COMMON PRE-BOARD EXAMINATION 2022-23

Subject: PHYSICS (042)

Date:

General Instructions:

a) There are 35 questions in all. All questions are compulsory.
b) This question paper has five sections: Section A, Section B, Section C, Section D and Section E. All the sections are compulsory.
c) 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.
d) 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.
e) Use of calculators is not allowed.
f) You may use the following values of physical constants where ever necessary.

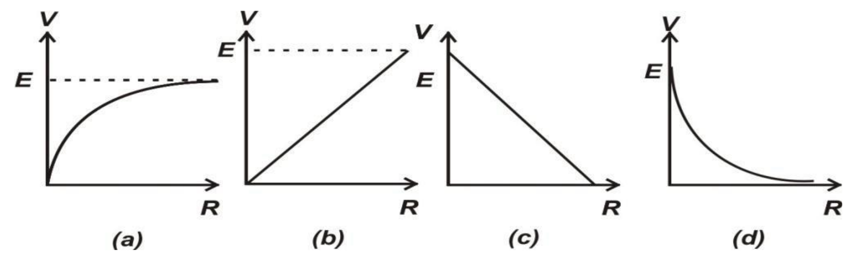
$c=3\times10^{8}$ m/s
$h=6.63\times10^{-34}$ Js
$e=1.6\times10^{-19}$ C
$\mu_0=4\pi\times10^{-7}$ TmA^{-1}
$\varepsilon_0=8.85\times10^{-12}$ $C^2N^{-1}m^{-2}$
$1/4\pi\varepsilon_0=9\times10^{9}Nm^2C^{-2}$
$m_e=9.1\times10^{-31}$kg
mass of neutron$=1.675\times10^{-27}$kg
mass of proton$=1.673\times10^{-27}$kg

SECTION A

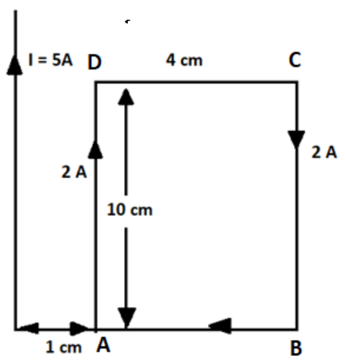
1. Which of the following statement is true for Gauss law? **1**

(a) All the charges whether inside or outside the Gaussian surface contribute to the electric flux.
(b) Electric flux depends upon the geometry of the Gaussian surface.
(c) Gauss theorem can be applied to non-uniform electric field.
(d) The electric field over the Gaussian surface remains continuous and uniform at every point.

2.	Three charges 2q, -q and -q are located at the vertices of an equilateral triangle. The values of E and V at the centroid of the triangle will be - (a) E=0, V≠0 (b) E≠0, V=0 (c) E=0, V=0 (d) E≠0, V≠0	**1**
3.	A cell of emf 'E' and internal resistance 'r' is connected across an external resistor 'R'. The graph which gives the terminal voltage of the cell 'V' with respect to 'R' is –	**1**



4.	A rectangular loop ABCD is placed near an infinitely long current carrying wire. The magnetic force on loop is	**1**



(a) 2.5×10^{-5} N towards the wire of infinite length
(b) 1.6×10^{-5} N towards the wire of infinite length
(c) 1.6×10^{-5} N away from wire of infinite length1
(d) 2.5×10^{-5} N away from the wire of infinite length

5.	Current sensitivity of a galvanometer can be increased by decreasing – (a) magnetic field B (b) number of turns N (c) torsional constant K (d) area A	**1**

6. A ferromagnetic material is heated above its curie temperature. Which among the following is a correct statement? **1**

(a) Ferromagnetic domains are not influenced.
(b) Ferromagnetic domains are perfectly arranged.
(c) Ferromagnetic domains become random.
(d) Ferromagnetic material changes into diamagnetic material.

7. Same current is flowing in two alternating circuits. The first circuit contains only inductance and the other contains only a capacitor. If the frequency of the ac source is increased, then the current **1**

(a) increases in the first circuit and decreases in the other
(b) increases in both the circuits
(c) decreases in both the circuits
(d) decreases in the first circuit and increases in the other

8. If 'ε_0' and 'μ_0' are the electric permittivity and magnetic permeability of free space and 'ε' and 'μ' are the corresponding quantities in the medium, then the refractive index of the medium is **1**

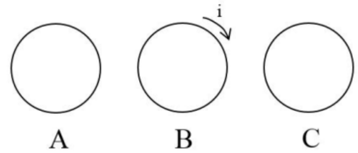
(a) $\frac{\varepsilon\mu}{\varepsilon_0\mu_0}$

(b) $\left(\frac{\varepsilon\mu}{\varepsilon_0\mu_0}\right)^{1/2}$

(c) $\frac{\varepsilon_0\mu_0}{\varepsilon\mu}$

(d) $\left(\frac{\varepsilon_0\mu_0}{\varepsilon\mu}\right)^{1/2}$

9. Three conducting loops are situated side-by-side in the plane of the page. If a clockwise current flows in the center loop and its magnitude is decreasing in time, then the induced current in loops A and C are **1**

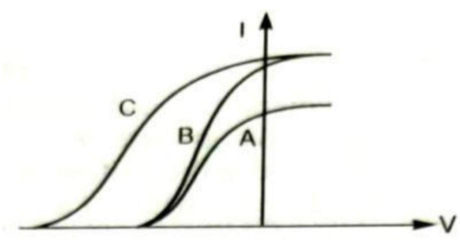


(a) zero
(b) clockwise in A, anticlockwise in C
(c) anticlockwise
(d) clockwise

10. A screen is placed 50 cm from a single slit, which is illuminated with 6000Å light. If the distance between the first and third minima in the diffraction pattern is 3.00mm, what is the width of the slit? **1**

(a) 200µm
(b) 300µm
(c) 250µm
(d) 350µm

11. In a photoelectric experiment, anode potential is plotted against photocurrent. Identify the curves corresponding to same intensities but different frequencies. **1**



(a) A and B
(b) B and C
(c) A and C
(d) A, B and C

12. The ratio of minimum to maximum wavelength in Balmer series is **1**
(a) 5: 9
(b) 5: 36
(c) 1: 4
(d) 3: 4

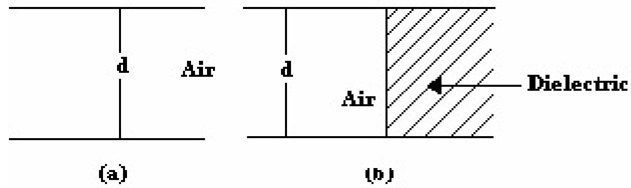
13. What is the ratio of nuclear radii if the mass numbers of two nuclei are 4 and 32? **1**

(a) 1:1
(b) 1:2
(c) 1:8
(d) 1:4

14. In a series LCR circuit, R= 100 Ω, X_L= 300 Ω and Xc= 200 Ω. The phase difference between the applied voltage and current will be: **1**

(a) 0^0
(b) 37^0
(c) 45^0
(d) 90^0

15. A parallel plate air filled capacitor shown in Fig. (a) has a capacitance of 10µF. When it is half filled with a dielectric medium of dielectric constant K=2 as shown in Fig. (b), its capacitance becomes **1**



(a) 15µF
(b) 10µF
(c) 25µF
(d) 20µF

16. **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.** **1**

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

ASSERTION(A): Semiconductors are solids with conductivities in the intermediate range from 10^{-6} to 10^{4} ohm^{-1} m^{-1}.

REASON (R): Intermediate conductivity in semiconductor Is due to partially filled valence band.

17. **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.** **1**

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(c) A is true but R is false
(d) A is false and R is also false

ASSERTION(A): In Young's double slit experiment, the fringes become indistinct if one of the slits is covered with cellophane paper.

REASON (R): The cellophane paper decreases the wavelength of light.

18. **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.** **1**

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ASSERTION(A): The de Broglie wavelength of a molecule varies inversely as the square root of temperature.

REASON (R): The root mean square velocity of the molecule depends on the temperature.

SECTION B

19. Identify the electromagnetic waves whose wavelengths vary as: **2**

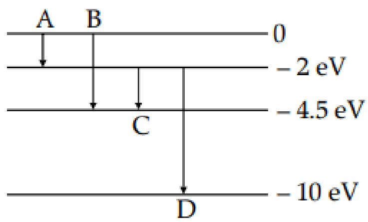
(a) 10^{-12} m < λ < 10^{-8} m

(b) 10^{-3} m < λ < 10^{-1} m

Write one use for each.

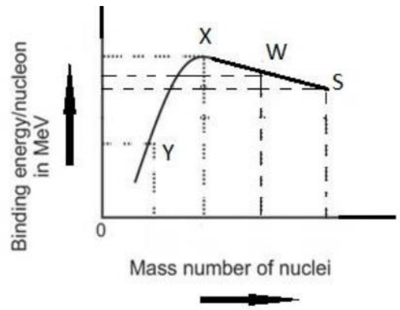
20. Define 'intensity of magnetization' of a magnetic material. How does it vary with temperature for a paramagnetic material? **2**

21. The energy levels of a hypothetical atom are given below. Which of the shown transitions will result in the emission of photon of wavelength 275 nm? **2**



OR

Binding energy per nucleon versus mass number curve is as shown. ${}^{A}_{Z}S, {}^{A1}_{Z1}W, {}^{A2}_{Z2}X$ and ${}^{A3}_{Z3}Y$ are four nuclei indicated on the curve.



Based on the graph:
(a)Arrange X, W and S in the increasing order of stability.
(b) Explain why binding energy for heavy nuclei is low.

22. A luminescent object is placed at a depth ‘d’ in a optically denser medium of refractive index ‘μ’. Prove that radius ‘r’, of the base of the cone of light, from the object, that can emerge out from the surface, is **2**

$$r = \frac{d}{\sqrt{\mu^2 - 1}}$$

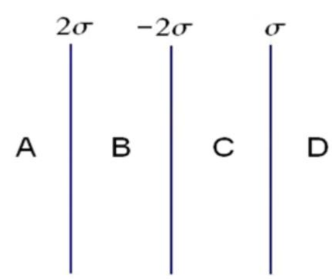
23. Draw the energy band diagram when intrinsic semiconductor (Ge) is doped with impurity atoms of Antimony (Sb). Name the extrinsic semiconductor so obtained and the majority charge carriers in it. **2**

OR

Draw the circuit diagram of a full wave rectifier and suggest an idea to convert it into a half wave rectifier by changing the connecting wire/s with suitable justification.

24. Two slits are made 1mm apart and the screen is placed 1m away. What should be the width of each slit to obtain 10 maxima of the double slit pattern within the central maximum of the single slit pattern when blue-green light of wavelength 500nm is used? **2**

25. In the figure there are three infinite long thin sheets having surface charge density +2σ, -2σ and +σ respectively. Give the magnitude and direction of electric field at a point to the left of sheet of charge density +2σ and to the right of sheet of charge density +σ. **2**



SECTION C

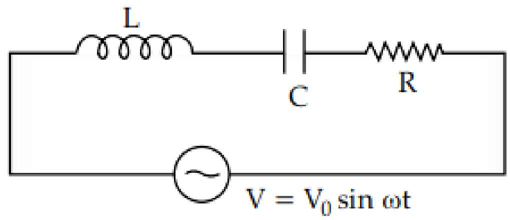
26. Using Biot-Savart’s law, derive the expression for magnetic field at a point along the axis of a current carrying circular loop of radius R. **3**

27. A square loop of side 10 cm and resistance 0.5 Ω is placed vertically in the east-west plane. A uniform magnetic field of 0.10 T is set up across the plane in the north-east direction. The magnetic field is decreased to zero in 0.70 s at a steady rate. Determine the magnitudes of induced emf and current during this time-interval. **3**

28. A device X is connected across an ac source of voltage $V = V_0 \sin \omega t$. The current through it is given as $I = I_0 \sin (\omega t+\pi/2)$. Identify the device X and obtain the expression for the average power in one complete cycle? **3**

OR

The current, in the LCR circuit shown in the figure is observed to lead the voltage in phase. Without making any other change in the circuit, a capacitor, of capacitance C_0, is (appropriately) joined to the capacitor C. This results in making the current, in the 'modified' circuit, flow in phase with the applied voltage. Draw a diagram of the 'modified' circuit and obtain an expression for C_0 in terms of ω, L and C.



29. (a) Define the term 'intensity' of radiation in photon picture. **3**

(b) Light of wavelength 2000Å, falls on a metal surface of work function 4.2eV. What is the kinetic energy (in eV) of the (i) fastest and (ii) slowest photoelectrons emitted from the surface?

OR

(i) Define the term 'cut off frequency' in photoelectric emission.

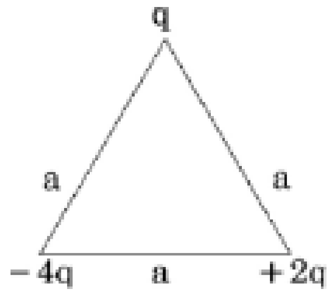
(ii) The threshold frequency of a metal is f. When the light of frequency 2f is incident on the metal plate, the maximum velocity of photo-electrons is v_1. When the frequency of the incident radiation is increased to 5f, the maximum velocity of photo-electrons is v_2. Find the ratio $v_1 : v_2$.

30. The ground state energy of hydrogen atom is -13.6 eV. The photon emitted during the transition of electron from n=3 to n=1 state, is incident on a photosensitive material of unknown work function. The photoelectrons are emitted from the material with the maximum kinetic energy of 9eV. Calculate the threshold wavelength of the material used. **3**

<u>SECTION D</u>

31. (a) Explain why, for any charge configuration, the equipotential surface through a point is normal to the electric field at that point. Draw a sketch of equipotential surfaces due to a single charge (– q), depicting the electric field lines due to the charge. **5**

(b) Obtain an expression for the work done to dissociate the system of three charges placed at the vertices of an equilateral triangle of side 'a' as shown below.



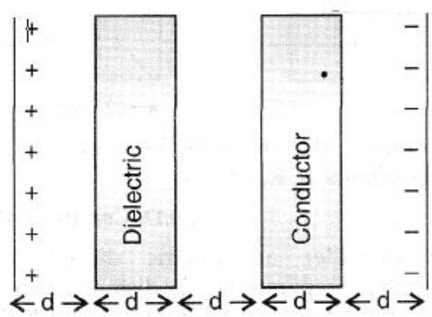
OR

(i) Compare the individual dipole moment and the specimen dipole moment for H_2O molecule and O_2 molecule when placed in

(a) absence of external electric field

(b) presence of external electric field. Justify your answer.

(ii) Given two parallel conducting plates of area 'A' and charge densities $+\sigma$ and $-\sigma$. A dielectric slab of constant K and a conducting slab of thickness 'd' each are inserted in between them as shown.

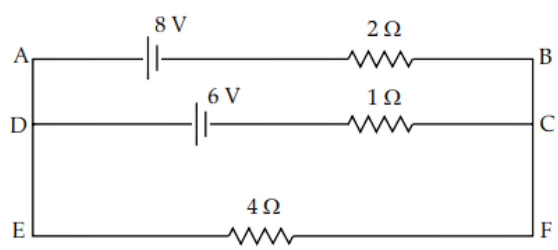


(a) Find the potential difference between the plates.

(b) Plot E versus x graph, taking x = 0 at positive plate and x = 5d at negative plate.

32. (a) State Kirchhoff's laws. **5**

(b) Calculate the potential difference across the 4 Ω resistor in the given electrical circuit, using Kirchhoff's rules.



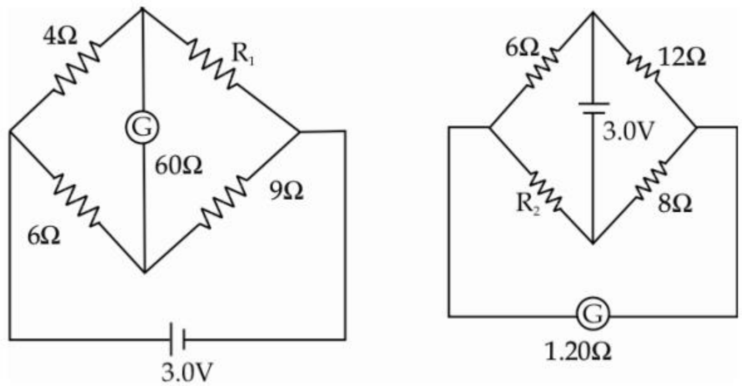
OR

(i) Write the nature of the path of free electrons in a conductor in the (a) presence of electric field (b) absence of electric field.

(ii) Between two successive collisions each free electron acquires a velocity from zero to 'v' where $v=eE\tau/m$. What is the average velocity of a free electron in the presence of an electric field? Do all electrons have the same average velocity?

(iii) How does this average velocity of the free electrons, in the presence of an electric field, vary with temperature?

(iv) The galvanometer, in each of the two given circuits, does not show any deflection. Find the ratio of the resistors R_1 and R_2, used in these two circuits.



33. (a) State Huygens principle in wave-optics. How did Huygens explain the absence of the back wave? **5**

(b) Use this principle to draw the refracted wave front for a plane wave incident from a denser to a rarer medium. Hence obtain Snell's law of refraction.

OR

(i) Draw a ray diagram of an astronomical telescope for the final image formed at infinity?

(ii) An astronomical telescope has an angular magnification of magnitude 5 for distant objects. The separation between the objective and an eye piece is 36 cm and the final image is formed at infinity. Calculate the focal length of the objective and the focal length of the eye piece?

SECTION E

34. **Case based question- Lens maker's formula:** **4**

Read the following paragraph and answer the questions:

The lens maker's formula relates the focal length of a lens to the refractive index of the lens material and the radii of curvature of its two surfaces. This formula is called so because it is used by manufacturers to design lenses of required focal length from a glass of given refractive index. If the object is placed at infinity, the image will be formed at focus for both double convex lens and double concave lens.

(a) A magician during a show makes a glass lens with n = 1.47 disappear in a trough of liquid. What is the refractive index of the liquid?

(b) How does power of a convex lens vary if the incident red light is replaced by violet light?

(c) Double-convex lenses are to be manufactured from a glass of refractive index 1.55, with both faces of the same radius of curvature. What is the radius of curvature required if the focal length is to be 20cm?

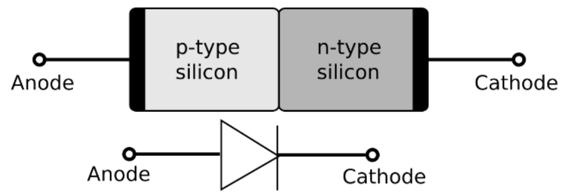
OR

(c) The radii of curvature of the faces of a double convex lens are 10 cm and 15 cm. Its focal length is 12 cm. What is the refractive index of glass?

35. **Case based question- Semiconductor Diode:** **4**

Read the following paragraph and answer the questions:

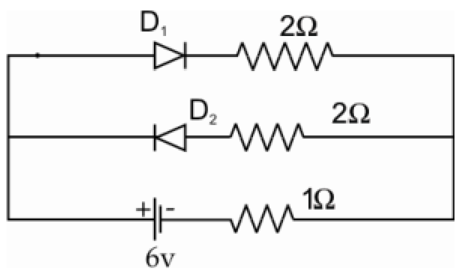
A semiconductor diode is basically a p-n junction with metallic contacts provided at the ends for the application of an external voltage. It is a two terminal device. A p-n junction diode is symbolically represented as shown in figure. The equilibrium barrier potential can be altered by applying an external voltage V across the diode.



(a) Explain how the width of depletion layer in a p-n junction change when the junction is (i) forward biased (ii) reverse biased.

(b) Name the important processes that occurs during the formation of a p-n junction.

(c) For the circuit shown here, find the current flowing through the 1Ω resistor. Assume that the two diodes, D1 and D2, are ideal diodes.



OR

(c) In the following diagram, which bulb out of B1 and B2 will glow and why?