# IIT JEE 2009 Test Series 4
# PHYSICS PART-I

## SECTION I
## STRAIGHT OBJECTIVE TYPE

This section contains 6 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.

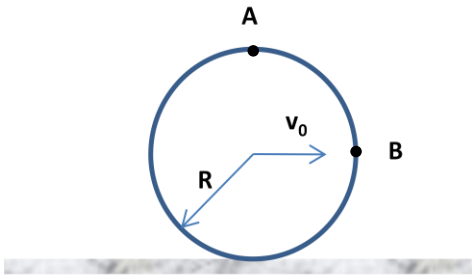
1. The electric field strngth in a region is given as $\vec{E} = \frac{x\hat{i} + y\hat{j}}{x^2 + y^2}$. Then, the net charge inside a sphere of radius a with centre at origin is
   (a) $4\pi\varepsilon_0 a$
   (b) $4\pi\varepsilon_0 a^2$
   (c) $\frac{a}{4\pi\varepsilon_0}$
   (d) $\frac{a^2}{4\pi\varepsilon_0}$

2. A source of sound with frequency 1000 Hz and a receiver are located at the same point. At the moment t = 0, the source and receiver starts receding from each other with acceleration 3.0 $m/s^2$ and 2.0 $m/s^2$ respectively. The oscillation frequency registered by the receiver at t = 9.0 sec after the start of the motion is
   (a) 860 Hz
   (b) 880 Hz
   (c) 900 Hz
   (d) 920 Hz

3. The potential energy of a particle of mass m is given by
   $$V(x) = \begin{cases} E_0 & 0 \le x \le 1 \\ 0 & x > 1 \end{cases}$$
   $\lambda_1$ and $\lambda_2$ are the de–Broglie wavelengths of the particle when $0 \le x \le 1$ and $x > 1$ respectively. If the total energy of particle is $2E_0$, then $\lambda_1/\lambda_2$ is
   (a) 1
   (b) 2
   (c) √2
   (d) ½

4. One mole of an ideal monatomic gas is kept in a rigid vessel. The vessel is kept inside a steam chamber whose temperature is 97 $^0$C. Initially, the temperature of the gas is 5.0 $^0$C. The walls of the vessel have an inner surface of area 800 cm$^2$ and thickness 1.0 cm. The temperature of the gas increases to 9.0 $^0$C in 5.0 seconds. Making suitable assumption, the thermal conductivity of the material of the walls is
   (a) 0. 014 J/m-s-K
   (b) 0. 01 J/m-s-K
   (c) 0. 009 J/m-s-K
   (d) None of the above

5. A ring of radius r is rolling without slipping over a rough horizontal surface with a velocity $v_0$. A is the topmost point and B is the rightmost point as shown in the figure. Then velocity of A w.r.t. B is



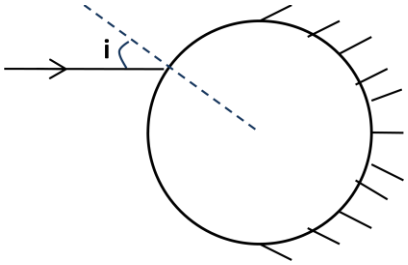

   (a) $\vec{0}$
   (b) $v_0\hat{i}$
   (c) $v_0\hat{i} + v_0\hat{j}$
   (d) $-v_0\hat{i} - v_0\hat{j}$

6. A cylindrical tank of base area A has a small hole of area 'a' at the bottom. At time t = 0, a tap starts to supply water into tank at a constant rate $\alpha$ m$^3$/s. Then, the maximum level of water $h_{max}$ in the tank is
   (a) more data required to answer
   (b) $\frac{2\alpha^2}{ga^2}$
   (c) $\frac{\alpha^2}{ga^2}$
   (d) $\frac{\alpha^2}{2ga^2}$

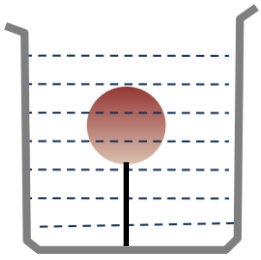
**SECTION II**
**MULTIPLE CHOICE TYPE QUESTIONS**

This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D), out of which ONLY ONE is correct. NO NEGATIVE marking.

7. A ray of light is incident on the surface of a sphere of refractive index √7/2. Other half of the sphere is silvered. After refraction it is reflected and then refracted out of the sphere again such that the total deviation is minimum. Then,
   (a) the angle incidence for the first refraction is $60^0$
   (b) the angle of refraction for the first refraction is $41^0$
   (c) the angle of incidence on the silvered surface is $30^0$
   (d) total deviation of the ray is $136^0$




8. A solid sphere of mass m = 2kg and density r = 500 kg/$m^3$ is held stationary relative to a tank filled with water. The tank is accelerating upward with acceleration 2 m/$s^2$. Choose correct option/s.
   (a) Tension in the string connected between the sphere and the bottom of the tank is 24 N
   (b) If the sphere snaps, tension in the string is 12 N
   (c) If the sphere snaps, the acceleration of sphere wrt ground is 14 m/$s^2$ upward
   (d) If the sphere snaps, the acceleration of sphere wrt tank is 12 m/$s^2$ upward



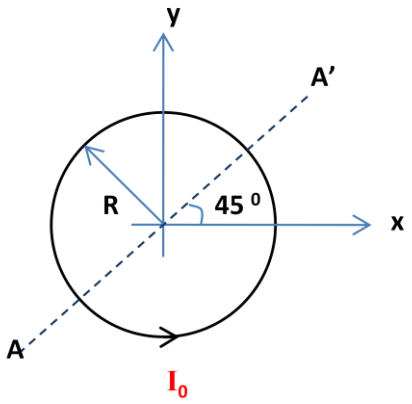
9. A ring of mass m and radius r carrying a current $I_0$ is lying in the x-y plane with centre at the origin. A uniform magnetic field of strength $B_0(2\hat{i}-3\hat{j}+5\hat{k})$ is applied in the region. The ring can rotate about the axis AA' in x-y plane only. All the quantities is in S.I. units. Choose the correct option/s:

(a) Initial angular acceleration of the loop is $\frac{I_0 B_0 \pi}{m}$

(b) Initial magnetic energy stored in the ring is $-5\pi r^2 I_0 B_0$

(c) The force on the loop is $I_0 r B_0$

(d) The force on the loop is zero



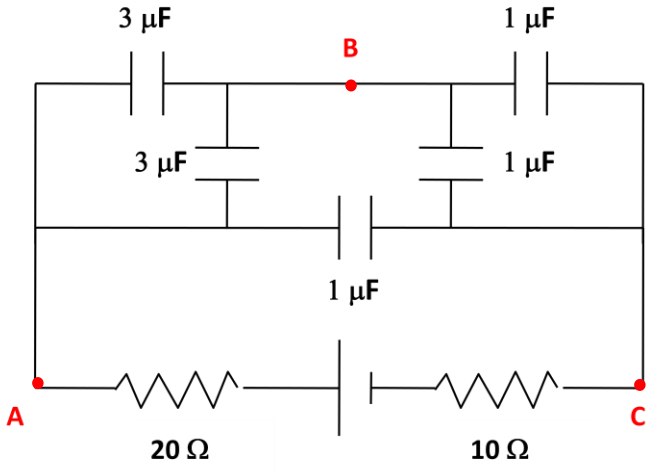

10. Consider the given circuit at steady state. Choose the correct option/s

(a) Potential difference between points A and B is 25 V

(b) Potential difference between points B and C is 75 V

(c) Potential difference between points A and C is 100 V

(d) Potential difference between points A and B is zero



**SECTION III**
**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.

11. STATEMENT-1: Standing in the sun is more pleasant on a cold winter than standing in shade.
STATEMENT-1: The temperature of air in the sun is considerably higher than that of the air in the shade.

    (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: There can be finite current in a pure LC circuit even without applied emf.
STATEMENT-2: When a charge capacitor is connected to a pure inductor, the capacitor gets discharged sending a current in the inductor and the induced emf in the inductor charges the capacitor again.
    (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: We can find the mass of a photon by the definition p = mv.
STATEMENT-2: Each photon has a definite linear momentum and energy.
    (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

14. STATEMENT-1: The formula "Refractive index = Real depth/Apparent depth" is valid if viewed from a position quite away from the normal.
STATEMENT-2: According to Snell's law "refractive index = sin i/sin r" where i is the angle of incidence and r is the angle of refraction.
(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 IV**
**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 15 to 17**

A ball of density d is dropped onto a horizontal solid surface. It bounces elastically from the surface and returns to its original position in a time $t_1$. Next, the ball is released and it falls through the same height before striking the face of a liquid of density $d_L$. Then,

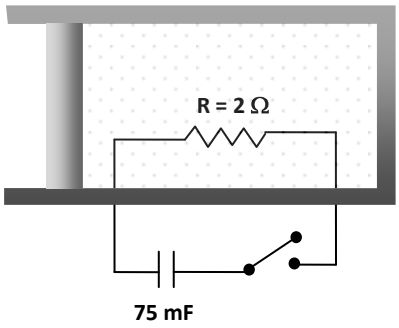
15. If $d < d_L$, the expression for the time $t_2$ the ball takes to come back to the position from which it was released is
(a) $t_2 = t_1$
(b) $t_2 = t_1 \frac{d_L}{d}$
(c) $t_2 = t_1 \frac{d_L - d}{d_L}$
(d) $t_2 = t_1 \frac{d_L}{d_L - d}$

16. The motion of the ball is
    (a) simple harmonic motion with time period $t_1$
    (b) simple harmonic motion with time period $t_2$
    (c) simple harmonic motion with time period $t_1 + t_2$
    (d) periodic motion but not simple harmonic

17. Assume the depth of the liquid to be large. Neglect all frictional and other dissipative forces. If d = $d_L$ , then
    (a) ball moves with a constant velocity v = g $t_1$/2 inside the liquid
    (b) ball moves with a constant velocity v = g $t_2$/2 inside the liquid
    (c) ball moves with a constant velocity v = g ($t_1 + t_2$)/2 inside the liquid
    (d) ball moves with uniform acceleration g inside the liquid

**Paragraph for Questions numbers 18 to 20**

One mole of an ideal gas is taken in a cylinder with a movable piston. A resistor R is connected to a capacitor through a key is immersed in the gas. Initial potential difference across the plates of the capacitor is equal to 640/3 V. When the key is closed for 2.5 ln 4 minutes, the gas expands isobarically and its temperature changes by 22 K. Then,



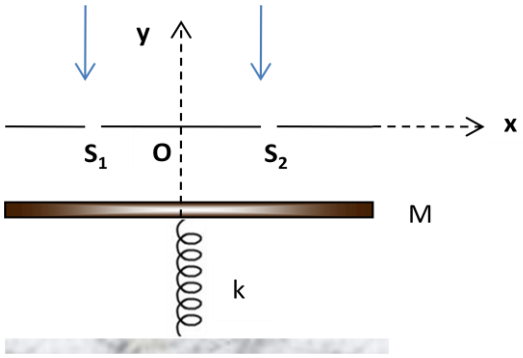

18. Work done by the gas is
    (a) zero
    (b) 0.182 kJ
    (c) 1. 6 kJ
    (d) 1.418 kJ

19. Change in internal energy of the gas is
    (a) zero
    (b) 0.182 kJ
    (c) 1. 6 kJ
    (d) 1.418 kJ

20. Value of ratio of specific heats $\gamma$ is
    (a) 1.67
    (b) 1.4
    (c) 1.29
    (d) 1.13

**Paragraph for Questions numbers 21 to 23**

Two slits $S_1$ and $S_2$ on the x-axis and symmetric with respect to y axis are illuminated by a parallel beam of wavelength $\lambda$. the distance between the slits is d (>> $\lambda$). Origin O is the midpoint of the line $S_1S_2$. The slits are in horizontal plane. The interference pattern is observed on a horizontal plate (acting as screen) of mass M, which is attached to one end of a vertical spring of spring constant k. the other end of the spring is fixed to ground. At t = 0 the plate is at a distance D (>> d) below the plane of slits and the spring is in its natural length. The plate is released from rest at t = 0. Assume that the spring is light and the plate always remains horizontal. Then answer the following questions:




21. The amplitude of the oscillation of the plate is
    (a) $\frac{Mg}{k}$
    (b) $\frac{2Mg}{k}$
    (c) $\frac{Mg}{2k}$
    (d) D + $\frac{Mg}{k}$

22. The y coordinate of the plate at t = $8\pi\sqrt{\frac{M}{k}}$ is

(a) D

(b) D + $\frac{Mg}{k}$

(c) D + $\frac{Mg}{2k}$

(d) D + $\frac{3Mg}{2k}$

23. The y coordinate of the n[th] maxima of interference pattern on the plate as a function of time t is

(a) $D+\frac{Mg}{k}\cos\omega t$

(b) $-D-\frac{Mg}{k}\cos\omega t$

(c) $D+\frac{Mg}{k}(1-\cos\omega t)$

(d) $-D-\frac{Mg}{k}(1-\cos\omega t)$