PHYSICS

BOOKS - JEE ADVANCED PREVIOUS YEAR

MOCK TEST 2022

Questions

1. Consider a spherical gaseous cloud of mass density $\rho(r)$ in a free space where r is the radial distance from its centre. The gaseous cloud is made of particle of equal mass m moving in circular orbits about their common centre with the same kinetic energy K. The force acting on the particles is their mutual gravitational force. If $\rho(r)$ is constant with time. the particle number density n(r)=$\rho(r)$ /m is : (g =universal gravitational constant)

A. $\dfrac{k}{2\pi r^2 m^2 G}$

B. $\dfrac{k}{\pi r^2 m^2 G}$

C. $\dfrac{3k}{\pi r^2 m^2 G}$

D. $\dfrac{k}{6\pi r^2 m^2 G}$

Answer:

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2. A thin spherical indulating shell of radius R caries a uniformly distributed charge such that the potential act its surface is V_0. A hole with small area $\alpha 4\pi R^2 (\alpha < \, < 1)$ is made in the shell without effecting the rest of the shell. Which one of the following is correct.

A. The potential at the center of the shell is reduced by $2\alpha V_0$

B. The magnitude of electric field at the center of the shell is reduced by $\frac{\alpha V_0}{2R}$

C. The ratio of the potential at the center of the shell to that of the point at $1/2$ R from center towards the hole will be

$$\frac{1-\alpha}{1-2\alpha}$$

D. The magnitude of electric field at a point, located on a line passing through the hole and shell's center, on a distance 2R from the center of the spherical shell will be reduced by $\frac{\alpha V_0}{2R}$

Answer:

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3. A current carrying wire heats a metal rod. The wire provides a constant power P to the rod. The metal rod is enclosed in an insulated container. It is observed that the temperature

(T) in the metal rod change with the (t) as

$T(t) = T_0\left(1 + \beta t^{1/4}\right)$ where β is a constant

with appropriate dimension of temperature.

the heat capacity of metal is :

A. $\dfrac{4P(T(t) - T_0)^2}{\beta^4 T_0^4}$

B. $\dfrac{4P(T(t) - T_0)^4}{\beta^4 T_0^5}$

C. $\dfrac{4P(T(t) - T_0)^2}{\beta^4 T_0^2}$

D. $\dfrac{4P(T(t) - T_0)}{\beta^4 T_0^2}$

Answer:

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4. In a radioactive sample. $._{19}^{40}K$ nuclei either decay into stable $._{20}^{40}Ca$ nuclei with decay constant 4.5×10^{-10} per year or into stable $._{18}^{40}Ar$ nuclei with decay constant 0.5×10^{-10} per year. Given that in this sample all the stable $._{20}^{40}Ca$ and $._{18}^{40}Ar$ nuclei are produced by the $._{19}^{40}K$ nuclei only. In time $t \times 10^{9}$ years. If the ratio of the sum of stable $._{20}^{40}Ca$ and $._{18}^{40}Ar$ nuclei to the radioactive $._{19}^{40}K$ nuclei is 99. The value of t will be. [Given : In 10 = 2.3]

A. 1.15

B. 9.2

C. 2.3

D. 4.6

Answer:

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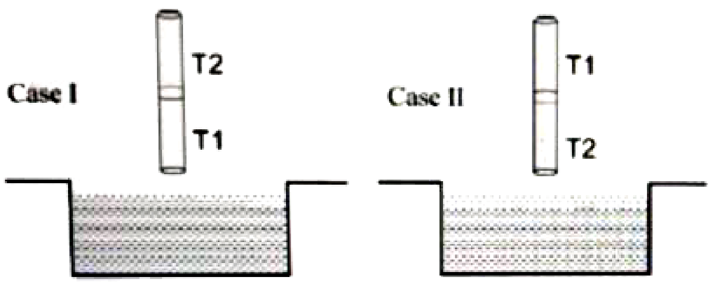
5. A cylindrical capillary tube of 0.2 mm radius is made by joining two capillaries T1 and T2 of different materials having water contact angles of 0° and 60°, respectively. The capillary tube is dipped vertically in water in two different configurations, case I and II as shown in figure. Which of the following option (s) is (are) correct?

[Surface tension of water = 0.075 N/m, density of water = 1000 kg/m^3, take g = $10m/s^2$]



A. The correction in the height of water column raised in the tube, due to weight of water contained in the meniscus, will be different for both cases.

B. For case II, if the capillary joint is 5 cm above the water surface, the height of water column raised in the tube will be 3.75 cm. (Neglect the weight of the water in the meniscus)

C. For case I, if the joint is kept at 8 cm above the water surface, the height of water column in the tube will be 7.5 cm.

(Neglect the weight of the water in the meniscus)

D. For case I, if the capillary joint is 5 cm above the water surface, the height of water column raised in the tube will be more than 8.75 cm. (Neglect the weight of the water in the meniscus)

Answer:

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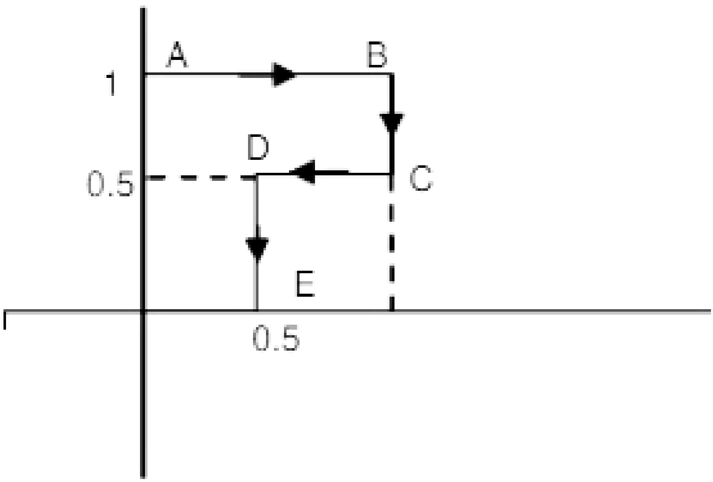
6. Conducting wire of parabolic shape, initially $y = x^2$ is moving with velocity $\overrightarrow{V} = v_0\hat{i}$ in a non-uniform magnetic field $\overrightarrow{B} = B_0\left(1 + \left(\frac{y}{L}\right)^{\beta}\right)\hat{k}$ as shown in figure. If V_0, B_0L and B are +ve constant $\Delta\phi$ is potential difference develop between the ends of wire, then correct statements (s) is/are



A. $|\Delta\phi| = \frac{1}{2}B_0V_0L \text{ for } \beta = 0$

B. $|\Delta\phi| = \frac{4}{3}B_0V_0L \text{ for } \beta = 2$

C. $|\Delta\phi|$ remains the same if the parabolic wire is replaced by a straight wire, y = x initially, of length $\sqrt{2}L$

D. $|\Delta\phi|$ is proportional to the length of the wire projected on the y-axis.

Answer:

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7. In the circuit shown, initially there is no change on capacitors and keys S_1 and S_2 are open. The values of the capacitors are $C_1 = 10\mu F, C_2 = 30\mu F$ and $C_3 = C_4 = 80\mu F$

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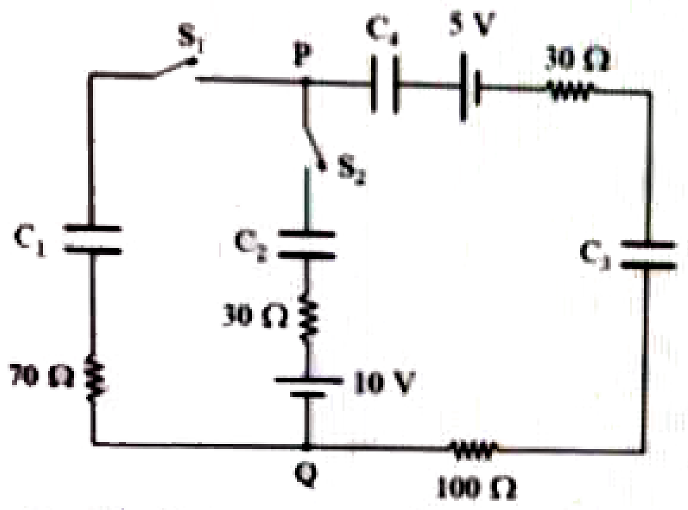

Which of the statement (s) is/are correct?

A. At time t = 0, the key S_1 is closed, the instantaneous current in the closed circuit will be 25 mA.

B. If key S_1 is kept closed for long time such that capacitors are fully charged, the voltage across the capacitor C_1 will be 4 V.

C. The key S_1 is kept closed for long time such that capacitors are fully charged, Now key S_2 is closed, at this time, the instantaneous current across 30Ω resistor (between points P and Q) will be 0.2 A (round off to 1^{st} decimal place).

D. If key S_1 is kept closed for long time such that capacitors are fully charged, the voltage difference between points P and Q will be 10 V.

Answer:

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8. A charged shell of radius R carries a total charge Q. Given ϕ as the flux of electric field through a closed cylindrical surface of height h, radius r & with its centre same as that of the shell. Here centre of cylinder is a point on the axis of the cylinder which is equidistant from its top & bottom surfaces. which of the followintg are correct.

A. If $h > 2R$ and $r > R$ then $\Phi = Q/\in_0$

B. If $h < 8R/5$ and $r = 3R/5$ then $\Phi = 0$

C. If $h > 2R$ and $r = 3R/5$ then

$\Phi = Q/5 \in_0$

D. If $h \to 2R$ and $r = 4R/5$ then

$\Phi = Q/5 \in_0$

Answer:

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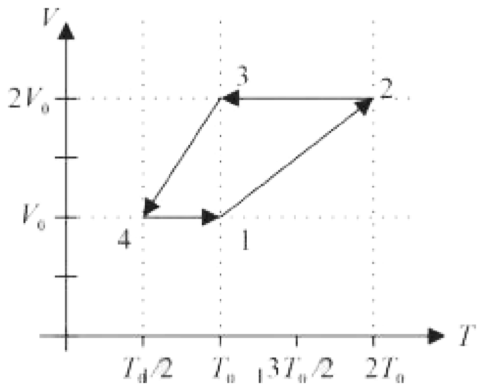
9. One mole of a monatomic ideal gas goes through a thermodynamic cycle, as shown in the volume versus temperature diagram. The correct statement(s) is(are) :



A. Work done in this thermodynamic cycle $(1 \rightarrow 2 \rightarrow 3 \rightarrow 4 \rightarrow 1)$ is $|W| = \frac{1}{2} RT_0$

B. The above thermodynamic cycle exhibits only isochoric and adiabatic processes.

C. The ratio of heat transfer during processes $1 \rightarrow 2$ and $2 \rightarrow 3$ is $\left|\frac{Q_{1 \rightarrow 2}}{Q_{2 \rightarrow 3}}\right| = \frac{5}{3}$

D. The ratio of heat transfer during processes $1 \rightarrow 2$ and $3 \rightarrow 4$ is $\left|\frac{Q_{1 \rightarrow 2}}{Q_{3 \rightarrow 4}}\right| = \frac{1}{2}$

Answer:

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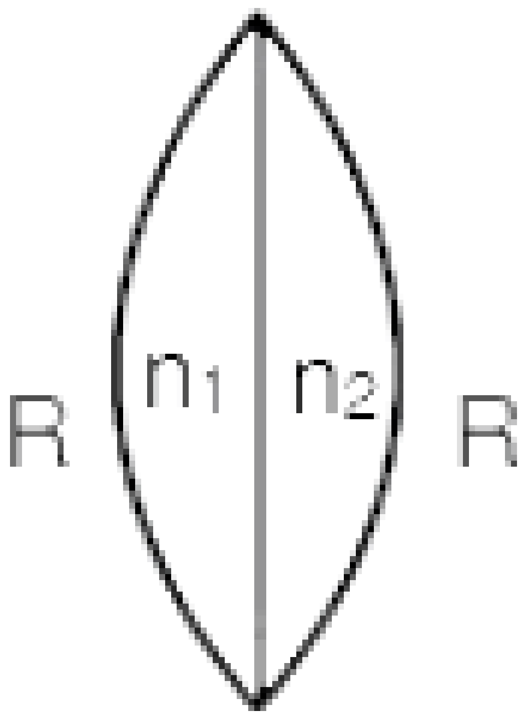
10. Consider two palne convex lanse of same radius of curvature and refrective index n_1 and n_2 respectively. Now consider two cases :



Case - I : When $n_1 = n_2 = n$, then equivalent focal length of length is f_0

Case - II : When $n_1 = n, n_2 = n + \Delta n$, then equilivant focal length of lens is $f = f_0 + \Delta f_0$

Then correct options are :

A. $\left|\frac{\Delta f}{f}\right| < \left|\frac{\Delta n}{n}\right|$

B. For $n = 1.5, \Delta n = 10^{-3}$ and f=20 cm, the value of $|\Delta f|$ will be 0.02 cm (round off to 2^{nd} decimal place).

C. If $\frac{\Delta n}{n} < 0$ then $\frac{\Delta f}{f} > 0$

D. The relation between $\frac{\Delta f}{f}$ and $\frac{\Delta n}{n}$ remains unchanged if both the convex surfaces are replaced by concave surfaces of the same radius of curvature.

Answer:

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11. Let us consider a system of units in which mass and angular momentum are dimensionless. If length has dimension of L, which of the following statement(s) is/are correct?

A. The dimension of linear momentum is

L^{-1}

B. The dimension of energy is L^{-2}

C. The dimension of force is L^{-3}

D. The dimension of power is L^{-5}

Answer:

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12. Two identical moving coil galvanometers have 10Ω resistance and full scale deflection at $2\mu A$ current. One of them is converted into a voltmeter of 100mA full scale reading and the other into an Ammeter of 1mA full scale current using appropriate resisters. These are then used to measure the voltage and current in the Ohm's law experiment with $R = 1000\Omega$ resistor by using an ideal cell. Which of the following statement(s) is(are) correct?

A. The resistance of the Voltmeter will be

100 $k\Omega$

B. The resistance of the Ammeter will be

0.02 Ω (round off to 2^{nd} decimal place)

C. The measured value of R will be

$978\Omega < R < 982\Omega$

D. If the ideal cell is replaced by a cell

having internal resistance of 5Ω then

the measured value of R will be more

than 1000 Ω

Answer:

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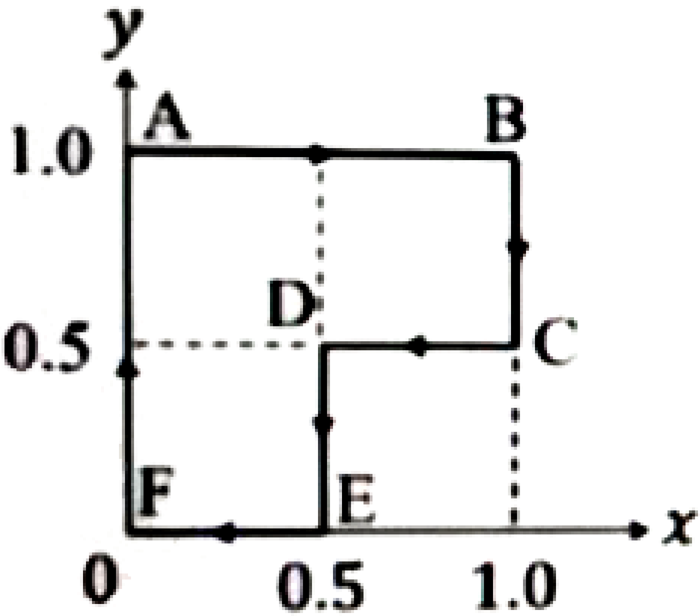
13. A particle is moved along a path AB-BC-CD-DE-EF-FA, as shown in figure, in presence of a force $\overrightarrow{F} = \left(\alpha y\hat{i} + 2\alpha x\hat{j}\right)N$, where x and y are in meter and $\alpha = -1Nm^{-1}$. The work done on the particle by this force $\overrightarrow{F}$ will be

_____ Joule.



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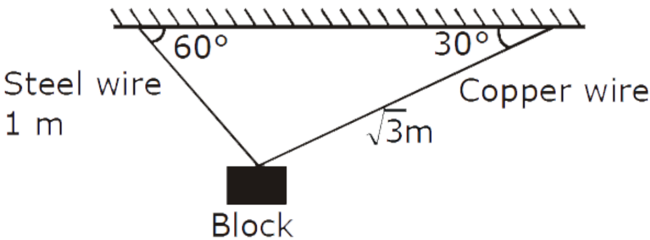
14. A block of weight 100 N is suspended by copper and steel wires of same cross sectional area $0.5 cm^2$ and, length $\sqrt{3}$ m and 1m, respectively. Their other ends are fixed on a ceiling as shown in figure. The angles subtended by copper and steel wires with ceiling are 30° and 60°, respectively. If elongation in copper wire is (Δl_C) and elongation in steel wire is (Δl_s), then the ratio $\dfrac{\Delta l_C}{\Delta l_s}$ is -



[Young's modulus for copper and steel are

$1 \times 10^{11} N / m^2$ and $2 \times 10^{11} N / m^2$,

respectively]

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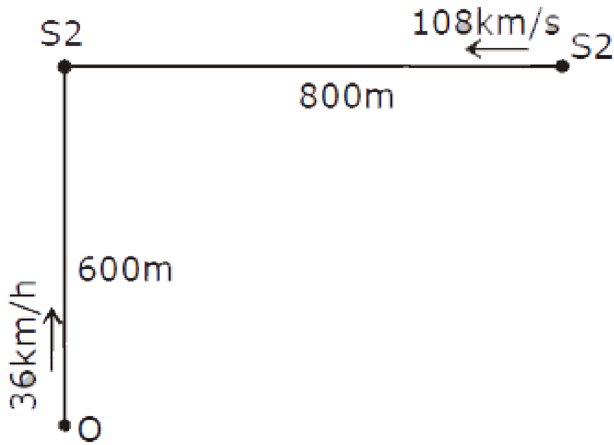
15. A train S1, moving with a uniform velocity of 108 km/h, approaches another train S2 standing on a platform. An observer O moves with a uniform velocity of 36 km/h towards S2, as shown in figure. Both the trains are blowing whistles of same frequency 120Hz. When O is 600 m away form S2 and distance between S1 and S2 is 800 m, the number of beats heard by O is .... [Speed of the sound = 330 m/s]



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16. A parallel plate capacitor of capacitance C has spacing d between two plates having area A. The region between the plates is filled with

N dielectric layers, parallel to its plates, each with thickness $\delta = \frac{d}{N}$ .The dielectric constant of the m^{th} layer is $K_m = K\left(1 + \frac{m}{N}\right)$. For a very large $N(< 10^3)$, the capacitance C is $\alpha\left(\frac{k \in_0 A}{d 1 n 2}\right)$ .The value of $\alpha will be$. [in _0 ` is the permittivity of free space]

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17. A liquid at 30°C is poured verly slowly into a Calorimeter that is at temperature of 110°C.

The boiling temperature of the liquid is 80°C. It is found that the first 5 gm of the liquid completely evaporates. After pouring another 80 gm of the liquid the equilibrium temperature is found to be 50°C. The ratio of the Latent heat of the liquid to its specific heat will be ____C°.

[Neglect the heat exchange with surrounding.]

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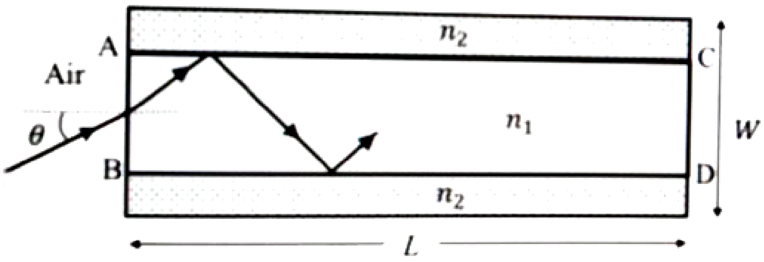
18. A planar structure of length L and width W is made of two different optical media of refractive indices $n_1 = 1.5$ and n_2 = 1.44 as shown in figure. If $L >> W$, a ray entering from end AB will emerge from end CD only if the total internal reflection condition is met inside the structure. For L = 9.6 m, if the incident angle θ is varied, the maximum time taken by a ray to exit the plane CD is $t \times 10^{-9}$ s, where t is_____.

[Speed of light $c = 3 \times 10^8 m / s$]



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