

General Instructions

- (i) This question paper contains 30 questions. All questions are compulsory.
- (ii) It comprises 6 single-correct multiple-choice questions.
- (iii) Attempt every question; detailed solutions are provided in the companion solutions booklet.

1. Two electrons in air are at a distance of 1 m. Gravitational and electrostatic forces acting between them are F_1 and F_2 respectively. If the dielectric constant of the medium between them becomes infinite, then:

- (A) F_1 remains unchanged and F_2 becomes halved.
- (B) F_1 remains unchanged but F_2 becomes zero.
- (C) $F_1 = 0$ and $F_2 = \infty$.
- (D) Both F_1 and F_2 will remain unchanged.

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2. In photoelectric emission, the value of the saturation current depends on:

- (A) the frequency of incident light.
- (B) the work function of the surface.
- (C) the intensity of incident light.
- (D) the anode potential.

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3. A narrow electron beam passes undeviated through an electric field of $4 \times 10^4 \text{ V/m}$ and a magnetic field $2 \times 10^{-3} \text{ weber/m}^2$ applied at the same place. The speed of the electron beam will be:

- (A) $2 \times 10^7 \text{ m/s}$
- (B) $8 \times 10^4 \text{ m/s}$
- (C) $6 \times 10^6 \text{ m/s}$
- (D) $6 \times 10^7 \text{ m/s}$

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4. Resistances of 10Ω and 15Ω are connected in parallel. The combination is connected with a battery of V volt. Choose the correct statement.

- (A) Value of current in the 10Ω resistance will be smaller than the current flowing in the 15Ω resistance.
- (B) Same current will flow in both the resistances.
- (C) Potential drop in both the resistances will be different.
- (D) Potential drop in both the resistances will be same.

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5. A convex and a concave lens are placed in contact. The focal lengths (F) of both are the same. The combination will behave:

- (A) as a concave lens.
- (B) as a convex lens.
- (C) as a planoconvex lens.
- (D) as a plane plate.

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6. The wavelength of the de-Broglie wave associated with a moving particle does not depend on:

- (A) mass
- (B) velocity
- (C) charge
- (D) momentum

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7. Write formula for the position of minima in the diffraction pattern of a single slit.

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8. Mainly on which factor does the stability of a nucleus depend?

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9. From which part of the atom are radioactive radiation emitted?

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10. State the result obtained from Rutherford's α -particle scattering.

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11. Define electromotive force of a cell.

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12. If electric field lines are mutually intersecting, then what is the meaning indicated?

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13. What is displacement current? How is displacement current different from conduction current?

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14. A non-conducting cylinder is placed inside the electric field (E). The axis of the cylinder is parallel to the electric field. How much will be the total electric flux passing through the cylinder?

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15. Assuming Earth as a spherical conductor of diameter 12,800 km, calculate its capacity.

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16. Write the formula relating the radius and mass number of a nucleus and show that nuclear density does not depend on the mass number.

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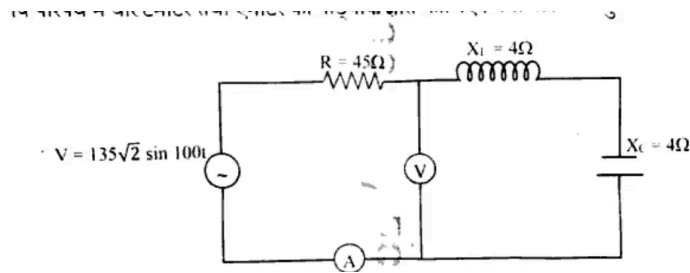
17. Give Einstein's equation for photoelectric emission. The work function of a metal is 4.2 eV. Electrons are emitted due to light of wavelength 2000 Å. Find the stopping potential for the emitted electrons.

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18. Give the postulates of Bohr's atomic model and draw the energy level diagram for the first three lines of the Balmer series in the hydrogen atomic spectrum.

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19.



Find the readings of the voltmeter and ammeter in the given AC circuit. Is the circuit in the state of resonance?

Given: $V = 135\sqrt{2} \sin 100t$ volt, $R = 45\Omega$, $X_L = 4\Omega$, $X_C = 4\Omega$. The voltmeter is connected across the series L-C combination and the ammeter is in series with the circuit.

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20. Find the formula for the work done in rotating a magnetic dipole in a uniform magnetic field through an angle θ . What will be the work done in rotating a magnetic dipole lying parallel to the magnetic field by an angle of 180° ?

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21. What are electromagnetic waves? An electromagnetic wave is moving in the X direction and the directions of its electric and magnetic fields are Y and Z respectively. Write the general equations for the electric and magnetic fields of the wave. How are electromagnetic waves different from sound waves?

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22. Explain the effect of biasing on the depletion region of a p-n junction. Using a p-n junction diode, draw the circuit diagram of a half-wave rectifier and show the shape of the input and output voltage.

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23. For any particle, its particle nature and wave nature can be observed simultaneously. Comment. Radiation of wavelength λ is incident on a surface of negligible work function. Find the de-Broglie wavelength of the emitted electron.

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24. Explain Kirchhoff's laws related to electrical circuits.

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25. Reflecting telescopes are supposed to be better than refracting telescopes. Why? Draw the ray diagram for image formation by a refracting telescope. Final image is formed at infinity.

OR

What is the meaning of polarisation of light? Whether sound waves are also polarized? Explain polarization of light by refraction.

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26. Potential difference at the ends of a conductor of length l is V . Diameter of the conductor is d . What will be the effect on the electric field inside the conductor and its resistance, if (i) V is halved? (ii) l is doubled? (iii) d is doubled?

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27. Derive the formula for energy loss on connecting two charged conductors through a conducting wire.

OR

Explain the meaning of polarization of a dielectric material. What will be the effect on the capacity of an air filled parallel plate capacitor on putting a dielectric material in between its plates? Equivalent capacity of two condensers in series is $7.5 \mu\text{F}$ and in parallel is $30 \mu\text{F}$. What will be the capacity of both the capacitors separately?

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28. Write Huygen's principle of secondary wavelets and verify laws of refraction on its basis.

OR

Explain the meaning of coherent sources and sustained interference. Why central fringe in Young's double slit experiment is always bright? In Young's double slit experiment, fringe width is 0.04 cm for light of $6000 \text{ \AA}$. Distance of screen from slits is 1 m . Find the distance of third bright and second dark fringe from central fringe and also the separation between the slits.

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29. Derive the formula for magnetic field due to an infinitely long current carrying conducting wire using Biot-Savart law.

OR

Differentiate between self-induction and mutual induction. The current in primary coil becomes zero in 10^{-3} s and an induced e.m.f. of 1500 volts is produced in secondary. Mutual inductance of coils is 0.5 H . Find the value of initial current in the primary.

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30. Explain the difference between conductor, insulator and semiconductor on the basis of energy band in solids.

OR

Define diamagnetic, paramagnetic and ferromagnetic materials. Explain that a current carrying solenoid behaves as a bar magnet.