

MODEL QUESTION PAPER-2 (2020-21)

PHYSICS (THEORY)

MM: 70 Marks

Time : 3 hours

General Instructions:

- (1) All questions are compulsory. There are 33 questions in all.
- (2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
- (3) Section A contains ten very short answer questions and four assertion reasoning MCQs of 1 mark each, Section B has two case based questions of 4 marks each, Section C contains nine short answer questions of 2 marks each, Section D contains five short answer questions of 3 marks each and Section E contains three long answer questions of 5 marks each.
- (4) There is no overall choice. However internal choice is provided. You have to attempt only one of the choices in such questions.

SECTION-A**All questions are compulsory. In case of internal choices, attempt any one of them.**

1. Write the necessary condition required for fusion reaction. [1]
2. Draw the pattern of electric field lines due to an electric dipole. [1]

OR

Define dielectric constant of a medium. What is its S.I. unit ?

3. What is the ratio of radii of the orbits corresponding to first excited state and ground state in a hydrogen atom? [1]
4. Name two factors on which electrical conductivity of a pure semiconductor at a given temperature depends. [1]
5. Two wires one of copper and other of manganin have same resistance and equal length. Which wire is thicker and why ? [1]

OR

Define the term 'relaxation time' in a conductor.

6. Explain why current flows through an ideal capacitor when it is connected to an a.c. source but not when it is connected to a d.c. source in a steady state. [1]
7. What is the magnitude of magnetic force per unit length on a wire carrying a current of 8 A and making an angle of 30° with the direction of a uniform magnetic field of 0.15 T? [1]
8. Must every magnetic configuration have a north pole and a south pole? What about the field due to a toroid? [1]
9. Name the electromagnetic radiations used for (a) water purification, and (b) eye surgery. [1]

OR

How are electromagnetic waves produced by accelerating charges?

10. Define the term 'wave front'. [1]

For question numbers 11, 12, 13 and 14, two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

- (a) Both A and R are true and R is the correct explanation of A
- (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

11. **Assertion(A)** : Critical angle is maximum for red colour in water air system for visible light. [1]
Reason(R) : Because $\sin\theta_c = \frac{1}{\mu}$, μ (Refractive index of red colour) is minimum for visible light.
12. **Assertion(A)** : Conductivity of a semiconductor increases on doping. [1]
Reason(R) : Doping raises the temperature of semiconductor.
13. **Assertion(A)** : Parallel plate capacitor is connected across battery through a key. A dielectric slab of constant K is induced between the plates. The energy which is stored becomes K times. [1]
Reason(R) : The surface density of charge on the plate remains constant or unchanged.
14. **Assertion(A)** : When wheatstone bridge is balanced the current through the cell depends on the resistance of galvanometer. [1]
Reason(R) : In a balanced condition current through the galvanometer is very high.

SECTION – B

Questions 15 and 16 are Case Study based questions and are compulsory. Attempt any 4 sub parts from each question. Each question carries 1 mark.

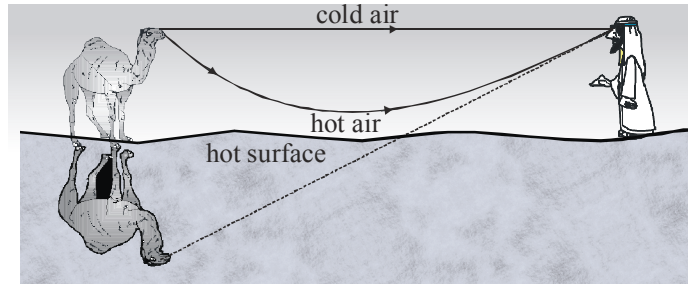
Faraday Cage:

15. A Faraday cage or Faraday shield is an enclosure made of a conducting material. The fields within a conductor cancel out with any external fields, so the electric field within the enclosure is zero. These Faraday cages act as big hollow conductors you can put things in to shield them from electrical fields. Any electrical shocks the cage receives, pass harmlessly around the outside of the cage. [4]



- (i) Which of the following material can be used to make a Faraday cage?
 (a) Plastic (b) Glass (c) Copper (d) Wood
- (ii) Example of a real-world Faraday cage is
 (a) car (b) plastic box (c) lightning rod (d) metal rod
- (iii) What is the electrical force inside a Faraday cage when it is struck by lightning?
 (a) The same as the lightning (b) Half that of the lightning
 (c) Zero (d) A quarter of the lightning
- (iv) An isolated point charge +q is placed inside the Faraday cage. Its surface must have charge equal to-
 (a) Zero (b) +q (c) -q (d) +2q
- (v) A point charge of 2C is placed at centre of Faraday cage in the shape of cube with surface of 9 cm edge. The number of electric field lines passing through the cube normally will be-
 (a) $1.9105 \text{ Nm}^2/\text{C}$ entering the surface (b) $1.9105 \text{ Nm}^2/\text{C}$ leaving the surface
 (c) $2.0105 \text{ Nm}^2/\text{C}$ leaving the surface (d) $2.0105 \text{ Nm}^2/\text{C}$ entering the surface

16. Mirage :



Mirage is caused due to total internal reflection in deserts and other hot regions where , refractive index of air near the surface of earth becomes lesser than that above it due to heating of the earth. Light from distant objects approach the surface of earth with successively increasing incident angle (i), till incident angle (i) > critical angle (θ_c) so that total internal reflection (TIR) takes place so that inverted images appear along with the objects as shown in figure. [4]

- (i) For the total internal reflection, which of the following statement is correct ?
 - (a) Light travels from denser to rarer medium.
 - (b) Light travels from rarer to denser medium.
 - (c) Light travels in air only.
 - (d) Light travels in water only.
- (ii) If the critical angles for TIR from a medium to vacuum is 30° , the velocity of light in the medium :-
 - (a) 3×10^8 m/s
 - (b) 0.5×10^8 m/s
 - (c) 1.5×10^8 m/s
 - (d) 0.2×10^8 m/s
- (iii) Critical angle of light passing from glass to air is minimum for
 - (a) red
 - (b) green
 - (c) yellow
 - (d) violet
- (iv) Mirage is phenomenon due to :-
 - (a) Reflection of light
 - (b) Refraction of light
 - (c) Total internal reflection of light
 - (d) Diffraction of light
- (v) If critical angle for a material to air is 30° the refractive index of the material will be?
 - (a) 1.0
 - (b) 1.5
 - (c) 2.0
 - (d) 2.5

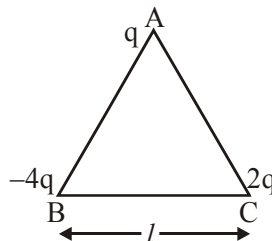
SECTION-C

All questions are compulsory. In case of internal choices, attempt anyone.

- 17. Find the ratio of the potential differences that must be applied across the series and parallel combination of two capacitors C_1 and C_2 with their capacitances in the ratio 1 : 2 so that the energy stored in the two cases becomes the same. [2]

OR

Three point charges q , $-4q$ and $2q$ are placed at the vertices of an equilateral triangle ABC of side ' l ' as shown in the figure. Obtain the expression for the magnitude of the resultant electric force acting on the charge q .



18. Define the following : [2]
(i) Root mean square value of A.C.
(ii) Quality factor in electrical resonance.
19. The number density of free electrons in a copper conductor estimated is $8.5 \times 10^{28} \text{ m}^{-3}$. How long does an electron take to drift from one end of a wire 3.0 m long to its other end? The area of cross-section of the wire is $2.0 \times 10^{-6} \text{ m}^2$ and it is carrying a current of 3.0 A. [2]
20. Explain briefly the process of emission of light by a Light Emitting Diode (LED) [2]
21. A long solenoid with 15 turns per cm has a small loop of area 2.0 cm^2 placed inside the solenoid normal to its axis. If the current carried by the solenoid changes steadily from 2.0 A to 4.0 A in 0.1 s, what is the induced emf in the loop while the current is changing ? [2]

OR

- (i) Define mutual inductance.
(ii) A pair of adjacent coils has a mutual inductance of 1.5 H. If the current in one coil changes from 0 to 20A in 0.5 s, what is the change of flux linkage with the other coil?
22. Draw the intensity pattern for single slit diffraction and double slit interference. Hence, state two differences between interference and diffraction patterns. [2]
23. What is the reason to operate photodiode in reverse bias?
A p-n photodiode is fabricated from a semiconductor with a band gap of range of 2.5 to 2.8 eV. Calculate the range of wavelengths of the radiation which can be detected by the photodiode. [2]
24. The focal lengths of an objective lens and eyepiece are 192 cm and 8 cm respectively in a small telescope. Calculate its magnifying power and the separation between the two lenses. [2]
25. In the magnetic meridian of a certain place, the horizontal component of the earth's magnetic field is 0.26G and the dip angle is 60° . What is the magnetic field of the earth at this location? [2]

OR

Name the elements of the earth's magnetic field. Define any two of them.

SECTION -D

All questions are compulsory. In case of internal choices, attempt any one.

26. Two identical cells of emf 1.5 V each joined in parallel to supply energy to an external circuit consisting of two resistances of 7Ω each joined in parallel. A very high resistance voltmeter reads the terminal voltage of cells to be 1.4 V. Calculate the internal resistance of each cell. [3]

OR

A storage battery of emf 8.0 V and internal resistance 0.5Ω is being charged by a 120 V dc supply using a series resistor of 15.5Ω . What is the terminal voltage of the battery during charging? What is the purpose of having a series resistor in the charging circuit?

27. What is the effect on the interference fringes in Young's double slit experiment due to each of the following operations ? Justify your answer. [3]
(a) The screen is moved away from the plane of the slits.
(b) The separation between slits is increased.
(c) The source slit is moved closer to the plane of double slit.

28. State two important properties of photon which are used to write Einstein's photoelectric equation. Define (i) stopping potential and (ii) threshold frequency, using Einstein's equation and drawing necessary plot between relevant quantities. [3]

OR

Define the term 'cut off frequency' in photoelectric emission. The threshold frequency of a metal is f . When the light of frequency $2f$ is incident on the metal plate, the maximum velocity of photo-electrons is v_1 . When the frequency of the incident radiation is increased to $5f$, the maximum velocity of photo-electrons is v_2 . Find the ratio $v_1 : v_2$.

29. Given the value of the ground state energy of hydrogen atom as -13.6 eV, find out its kinetic and potential energy in the ground and second excited states. [3]
30. Differentiate between nuclear fission & fusion. Give an example of each. Which of the above reactions take place in nuclear reactor? [3]

OR

From the relation $R = R_0 A^{1/3}$, where R_0 is a constant and A is the mass number of a nucleus, shows that the nuclear matter density is nearly constant. (i.e. independent of A).

SECTION – E

All questions are compulsory. In case of internal choices, attempt any one.

31. (a) Write an expression of magnetic moment associated with a current (I) carrying circular coil of radius r having N turns. [5]
- (b) Consider the above mentioned coil placed in YZ plane with its centre at the origin. Derive expression for the value of magnetic field due to it at point $(x, 0, 0)$.
- OR
- (a) Define current sensitivity of a galvanometer. Write its expression.
- (b) A galvanometer has resistances G and shows full scale deflection for current I_g .
- (i) How can it be converted into an ammeter to measure current up to I_0 ($I_0 > I_g$)?
- (ii) What is the effective resistance of this ammeter?
32. (i) Draw a labelled diagram of a step-down transformer. State the principle of its working.
- (ii) Express the turn ratio in terms of voltages.
- (iii) Find the ratio of primary and secondary currents in terms of turn ratio in an ideal transformer.
- (iv) How much current is drawn by the primary of a transformer connected to 220 V supply when it delivers power to a 110 V – 550 W refrigerator? [5]

OR

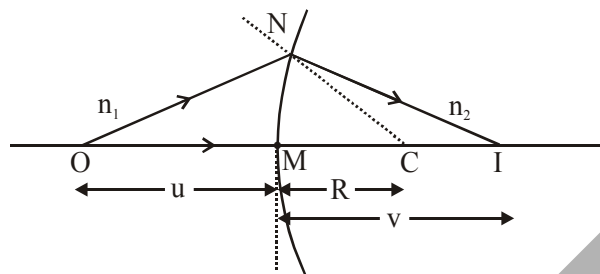
A $2 \mu\text{F}$ capacitor, 100Ω resistor and 8 H inductor are connected in series with an AC source.

- (i) What should be the frequency of the source such that current drawn in the circuit is maximum, What is this frequency called?
- (ii) If the peak value of e.m.f. of the source is 200 V, find the maximum current.
- (iii) Draw a graph showing variation of amplitude of circuit current with changing frequency of applied voltage in a series LCR circuit for two different values of resistance R_1 and R_2 ($R_1 > R_2$).

33. A point object O on the principal axis of a spherical surface of radius of curvature R separating two media of refractive indices n_1 and n_2 forms an image 'I' as shown in the figure. [5]

Prove that

$$\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$$



OR

- (a) Derive the relation $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$

Where f_1 and f_2 are focal lengths of two thin lenses and f is the focal length of the combination in contact.

- (b) Draw the ray diagram of an compound microscope, when the final image is formed at the least distance of distinct vision. Write the formula for magnifying power in the above noted case.

