PHYSICS

BOOKS - KVPY PREVIOUS YEAR

SOLVED PAPER 2018

Example

1. A table has a heavy circular top of radius $1m$ and mass $20kg$, placed on four light (considered massless) legs placed

symmetrically on its circumference. The maximum mass that can be kept anywhere on the table without toppling it is close to

A. 20kg

B. 34kg

C. 47kg

D. 59kg

Answer:

2. Air (density ρ) is the being down on soap film (surface tension T) by pipe of radius R with its opening right next to the film. The film is deformed and a bubble detached from the film when the shape of the deformed surface is a hemisphere. Given that the dynamic pressure on the film due to the air blown at speed v is $\frac{1}{2}\rho v^2$ the speed at which the bubble is formed is

A. $\sqrt{\dfrac{T}{\rho R}}$

B. $\sqrt{\dfrac{2T}{\rho R}}$

C. $\sqrt{\dfrac{4T}{\rho R}}$

D. $\sqrt{\dfrac{8T}{\rho R}}$

Answer:

3. For an ideal gas the internal energy is given by $U = 5PV/2 + C$, where C is a constant. The equation of the adiabatic in the PV plane will be

A. p^5V^7=constant

B. p^7V^5=constant

C. p^3V^5=constant

D. p^5V^2=constant

Answer:

4. A thermally insulated rigid container of one litre volume contains a diatomic ideal gas at room temperature. A small paddle installed

inside the container is rotated from the

outside such that the pressure rises by $10^5 Pa$.

The change in internal energy is close to

A. zero

B. 67 J

C. 150 J

D. 250 J

Answer:

5. In a Young's double slit experiment the amplitudes of the two waves incident on the two slits are A and $2A$. If I_0 is the maximum intensity, then the intensity at a spot on the screen where the phase difference between the two interfering waves is ϕ.

A. $I_0 \cos^2(\phi/2)$

B. $\dfrac{I_0}{3} \sin^2(\phi/2)$

C. $\dfrac{I_0}{9}(5 + 4\cos\phi)$

D. $\dfrac{I_0}{9}(5 + 8\cos\phi)$

Answer:

6. Figure below show water flowing through a horizontal pipe from left to right. Note that the pipe in the middle is narrower. Choose the most appropriate depiction of water levels in the vertical pipes.

A.

B.

C.

D.

Answer:

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7. A plank is moving in a horizontal direction with a constant acceleration $a\hat{i}$. A uniform rough cubical block of side l rests on the plank, and is at rest relative to the plank. Let the center of mass of the block be at $(0, l/2)$ at a given instant. If $a = g/10$, then the normal reaction exerted by the plank on the block at that instant acts at

   A. (0,0)

   B. (-l/20,0)

   C. (-l/10,0)

D. (l/10,0)

Answer:

8. The current is flowing along the path abcd of a cube (shown to the left) produces a magnetic field at the centre of cube of magnitude B. Dashed line depicts the non-conducting part of the cube.

Consider a cubical shape shown to the right which is identical in size and shape to the left. If the same current now flows in along the path daefgcd, then the magnitude of magnetic field at the centre will be

A. zero

B. $\sqrt{2}B$

C. $\sqrt{3}B$

D. B

Answer:

9. A thin metallic disc is rotating with constant angular velocity about a vertical axis that is perpendicular to its plane and passes through its centre. The rotation causes the free electrons in the disc to redistribute. Assume that there is no external electric or magnetic field. Then

A. a point on the rim of the disc is a higher poential than its centre

B. a point on the rim of the disc is at a

lower potential than its centre

C. a point on the rim of the disc is at the

same potential as its center

D. the potential in the material has an

extremum between center and the rim

Answer:

10. One mole of a monatomic gas and one mole of a diatomic gas are initially in the same state. Both gases are expanded isothermally and then adiabatically such that they acquire the same final state. Choose the correct statement.

A. Work done by diatomic gas is more than that by monoatomic gas

B. Work done by monoatomic gas is more than that by diatomic gas

C. Work done by both the gases are equal

D. Change in internal energies of both the

gases are equal

Answer:

11. Two balls of mass M and $2M$ are thrown

horizontally with the same initial velocity v_0

from top of a tall tower and experience a drag

force of $-kv(k > 0)$, where v is the

instantaneous velocity. Then

A. the heavier ball will hit the ground further away than the lighter ball

B. the heavier ball will hit the ground closer than the lighter ball

C. both balls will hit the ground at the same point

D. both balls will hit the ground at the same time

Answer:

12. Consider a glass cube of dielectric bound by the planes

$$x = 0, x = a, u = 0, y = b, z = 0, z = c,$$

with $b > a > c$. The slab is placed in air andhas a refractive index of n. The minimum value of n such that all rays entering the dielectric at $y = 0$ reach $y = b$ is

A. 1

B. $\sqrt{2}$

C. $\sqrt{3}$

D. 2

Answer:

13. The graph shows the log of activity $(\log R)$ of a radioactive material as a function of time t in minutes

The half -life (in minutes) for the decay is closest to
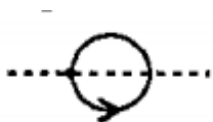
A. 2.1

B. 3

C. 3.9

D. 4.4

Answer:

14. The magnetic field is uniform for $y > 0$ and points into the plane. The magnetic field is uniform and points out of the plane for $y < 0$.

A proton denoted by filled circle leaves $y = 0$ in the y direction with some speed as shown below.

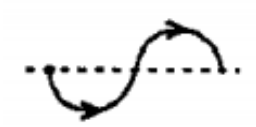Which of the following best denotes the trajectory of the proton.
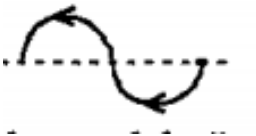
A.

B.

C.

D.

Answer:

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15. The Hitomi satellite recently observed the Lyman alpha emission line ($n = 2$ to $n = 1$) of Hydrogen-like iron ion (atomic number of iron is 26) from the Perseus galaxy cluster. The wavelength of the line is closest to

A. 2Å

B. 1Å

C. 50Å

D. 10Å

Answer:

16. Assume that the drag force on a football depends only on the density of the air, velocity of the ball and the cross-sectional area of the ball. Balls of different sizes but the same density are dropped in an air column. The terminal velocity reached by balls of masses $250g$ and $125g$ are in the ratio :

A. $2^{\frac{1}{6}}$

B. $2^{\frac{1}{3}}$

C. $2^{\frac{1}{2}}$

D. $2^{\frac{2}{3}}$

Answer:

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17. An electrostatic field line leaves at an angle α from pint change q_1 and connects with point charge $-q_2$ at an angle β (q_1 and q_2 are positive) (see figure below). If $q_2 = \dfrac{3}{2} q_1$ and

$\alpha = 30°$, then

A. $0° < \beta < 30°$

B. $\beta = 30°$

C. $30° < \beta \leq 60°$

D. $60° < \beta \leq 90°$

Answer:

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18. A wheel of radius R is trapped in a mud pit and spinning. As the wheel is spinning , it splashes mud blobs with initial speed u from various points on its circumference . the maximum height from the center of the wheel , to which mud blob can reach is

A. $u^2 / 2g$

B. $\dfrac{u^2}{2g} + \dfrac{gR^2}{2u^2}$

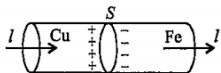C. 0

D. $R + \dfrac{u^2}{2g}$

Answer:

19. Two rods of copper and iron with the same cross sectional area are joined at S and a steady current i flows through the rods as shown in the figure
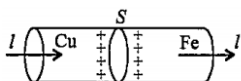

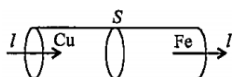Choose the most appropriate representation of charges accumulated near the junction S.

A.

B.

C.

D.

Answer:

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20. Graphs below show the entropy vs energy (U) of two systems I and II at constant volume. The initial energies of the systems are indicated by $U_{I,i}$ and $U_{II,i}$ respectively. Graphs are drawn to the same scale. The same scale . the systems are then brought into thermal contact with each other . Assume that at all Time the combined energy of the two systems remains constant. Choose the most appropriate option indicating the energies of the two systems and the total entropy after

they achieve the equilibrium.

A. U_1 increases and U_2 decreases and the

   total entropy remains the same

B. U_1 decreases and U_2 increases and the

   total entropy remains the same

C. U_1 increases and U_2 decreases and the

   total entropy increases

D. U_1 decreases and U_2 increases and the

   total entropy increases

Answer:

21. The image of an object O due to reflection from the surface of a lake is elongated due to the ripples on the water surface caused by a light breeze. This is because the ripples act as tilted mirrors as shown. Consider the case where O and the observer E are at the same height above the surface of the lake. If the maximum angle that the ripples make with the

horizontal is a, the angular extent δ of the image will be

A. $\dfrac{\alpha}{2}$

B. α

C. 2α

D. 4α

Answer:

22. A spiral galaxy can be approximated as an infinitesimally thin disk of a uniform surface mass density (mass per unit area) located at $z = 0$. Two stars A and B start from rest from heights $2z_0$ and z_0 ($z_0 < <$ radial extent of the disk), respectively, and fall towards the disk, cross over to the other side, and execute periodic oscillations. The ratio of time periods of A and B is

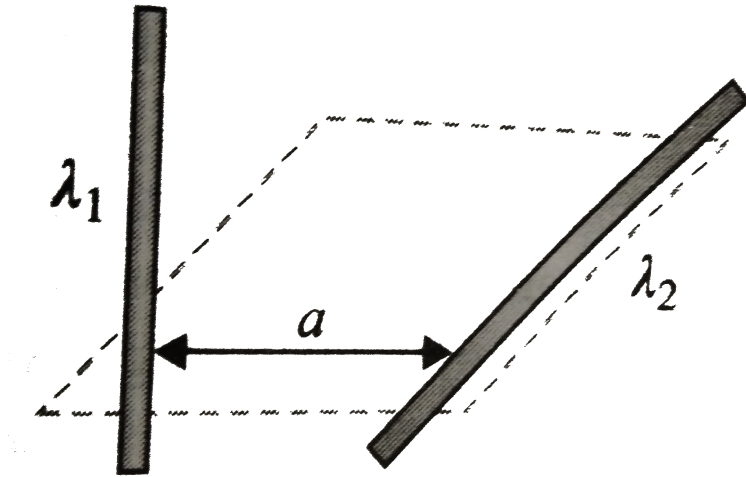   A. $2^{-1/2}$

    B. 2

C. 1

D. $2^{1/2}$

Answer:

23. Two mutually perpendicular long straight conductors carrying uniformly distributed charges of linear charges densities λ_1 and λ_2 are position at a distance a from each other. How does the interaction between the rods

depends on a ?

A. I/r

B. I/r^2

C. r

D. r^0

Answer:

24. The graph below shows the variation of a force (F) with time (t) on a body which is moving in a straight line. Dependence of force on time is $F \propto t^n$. Initially body is rest.

If the speed of the object is $2m/s$ at $3s$, the speed at $4s$ will be approximately (m/s)

    A. 2.5

    B. 6.5

C. 7.8

D. 3.1

Answer:

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