Figure 2(b)

Comments of Examiners

In both the parts (a) and (b) of this question, several candidates were confused in writing the expression and direction for the magnetic field at point P due to an infinitely long current carrying conductor and current carrying coil. Many candidates instead of using notation [. *or* x] to represent the direction of magnetic field simply wrote outside, inside, upside, downside which was ambiguous. Most of the candidates missed out the direction.

Suggestions for teachers

Train students to determine the direction of magnetic field at point P (as asked in the question) due to an infinitely long current carrying conductor or current carrying coil and proper representation of the direction of the magnetic field (in words or on the figure).

MARKING SCHEME

Question 4

(a)	$B = \frac{\mu o\ I}{2\pi r}$ Inward and perpendicular to the plane of the paper OR correctly shown diagrammatically.
(b)	$B = \frac{\mu o\ I}{2r}$ Outward and perpendicular to the plane of the paper OR correctly shown diagrammatically.

Question 5

[2]

A transformer is used to step up an alternating emf of 200V to 440V. If the primary coil has 1000 turns, calculate the number of turns in the secondary coil.

Comments of Examiners

Many candidates took the value of emf as 220V instead of 200V. A few made mistakes in the substitution.

Suggestions for teachers

- Discuss clearly the theory of transformer with symbols N_p, N_s, E_p, and E_s along with the formula.
- Give adequate practice to the students in correct usage of the formula, substitution and units.

MARKING SCHEME

Question 5

$$\frac{\varepsilon_1}{\varepsilon_2} = \frac{N_1}{N_2}$$

$$\frac{200}{440} = \frac{1000}{N_2}$$

correct substitution with or without formula

$$N_2 = \frac{\overset{22}{\cancel{440}} \times 10\cancel{00}}{{}_1\cancel{2}\,\cancel{00}} = 2200 \text{ turns}$$

Question 6

[2]

State *any two* properties of **microwaves**.

Comments of Examiners

Most candidates wrote applications or uses rather than properties of microwaves.

Suggestions for teachers

- Point out the difference between properties (characteristics) and applications or uses of microwaves.
- Explain the common properties of Electromagnetic waves, their differences and specific properties of each region.
- Train students to read the question carefully and answer according to its requirement.

MARKING SCHEME

Question 6

- No material medium is required for its propagation
- Travels at the speed of light in vacuum / air
- Travels at a speed of 3×10^8 m/s
- Reflected
- Refracted
- Diffracted
- Polarized.
- Interference

(Or any other correct property)

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Question 7

[2]

Write *any one* use for each of the following mirrors:

(a) Convex

(b) Concave

Comments of Examiners

Majority of the candidates were unable to answer this question.

Suggestions for teachers

While teaching the concept of concave and convex mirrors, familiarise students with their uses and applications.

MARKING SCHEME

Question 7

(a)	Convex: • Rear view mirrors in vehicles. • Used as reflectors in street lights. • Placed at corners in hospitals, shopping malls, etc. to enable people to see what is approaching around the corner. • Used in making lens for sunglasses (this is done to help reflect the light of the sun away from the eyes of the person wearing the sunglasses). *(Or any other correct use)*
(b)	Concave: • Shaving mirror • Parabolic mirrors in astronomical telescope • Search lights • Head lights • Solar reflectors • To determine the focal length of a lens. *(Or any other correct use)*

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Question 8

[2]

The deviation produced for violet, yellow and red lights for crown glass are 3·75°, 3·25° and 2·86° respectively. Calculate the dispersive power of the crown glass.

Comments of Examiners

Most candidates, instead of the formula for dispersive power $(\delta_V - \delta_R)/\delta_Y$ wrote $(\mu_V - \mu_R)/(\mu_Y - 1)$.

Suggestions for teachers

Ensure that the students can show the dispersive power of the crown glass not only through a diagram but also able to calculate the dispersive power using the appropriate formula.

MARKING SCHEME

Question 8

$$\delta = \frac{\delta_v - \delta_R}{\delta_y} / = \frac{3{\cdot}75 - 2{\cdot}86}{3{\cdot}25}$$

$= 0.2738 \approx 0.27$

Question 9

[2]

(a) What is meant by **mass defect**?

(b) What conclusion is drawn from **Rutherford's** scattering experiment of α-particles?

Comments of Examiners

(a) Some answer scripts lacked clarity in terms of nucleus and nucleons.

(b) Many candidates explained the Rutherford's scattering experiment but did not write the result / inferences / conclusion of the experiment.

Suggestions for teachers

- Clarify students, the difference between the nucleus and nucleons.
- Explain the concept of mass defect and binding energy, laying stress on the keywords, along with the usefulness of binding energy.
- Encourage the students to learn the definitions.
- Teach Rutherford's scattering experiment in detail in the class.

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MARKING SCHEME

Question 9

(a)	When a nucleus is formed from its constituent nucleons, the mass of the nucleus is found to be less that the total mass of the nucleons. The difference in mass is called mass defect. **OR** The difference between the real mass and the expected mass in a nuclear reaction. **OR** The difference between the mass of a nucleus and its constituents, ΔM, is called the mass defect. **OR** The difference between the atomic mass (M) and mass number (A). *(or any other correct answer)*
(b)	The positive charge of the atom is concentrated in a small central core called the nucleus **OR** The whole mass of the atom remains in a small region of the atom **OR** The space around the nucleus is almost empty.

Question 10

[2]

Define the following with reference to photoelectric effect:

(a) Threshold frequency (f_o)

(b) Stopping potential (V_s)

Comments of Examiners

(a) This question was attempted well by most candidates. A few candidates, however, got confused whether it was *minimum cut off* or *maximum cut off frequency*… in threshold frequency.

(b) Many candidates missed the word *negative*… in stopping potential, but they knew that electrons had to be stopped.

Suggestions for teachers

- Explain photo-electric effect with definitions laying stress on keywords/laws.
- Clarify retarding potential / stopping potential with the help of graphs too, laying stress on keywords.

MARKING SCHEME

Question 10

(a)	Threshold frequency (f_o) is defined as the minimum cut off frequency of the incident radiation below which no emission of photoelectrons takes place. *(Any equivalent correct definition)*
(b)	• Stopping potential is defined as that negative voltage for which the fastest moving electron may be stopped. • Negative voltage for which photo electric current is stopped or becomes zero. *(Any equivalent correct definition)*

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Question 11

[2]

(a) The half-life of radium is 1550 years. Calculate its disintegration constant (λ).

OR

(b) Copy and complete the following table for a radioactive element whose half-life is 10 minutes. Assume that you have 30g of this element at t = 0.

t (minute)	0	20	30
Amount of radioactive element left in gm	30	--	--

Comments of Examiners

(a) Most candidates were able to write the correct answer. Some candidates used $\log_{10} 2$ instead of $\log_e 2$. A few candidates wrote the incorrect unit.

(b) Many candidates used $N=N_o e^{-\lambda t}$ which although correct, involved more mathematics than the method used by number of half-lives, where time was an integral multiple of half-life (T). Some candidates did not notice the variation of time to be 20 and 30 minutes and worked it out for 10 and 20 minutes.

Suggestions for teachers

- Clarify the mathematical operation of $\log_e x$ and $\log_{10} x$, commonly used in Radioactivity, as the base changes the value.
- Explain clearly the various terms like half-life, mean life, law of radioactive decay, disintegration constant, activity of a sample etc. and ensure by giving ample practice that they are able to apply different formulae judiciously in variety of numerical problems.
- Train students to read the question carefully before attempting it.

MARKING SCHEME

Question 11

(a) $T = \frac{0.693}{\lambda}$ ***OR*** $1550 = \frac{0.693}{\lambda}$

$\lambda = \frac{0.693}{1550} = 4.4709 \times 10^{-4}$ / y or 1.225×10^{-6} / d or 5.1×10^{-8}/h or 8.51×10^{-10} /min or 1.4177×10^{-11} /s

OR

(b)

t (minute)	0	20	30
Amount of radioactive element left in gram	30	7.5	3.75

Question 12

[2]

Define **frequency modulation** and state *any one* advantage of frequency modulation (FM) over amplitude modulation (AM).

Comments of Examiners

Many candidates did not define the frequency modulation correctly. Some candidates were unable to write its advantage too.

Suggestions for teachers

- Spell out the concept of modulation and its types like amplitude modulation (AM) and frequency modulation (FM) and their advantages clearly to the students.
- Demonstrate wave forms of FM and AM also.

MARKING SCHEME

Question 12

The frequency of a carrier wave is varied in accordance with the modulating wave. This is called frequency modulation.

- Reduces noise factor or FM is immune to all forms of noise existing in nature.
- FM has higher efficiency than AM
- The sound of a TV set (FM) is of much better quality than that of a radio set (AM)
- Bandwidth of FM is greater than the AM
- Amplitude of FM is constant unlike AM wave

(Or any equivalent answer)

Question 13

[3]

Obtain an expression for electric potential '*V*' at a point in an **end-on position** i.e. axial position of an electric dipole.

Comments of Examiners

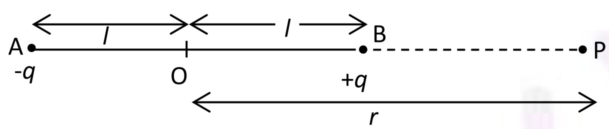
Most candidates derived the expression for electric field instead of electric potential. A few candidates derived an expression for electric potential at a point in broad side **on** position, instead of an **end on** position of an electric dipole. Several candidates drew arrows to show electric potential whereas it was a scalar quantity. Many candidates derived potential due to a point charge. Some candidates wrote the final expression for a short dipole which was not required.

Suggestions for teachers

- Differentiate between electric field and electric potential clearly.
- Discuss in detail the methods of obtaining electric potential and electric field intensity at a point due to an electric dipole.
- Teach the relation E α $\frac{1}{r^3}$ and V α $\frac{1}{r^2}$ for an electric dipole.

MARKING SCHEME

Question 13



The potential at point P due to the charge +q is

$$V_1 = \frac{1}{4\pi\epsilon_0}\frac{q}{(r-l)}$$

The potential at point P due to the charge - q is

$$V_2 = \frac{1}{4\pi\ \epsilon_0}\frac{q}{(r+l)}$$

The potential due to the dipole at point P is equal to the sum of the potentials due to the charges +q and -q i.e.,

$$V = V_1 + V_2$$

$$= \frac{q}{4\pi\ \epsilon_0}\left[\frac{1}{(r-l)} - \frac{1}{(r+l)}\right]$$

$$= \frac{q}{4\pi\ \epsilon_0}\left[\frac{r+l-r+l}{r^2-l^2}\right]$$

$$V = \frac{q\ 2l}{4\pi\ \epsilon_0\ (r^2-l^2)}$$

OR $= \frac{p}{4\pi\epsilon_0(r^2-l^2)}$ ($p = 2ql$)

Note: 'K' can be used instead of $\frac{1}{4\pi\ \epsilon_0}$ (Or *any other correct method*)

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Question 14

[3]

Three capacitors of capacitance $C_1 = 3\mu f$, $C_2 = 6\mu f$ and $C_3 = 10\mu f$, are connected to a 10V battery as shown in ***Figure 3*** below:

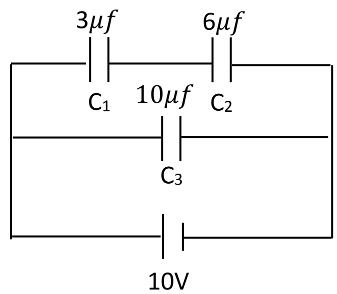


Figure 3

Calculate:

(a) Equivalent capacitance.

(b) Electrostatic potential energy stored in the system.

Comments of Examiners

(a) Most candidates calculated the equivalent capacitance incorrectly. Capacitances were added like resistances in several answer scripts. Many candidates did not write the unit of capacitance.

(b) Many candidates used CV^2 and qV as the formula to calculate the electrostatic potential energy stored in the system which was incorrect. Most candidates did not convert the unit of capacitance μF to F to calculate electrostatic potential energy.

Suggestions for teachers

- Lay stress on the basics of connecting capacitors in a circuit in series/parallel combinations, clearly explaining the quantity of charge on each capacitor and potential difference across each capacitor.
- Give ample practice of numerical problems based on capacitor.

MARKING SCHEME

Question 14

(a)	$\frac{1}{C^1} = \frac{1}{3} + \frac{1}{6}$ OR $C^1 = \frac{3 \times 6}{3+6}$ $\frac{1}{C^1} = \frac{3}{6_2}$ $C^1 = 2\ \mu F$ $C_{equivalent} = C^1 + C_3 = 2 + 10 = 12\ \mu F$
(b)	$E = \frac{1}{2} CV^2$ $= \frac{1}{2} \times 12 \times 10^{-6} \times (10)^2$ $E = 600 \times 10^{-6}\ J$

Question 15

[3]

(a) Obtain the balancing condition for the **Wheatstone bridge** arrangement as shown in ***Figure 4*** below:

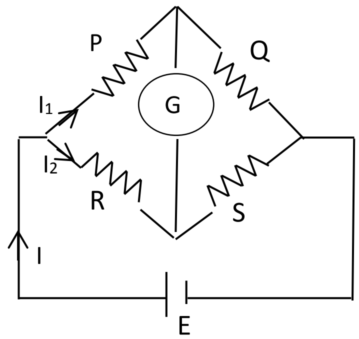


Figure 4

OR

(b) Draw a labelled circuit diagram of a **potentiometer** to measure the internal resistance '*r*' of a cell. Write the working formula (*derivation is not required*).

Comments of Examiners

(a) A large number of candidates used the concept of balanced bridge as Ig=0 or $V_b = V_d$ directly without any mention of it. Several candidates were not able to use the Kirchhoff's law, and this induced an error.

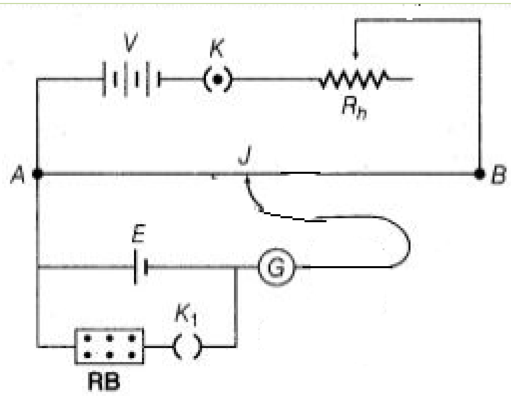
(b) Many candidates did not know the theory of the potentiometer and derived $E_1/E_2 = l_1/l_2$. Some candidates drew incorrect circuit diagram of a **potentiometer** to measure the internal resistance of a cell. A few candidates used it as a Wheatstone bridge. A few others did not use the resistance box which was critical.

Suggestions for teachers

- Interpret Kirchhoff's rules for analysis of electrical circuits thoroughly to the students giving adequate number of conceptual/numerical problems.
- Explain Wheatstone bridge and Potentiometer, their principle, theory, uses/applications etc. in detail to the students.
- Demonstrate Wheatstone Bridge and Potentiometer based experiments to the students clarifying minute details related to the apparatuses and their proper connections. Also, explain clearly the importance of each component of the circuit.
- Instruct students to practice, drawing labelled circuit diagrams of Wheatstone bridge and Potentiometer.

MARKING SCHEME

Question 15

(a)	$I_1P = I_2 R$ $I_1Q = I_2 S$ $I_g = 0$ $\frac{P}{R} = \frac{Q}{S}$ *(Or any other correct method)*
(b)	 (Correct diagram with both batteries connected correctly) $r = R\left(\frac{\varepsilon}{V} - 1\right)$ OR $r = R\left(\frac{l_1}{l_2} - 1\right)$

Question 16

[3]

(a) A ray of light is incident on a prism whose refractive index is 1·52 at an angle of 40°. If the angle of emergence is 60°, calculate the angle of the prism.

OR

(b) Calculate the focal length of a convex lens whose radii of curvature of two surfaces is 10 cm and 15 cm respectively and its refractive index is 1·5.

Comments of Examiners

(a) Most candidates used the expression for minimum deviation to calculate the angle of prism. Several candidates used the incorrect formula. Some candidates used the formula for thin prism. The answer was not expressed up to correct decimal places in many answer scripts.

(b) Majority of the candidates made an error in using the proper sign (+ or -) for 'u', 'v' and radius of curvature, R. Many candidates used the formula 1/f =1/u+1/v to calculate the focal length of the convex lens which was incorrect.

Suggestions for teachers

- Advise students to draw diagrams and use Snell's law rather than memorising the formula.
- Teach sign convention for both convex and concave surfaces.
- Give adequate practice in all kinds of numerical.
- Lay stress on writing the answer with units.

MARKING SCHEME

Question 16

(a)	$\left(\mu = \frac{Sin\, i}{Sin\, r}\right)$ $Sin\, r_1 = \frac{Sin\, 4\, 0}{1.52} = 0.4228$ $r_1 = 25.049$ $Sin\, r_2 = \frac{Sin\, 6\, 0}{1.52} = 0.5697$ $r_2 = 34.75$ $A = r_1 + r_2$ = 25.0169+34.75 $= 59.7499$ $A = 59.8°$
OR	
(b)	$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ $\frac{1}{f} = (1.5 - 1)\left(\frac{1}{10} + \frac{1}{15}\right)$ $\frac{1}{f} = 0.5\left(\frac{15 + 10}{150}\right)$ $= \frac{25 \times 0.5}{150}$ $f = 12$ cm

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Question 17

[3]

Derive the law of reflection using **Huygen's** Wave Theory.

Comments of Examiners

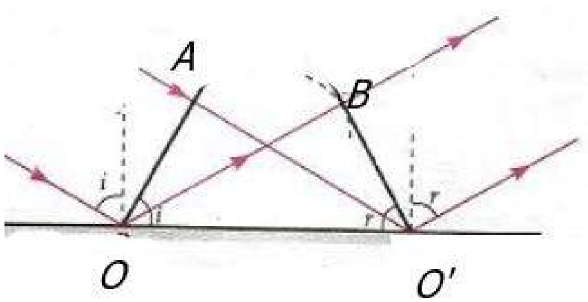
Most of the candidates did not draw the wave front properly. Several candidates missed out the arrows. Many candidates did not show the wave and wave front being normal to each other properly. Some candidates did not mark angle *i* and *r*. Very few candidates showed refraction and derived Snell's Law instead of law of reflection.

Suggestions for teachers

- Teach construction of wave front using proper angles.
- Explain students to derive laws of reflection using Huygens wave theory comprehensively.

MARKING SCHEME

Question 17



In triangles AOO′ & BOO′

OO′ is common.

AO′= O′B = c t or v t

∟OAO′= ∟OBO′ = 90°

Hence, the two triangles are congruent in all respects

$\boxed{\Delta AOO'} = \boxed{\Delta BO'O}$

$\therefore \angle i = \angle r$

(Any other correct derivation)

Question 18

[3]

State *any two* **Bohr's** postulates and write the **energy value** of the ground state of the hydrogen atom.

Comments of Examiners

Several candidates intermixed Rutherford's and Bohr's postulates. Many candidates did not define L as mvr (in the relation L= mvr = nh/2π). Some candidates did not know the value of ground state of H - atom. A few candidates did not write the unit of the energy value of the ground state of the hydrogen atom.

Suggestions for teachers

- Clarify Rutherford's and Bohr's model of the atom in detail to the students.
- Advise students to memorise the technical terms, definitions, laws, postulates, principles in Physics only after comprehension and to practise these frequently.
- Train students to convert the units from one system of unit to other.

MARKING SCHEME

Question 18

- An electron in an atom could revolve in certain stable orbits without the emission of radiant energy.
- Electrons revolve around the nucleus only in those orbits in which their angular momentum is an integral multiple of $h/2\pi$ where h is the Planck's constant (6.6 x 10^{-34} J s) that is

  $L \text{ or } mvr = \frac{nh}{2\pi}$
- An electron might make a transition from one of its specified non-radiating orbits to another of lower energy. In doing so a photon is emitted having energy equal to the energy difference between the initial and final states. The frequency of the emitted photon is given by

  $$f = (E_i - E_f)/h$$

  where E_i and E_f are the energies of the initial and final states ($E_i > E_f$)

(Any two Bohr's postulate)

Energy value of the ground state of hydrogen atom, $E = -13.56\ eV$ or 13.6 eV

Question 19

[3]

With reference to semi-conductors answer the following:

(i) What is the change in the resistance of the semi-conductor with **increase** in temperature?

(ii) Name the majority charge carriers in **n-type** semi-conductor.

(iii) What is meant by **doping**?

Comments of Examiners

(i) Many candidates wrote direct proportionality between the temperature and resistance, i.e., with the increase in temperature, the resistance of the semiconductor increases, which was incorrect.

(ii) Some candidates mentioned the majority charge carriers in n-type semi-conductor as holes instead of electrons.

(iii) Some candidates, instead of semi-conductor, wrote metal. Very few candidates wrote impurities added in a controlled manner.

Suggestions for teachers

- Stress upon the concept clarity and comprehension of the factors affecting semi-conductors.
- Explain clearly the concept of intrinsic semiconductor, doping and extrinsic semiconductors (p-type and n-type).

MARKING SCHEME

Question 19

(i)	The resistance of the semiconductor decreases with increase in temperature.
(ii)	In n-type semi-conductor majority charge carriers are electrons.
(iii)	Adding impurity atoms to a (pure) semi-conductor (to increase its conductivity) in a calculated manner is called doping. **OR** Adding a trivalent or a pentavalent atom to a semi-conductor (germanium or silicon) in a calculated manner is called doping. **OR** Adding a small amount of a suitable impurity to a pure semiconductor to increase its conductivity. *Note: name of a trivalent or a pentavalent may be used.* *(Or any correct definition)*

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SECTION D

*Answer **all** questions.*

Question 20

[5]

(a) (i) An alternating emf of 200V, 50Hz is applied to an **L-R** circuit, having a resistance **R** of 10Ω and an inductance **L** of 0·05H connected in **series**. Calculate:

(1) Impedance**.**

(2) Current flowing in the circuit.

(ii) Draw a labelled graph showing the variation of inductive reactance (**X_L**) versus frequency ***(f)***.

OR

(b) (i) An a.c. source of emf $\varepsilon = 200 \sin \omega t$ is connected to a resistor of 50Ω. Calculate:

(1) Average current (**I_{avg}**).

(2) Root mean square (**rms**) value of emf.

(ii) State *any two* characteristics of resonance in an LCR series circuit.

Comments of Examiners

(a) (i) Many candidates used 'L' instead if ωL. Several candidates used R instead of Z to calculate I. Some candidates did not write the units of impedance and current.

(ii) Most candidates labelled the x-axis and y - axis incorrectly. Several candidates showed the variation of inductive reactance (***X_L***) versus frequency ***(f)***, a curved line with decreasing slope instead of a straight line.

(b)(i) A large number of candidates wrote incorrect formulae to calculate the average current and root mean square value of emf. Several candidates did not write the answer with proper units.

(ii) Many candidates did not write the characteristics of resonance in an LCR series circuit.

Suggestions for teachers

- Train students by giving them regular practice in the class to solve the conceptual/numerical problems related to A.C. circuits based on variation in voltage and current with time, average current, rms current, average voltage, rms voltage, reactance, impedance, power factor, resonance in an LCR series circuit etc.
- Lay stress on writing all parts and sub parts of a numerical problem with proper unit.
- Stress on drawing and practicing all the graphs of A.C. circuits. X_L versus f, X_C versus f, Z versus f etc.
- Explain the condition of series resonance in L-C-R circuits and its applications.

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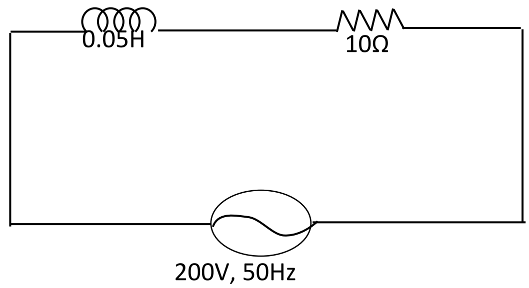
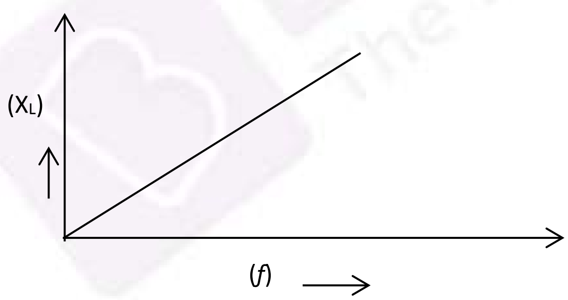
MARKING SCHEME

Question 20

(a)	(i)	 $Z = \sqrt{{X_L}^2 + R^2}$ OR $Z = \sqrt{(\omega L)^2 + R^2}$ OR $Z = \sqrt{(2\pi f L)^2 + R^2}$ OR $Z = \sqrt{(2 \times 3.14 \times 50 \times 0.05)^2 + 10^2}$ $Z = 18.61\ \Omega$ $I = \frac{200}{18.61} = 10.74$ A
	(ii)	
	OR	
(b)	(i)	$E_0 = 200V$ $I_{average} = \frac{2E_0}{\pi R} = \frac{2 \times 200}{3.14 \times 50} = 2.55$ A $E_{rms} = \frac{E_0}{\sqrt{2}} = 141.42\ V$
	(ii)	• Z = R • Cosϕ = 1

		• $P = I^2Z = I^2 R$ that is maximum power is dissipated in a circuit (through R) at resonance • Current is maximum • Resistance is minimum or impedance is minimum • $f = \frac{1}{2\pi\sqrt{LC}}$ • $X_L = X_C$ OR $\omega L = 1/\omega C$ OR $2\pi f L = 1/2\pi f C$ *(Any two characteristics)*

Question 21

[5]

(a) Draw a neat labelled ray diagram showing the formation of an image at the **least distance of distinct vision D** by a **simple microscope.** When the final image is at D, derive an expression for its magnifying power at D.

OR

(b) Draw a neat labelled diagram of **Young's** Double Slit experiment. Show that $\beta = \frac{\lambda D}{d}$, where the terms have their usual meaning *(either for bright or dark fringe).*

Comments of Examiners

(a) Some common errors observed in this question were:

- Many candidates, instead of simple microscope, drew the compound microscope.
- Several candidates did not mark the arrows on the rays in the drawn ray diagram of simple microscope.
- A few candidates did not show the virtual image in dotted lines and also did not properly label the diagram.
- Some candidates showed the calculation of M only up to D/u.

(b) Most of the candidates were unable to draw the correct ray diagram. Several candidates did not derive the formula. Many candidates did not mark angle θ in the method of sin θ and tan θ. Some candidates were confused in the final expression.

Suggestions for teachers

- Explain the difference between simple and compound microscope.
- Give ample practice of ray diagrams to the students.
- Make the students practice derivations with complete steps and proper sign conventions.
- Explain and make the students practice the difference between linear magnification and angular magnification.

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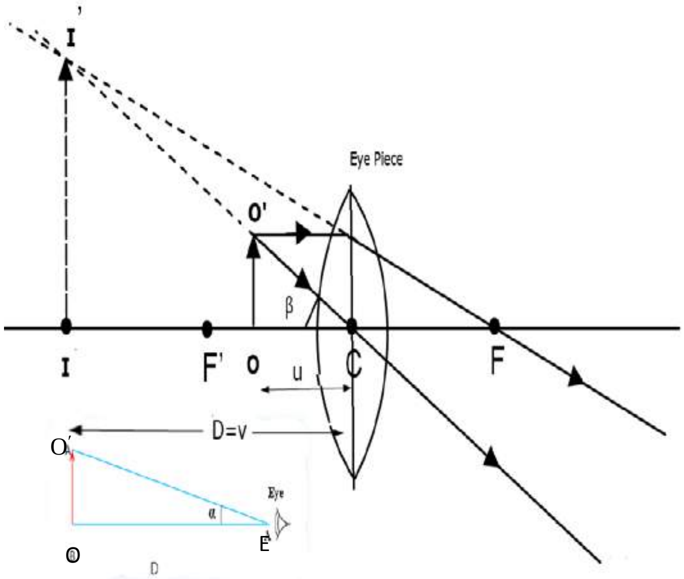
MARKING SCHEME

Question 21

(a)



$\tan\beta = (OO'/OC)$, $\tan\alpha = (OO'/OE)$ *(α and β are very very small)*

$M = \beta/\alpha = (OO'/OC)/(OO'/OE) = (OE/OC) = (IC/OC) = v/u$

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

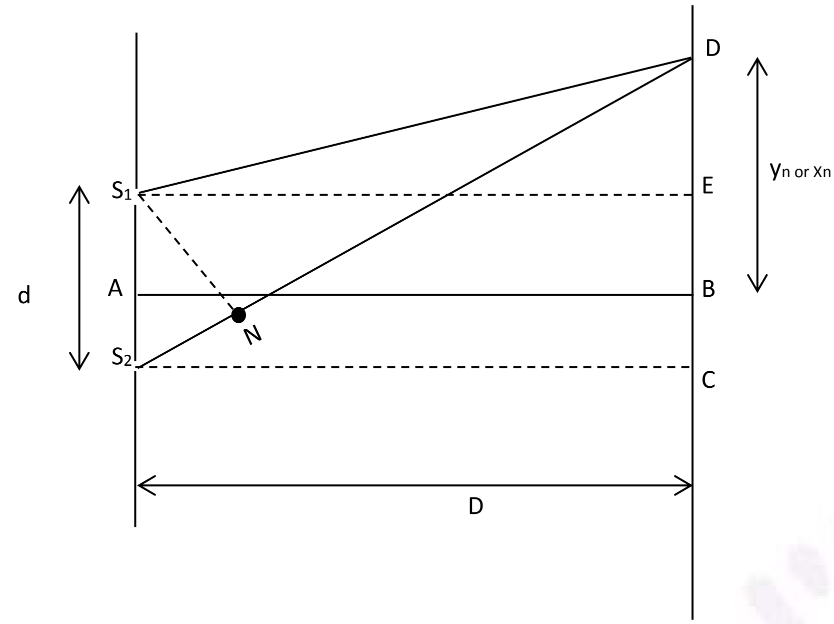
$$\frac{v}{v} - \frac{v}{u} = \frac{v}{f}$$

$$1 - M = -\frac{D}{f}$$

$$\therefore M = 1 + \frac{D}{f}$$

(Or any correct working)

OR

(b)	 $S_1D^2 = S_1E^2 + DE^2$ $= D^2 + (y - d/2)^2$ $S_1D^2 = D^2 + y^2 - \frac{2yd}{2} + \frac{d^2}{4}$ $S_2D^2 = S_2C^2 + \left(y + \frac{d}{2}\right)^2$ $= D^2 + y^2 + yd + \frac{d^2}{4}$ $S_2D - S_1D = \frac{2yd}{2D}$ Path difference $= \frac{yd}{D}$ For bright fringe: $\beta_{bright} = y_n d/D = n\lambda$ $y_n = n\,\lambda\,D/d$ For $y_{(n+1)} = (n+1)\,\lambda\,D/d$ $\beta_{bright} = y_{(n+1)} - y_n = \lambda\,D/d$

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	For dark fringe $\frac{y_n d}{D} = (2n+1)\frac{\lambda}{2}$ $y_n = \frac{(2n+1)\lambda D}{2d}$ $y_{n+1} = \frac{[2(n+1)+1]\lambda D}{2d}$ $\beta_{dark} = y_{n+1} - y_n = \frac{\lambda D}{d}$

Question 22

[5]

(a) (i) Draw a labelled circuit diagram of a **half wave rectifier** and give its output waveform.

(ii) Draw a symbol for **NOR** gate and write its truth table.

OR

(b) (i) Draw a neat circuit diagram to study the input and output characteristics of a **common emitter** transistor.

(ii) Draw the symbol for **AND** gate and write its truth table.

Comments of Examiners

(a) (i) Most candidates, instead of half wave rectifier, drew the circuit diagram of the full wave rectifier. Many candidates were unable to show correctly labelled input and output waveforms. Some candidates did not draw the complete circuit diagram. Some did not show the load resistance in the output circuit. A few candidates did not label the axis.

(ii) A number of candidates gave the incomplete truth table. Some candidates wrote the incorrect truth table. A few candidates did not show the symbol of NOR gate as a combination of OR and NOT.

(b) (i) Majority of the candidates did not understand the difference between the circuit diagram of a common emitter amplifier and that of a characteristic curve of a common emitter transistor. Most candidates missed out on the output characteristics. Several candidates did not show the correct biasing. Many candidates did not

Suggestions for teachers

- Explain the semiconductor diode and its application as a rectifier in detail to the students.
- Advise students to practise to draw the labelled circuit diagrams including the variation of input and output waveforms of half wave and full wave rectifiers.
- Emphasise the labelling of the axis for the graphs of input/ output/transfer characteristics and input/ output waveforms.
- Explain five common logic gates AND, OR, NOT, NAND and NOR with symbols, diagrams, Boolean expressions and truth table.
- Teach students the logic behind the truth table. Give enough practice of the same.

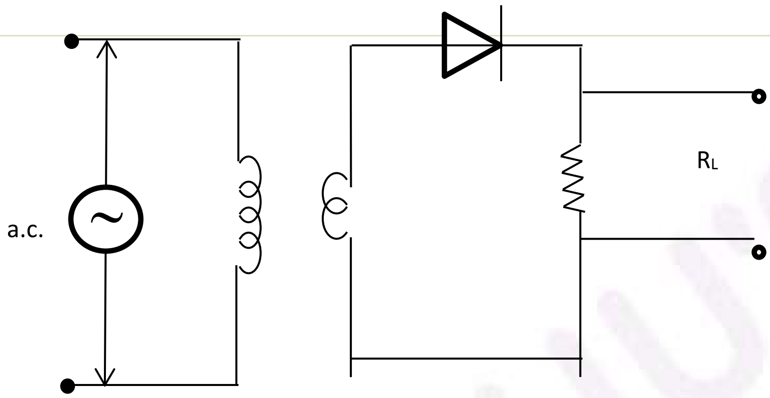
show the ammeters and voltmeters in the output and input of the circuit diagram. Some candidates did not label the circuit correctly. A few candidates did not show the variable resistor and potential divider in the circuit diagram.

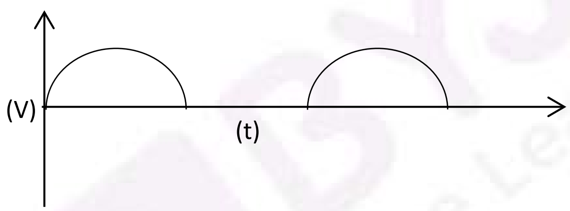
(ii) A few candidates drew the incorrect symbol for AND gate. Some candidates gave the incorrect truth table.

MARKING SCHEME

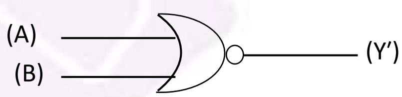
Question 22

(a) (i)





(ii)



A	B	(Y)	Y′
0	0	0	1
1	0	1	0
0	1	1	0
1	1	1	0

OR

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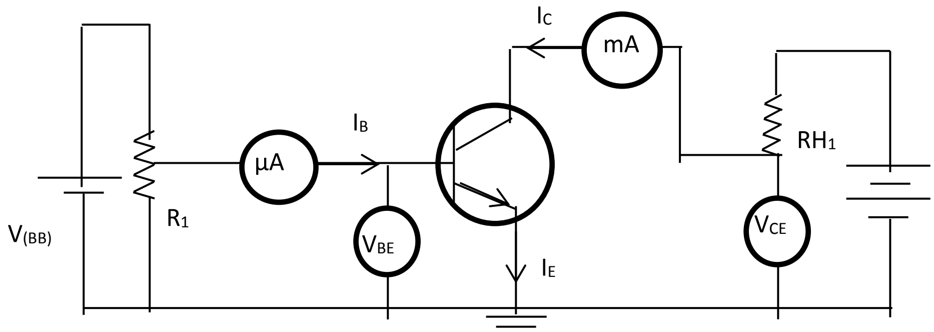
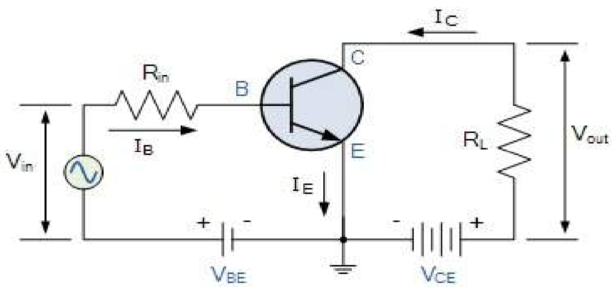
(b) (i)

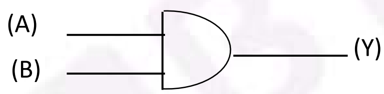


OR



Input and Output with correct biasing

(ii)



A	B	Y
0	0	0
1	0	0
0	1	0
1	1	1

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

- Gauss Theorem.
- Kirchhoff's Law.
- Combination of cells.
- Diagram of potentiometer to measure internal resistance of the cell.
- Direction of magnetic field for a current carrying conductor.
- Radial magnetic field.
- Application of mirrors.
- Sign convention in lenses and mirrors.
- Numerical problems on prism and Lens maker's formulae.
- Huygens applications.
- Numerical problems based on alternating current and Radioactivity.
- Power Factor.
- Relation between energy associated with light, its relationship with wave length and frequency.
- Mass defect and stopping potential.
- Circuit diagram to study the input and output characteristics of transistor in common emitter mode.
- Modulation.

Concepts in which candidates got confused

- End on position and broad side on position of an electric dipole.
- Derivation of electric field and electric potential.
- Capacitors in series and parallel.
- I_{avg} and I_{rms}
- Magnetic Flux (Either 0^0 or 90^0) and Magnetic field in a coil.
- Formula of dispersive power.
- Simple and compound microscope.
- Path difference and Phase difference.
- Properties and uses of microwaves.
- Threshold wavelength and threshold frequency.
- Full wave and Half wave rectifier.

Suggestions for candidates

- Make a list of definitions, principles and formulae.
- Memorise the technical terms/laws/key words, principles and derivations etc. only after comprehension.
- Refer to various standard text books, and scope of syllabus.
- Follow the steps while doing a numerical (write the data, make conversion of units if required in SI., write the correct formula, make correct substitution and write correct answer with correct unit and the direction in case of a vector quantity).Be careful with the units like mm, cm, nm, μC and μF, mA, electron volt etc. These must be converted to SI units.
- Draw a ray diagram with arrow heads.
- Draw a graph with properly labelled axes.
- Take notes in the class to summarize lectures in your own words to remember the concept/ideas/derivations.
- Create Mind Maps/flow charts to consolidate your knowledge for quick revision during examinations.
- If you find it easier to recall images rather than text, and able to memorise concepts quickly, associate them with pictures, ray diagrams, graphs and drawings.
- Practice the difficult topics regularly.
- Understand the basics of any derivation and their outcome.
- Practice previous years' question papers.
- Utilize the reading time judiciously and plan accordingly.
- Work on time management on each question depending upon the marks distribution.
- Write to the point and precise answers.

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