PHYSICS

BOOKS - D MUKHERJEE PHYSICS (HINGLISH)

IIT QUESTIONS 5

Straight Objective Type

1. A hollow pipe of length $0.8m$ is closed at one end. At its open end a $0.5m$ long uniform string

is vibrating in its second harmonic and it resonates with the fundamental frequency of the pipe. If the tension in the wire is $50N$ and the speed of sound is $320ms^{-1}$, the mass of the string is

A. 5 grams

B. 10 grams

C. 20 grams

D. 40 grams

Answer: B

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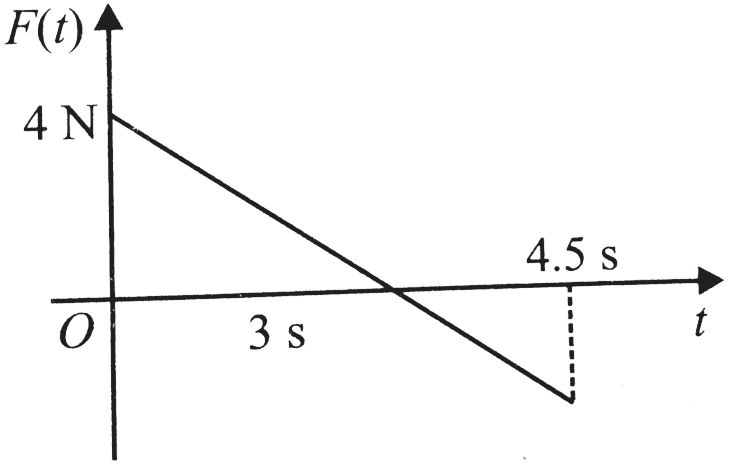
2. A block of mass $2kg$ is free to move along the x-axis. It at rest and from $t = 0$onwards it is subjected to a time-dependent force $F(t)$ in the x direction. The force $F(t)$ varies with t as shown in the figure. The kinetic energy of the block after 4.5 seconds is



A. 4.50 J

B. 7.50 J

C. 5.06 J

D. 14.06 J

Answer: C

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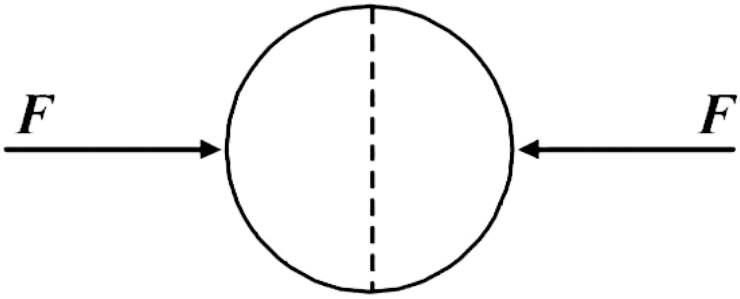
3. A uniformly charged thin spherical shell of radius R carries uniform surface charge denisty of $isgma$ per unit area. It is made of two

hemispherical shells, held together by presisng them with force F(see figure). F is proportional to



A. $\frac{1}{\varepsilon_0}\sigma^2 R^2$

B. $\frac{1}{\varepsilon_0}\sigma^2 R$

C. $\frac{1}{\varepsilon_0}\frac{\sigma^2}{R}$

D. $\frac{1}{\varepsilon_0}\frac{\sigma^2}{R^2}$

Answer: A

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4. A tiny spherical oil drop carrying a net charge q is balanced in still air with a vertical uniform electric field of strength $\frac{81\pi}{7} \times 10^5 Vm^{-1}$. When the field is switched off, the drop is observed to fall with terminal velocity $2 \times 10^{-3} ms^{-1}$. Given $g = 9.8 ms^{-2}$, viscoisty of the air $= 1.8 \times 10^{-5} Nsm^{-2}$ and the

denisty of oil $= 900 kgm^{-3}$, the magnitude of q is

A. 1.6×10^{19} C

B. 3.2×10^{19} C

C. 4.8×10^{19} C

D. 8.0×10^{19} C

Answer: D

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5. A biconvex lens of focal length 15 cm is in front of a plane mirror. The distance between the lens and the mirror is 10 cm. A small object is kept at a distance of 30 cm from the lens. The final image is

A. virtual and at a distance of 16cm from the mirror

B. real and at a distance of 16 cm from the mirror

C. virtual and at a distance of 20 cm from the mirror

D. real and at a distance of 20 cm from the mirror

Answer: B

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6. A vernier calipers has $1mm$ marks on the main scale. It has 20 equal divisions on the Verier

scale which match with 16 main scale divisions.

For this Vernier calipers, the least count is

A. 0.02 mm

B. 0.05 mm

C. 0.1 mm

D. 0.2 mm

Answer: D

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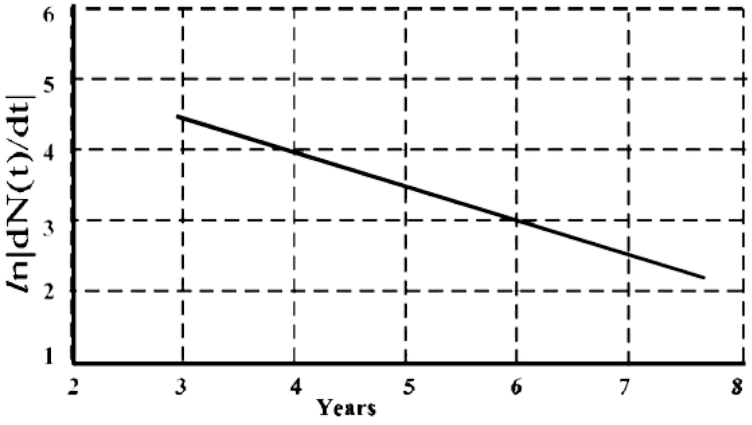
Integer Type

1. To determine the half life of a radioactive element , a student plote a graph of in $\left|\frac{dN(t)}{dt}\right| versus t, Here \left|\frac{dN(t)}{dt}\right|$ is the rate of radioatuion decay at time t , if the number of radoactive nuclei of this element decreases by a factor of p after 4.16 year the value of p is



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2. Image of an object approaching a convex mirror of radius of curvature 20m slong its optical axis is observed to move from $\frac{25}{3}$m to $\frac{50}{7}$m in 30 seconds. What is the speed of the object in km per hour?

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3. A large glass slabe $(\mu = 5/3)$ of thickness 8cm is placed over a point source of light on a plane surface. It is seen that light emerges out

of th etop surface fo the slab from a circular area of radius R cm. What is the value of R?

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4. A diatomic ideal gas is compressed adiabatically to 1/32 of its initial volume. If the initial temperature of the gas is T_i (in Kelvin) and the final temperature is a T_i, the value of a is

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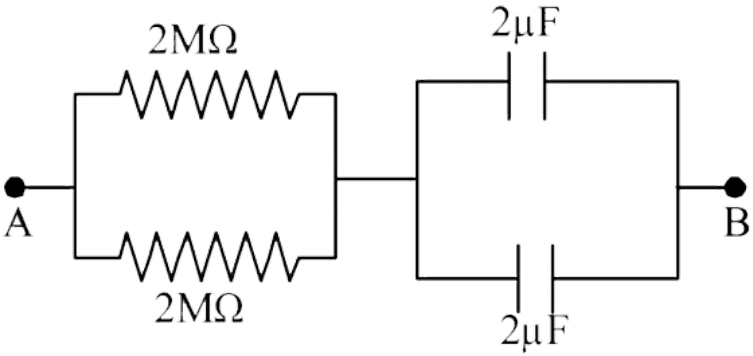
5. At time t=0, a battery of 10 V is connected across points A and B in the given circuit. If the capacitors have no charge initially, at what time (in seconds) does the voltage across them beocme 4V? $[Take: In5 = 1.6, In3 = 1.1]$.



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Linked Comprehension Type

1. When liquid medicine of density ρ is to put in the eye, it is done with the help of a dropper. As the bulp on the top of the dropper is pressed, a drop forms at the opening of the dropper. We wish to estimate the size of the drop. We first assume that the drop formed at the opening is spherical because that requires a minimum increase in its surface energy. To determine the size, we calculate the net vertical force due to the surface tension T when the radius of the drop is R. When this force becomes smaller than

the weight of the drop, the drop gets detached from the dropper.

If the radius of the opening of the dropper is r, the vertical force due to the surface tension on the drop of radius R (assuming r ltltR) is

A. $2\pi rT$

B. $2\pi RT$

C. $\frac{2\pi r^2 T}{R}$

D. $\frac{2\pi R^2 T}{r}$

Answer: c

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becomes smaller than the weight of the drop, the drop gets detached from the dropper.

If $r = 5 \times 10^{-4}$m $\widetilde{n} = 10^{3} kgm^{-3}$, $g = 10ms^{-2}, T = 0.11Nm^{-1}$ the radius of the drop when it detaches from the dropper is approximately

A. $1.4 \times 10^{-3}m$

B. 3.3×10^{-3} m

C. 2.0×10^{-3} m

D. 4.1×10^{-3} m

Answer: a

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A. 1.4×10^{-6} J

B. 2.7×10^{-6} J

C. 5.4×10^{-6} J

D. 8.1×10^{-6} J

Answer: b

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4. The key feature of Bohr's spectrum of hydrogen atom is the quantization of angular momentum when an electron is revolving around a proton. We will extend this to a general rotational motion to find quantized rotational energy of a diatomic molecule assuming it to be rigid.The rule to be applied is Bohr's quantization condition.

A diatomic molecule has moment of inertia I. By Bohr's quantization condition its rotational energy in the n^{th} level ($n = 0$ is not allowed) is

A. $\frac{1}{n^2}\left(\frac{h^2}{8\pi^2 I}\right)$

B. $\frac{1}{n}\left(\frac{h^2}{8\pi^2 I}\right)$

C. $n\left(\frac{h^2}{8\pi^2 I}\right)$

D. $n^2\left(\frac{h^2}{8\pi^2 I}\right)$

Answer: d

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it is found that the excitation from ground to the first excited state of rotation for the CO molecule is close to $\frac{4}{\pi} \times 10^{11} Hz$ then the moment of inertia of CO molecule about its

center of mass is close to

$(Takeh = 2\pi \times 10^{-34} Js)$

A. $2.76 \times 10^{-64} kgm^2$

B. $1.87 \times 10^{-64} kgm^2$

C. $4.67 \times 10^{-47} kgm^2$

D. $1.17 \times 10^{-47} kgm^2$

Answer: b

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In a CO molecule, the distance between $C(mass = 12a.\,m.\,u)$ and $O(mass = 16a.\,m.\,u)$ where $1a.\,m.\,u = \frac{5}{3} \times 10^{-27} kg$, is close to

A. 2.4×10^{-10} m

B. 1.9×10^{-10} m

C. 1.3×10^{-10} m

D. 4.4×10^{-11} m

Answer: c

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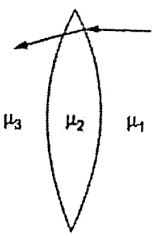
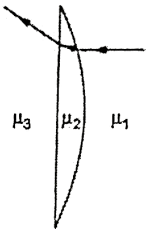
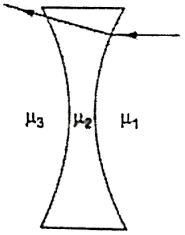
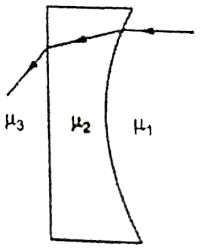
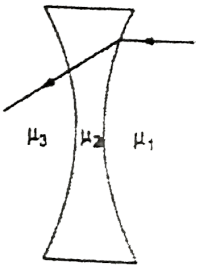
Matrix Matching Type

1. Two transparent media of refractive indices μ_1 and μ_3 have a solid lens shaped transparent

material of refractive index μ_2 between them as shown in figures in Columns B. A ray traversing these media is also shown in the figures. In Column A different relationships between μ_1, μ_2 and μ_3 are given. Match them to the ray

diagrams shown in Columns B.

Column A	Column B
(a) $\mu_1 < \mu_2$	(p) 
(b) $\mu_1 > \mu_2$	(q) 
(c) $\mu_2 = \mu_3$	(r) 
(d) $\mu_2 > \mu_3$	(s) 
	(t) 

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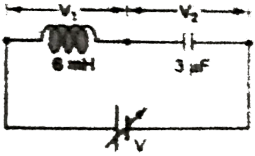
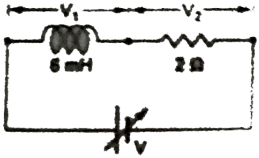
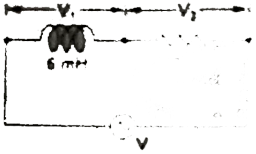
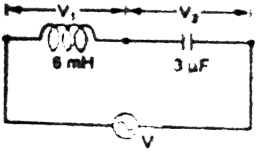
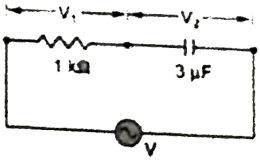
2. Two are given many resistance, capacitors and inductors . These are connected to a variable DC voltage source (the first two circuits) or an AC voltage source of 50Hz frequency (the next three circuits) in different ways as shown in Column B. When a current I (steady state for DC or rms for AC) flows through the circuit, the corresponding voltage V_1 and V_2 (indicated in circuits) are related as shown in Column A .

Match the two

Column A		*Column B*
(a) $I \neq 0, V_1$ is proportional to I	(p)	
(b) $I \neq 0, V_2 > V_1$	(q)	
(c) $V_1 = 0, V_2 = V$	(r)	
(d) $I \neq 0, V_2$ is proportional to I	(s)	
	(t)	

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