



**JEE  
MAIN  
July  
2021**

**PHYSICS**  
**25<sup>th</sup> July 2021 [SHIFT – 2]**  
**QUESTION WITH ANSWER**

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SELECTIONS SINCE 2007

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### SECTION - A

1. Two vectors  $\vec{X}$  and  $\vec{Y}$  have equal magnitude. The magnitude of  $(\vec{X} - \vec{Y})$  is  $n$  times the magnitude of  $(\vec{X} + \vec{Y})$ . The angle between  $\vec{X}$  and  $\vec{Y}$  is -

(1)  $\cos^{-1}\left(\frac{n^2 + 1}{n^2 - 1}\right)$     (2)  $\cos^{-1}\left(\frac{n^2 - 1}{-n^2 - 1}\right)$     (3)  $\cos^{-1}\left(\frac{-n^2 - 1}{n^2 - 1}\right)$     (4)  $\cos^{-1}\left(\frac{n^2 + 1}{n^2 - 1}\right)$

**Sol. 2**

2. A heat engine has an efficiency of  $\frac{1}{6}$ . When the temperature of sink is reduced by  $62^\circ\text{C}$ , its efficiency get doubled. The temperature of the source is -

(1)  $37^\circ\text{C}$     (2)  $99^\circ\text{C}$     (3)  $62^\circ\text{C}$     (4)  $124^\circ\text{C}$

**Sol. 2**

3. Two spherical soap bubbles of radii  $r_1$  and  $r_2$  in vacuum combine under isothermal conditions. The resulting bubble has a radius equal to -

(1)  $\frac{r_1 r_2}{r_1 + r_2}$     (2)  $\sqrt{r_1^2 + r_2^2}$     (3)  $\sqrt{r_1 r_2}$     (4)  $\frac{r_1 + r_2}{2}$

**Sol. 2**

4. A balloon was moving upwards with a uniform velocity of  $10 \text{ m/s}$ . An object of finite mass is dropped from the balloon when it was at a height of  $75 \text{ m}$  from the ground level. The height of the balloon from the ground when object strikes the ground was around. (Takes the value of  $g = 10 \text{ m/s}^2$ )

(1)  $125 \text{ m}$     (2)  $250 \text{ m}$     (3)  $300 \text{ m}$     (4)  $200 \text{ m}$

**Sol. 1**

5. When radiation of wavelength  $\lambda$  is incident on a metallic surface, the stopping potential of ejected photoelectrons is  $4.8 \text{ V}$ . If the same surface is illuminated by radiation of double the previous wavelength, then the stopping potential becomes  $1.6 \text{ V}$ . The threshold wavelength of the metal is -

(1)  $4\lambda$     (2)  $2\lambda$     (3)  $8\lambda$     (4)  $6\lambda$

**Sol. 1**

6. A force  $\vec{F} = (40\hat{i} + 10\hat{j}) \text{ N}$  acts on a body of mass  $5 \text{ kg}$ . If the body starts from rest, its position vector  $\vec{r}$  at time  $t = 10 \text{ s}$ , will be -

(1)  $(100\hat{i} + 400\hat{j}) \text{ m}$     (2)  $(400\hat{i} + 100\hat{j}) \text{ m}$     (3)  $(100\hat{i} + 100\hat{j}) \text{ m}$     (4)  $(400\hat{i} + 400\hat{j}) \text{ m}$

**Sol. 2**

7. A prism of refractive index  $\mu$  and angle of prism  $A$  is placed in the position of minimum angle of deviation. If minimum angle of deviation is also  $A$ , then in terms of refractive index value of  $A$  is

(1)  $\sin^{-1}\left(\frac{\mu}{2}\right)$     (2)  $2 \cos^{-1}\left(\frac{\mu}{2}\right)$     (3)  $\sin^{-1}\left(\sqrt{\frac{\mu - 1}{2}}\right)$     (4)  $\cos^{-1}\left(\frac{\mu}{2}\right)$

**Sol. 2**

8. A  $10 \Omega$  resistance is connected across  $220 \text{ V} - 50 \text{ Hz}$  AC supply. The time taken by the current to change from its maximum value to the rms value is -

(1)  $2.5 \text{ ms}$     (2)  $1.5 \text{ ms}$     (3)  $4.5 \text{ ms}$     (4)  $3.0 \text{ ms}$

**Sol. 1**

9. The relation between time  $t$  and distance  $x$  for a moving body is given as  $t = mx^2 + nx$ , where  $m$  and  $n$  are constants. The retardation of the motion is -  
(Where  $v$  stands for velocity)

(1)  $2n^2 v^3$     (2)  $2m v^3$     (3)  $2n v^3$     (4)  $2m n v^3$

**Sol. 2**

**10.** The instantaneous velocity of a particle moving in a straight line is given as  $v = \alpha t + \beta t^2$ , where  $\alpha$  and  $\beta$  are constants. The distance travelled by the particle between 1 s and 2s is -

- (1)  $\frac{\alpha}{2} + \frac{\beta}{3}$       (2)  $\frac{3}{2}\alpha + \frac{7}{3}\beta$       (3)  $3\alpha + 7\beta$       (4)  $\frac{3}{2}\alpha + \frac{7}{2}\beta$

**Sol. 2**

**11.** The force is given in terms of time  $t$  and displacement  $x$  by the equation  $F = A \cos Bx + C \sin Dt$

The dimensional formula of  $\frac{AD}{B}$  is -

- (1)  $[M^2L^2T^{-3}]$       (2)  $[ML^2T^{-3}]$       (3)  $[M^1L^1T^{-2}]$       (4)  $[M^0LT^{-1}]$

**Sol. 1**

**12.** An electron moving with speed  $v$  and a photon moving with speed  $c$ , have same D-Broglie wavelength. The ratio of kinetic energy of electron to that of photon is -

- (1)  $\frac{3c}{v}$       (2)  $\frac{2c}{v}$       (3)  $\frac{v}{2c}$       (4)  $\frac{v}{3c}$

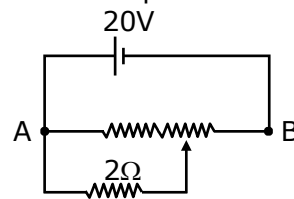
**Sol. 3**

**13.** Two ions having same mass have charges in the ratio 1 : 2. They are projected normally in a uniform magnetic field with their speeds in the ratio 2 : 3. The ratio of the radii of their circular trajectories is -

- (1) 4 : 3      (2) 3 : 1      (3) 2 : 3      (4) 1 : 4

**Sol. 1**

**14.** the given potentiometer has its wire of resistance  $10\Omega$ . When the sliding contact is in the middle of the potentiometre wire, the potential drop across  $2\Omega$  resistor is -

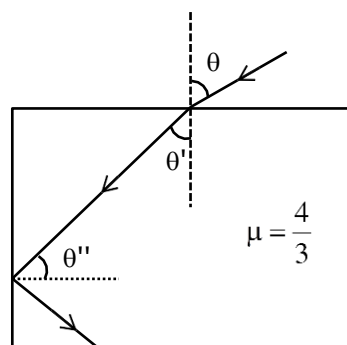


- (1)  $\frac{40}{11}$  V      (2) 10 V      (3)  $\frac{40}{9}$  V      (4) 5V

**Sol. 3**

**15.** A ray of light entering from air into a denser medium of refractive index  $\frac{4}{3}$ , as shown in figure.

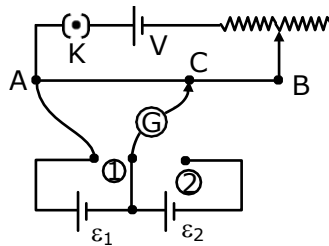
The light ray suffers total internal reflection at the adjacent surface as shown. The maximum, value of angle  $\theta$  should be equal to -



- (1)  $\sin^{-1} \frac{\sqrt{5}}{3}$       (2)  $\sin^{-1} \frac{\sqrt{7}}{3}$       (3)  $\sin^{-1} \frac{\sqrt{7}}{4}$       (4)  $\sin^{-1} \frac{\sqrt{5}}{4}$

**Sol. 2**

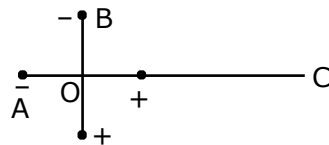
16. In the given potentiometer circuit arrangement, the balancing length AC is measured to be 250 cm. When the galvanometer connection is shifted from point (1) to point (2) in the given diagram, the balancing length becomes 400 cm. The ratio of the emf of two cells,  $\frac{\epsilon_1}{\epsilon_2}$  is -



- (1)  $\frac{4}{3}$                       (2)  $\frac{3}{2}$                       (3)  $\frac{5}{3}$                       (4)  $\frac{8}{5}$

Sol. 3

17. Two ideal electric dipoles A and B having their dipole moment  $p_1$  and  $p_2$  respectively are placed on a plane with their centres at O as shown in the figure. At point C on the axis of dipole A, the resultant electric field is making an angle of  $37^\circ$  with the axis. The ratio of the dipole moment of A and B,  $\frac{p_1}{p_2}$  is (take  $\sin 37^\circ = \frac{3}{5}$ )



- (1)  $\frac{3}{2}$                       (2)  $\frac{2}{3}$                       (3)  $\frac{3}{8}$                       (4)  $\frac{4}{3}$

Sol. 2

18. In a simple harmonic oscillation, what fraction of total mechanical energy is in the form of kinetic energy, when the particle is midway between mean and extreme position.

- (1)  $\frac{1}{4}$                       (2)  $\frac{1}{3}$                       (3)  $\frac{3}{4}$                       (4)  $\frac{1}{2}$

Sol. 3

19. If  $q_f$  is the free charge on the capacitor plates and  $q_b$  is the bound charge on the dielectric slab of dielectric constant  $k$  placed between the capacitor plates, then bound charge  $q_b$  can be expressed as -

- (1)  $q_b = q_f \left(1 - \frac{1}{k}\right)$     (2)  $q_b = q_f \left(1 - \frac{1}{\sqrt{k}}\right)$     (3)  $q_b = q_f \left(1 + \frac{1}{\sqrt{k}}\right)$     (4)  $q_b = q_f \left(1 + \frac{1}{k}\right)$

Sol. 1

20. Consider a planet in some solar system which has a mass double the mass of earth and density equal to the average density of earth. If the weight of an object on earth is  $W$ , then weight of the same object on that planet will be -

- (1)  $\sqrt{2}W$                       (2)  $2W$                       (3)  $W$                       (4)  $2^{\frac{1}{3}}W$

Sol. 4

### Section - B

1. A message signal of frequency 20 kHz and peak voltage of 20 volt is used to modulate a carrier wave of frequency 1 MHz and peak voltage of 20 volt. The modulation index will be \_\_\_\_\_.

Sol. 1

2. The nuclear activity of a radioactive element becomes  $\left(\frac{1}{8}\right)^{\text{th}}$  of its initial value in 30 years. The half-life of radioactive element is \_\_\_\_\_ years.

Sol. 10

3. From the given data, the amount of energy required to break the nucleus of aluminium  ${}_{13}^{27}\text{Al}$  is \_\_\_\_\_  $\times 10^{-3}$  J.

Mass of neutron = 1.00866 u

Mass of proton = 1.00726 u

Mass of aluminium nucleus = 27.18846 u

(Assume 1u corresponds to x J of energy)

(Round off to the nearest integer)

Sol. 27

4. A solid disc of radius 20 cm and mass 10 kg is rotating with an angular velocity of 600 rpm, about an axis normal to its circular plane and passing through its centre of mass. The retarding torque required to bring the disc at rest in 10 s \_\_\_\_\_  $\pi \times 10^{-1}$  Nm.

Sol. 4

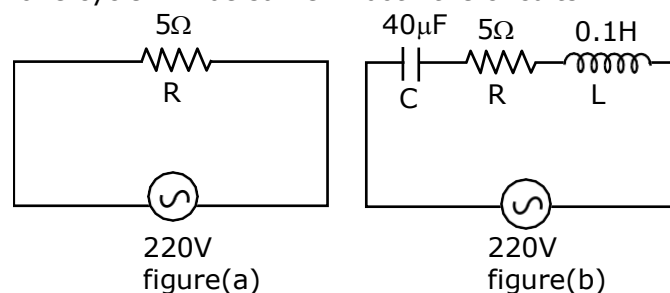
5. A  $16\Omega$  wire is bend to form a square loop. A 9V supply having internal resistance of  $1\Omega$  is connected across one of its sides. The potential drop across the diagonals of the square loop is \_\_\_\_\_  $\times 10^{-1}$  V.

Sol. 45

6. A system consists of two types of gas molecules A and B having same number density  $2 \times 10^{25}/\text{m}^3$ . The diameter of A and B are  $10 \text{ \AA}$  and  $5 \text{ \AA}$  respectively. They suffer collision at room temperature. The ratio of average distance covered by the molecule A to that of B between two successive collision is \_\_\_\_\_  $\times 10^{-2}$ .

Sol. 25

7. Two circuit are shown in the figure (a) and (b). At a frequency of \_\_\_\_\_ rad/s the average power dissipated in one cycle will be same in both the circuits.



Sol. 500

8. A force of  $F = (5y + 20)\hat{j}\text{N}$  acts on a particle. The work done by this force when the particle is moved from  $y = 0$  m to  $y = 10$  m is \_\_\_\_\_ J.

Sol. 450

9. In a semiconductor, the number density of intrinsic charge carriers at 27°C is  $1.5 \times 10^{16}/\text{m}^3$ . If the semiconductor is doped with impurity atom, the hole density increase to  $4.5 \times 10^{22}/\text{m}^3$ . The electron density in the doped semiconductor is \_\_\_\_\_  $\times 10^9/\text{m}^3$

**Sol. 5**

10. A light beam of wavelength 500 nm is incident on a metal having work function of 1.25 eV, placed in a magnetic field of intensity B. The electrons emitted perpendicular to the magnetic field B, with maximum kinetic energy are bent into circular arc of radius 30 cm. The value of B is \_\_\_\_\_  $\times 10^{-7}$  T.

Given  $hc = 20 \times 10^{-26}$  J-m, mass of electron =  $9 \times 10^{-31}$  kg

**Sol. 125**

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