JEE MAIN July 2021

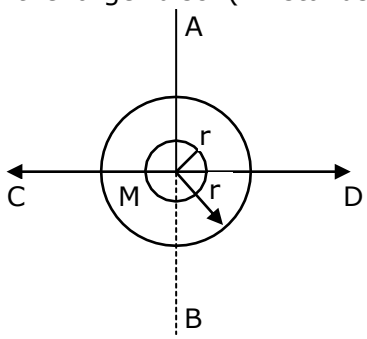
PHYSICS

27th July 2021 [SHIFT – 1]

QUESTION WITH ANSWER

SECTION - A

1. The figure shows two solid discs with radius R and r respectively. If mass per unit area is same for both, what is the ratio of MI of bigger disc around axis AB (Which is $\perp$ to the plane of the disc and passing through its centre) of MI of smaller disc around one of its diameters lying on its plane? Given 'M' is the mass of the larger disc. (MI stands for moment of inertia)



(1) $2r^4 : R^4$ (2) $2R^2 : r^2$ (3) $2R^4 : r^4$ (4) $R^2 : r^2$

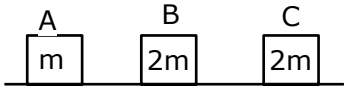
Sol. **3**

2. The number of molecules in one litre of an ideal gas at 300 K and 2 atmospheric pressure with mean kinetic energy 2×10^{-9} J per molecules is :

(1) 6×10^{11} (2) 3×10^{11} (3) 1.5×10^{11} (4) 0.75×10^{11}

Sol. **3**

3. Three objects A, B and C are kept in a straight line on a frictionless horizontal surface. The masses of A, B and C are m, 2 m and 2 m respectively. A moves towards B with a speed of 9 m/s and makes an elastic collision with it. Thereafter B makes a completely inelastic collision with C. All motions occur along same straight line. The final speed of C is :



(1) 3 m/s (2) 6 m/s (3) 9 m/s (4) 4 m/s

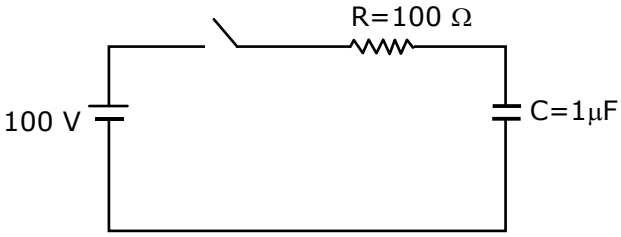
Sol. **1**

4. A body takes 4 min. to cool from 61° C to 59°C. If the temperature of the surroundings is 30°C, the time taken by the body to cool from 51°C to 49° C is :

(1) 8 min (2) 4 min (3) 6 min (4) 3 min

Sol. **3**

5. A capacitor of capacitance C=1 μF is suddenly connected to a battery of 100 volt through a resistance R = 100 Ω . The time taken for the capacitor to be charged to get 50 V is :
[Take ln 2 = 0.69]



(1) 0.30×10^{-4} s (2) 1.44×10^{-4} s
(3) 3.33×10^{-4} s (4) 0.69×10^{-4} s

Sol. **4**

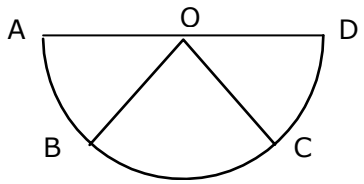
6. A particle starts executing simple harmonic motion (SHM) of amplitude 'a' and total energy E. At any instant, its kinetic energy is $\frac{3E}{4}$ then its displacement 'y' is given by:

(1) $y = \frac{a}{\sqrt{2}}$ (2) $y = a$ (3) $y = \frac{a}{2}$ (4) $y = \frac{a\sqrt{3}}{2}$

Sol. 3

7. Assertion A: If A, B, C, D are four points on a semi-circular arc with centre at 'O' such that $|\vec{AB}| = |\vec{BC}| = |\vec{CD}|$, then $\vec{AB} + \vec{AC} + \vec{AD} = 4\vec{AO} + \vec{OB} + \vec{OC}$

Reason R : Polygon law of vector addition yields $\vec{AB} + \vec{BC} + \vec{CD} + \vec{AD} = 2\vec{AO}$



In the light of the above statements, choose the most appropriate answer from the options given below:

(1) Both **A** and **R** are correct and **R** is the correct explanation of **A**.

(2) **A** is not correct but **R** is correct.

(3) Both **A** and **R** are correct but **R** is not the correct explanation of **A**.

(4) **A** is correct but **R** is not correct.

Sol. 3

8. Two capacitors of capacities 2C and C are joined in parallel and charged up to potential V. The battery is removed and the capacitor of capacity C is filled completely with a medium of dielectric constant K. The potential difference across the capacitors will now be :

(1) $\frac{3V}{K}$ (2) $\frac{V}{K}$ (3) $\frac{3V}{K+2}$ (4) $\frac{V}{K+2}$

Sol. 3

9. In Young's double slit experiment, if the source of light changes from orange to blue then :

(1) the central bright fringe will become a dark fringe.

(2) the distance between consecutive fringes will decrease.

(3) the distance between consecutive fringes will increase.

(4) the intensity of the minima will increase.

Sol. 2

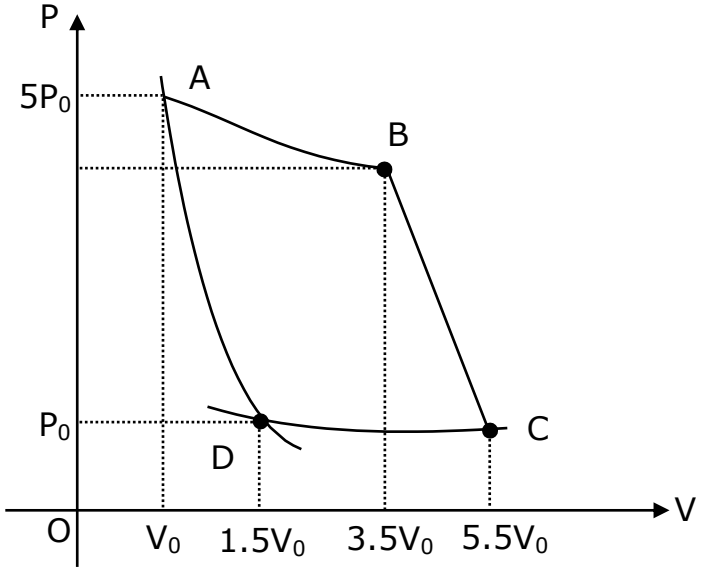
10. The relative permittivity of distilled water is 81. The velocity of light in it will be :
(Given μ_r = 1)

(1) 5.33×10^7 m/s (2) 4.33×10^7 m/s

(3) 3.33×10^7 m/s (4) 2.33×10^7 m/s

Sol. 3

11. In the reported figure, there is a cyclic process ABCDA on a sample of 1 mol of a diatomic gas. The temperature of the gas during the process A → B and C → D are T_1 and T_2 ($T_1 > T_2$) respectively.



Choose the correct option out of the following for work done if processes BC and DA are adiabatic.

(1) $W_{AB} < W_{CD}$ (2) $W_{AD} = W_{BC}$ (3) $W_{BC} + W_{DA} > 0$ (4) $W_{AB} = W_{DC}$

Sol. 2

12.

List – I	List – II
(a) MI of the rod (length L, Mass M, about an axis ⊥ to the rod passing through the midpoint)	(i) 8 $ML^2/3$
(b) MI of the rod (length L, Mass 2M, about an axis ⊥ to the rod Passing through one its end)	(ii) $ML^2/3$
(c) MI of the rod (length 2L, Mass M, about an axis ⊥ to the rod Passing through its midpoint)	(iii) $ML^2/12$
(d) MI of the rod (length 2L, Mass 2M, about an axis ⊥ to the rod passing through one of its end)	(iv) $2ML^2/3$

Choose the correct answer from the options given below :

(1) (a)–(iii), (b)–(iv), (c)– (ii), (d)–(i)

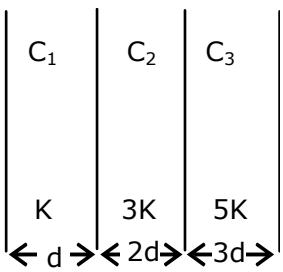
(2) (a)–(iii), (b)–(iv), (c)– (i), (d)–(ii)

(3) (a)–(ii), (b)–(i), (c)– (iii), (d)–(iv)

(4) (a)–(ii), (b)–(iii), (c)– (i), (d)–(iv)

Sol. 1

13. In the reported figure, a capacitor is formed by placing a compound dielectric between the plates of parallel plate capacitor. The expression for the capacity of the said capacitor will be : (Given area of plate = A)



(1) $\frac{25}{6}\frac{K\varepsilon_0 A}{d}$ (2) $\frac{15}{34}\frac{K\varepsilon_0 A}{d}$ (3) $\frac{15}{6}\frac{K\varepsilon_0 A}{d}$ (4) $\frac{9}{6}\frac{K\varepsilon_0 A}{d}$

Sol. 2

14. If '*f*' denotes the ratio of the number of nuclei decayed (N_d) to the number of nuclei at t = 0 (N_0) then for a collection of radioactive nuclei, the rate of change of 'f' with respect to time is given as:
[λ is the radioactive decay constant]

(1) $\lambda(1-e^{-\lambda t})$ (2) $-\lambda e^{-\lambda t}$ (3) $\lambda e^{-\lambda t}$ (4) $-\lambda(1-e^{-\lambda t})$

Sol. 3

15. A ball is thrown up with a certain velocity so that it reaches a height 'h'. Find the ratio of the two different times of the ball reaching $\frac{h}{3}$ in both the directions.

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

Sol. 1

16. **Asseretion A:** If in five complete rotations of the circular scale, the distance travelled on main scale of the screw gauge is 5 mm and there are 50 total divisions on circular scale, then least count is 0.001 cm.

Reason R : Least Cound = $\frac{\text{Pitch}}{\text{Total divisions on circular scale}}$

In the light of the above statements, choose the most appropriate answer from the options given below:
(1) Both A and R are correct and R is the correct explanation of A
(2) A is not correct but R is correct.
(3) Both A and R are correct and R is NOT the correct explanation of A.
(4) A is correct but R is not correct.

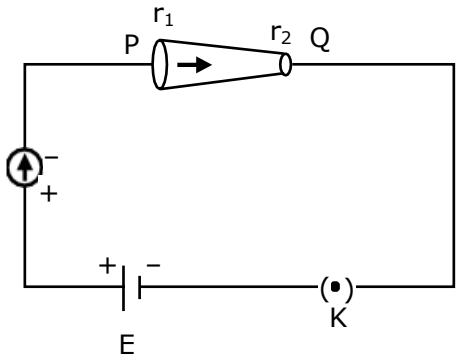
Sol. 2

17. Two identical tennis balls each having mass 'm' and charge 'q' are suspended from a fixed point by threads of length '*l*'. What is the equilibrium separation when each thread makes a small angle 'θ' with the vertical?

(1) $x=\left(\frac{q^2 l}{2\pi\varepsilon_0 mg}\right)^{1/2}$ (2) $x=\left(\frac{q^2 l^2}{2\pi\varepsilon_0 m^2 g^2}\right)^{1/3}$ (3) $x=\left(\frac{q^2 l}{2\pi\varepsilon_0 mg}\right)^{1/3}$ (4) $x=\left(\frac{q^2 l^2}{2\pi\varepsilon_0 m^2 g}\right)^{1/3}$

Sol. 3

18. In the given figure, a battery of emf E is connnected across a conductor PQ of length '*l*' and different area of cross-sections having radii r_1 and r_2 ($r_2 < r_1$).



Choose the correct option as one moves from P to Q:
(1) Electric field decreases.
(2) Drift velocity of electron increases.
(3) Electron current decreases.
(4) All of these

Sol. 2

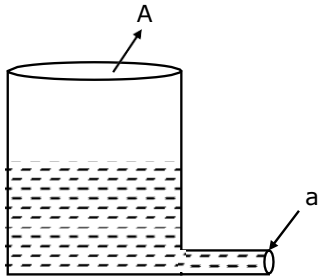
19. A 0.07 H inductor and a 12Ω resistor are connected in series to a 220 V, 50 Hz ac source. The approximate current in the circuit and the phase angle between current and source voltage are respectively. [Take π as $\frac{22}{7}$]

(1) 88 A and $\tan^{-1}\left(\frac{11}{6}\right)$ (2) 0.88 A and $\tan^{-1}\left(\frac{11}{6}\right)$

(3) 8.8 A and $\tan^{-1}\left(\frac{11}{6}\right)$ (4) 8.8 A and $\tan^{-1}\left(\frac{6}{11}\right)$

Sol. 3

20. A light cylindrical vessel is kept on a horizontal surface. Area of base is A. A hole of cross-sectional area 'a' is made just at its bottom side. The minimum coefficient of friction necessary to prevent sliding the vessel due to the impact force of the emerging liquid is (a < < A) :



(1) $\frac{2a}{A}$ (2) None of these (3) $\frac{a}{A}$ (4) $\frac{A}{2a}$

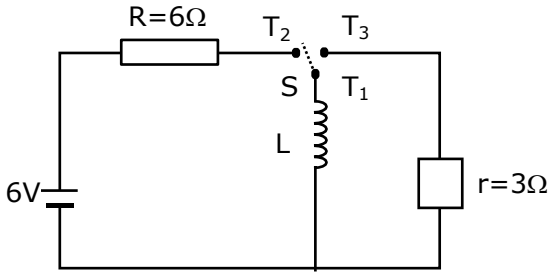
Sol. 1

Section B

1. In a uniform magnetic field, the magnetic needle has a magnetic moment 9.85 × 10^{-2} A/m^2 and moment of inertia $5\times10^{-6}\,kg\,m^2$. If it performs 10 complete oscillations in 5 seconds then the magnitude of the magnetic field is _____ mT. [Take $\pi^2 as 9.85$]

Sol. 8

2. Consider an electrical circuit containing a two way switch 'S'. Initially S is open and then T_1 is connected to T_2. As the current in R = 6 Ω attains a maximum value of steady state level, T_1 is disconnected from T_2 and immediately connected to T_3. Potential drop across $r=3\Omega$ resistor immediately after T_1 is connected to T_3 is _____ V. (Round off to the Nearest Integer)



Sol. 3

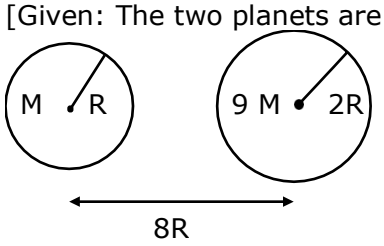
3. A trransistor is connected in common emitter circuit configuration, the collector supply voltage is 10 V and the voltage drop across a resistor of 1000 Ω in the collector circuit is 0.6 V. If the current gain factor (β) is 24, then the base currect is _____ μA. (Round off to the Nearest Integer)

Sol. 25

4. A stone of mass 20 g is projected from a rubber catapult of length 0.1 m and area of cross section 10^{-6} m^2 stretched by an amount 0.04 m. The velocity of the projected stone is _____m/s.
(Young's modulus of rubber = 0.5×10^9 N/m^2)

Sol. **20**

5. Suppose two planets (spherical in shape) of radii R and 2R, but mass M and 9 M respectively have a centre to centre separation 8 R as shown in the figure. A satellite of mass 'm' is projected from the surface of the planet of mass 'M' directly towards the centre of the second planet. The minimum speed 'v' required for the satellite to reach the surface of the second planets is $\sqrt{\frac{a}{7}=\frac{GM}{R}}$ then the value of 'a' is _____.
[Given: The two planets are fixed in their position]

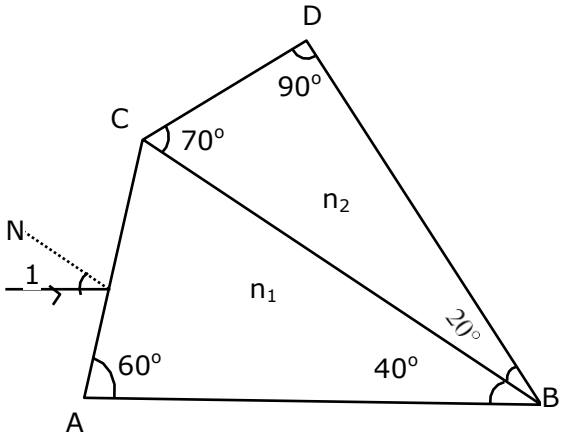


Sol. **4**

6. A prism of refractive index n_1 and another prism of refractive index n_2 are stuck together (as shown in the figure). n_1 and n_2 depend on λ, the wavelength of light, according to the relation

$$n_1 = 1.2 + \frac{10.8\times10^{-14}}{\lambda^2} \text{ and } n_2 = 1.45 + \frac{1.8\times10^{-14}}{\lambda^2}$$

The wavelength for which rays incident at any angle on the interface BC pass through without bending at that interface will be _____ nm.



Sol. **600**

7. A radioactive sample has an average life of 30 ms and is decaying. A capacitor of capacitance 200 μF is first charged and later connected with resistor 'R'. If the ratio of charge on capacitor to the activity of radioactive sample is fixed with respect to time then the value of 'R' should be _____ Ω.

Sol. **150**

8. A particle of mass 9.1×10^{-31} kg travels in a medium with a speed of 10^6 m/s and a photon of a radiation of linear momentum 10^{-27} kg m/s travels in vacuum. The wavelength of photon is _____ times the wavelength of the particle.

Sol. **910**

9. In Bohr's atomic model, the electron is assumed to revolve in a circular orbit of radius 0.5 Å. IF the speed of electron is 2.2×10^6 m/s, then the current associated with the electron will be _____ $\times 10^{-2}$ mA. [Take π as $\frac{22}{7}$]

Sol. **112**

10. The amplitude of upper and lower side bands of A.M. wave where a carrier signal with frequency 11.21 MHz, peak voltage 15 V is amplitude modulated by a 7.7 kHz sine wave of 5 V amplitude are $\frac{a}{10}$ V and $\frac{b}{10}$ V respectively. Then the value of $\frac{a}{b}$ is _____

Sol. **1**