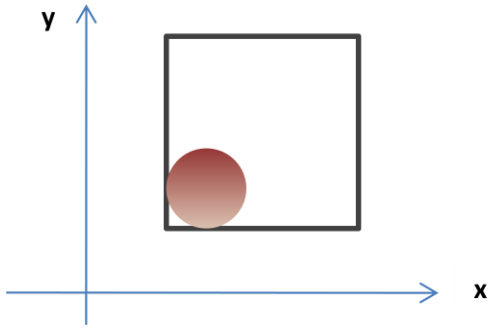
IIT JEE 2009 Test Series 4
PHYSICS PART-II

SECTION I
STRAIGHT OBJECTIVE TYPE

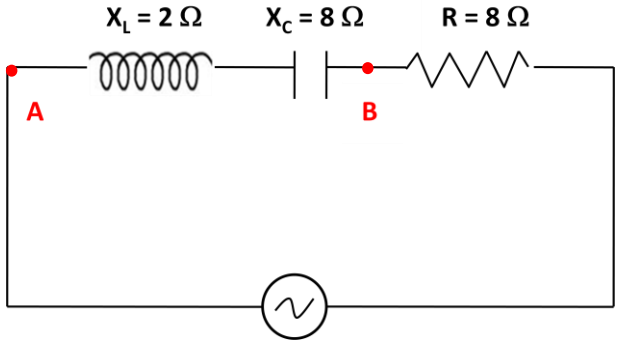
This section contains 9 multiple choice questions. Each question has four choices (a), (b), (c) and (d), out of which ONLY ONE is correct. 3 MARKS will be awarded for correct answer. 1 MARK will be deducted for wrong answer.

1. A solid sphere of mass 2 kg is resting inside a cube as shown in figure. The cube is moving with a velocity $\vec{v} = (5t\hat{i} + 2t\hat{j})$ m/s, where t is the time in seconds. All the surfaces are smooth. The sphere is at rest with respect to cube. Take g = 10 m/s^2. The total force exerted by the sphere on the cube is
   (a) $(10\hat{i} + 12\hat{j})$ N
   (b) $(-5\hat{i} + 12\hat{j})$ N
   (c) $(20\hat{i} - 24\hat{j})$ N
   (d) $(10\hat{i} + 24\hat{j})$ N

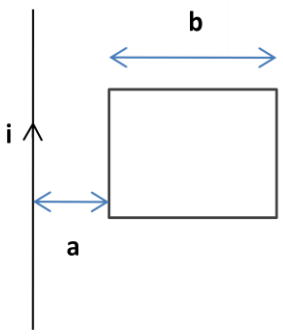


2. Light corresponding to the transition n = 4 to n = 2 in hydrogen atoms falls on cesium metal (work function 1.9 eV). The maximum kinetic energy of the photoelectron emitted
   (a) 2.55 eV
   (b) 1.9 eV
   (c) 1.0 eV
   (d) 0.65 eV

3. An inductor (X_L = 2 Ω), a capacitor (X_C = 8 Ω), and a resistance (8 Ω), are connected in series with an ac source. The voltage output of ac source is given by V = 10 cos 2π50t. The instantaneous potential difference between A and B, when it is half of the voltage output from source at that instant will be
   (a) 24/7 V
   (b) 24/5 V
   (c) 7/24 V
   (d) 5/24 V



4. The mutual inductance in given figure is
   (a) zero
   (b) $\frac{\mu_0 a}{2\pi}\ln\frac{b}{a}$
   (c) $\frac{\mu_0 a}{2\pi}\ln\left(1+\frac{a}{b}\right)$
   (d) $\frac{\mu_0 a}{2\pi}\ln\left(1+\frac{b}{a}\right)$



5. An insulated box containing a monatomic gas of molar mass M moving with a speed v_0 is suddenly stopped. Then, the increment in gas temperature as a result of stopping the box is

(a) $\frac{mv_0^2}{R}$

(b) $\frac{mv_0^2}{2R}$

(c) $\frac{mv_0^2}{3R}$

(d) zero

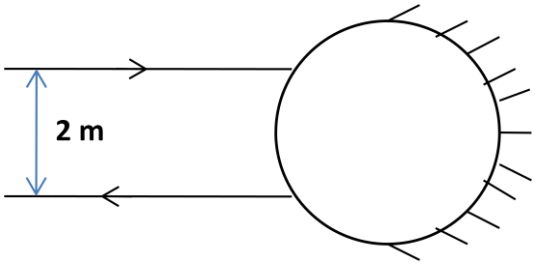
6. A transparent cylinder of radius R = 2.00 m has a mirrored surface on its right half as shown in figure. A light ray travelling in air is incident on the left side of the cylinder. The incident ray and the exiting ray are parallel and at a distance 2.00 m. Then, the refractive index of the material is

(a) 1.414

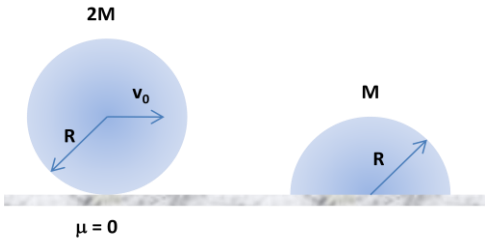
(b) 1.732

(c) 1.932

(d) 2



7. A hemisphere of mass M and radius R is at rest. One solid sphere of mass 2M and radius R , moving with a velocity v_0 , collides with the hemisphere. If e is the coefficient of restitution, then the speed of the hemisphere just after the collision is



(a) $(1+e)\frac{2v_0}{3}$

(b) $(1-e)\frac{2v_0}{3}$

(c) $(2+e)\frac{v_0}{3}$

(d) $(2-e)\frac{v_0}{3}$

8. A neutron travelling with a velocity v and kinetic energy E collides perfectly elastically head on with the nucleus of an atom of mass number A at rest. The fraction of the total energy retained by the neutron is

(a) $\left(\frac{A-1}{A}\right)^2$

(b) $\left(\frac{A+1}{A}\right)^2$

(c) $\left(\frac{A-1}{A+1}\right)^2$

(d) $\left(\frac{A+1}{A-1}\right)^2$

9. A transparent paper (refractive index = 1.45) of thickness 0.02 mm is pasted on one of the slits of a Young's double slit experiment which uses monochromatic light of wavelength 620 nm. How many fringes will cross through the centre if the paper is removed?

(a) zero
(b) 12.5
(c) 13.5
(d) 14.5

SECTION II
ASSERTION-REASON TYPE

This question contains 4 reasoning type questions. Each question has 4 choices (a), (b), (c) and (d), out of which ONLY ONE is correct. 3 MARKS will be awarded for correct answer. 1 MARK will be deducted for wrong answer. NO MARKS WILL BE GIVEN OR DEDUCTED IF A QUESTION IS NOT ANSWERED.

10. STATEMENT-1: A body having pure translation motion has zero net torque about its centre of mass
    STATEMENT-2: Torque of normal force about the centre of mass is zero.
    (a) STATEMENT-1 is True, STATEMENT-2 is true; STATEMENT-2 is a correct explanation for STATEMENT 1
    (b) STATEMENT-1 is True, STATEMENT-2 is true; STATEMENT-2 is NOT a correct explanation for STATEMENT-1
    (c) STATEMENT-1 is True, STATEMENT-2 is False
    (d) STATEMENT-1 is False, STATEMENT-2 is true

11. STATEMENT-1: During an isothermal process heat can't be transferred between system and surrounding.
    STATEMENT-2: An isothermal process can be achieved by immersing the system in a large reservoir and performing the process very slowly. The temperature of the system then remains equal to the temperature of the reservoir.
    (a) STATEMENT-1 is True, STATEMENT-2 is true; STATEMENT-2 is a correct explanation for STATEMENT 1
    (b) STATEMENT-1 is True, STATEMENT-2 is true; STATEMENT-2 is NOT a correct explanation for STATEMENT-1
    (c) STATEMENT-1 is True, STATEMENT-2 is False
    (d) STATEMENT-1 is False, STATEMENT-2 is true

12. STATEMENT-1: When a capacitor is connected to a battery half the energy of the battery is used in charging.
    STATEMENT-2: Half the energy of the battery is lost as heat while charging the battery.
    (a) STATEMENT-1 is True, STATEMENT-2 is true; STATEMENT-2 is a correct explanation for STATEMENT 1
    (b) STATEMENT-1 is True, STATEMENT-2 is true; STATEMENT-2 is NOT a correct explanation for STATEMENT-1
    (c) STATEMENT-1 is True, STATEMENT-2 is False
    (d) STATEMENT-1 is False, STATEMENT-2 is true

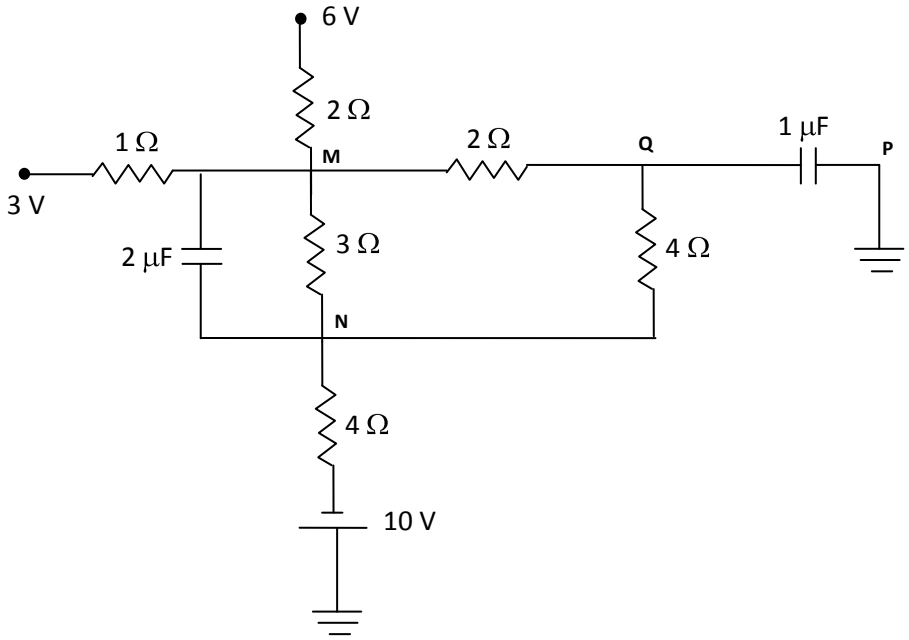
13. STATEMENT-1: When no electric field exists in a conductor, current is zero.
    STATEMENT-2: Drift velocity depends on random motion of free electrons.
    (a) STATEMENT-1 is True, STATEMENT-2 is true; STATEMENT-2 is a correct explanation for STATEMENT 1
    (b) STATEMENT-1 is True, STATEMENT-2 is true; STATEMENT-2 is NOT a correct explanation for STATEMENT-1
    (c) STATEMENT-1 is True, STATEMENT-2 is False
    (d) STATEMENT-1 is False, STATEMENT-2 is true

SECTION III
LINKED COMPREHENSION TYPE

This section contains 2 paragraphs. Based upon each paragraph, 3 multiple choice questions have to be answered. Each question has four choices (a), (b), (c) and (d), out of which ONLY ONE is correct. 4 MARKS will be awarded for correct answer. 1 MARK will be deducted for wrong answer. NO MARKS WILL BE GIVEN OR DEDUCTED IF A QUESTION IS NOT ANSWERED.

Paragraph for Questions numbers 14 to 16

Figure shows as network of capacitors and resistances. Potential of some of the points are given. Assume steady state conditions. Then,



14. Potential of point M is
    (a) zero
    (b) 1.6 V
    (c) 2.6 V
    (d) 3.6 V

15. Potential of point N is
    (a) Zero
    (b) – 1.6 V
    (c) – 2.6 V
    (d) – 3.6 V

16. The charge stored in both the capacitors in steady state
    (a) Charge on 1 μF = zero ; Charge on 2 μF = zero
    (b) Charge on 1 μF = 1.2 μC ; Charge on 2 μF = 4.8 μC
    (c) Charge on 1 μF = 1.2 μC ; Charge on 2 μF = 8.4 μC
    (d) Charge on 1 μF = 4.8 μC ; Charge on 2 μF = 8.4 μC

Paragraph for Questions numbers 17 to 19

Two metallic plates A and B, each of area $5 \times 10^{-4}\ m^2$, are placed parallel to each other at a separation of 1 cm. Plate B carries a positive chare of 33.7×10^{-12} C. A monochromatic beam of light, with photons of energy 5 eV each, starts falling on plate A at t = 0 so that 10^6 photons fall on it per square metre per second. Assume that one photoelectron is emitted for every 10^6 incident photons. Also assume that all the emitted photoelectrons are collected by plate B and the work function of plate A remains constant at the value of 2 eV. Take $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2 / N\ m^2$ and $1\ eV = 1.6 \times 10^{-19}$ J. Then,

17. The number of photoelectrons emitted upto t = 10 s is
    (a) 10^6
    (b) 1.2×10^7
    (c) 2.4×10^7
    (d) 5×10^7

18. The magnitude of electric field between the plates A and B at t = 10 s is
    (a) 10^3 N/C
    (b) 2×10^3 N/C
    (c) 5×10^3 N/C
    (d) 10^4 N/C

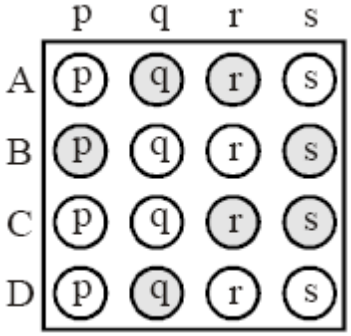
19. Neglect the time taken be the photoelectron to reach the plate B. The kinetic energy of the most energetic photoelectron emitted at t = 10 s when it reaches plate B is
    (a) 3 eV
    (b) 17 eV
    (c) 20 eV
    (d) 23 eV

SECTION-IV

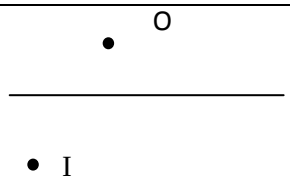
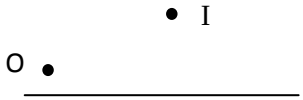
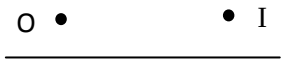
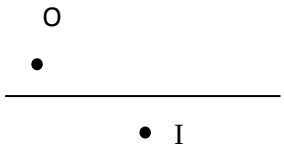
Matrix Match Type

This section contains 3 questions. Each question contains statements given in two columns which have to be matched. Statements in **Column I** are labelled as A, B, C and D whereas statements in **Column II** are labelled as p, q, r and s. The answers to these questions have to be appropriately bubbled asillustrated in the following example.

If the correct matches are A-q, A-r, B-p, B-s, C-r, C-s and D-q, then the correctly bubbled matrix will look like the following :



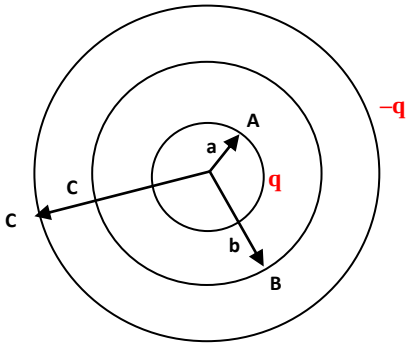
20. Given: O = position of object, I = position of image and horizontal line = principle axis in column I. Column II represents location and nature of the lens/mirror used. Match the column I with column II.

Column I	Column II
(a) 	(p) Plane mirror between O, I
(b) 	(q) Convex mirror between O, I
(c) 	(r) Convex mirror beyond I
(d) 	(s) Convex lens between O, I

21. Match the column I with column II.

Column I	Column II
(a) Ammeter	(p) small resistance parallel to the coil
(b) Voltmeter	(q) large resistance added in series with the coil
(c) Potentiometer	(r) measures potential difference
(d) Galvanometer	(s) measures current

22. Figure shows three concentric thin conducting spherical shells A, B and C of radii a, b and C respectively. The shells A and B are given charges q and –q respectively and the shell B is earthed. Match the column I with column II.



Column I	Column II
(a) Charge at inner surface of B	(p) –q
(b) Charge at outer surface of B	(q) bq/c
(c) Charge at inner surface of C	(r) –bq/c
(d) Charge at outer surface of C	(s) –q(1 – b/c)