1.The relative error in the determination of the surface area of a sphere is α. Then the relative error in the determination of its volume is:

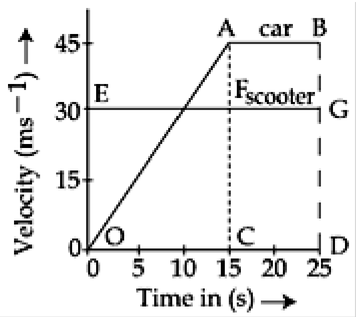
A. $\frac{3}{2}\alpha$

B. $\frac{2}{3}\alpha$

C. $\frac{5}{2}\alpha$

D. α

2.The velocity-time graphs of a car and a scooter are shown in the figure. (i) The difference between the distance travelled by the car and the scooter in 15 s and (ii) the time at which the car will catch up with the scooter are, respectively.



A. 112.5 m and 22.5 s

B. 337.5 m and 25 s

C. 112.5 m and 15 s

D. 225.5 m and 10 s

3.A given object takes n times more time to slide down a 45^{0} rough inclined plane as it takes to slide down a perfectly smooth 45^{0} incline. The coefficient of kinetic friction between the object and the incline is :

A. $\frac{1}{2-n^2}$

B. $1-\frac{1}{n^2}$

C. $\sqrt{1-\frac{1}{n^2}}$

D. $\sqrt{\frac{1}{1-n^2}}$

4.An automobile, travelling at 40 km/h, can be stopped at a distance of 40 m by applying brakes. If the same automobile is travelling at 80 km/h, the minimum stopping distance, in metres, is (assume no skidding):

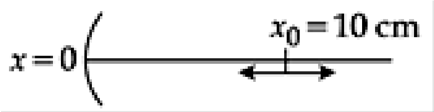
A. 75 m

B. 100 m

C. 150 m

D. 160 m

5.A particle is oscillating on the X-axis with amplitude 2 cm about the point $x_0 = 10$ cm, with a frequency ω. A concave mirror of focal length 5 cm is placed at the origin (see figure).



Identify the correct statements.

1) The image executes periodic motion.

2) The image executes non-periodic motion.

3) The turning points of the image are asymmetric w.r.t. the image of the point at $x = 10$ cm.

4) The distance between the turning points of the oscillation of the image is $\frac{100}{21}$ cm.

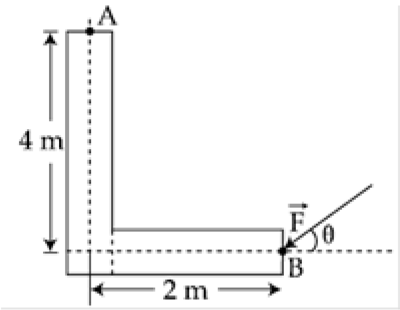
A. (1), (4)

B. (1), (3), (4)

C. (2), (4)

D. (2), (3)

6.A force of 40 N acts on a point B at the end of an L-shaped object, as shown in the figure. The angle θ that will produce maximum moment of the force about point A is given by :



A. $\tan\theta = \frac{1}{2}$

B. $\tan\theta = 2$

C. $\tan\theta = 4$

D. $\tan\theta = \frac{1}{4}$

7.A body of mass m is moving in a circular orbit of radius R about a planet of mass M. At some instant, it splits into two equal masses. The first mass moves in a circular orbit of radius $\frac{R}{2}$, and the other mass, in a circular orbit of radius $\frac{3R}{2}$. The difference between the final and initial total energies is :

A. $-\frac{GMm}{2R}$

B. $+\frac{GMm}{6R}$

C. $\frac{GMm}{2R}$

D. $-\frac{GMm}{6R}$

8.Take the mean distance of the moon and the sun from the earth to be 0.4×10^6 km and 150×10^6 km respectively. Their masses are 8×10^{22} kg and 2×10^{30} kg respectively. The radius of the earth is 6400 km. Let ΔF_1 be the difference in the forces exerted by the moon at the nearest and farthest points on the earth and ΔF_2 be the difference in the force exerted by the sun at the nearest and farthest points on the earth. Then, the number closest to $\frac{\Delta F_1}{\Delta F_2}$ is:

A. 2

B. 10^{-2}

C. 0.6

D. 6

9.A thin uniform tube is bent into a circle of radius r in the vertical plane. Equal volumes of two immiscible liquids, whose densities are ρ_1 and $\rho_2 (\rho_1 > \rho_2)$, fill half the circle. The angle θ between the radius vector passing through the common interface and the vertical is :

A. $\theta = \tan^{-1}\left(\frac{\rho_1}{\rho_2}\right)$

B. $\theta = \tan^{-1}\left(\frac{\rho_2}{\rho_1}\right)$

C. $\theta = \tan^{-1}\left[\left(\frac{\rho_1 - \rho_2}{\rho_1 + \rho_2}\right)\right]$

D. $\theta = \tan^{-1}\left(\frac{\rho_1 + \rho_2}{\rho_1 - \rho_2}\right)$

10.A Carnot’s engine works as a refrigerator between 250 K and 300 K. It receives 500 cal heat from the reservoir at the lower temperature. The amount of work done in each cycle to operate the refrigerator is:

A. 420 J

B. 772 J

C. 2100 J

D. 2520 J

11.One mole of an ideal monoatomic gas is compressed isothermally in a rigid vessel to double its pressure at room temperature, $27^{o}C$. The work done on the gas will be :

A. 300 R
B. 300 R ln 6
C. 300 R ln 2
D. 300 R ln 7

12.A body of mass M and charge q is connected to a spring of spring constant k. It is oscillating along x-direction about its equilibrium position, taken to be at $x = 0,$ with an amplitude A. An electric field E is applied along the x-direction. Which of the following statements is correct?

A. The new equilibrium position is at a distance $\frac{q\,E}{2\,K}$ from $x = 0.$

B. The total energy of the system is $\frac{1}{2}m\omega^2A^2 + \frac{1}{2}\frac{q^2E^2}{k}.$

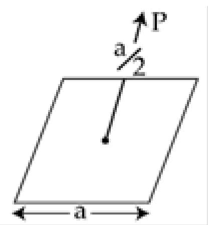
C. The total energy of the system is $\frac{1}{2}m\omega^2A^2 - \frac{1}{2}\frac{q^2E^2}{k}.$

D. The new equilibrium position is at a distance $\frac{2\,q\,E}{K}$ from $x = 0.$

13.A tuning fork vibrates with frequency 256 Hz and gives one beat per second with the third normal mode of vibration of an open pipe. What is the length of the pipe? (Speed of sound in air is 340 ms^{-1})

A. 220 cm
B. 190 cm
C. 180 cm
D. 200 cm

14.A charge Q is placed at a distance a/2 above the centre of the square surface of edge a as shown in the figure



The electric flux through the square surface is :

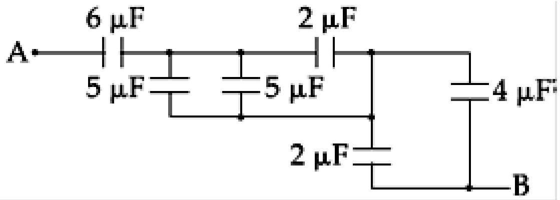
A. $\frac{Q}{\epsilon_0}$

B. $\frac{Q}{2\,\epsilon_0}$

C. $\frac{Q}{3\,\epsilon_0}$

D. $\frac{Q}{6\,\epsilon_0}$

15.The equivalent capacitance between A and B in the circuit given below, is :



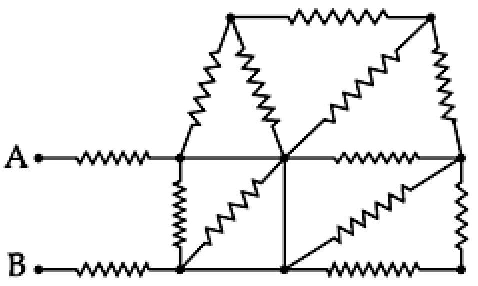
A. 2.4 μF

B. 4.9 μF

C. 3.6 μF

D. 5.4 μF

16.In the given circuit all resistances are of value R ohm each. The equivalent resistance between A and B is :

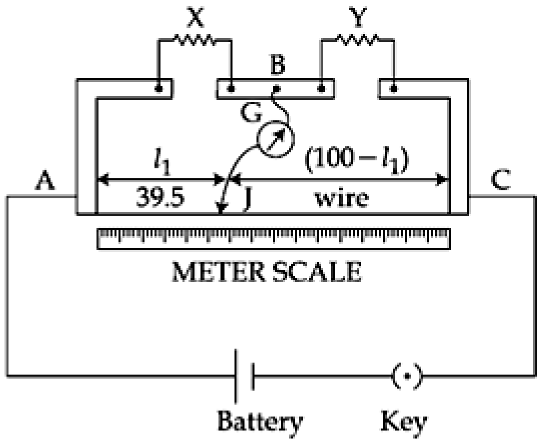


A. 2R

B. 3R

C. $\frac{5R}{3}$

D. $\frac{5R}{2}$

17. 

In a meter bridge, as shown in the figure, it is given that resistance Y=12.5 Ω and that the balance is obtained at a distance 39.5 cm from end A (by Jockey J). After interchanging the resistances X and Y, a new balance point is found at a distance l_2 from end A. What are the values of X and l_2 ?

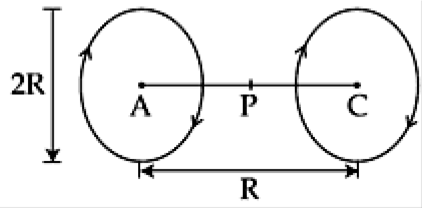
A. 8.16 Ω and 60.5 cm

B. 19.15 Ω and 39.5 cm

C. 8.16 Ω and 39.5 cm

D. 19.15 Ω and 60.5 cm

18.A Helmholtz coil has a pair of loops, each with N turns and radius R. They are placed coaxially at distance R and the same current I flows through the loops in the same direction. The magnitude of magnetic field at P, midway between the centres A and C, is given by [Refer to figure given below] :



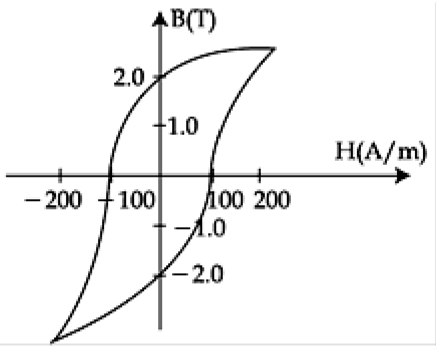
A. $\dfrac{8\ N\ \mu_0 I}{5^{1/2} R}$

B. $\dfrac{8\ N\ \mu_0 I}{5^{3/2} R}$

C. $\dfrac{4\ N\ \mu_0 I}{5^{1/2} R}$

D. $\dfrac{4\ N\ \mu_0 I}{5^{3/2} R}$

19.The B-H curve for a ferromagnet is shown in the figure. The ferromagnet is placed inside a long solenoid with 1000 turns/cm. The current that should be passed in the solenoid to demagnetise the ferromagnet completely is :



A. 1 mA

B. 2 mA

C. 20 μA

D. 40 μA

20.An ideal capacitor of capacitance 0.2 μF is charged to a potential difference of 10 V. The charging battery is then disconnected. The capacitor is then connected to an ideal inductor of self inductance 0.5 mH. The current at a time when the potential difference across the capacitor is 5 V, is :

A. 0.34 A

B. 0.25 A

C. 0.17 A

D. 0.15 A

21.A monochromatic beam of light has a frequency $\nu = \dfrac{3}{2\pi} \times 10^{12}\,\text{Hz}$ and is propagating along the direction $\dfrac{\hat{i} + \hat{j}}{\sqrt{2}}$. It is polarized along the $\hat{k}$ direction. The acceptable form for the magnetic field is :

A. $k\frac{E_0}{C}\left(\frac{\hat{i}-\hat{j}}{\sqrt{2}}\right)\cos\left[10^4\left(\frac{\hat{i}-\hat{j}}{\sqrt{2}}\right).\vec{r}-(3\times10^{12})t\right]$

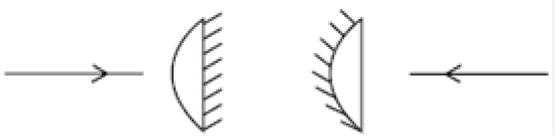
B. $\frac{E_o}{C}\frac{(\hat{i}-\hat{j})}{\sqrt{2}}\cos\left[10^4\frac{(\hat{i}-\hat{j})}{\sqrt{2}}\cdot\bar{r}-(3\times10^{12})t\right]$

C. $\frac{E_o}{C}\hat{k}\cos\left[10^4\frac{(\hat{i}+\hat{j})}{\sqrt{2}}\cdot\bar{r}+(3\times10^{12})t\right]$

D. $\frac{E_o}{C}\frac{(\hat{i}+\hat{j}+\hat{k})}{\sqrt{3}}\cos\left[10^4\frac{(\hat{i}+\hat{j})}{\sqrt{2}}\cdot\bar{r}-(3\times10^{12})t\right]$

22.A planoconvex lens becomes an optical system of 28 cm focal length when its plane surface is silvered and illuminated from left to right as shown in Fig-A.

If the same lens is instead silvered on the curved surface and illuminated from other side as in Fig.B, it acts like an optical system of focal length 10 cm. The refractive index of the material of lens is :



A. 1.50

B. 1.55

C. 1.75

D. 1.51

23.Light of wavelength 550 nm falls normally on a slit of width 22×10^{-5} cm. The angular position of the second minima from the central maximum will be (in radians) :

A. π/12

B. π/8

C. π/6

D. π/4

24.Two electrons are moving with non-relativistic speeds perpendicular to each other. If corresponding de Broglie wavelengths are λ_1 and λ_2, their de Broglie wavelength in the frame of reference attached to their centre of mass is :

A.

$\lambda_{CM} = \lambda_1 = \lambda_2$

B. $\lambda_{CM} = \frac{2\lambda_1\lambda_2}{\sqrt{\lambda_1^2+\lambda_2^2}}$

C. $\frac{1}{\lambda_{CM}} = \frac{1}{\lambda_1} + \frac{1}{\lambda_2}$

D. $\lambda_{CM} = \left(\frac{\lambda_1 + \lambda_2}{2}\right)$

25.The energy required to remove the electron from a singly ionized Helium atom is 2.2 times the energy required to remove an electron from Helium atom. The total energy required to ionize the Helium atom completely is :

A. 20 eV

B. 34 eV

C. 79 eV

D. 109 eV

26.A solution containing active cobalt $^{60}_{27}$Co having activity of 0.8 μCi and decay constant λ is injected in an animal's body. If 1 cm3 of blood is drawn from the animal's body after 10 hrs of injection, the activity found was 300 decays per minute. What is the volume of blood that is flowing in the body ? (1 Ci=3.7×10^{10} decays per second and at $t = 10$ hrs $e^{-\lambda t} = 0.84$)

A. 6 liters

B. 7 liters

C. 4 liters

D. 5 liters

27.In a common emitter configuration with suitable bias, it is given that R_L is the load resistance and R_{BE} is small signal dynamic resistance (input side). Then, voltage gain, current gain and power gain are given, respectively, by : β is current gain, I_B, I_C and I_E are respectively base, collector and emitter currents.

A. $\beta \frac{R_L}{R_{BE}}, \frac{\Delta I_C}{\Delta I_B}, \beta^2 \frac{R_L}{R_{BE}}$

B. $\beta \frac{R_L}{R_{BE}}, \frac{\Delta I_E}{\Delta I_B}, \beta^2 \frac{R_L}{R_{BE}}$

C. $\beta \frac{R_L}{R_{BE}}, \frac{\Delta I_C}{\Delta I_E}, \beta^2 \frac{R_L}{R_{BE}}$

D. $\beta \frac{R_L}{R_{BE}}, \frac{\Delta I_C}{\Delta I_B}, \beta \frac{R_L}{R_{BE}}$

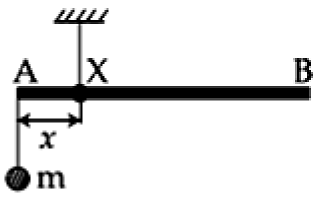
28.The number of amplitude modulated broadcast stations that can be accommodated in a 300 kHz band width for the highest modulating frequency 15 kHz will be :

A. 20

B. 15

C. 10

D. 8

29. 

A uniform rod AB is suspended from a point X, at a variable distance x from A, as shown. To make the rod horizontal, a mass m is suspended from its end A. A set of (m, x) values is recorded. The appropriate variables that give a straight line, when plotted are

A. m, x

B. $m, \frac{1}{x}$

C. $m, \frac{1}{x^2}$

D. m, x^2

30.In a screw gauge, 5 complete rotations of the screw cause it to move a linear distance of 0.25 cm. There are 100 circular scale divisions. The thickness of a wire measured by this screw gauge gives a reading of 4 main scale divisions and 30 circular scale divisions. Assuming negligible zero error, the thickness of the wire is :

A. 0.4300 cm

B. 0.2150 cm

C. 0.3150 cm

D. 0.0430 cm