Registration No | | | | | | | **SET 1**

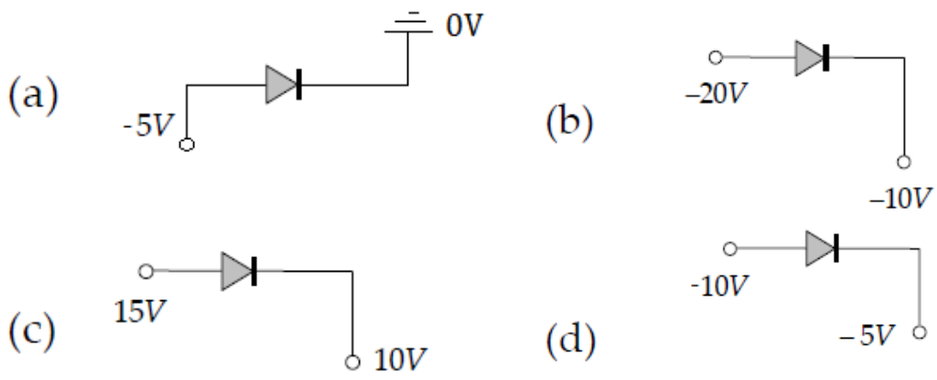
ALL KERALA COMMON MODEL EXAMINATION
PHYSICS (042)
CLASS XII (2023-24)

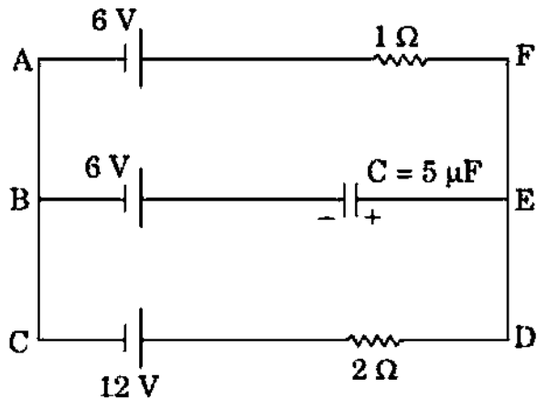
TIME: 3 Hours **MAX.MARKS: 70**

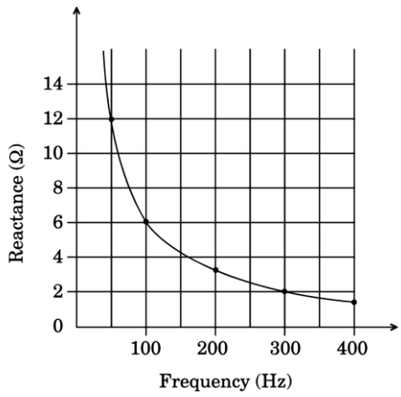
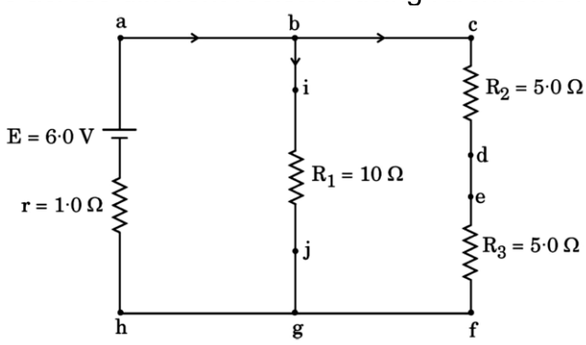
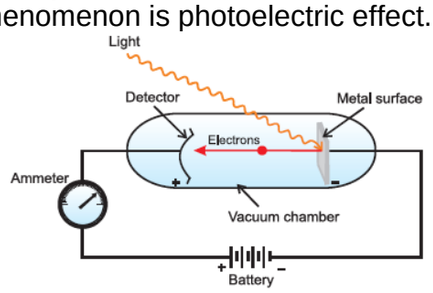
General Instructions:
(1) There are 33 questions in all. All questions are compulsory
(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E. All the sections are compulsory.
(3) Section A contains sixteen questions, twelve MCQ and four Assertion Reasoning based of 1 mark each, Section B contains five questions of two marks each, Section C contains seven questions of three marks each, Section D contains two case study based questions of 4 marks each and Section E contains three long questions of five marks each.
(4) There is no overall choice. However, an internal choice has been provided in section B, C, D and E. You have to attempt only one of the choices in such questions.

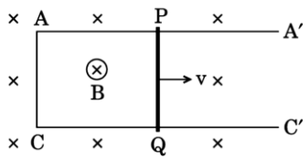
SECTION A

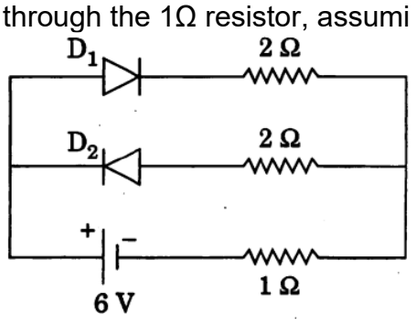
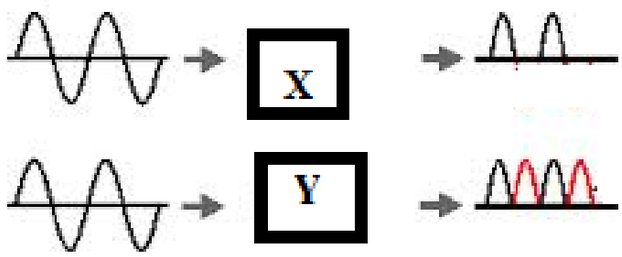
1.	A charge Q is uniformly distributed over the surface of a spherical shell of radius R. The work done in bringing a test charge Q_0 from its centre to its surface is (a) $\frac{QQ_0}{4\pi\varepsilon_0 R}$ (b) $\frac{QQ_0}{4\pi\varepsilon_0 2R}$ (c) $\frac{QQ_0}{\varepsilon_0 R}$ (d) zero	(1)
2.	If N_1 is the number of electric field lines going out of an imaginary cube of side 'a' enclosing a charge 2Q and N_2 the corresponding number for an imaginary sphere of radius 'a' enclosing charge 3Q, then N_1/N_2 is (a) $\frac{1}{\pi}$ (b) $\frac{2}{3}$ (c) $\frac{4}{9}$ (d) π	(1)
3.	An electric dipole in a non-uniform electric field will experience (a) only force (b) only torque (c) both force and torque (d) neither force nor torque	(1)
4.	The electric field at a point on the axis of a short electric dipole at a distance r from the midpoint of the dipole is proportional to (a) $\frac{1}{r^4}$ (b) $\frac{1}{r^{3/2}}$ (c) $\frac{1}{r^3}$ (d) $\frac{1}{r^2}$	(1)
5.	A constant voltage is applied between the two ends of a uniform metallic wire, heat 'H' is developed in it. If another wire of the same material, double the radius and twice the length as compared to original wire is used then the heat developed in it will be (a) H/2 (b) H (c) 2H (d) 4H	(1)
6.	Relative permeability of a material is 0.9. The material is (a) diamagnetic (b) paramagnetic (c) ferromagnetic (d) diamagnetic or paramagnetic	(1)
7.	The magnetic field at the centre of a circular coil of radius 10cm is $5\sqrt{5}$ times the magnetic field at a point on the axis. The distance of the point from the centre is (a) 5cm (b) 10cm (c) 20cm (d) 25cm	(1)
8.	Alternating emf E= 220sin100πt is applied to a circuit containing an ideal inductor of L=2/π H. Instantaneous value of current is (a) 1.1cos100πt (b) -1.1cos100πt (c) 1.1sin100πt (d) -1.1sin100πt	(1)
9.	Photons of energy 5.5eV fall on the surface of the metal emitting photoelectrons of maximum kinetic energy 4eV. The stopping potential required for these electrons is (a) 5.5V (b) 1.5V (c) 4V (d) 9.5V	(1)

10.	The ratio of the nuclear radius if the mass numbers of the nuclei are 4 and 32 is (a) 1:2 (b) 1:3 (c) 1:4 (d) 1:8	(1)
11.	A glass slab of refractive index 1.5 is placed on a cross marked on paper. The cross appears to be raised by 1cm. The thickness of the slab is (a) 2cm (b) 4cm (c) 3cm (d) 6cm	(1)
12.	Which of the diodes is forward biased?  	(1)
13.	**Assertion (A):** When a light wave travels from a rarer to a denser medium, its speed decreases. The reduction in speed implies a reduction in energy carried by the light wave. **Reason (R):** The energy of a wave is proportional to velocity of wave. (a) Both A and R are true and R is the correct explanation (b) Both A and R are true but R is NOT the correct explanation of A (c) A is true but R is false (d) A is false and R is also false	(1)
14.	**Assertion (A):** A proton and electron with the same momenta enter a uniform magnetic field in a direction perpendicular to the field lines. The radius of the path followed by them will be the same. **Reason (R):** Electron has less mass than the proton. (a) Both A and R are true and R is the correct explanation (b) Both A and R are true but R is NOT the correct explanation of A (c) A is true but R is false (d) A is false and R is also false	(1)
15.	**Assertion (A):** The refractive index of diamond is $\sqrt{6}$ and of liquid is $\sqrt{3}$. If light travels from diamond into the liquid, it will be totally internally reflected when angle of incidence is 30^0. **Reason (R):** For total internal reflection, light should travel from rarer to denser medium. (a) Both A and R are true and R is the correct explanation (b) Both A and R are true but R is NOT the correct explanation of A (c) A is true but R is false (d) A is false and R is also false	(1)
16.	**Assertion (A):** Pure semiconductors have negative temperature coefficient of resistance. **Reason (R):** On increasing the temperature, more charge carriers are produced and hence resistance decreases. (a) Both A and R are true and R is the correct explanation (b) Both A and R are true but R is NOT the correct explanation of A (c) A is true but R is false (d) A is false and R is also false	(1)
	SECTION B	
17.	Using Huygen's principle, prove the laws of reflection.	(2)

18.	Derive the expression for electric field intensity $\vec{E}$ at a point on the equatorial line of an electric dipole**.**	(2)
19.	Two aluminium wires have their lengths in the ratio 2:3 and radii in the ratio 1:3. They are connected in parallel to a battery of emf E and negligible internal resistance. Find the ratio of their drift velocities.	(2)
	OR	
19.	In the given circuit in steady state find the potential difference across the capacitor and the charge stored in it.  	(2)
20.	Two wavelengths of sodium light of 590nm and 596nm are used in turn to study the diffraction taking place at a single slit of width 4mm. If the distance between the slit and the screen is 2m, calculate the separation between the positions of the first maxima of the diffraction pattern in the two cases.	(2)
21.	A bar magnet of dipole moment $3Am^2$ is suspended in a uniform magnetic field of 0.25T with the dipole moment vector making an angle of 30^0 with the field. Find i) net force on the magnet ii) torque on the magnet.	(2)
	SECTION C	
22.	Name the electromagnetic wave of wavelength range 10nm to 10^{-3}nm. How are they produced? Write their two uses.	(3)
23. a) b)	Write two characteristics of nuclear force. Draw a plot of the potential energy of a pair of nucleons as a function of their separation.	(3)
24.	Two long parallel straight wires are placed 12cm apart and carry currents of 3A each. Find the magnitude and direction of the magnetic field at a point midway between them if the currents in them flow in opposite directions. Also find the force per unit length on the wires.	(3)
25.	Hydrogen atom is in its third excited state. How many spectral lines can be emitted by it before coming to the ground state? Show the transitions in the energy level diagram. In which of the above transitions will spectral line of shortest wavelength be emitted?	(3)
26.	The focal lengths of the objective and eyepiece of a compound microscope are 1.25cm and 5cm respectively. Find the position of the object relative to the objective in order to obtain an angular magnification of 30 when the final image is formed at near point. Also find the distance between the lenses.	(3)
27.	Determine the electrostatic potential energy of a system consisting of two charges 7μC and –2μC (and with no external field) placed at (–9 cm, 0, 0) and (9 cm, 0, 0) respectively. a) How much work is required to separate the two charges infinitely away from each other? b) Suppose that the same system of charges is now placed in an external electric field $E = A (1/r^2)$; $A = 9 \times 10^5$ NC^{-1} m^2. What would the electrostatic energy of the configuration be?	(3)

28.	The figure shows the graphical variation of the reactance of a capacitor with frequency of ac source. a) Find the capacitance of the capacitor. b) An ideal inductor has the same reactance at 100 Hz frequency as the capacitor has at the same frequency. Find the value of inductance of the inductor. c) Draw the graph showing the variation of the reactance of this inductor with frequency.  	(3)
	OR	
28.	An ideal inductor of inductance $\frac{4}{\pi^2}$ H, a resistor of 100Ω and a capacitor of unknown capacitance are connected in series to an ac source of 200V, 50Hz. Calculate the capacitance and impedance when the voltage and current are in phase. Also find the power dissipated in the circuit.	(3)
	SECTION D	
29.	**<u>Kirchhoff's laws</u>** The following figure shows a circuit diagram. We can find the currents through and potential differences across different resistors using Kirchhoff's rules.  Answer the following questions based on the above: (a) Which points are at the same potential in the circuit? (b) What is the current through arm bg? (c) Find the potential difference across resistance R_3. **OR** (c) What is the power dissipated in resistance R_2 ?	(1) (1) (2) (2)
30.	**CASE STUDY – Photoelectric Effect** When ultraviolet light falls on certain metals like zinc, cadmium and magnesium etc. electron emission take place from the surface. Alkali metals emit electrons even with visible light. After the discovery of electrons in 1897, these electrons were termed as photoelectrons and the phenomenon is photoelectric effect.  	

	a) Alkali metals show photoelectric effect with visible light but Zn, Mg and Cd respond to uv light. Why? (i) Alkali metals have less threshold wavelength. (ii) Zn, Cd and Mg have greater threshold wavelength. (iii) Alkali metals have greater threshold frequency. (iv) Zn, Cd and Mg have greater threshold frequency.	(1)
	b) Maximum kinetic energy of the emitted photoelectrons is 5eV. What is its stopping potential?	(1)
	c) By how much would the stopping potential of a given photosensitive surface go up if the incident radiation is increased from $4x10^{15}$ Hz to $8x10^{15}$ Hz?	(2)
	OR	
	c) The threshold frequency for a given metal is f_0. If light of frequency $2f_0$ is incident on it, velocity of the emitted photoelectrons is v_1 and for frequency $5f_0$, velocity is v_2. Find ratio of velocities.	(2)
	SECTION E	
31.	a) Derive mirror formula for a convex mirror. b) Two objects P and Q when placed at different positions in front of a concave mirror of focal length 20 cm, form real images of equal size. Size of object P is three times size of object Q. If the distance of P is 50 cm from the mirror, find the distance of Q from the mirror.	(3) (2)
	OR	
31.	a) Two thin convex lenses are placed coaxially in contact. Obtain the expression for focal length of the combination in terms of the focal length of the two lenses. b) A converging lens of refractive index 1.5 has power of 10D. When it is immersed in a liquid it behaves as a diverging lens of focal length 50cm. Find the refractive index of the liquid.	(3) (2)
32.	a) With the help of a labelled diagram, explain the working of a step-down transformer. Give reasons for the following i) The core of the transformer is laminated ii) Thick copper wires are used in the windings	(3)
	b) A conducting rod PQ of length 20 cm and resistance 0·1 Ω rests on two smooth parallel rails of negligible resistance AA' and CC'. It can slide on the rails and the arrangement is positioned between the poles of a permanent magnet producing uniform magnetic field B = 0·4 T. The rails, the rod and the magnetic field are in three mutually perpendicular directions as shown in the figure. If the ends A and C of the rails are short circuited, find the (i) induced emf if the rod moves with uniform velocity v = 10 cm/s, and (ii) induced current.  	(2)
	OR	
32.	a) Draw a labelled diagram of an ac generator. Obtain the expression for induced emf.	(3)
	b) A horizontal straight wire 10 m long extending from east to west is falling with a speed of 5.0 m s^{-1}, at right angles to the horizontal component of the earth's magnetic field, 0.30×10^{-4} Wb m^{-2}. i) What is the instantaneous value of the emf induced in the wire? ii) Which end of the wire is at a higher potential?	(2)

33.	a) The ratio of the number density of free electrons to holes, (n_e/n_h), for three different materials A, B, C are equal to one, less than one and more than one respectively. Name the type of semiconductor and draw energy band diagrams for A, B & C.	(3)
	b) Find the current flowing through the 1Ω resistor, assuming the diodes are ideal. 	(2)
	OR	
33.	a) An ac signal is fed into two circuits X and Y and the corresponding output in the two cases have the waveforms shown below. Name the circuits X and Y. Also draw their circuit diagram. 	(3)
	b) If the frequency of the input signal is 50Hz, what will be the frequency of the output signal in X & Y.	(2)