SESSION : 2022-2023
SAMPLE QUESTION PAPER (THEORY)
SUBJECT: PHYSICS

Maximum Marks: 70 Marks | Time Allowed: 3 hours.

General Instructions:

(1) There are 35 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 eighteen MCQ of 1 mark each, Section B contains seven questions of two marks each, Section C contains five questions of three marks each, section D contains three long questions of five marks each and Section E contains two case study-based questions of 4 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.

5. Use of calculators is not allowed.

SECTION A

Q1. Photons of energies 1 eV and 2 eV are successively incident on a metallic surface of work function 0·5 eV. The ratio of kinetic energy of most energetic photoelectrons in the two cases will be 1

(A) 1 : 2

(B) 1 : 1

(C) 1 : 3

(D) 1 : 4

Q2. Which of the following statements is not correct according to Rutherford model ? 1

(A) Most of the space inside an atom is empty.

(B) The electrons revolve around the nucleus under the influence of coulomb force acting on them.

(C) Most part of the mass of the atom and its positive charge are concentrated at its centre.

(D) The stability of atom was established by the model.

Q3. The resolving power of a telescope can be increased by increasing 1

(A) wavelength of light.

(B) diameter of objective.

(C) length of the tube.

(D) focal length of eyepiece.

Q4. The magnetic dipole moment of a current carrying coil does not depend upon 1

(A) number of turns of the coil.

(B) cross-sectional area of the coil.

(C) current flowing in the coil.

(D) material of the turns of the coil.

Q5. For a glass prism, the angle of minimum deviation will be smallest for the light of 1

(A) red colour.

(B) blue colour.

(C) yellow colour.

(D) green colour.

Q6. A biconvex lens of glass having refractive index 1·47 is immersed in a liquid. It becomes invisible and behaves as a plane glass plate. The refractive index of the liquid is 1

(A) 1·47

(B) 1·62

(C) 1·33

(D) 1·51

Q7. The resistance of a metal wire increases with increasing temperature on account of 1

(A) decrease in free electron density.

(B) decrease in relaxation time.

(C) increase in mean free path.

(D) increase in the mass of electron.

Q8. An electric dipole placed in a non-uniform electric field can experience 1

(A) a force but not a torque.

(B) a torque but not a force.

(C) always a force and a torque.

(D) neither a force nor a torque

Q9. If the net electric flux through a closed surface is zero, then we can infer 1

(A) no net charge is enclosed by the surface.

(B) uniform electric field exists within the surface.

(C) electric potential varies from point to point inside the surface.

(D) charge is present inside the surface.

Q10. Kirchhoff 's first rule at a junction in an electrical network, deals with conservation of 1

(A) energy

(B) charge

(C) momentum

(D) both energy and charge

Q11. The magnetic field lines are traced in a certain region in which a diamagnetic substance is placed then

i) Magnetic field lines enhance with in the material.
ii) Magnetic field lines diminish with in the material.
iii) No effect on the strength of the magnetic field lines.
iv) Magnetic field lines decreses while entering and increses while exit.

Q12. A square of side L meters lies in the *x-y* plane in a region where the magnetic field is given by $B = B_0 (2\hat{i} + 3\hat{j} + 4\hat{k})$ Tesla, where B_0 is constant. The magnitude of flux passing through the square is

(A) $2B_0L^2$ Wb

(B) $3B_0L^2$ Wb

(C) $4B_0L^2$ Wb

D) $\sqrt{29}B_0L^2$ Wb

Q13. Huygens theory could not explain

(A) photoelectric effect.
(B) reflection of light.
(C) diffraction of light.
(D) interference of light.

Q14. In an n-type silicon, which of the following statement is true :

a) Electrons are majority carriers and trivalent atoms are the dopants.
b) Electrons are minority carriers and pentavalent atoms are the dopants.
c) Holes are minority carriers and pentavalent atoms are the dopants.
d) Holes are majority carriers and trivalent atoms are the dopants.

Q15. The wavelength of a photon needed to remove a proton from a nucleus which is bound to the nucleus with 1 MeV energy is nearly

(A) 1.2 nm

(B) 1.2×10^{-3} nm

(C) 1.2×10^{-6} nm

(D) 1.2×10 nm

a) If both assertion and reason are true and the reason is the correct explanation ofthe assertion.
b) If both assertion and reason are true but reason is not the correct explanation of the assertion.
c) If assertion is true but reason is false.
d) If the assertion and reason both are false.
e) If assertion is false but reason is true.

Q16 Assertion: It is not possible to use 35Cl as the fuel for fusion energy

Reason: The binding energy of 35Cl is too small.

Q17. Assertion: Photoelectric effect demonstrates the wave nature of light.

Reason. The number of photoelectrons is proportional to the frequency of light.

Q18.` Assertion (A): A Pure semiconductor has negative temperature coefficient of resistance.

Reason (R): On raising the temperature, more charge carriers are released, conductance increases and resistance decreases.

SECTION B

Q19. (i)Derive an expression for the force experienced by any one of the two parallel wires carrying current I_1 and I_2 separated by distance r.

(ii) Also mention the direction of force in each case.

Q20. Using Bohr's atomic model, derive the expression for the radius of n th orbit of the revolving electron in a hydrogen atom. 2

OR

The energy of the electron in the ground state of hydrogen atom is -13.6 eV.

i) What does the negative sign signify?

ii) How much energy is required to take an electron in this atom from the ground state to the first excited state?

Q21. Define wavefront of a travelling wave. Using Huygens principle, obtain the law of refraction at a plane interface when light passes from a rarer to a denser medium. 2

OR

Using lens maker's formula, derive the thin lens formula $\frac{1}{f} = \frac{i}{v} - \frac{1}{u}$ for a biconvex lens. 2

Q22. Explain the principle of working of a meter bridge. Draw the circuit diagram for determination of an unknown resistance using it. 2

Q23. Explain the terms 'depletion layer' and 'potential barrier' in a p-n junction diode. How are the

(a) width of depletion layer, and

(b) value of potential barrier affected when the p-n junction is forward biased? 2

Q24. N small conducting liquid droplets, each of radius r, are charged to a potential V each. These droplets coalesce to form a single large drop without any charge leakage. Find the potential of the large drop. 2

Q25. (a) Write two main observations of photoelectric effect experiment which could only be explained by Einstein's photoelectric equation.

(b) Draw a graph showing variation of photocurrent with the anode potential of a photocell. 2

SECTION C

Q26. A resistor R and an inductor L are connected in series to a source V = V0 sin ωt. Find the

(a) peak value of the voltage drops across R and across L,

(b) phase difference between the applied voltage and current.

Which of them is ahead? 3

Q27. . (a) Write the expression for the speed of light in a material medium of relative permittivity ε_r and relative magnetic permeability μ_r .

(b) Write the wavelength range and name of the electromagnetic waves which are used in

(i) radar systems for aircraft navigation, and

(ii) Earth satellites to observe the growth of the crops.

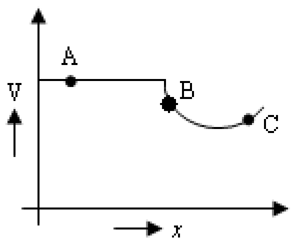
Q28. With the help of a simple diagram, explain the working of a silicon pn junction, giving all the basic processes involved. Draw its I-V characteristic.

Q29. The nucleus ${}_{92}Y^{235}$, initially at rest, decays into ${}_{90}X^{231}$ by emitting an α-particle

$${}_{92}Y^{235} \longrightarrow {}_{90}X^{231} + {}_{2}He^{4} + \text{energy.}$$

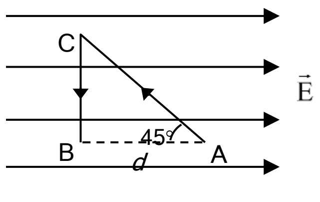
The binding energies per nucleon of the parent nucleus, the daughter nucleus and α-particle are 7·8 MeV, 7·835 MeV and 7·07 MeV, respectively. Assuming the daughter nucleus to be formed in the unexcited state and neglecting its share in the energy of the reaction, find the speed of the emitted α-particle. (Mass of α-particle = $6{\cdot}68 \times 10^{-27}$ kg)

Q30. The adjoining figure shows the variation of electrostatic potential V with distance '*x*' for a given charge distribution. From the points marked A, B and C, identify the point at which the electric field is : (*i*) Zero , (*ii*) Maximum. Explain your answer in each case.



OR

A test charge q_0 is moved without acceleration from point A to B along the path A→C→B as shown in figure. Calculate the potential difference between A and B.



SECTION D

Q31. (a) Derive the expression for the torque acting on the rectangular current carrying coil of a galvanometer. Why is the magnetic field made radial?

(b) An α-particle is accelerated through a potential difference of 10 kV and moves along x-axis. It enters in a region of uniform magnetic field B = 2×10^{-3} T acting along y-axis. Find the radius of its path. (Take mass of α-particle = $6{\cdot}4 \times 10^{-27}$ kg) 5

OR

(a) With the help of a labelled diagram, explain the working of a step-up transformer. Give reasons to explain the following:

(i) The core of the transformer is laminated.

(ii) Thick copper wire is used in windings.

b) A circular coil of radius 10 cm, 500 turns and resistance 2 Ω is placed with its plane perpendicular to the horizontal component of the earth's magnetic field. It is rotated about its vertical diameter through 180° in 0.25 s. Estimate the magnitudes of the emf and current induced in the coil. Horizontal component of the earth's magnetic field at the place is 3.0×10^{-5} T.

Q32. (a) Draw the ray diagram of an astronomical telescope when the final image is formed at infinity. Write the expression for the resolving power of the telescope.

(b) An astronomical telescope has an objective lens of focal length 20 m and eyepiece of focal length 1 cm. (i) Find the angular magnification of the telescope. (ii) If this telescope is used to view the Moon, find the diameter of the image formed by the objective lens. Given the diameter of the Moon is 3·5 × 106 m and radius of lunar orbit is 3·8 × 108 m. 5

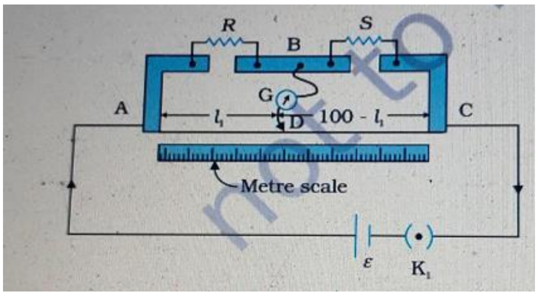
OR

(a) An object is placed in front of a concave mirror. It is observed that a virtual image is formed. Draw the ray diagram to show the image formation and hence derive the mirror equation v 1 u 1 f 1 = + .

(b) An object is placed 30 cm in front of a plano-convex lens with its spherical surface of radius of curvature 20 cm. If the refractive index of the material of the lens is 1·5, find the position and nature of the image formed.

Q33. (i) Derive the condition for balanced wheat stone bridge.

(ii) In a metre bridge the null point is found at a distance of 33.7 meters from point A. If now a resistance of 12Ω is connected in parallel with S the null point occurs at 51.9cm. Determine the values of R and S.



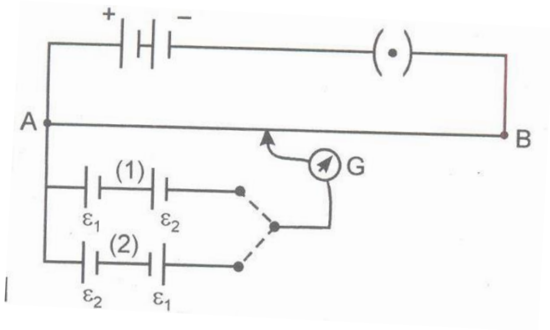
Or

i) State the principle of potentiometer. With the help of circuit diagram describe a method to find the internal resistance of primary cell.

ii) A circuit using a potentiometer and a battery of negligible internal resistance is set up as shown in figure below to develop a constant potential gradient along the wire AB. The 2 cells of emfs E_1 and E_2 are connected in series as shown in combinations (1) and (2). The balance points are obtained respectively at 400 cm and 240cm from the point A.

Find (i) E_1/E_2

ii) Balancing length for E_1 only.



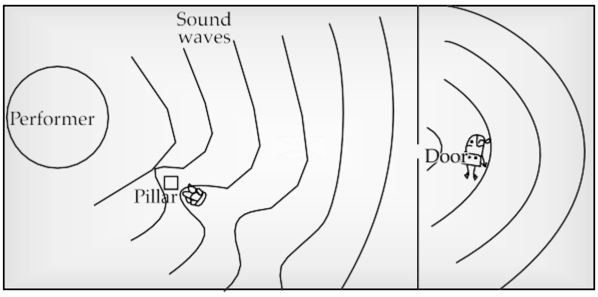
<u>SECTION E</u>

Q34. Diffraction in a hall:

A and B went to purchase a ticket of a music programmed. But unfortunately, only one ticket was left. They purchased the single ticket and decided that A would be in the hall during the 1st half and B during the 2nd half.

Both of them reached the hall together. A entered the hall and found that the seat was behind a pillar which creates an obstacle. He was disappointed. He thought that he would not be able to hear the program properly.

B was waiting outside the closed door. The door was not fully closed. There was a little opening. surprisingly, A could hear the music program. This happened due to diffraction of sound. The fact we hear sounds around corners and around barriers involves both diffraction and reflection of sound. Diffraction in such cases helps the sound to "bend around" the obstacles. In fact, diffraction is more pronounced with longer wavelengths implies that we can hear low frequencies around obstacles better than high frequencies. B was outside the door. He could also hear the programme. But he noticed that when the door opening is comparatively less he could hear the programme even being little away from the door. This is because when the width of the opening is larger than the wavelength of the wave passing through the gap then it does not spread out much on the other side. But when the opening is smaller than the wavelength more diffraction occurs and the waves spread out greatly – with semicircular wavefront. The opening in this case functions as a localized source of sound.



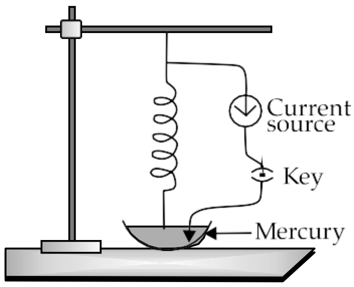
Q.1. How A and B could hear the music programme.

Q.2. Under what condition Diffraction of sound pronounced more.

Q.3. Give any two applications from daily life where concept of diffraction is used.

Q35. Roget's spiral:

Magnetic effects are generally smaller than electric effects. As a consequence, the force between currents is rather small, because of the smallness of the factor μ. Hence, it is difficult to demonstrate attraction or repulsion between currents. Thus, for 5 A current in each wire at a separation of 1 cm, the force per metre would be 5×10^{-4} N, which is about 50 mg weight. It would be like pulling a wire by a string going over a pulley to which a 50 mg weight is attached. The displacement of the wire would be quite unnoticeable. With the use of a soft spring, we can increase the effective length of the parallel current and by using mercury, we can make the displacement of even a few mm observable very dramatically. You will also need a constant-current supply giving a constant current of about 5 A. Take a soft spring whose natural period of oscillations is about 0.5–1 s. Hang it vertically and attach a pointed tip to its lower end, as shown in the figure here. Take some mercury in a dish and adjust the spring such that the tip is just above the mercury surface. Take the DC current source, connect one of its terminals to the upper end of the spring and dip the other terminal in mercury. If the tip of the spring touches mercury, the circuit is completed through mercury. Let the DC source be put off to begin with. Let the tip be adjusted so that it just touches the mercury surface. Switch on the constant current supply and watch the fascinating outcome. The spring shrinks with a jerk, the tip comes out of mercury (just by a mm or so), the circuit is broken, the current stops, the spring relaxes and tries to come back to its original position, the tip again touches mercury establishing a current in the circuit and the cycle continues with tick, tick, tick



Q1. Why the spring shrinks in Roget's spiral?

Q2. What are the main 3 components in a Roget's spiral?

Q3. What principal is lying behind Roget's spiral? What else can be used instead of mercury in Roget's spiral?