

Physics Q&A for ESSLCE Preparation

1. A mass suspended from the end of a spring vibrates up and down 24 times in 36s. What are the frequency and period of the vibration?

A 1.5Hz, 0.67s

C 0.0012Hz, 854s

B 0.67Hz, 1.5s

D 864Hz, 0.0012s

Solution



T = 36 seconds Number of oscillation = 24 cycle, f=?

T = Time taken / Number of oscillation

$$= 36/24$$

$$= 1.5s$$

$$f = 1/T$$

$$= 1/1.5s$$

$$= 0.67Hz$$

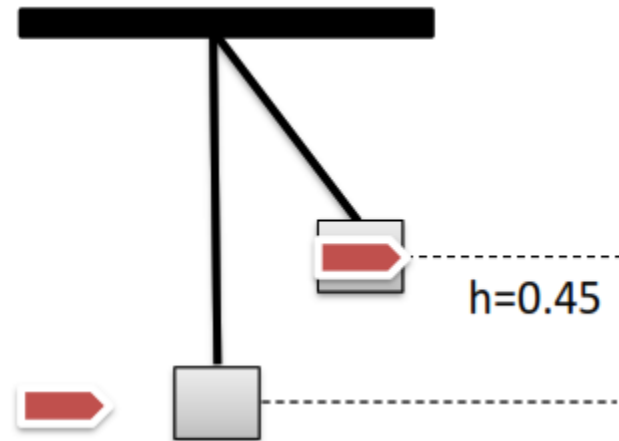
Answer B



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2. A bullet of mass 10gm, moving horizontally, strikes and embeds itself in a box of mass 1kg suspended from a light string as shown in the figure below. If the composite mass rises to a height, $h = 0.45\text{m}$, then what is the speed of the bullet before collision?

- A 303m/s
- B 300m/s
- C 90.9m/s
- D 90m/s



Solution



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$$m_1 = 10\text{kg} = 0.01\text{Kg}, m_2 = 1\text{Kg}, V = ?$$

$$m_1 u_1 = (m_1 + m_2) V$$

$$v = \sqrt{2gh}$$

$$= \sqrt{(2)(10)(0.45)} = 3\text{m/s}$$

$$u_1 = \frac{m_1 + m_2}{m_1} V$$

$$u_1 = \frac{0.01 + 1}{0.01} (3)$$

$$= 303 \text{ m/s}$$

Answer A



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3. The electric potential at a distance of 2cm from a $-1.6 \times 10^{-9}\text{C}$ point charge is (2014/15 E.C)

A -720V

C 720V

B 4.4V

D -14.4V

Solution

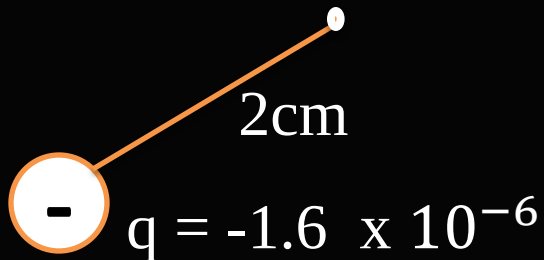


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$$K = 9 \times 10^{-9}$$

$$r = 2\text{cm} = 2 \times 10^{-2}\text{m}$$

$$V = ?$$



$$V = \frac{Kq}{r}$$

$$= \frac{(9 \times 10^{-9})(-1.6 \times 10^{-6})}{2 \times 10^{-2}}$$

$$= -720\text{V}$$

Answer A



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4. According to the work-energy theorem, (2014/15E.C)

- A** work done by gravity on an object thrown upward and moving upward is negative.
- B** work done by gravitational force on a satellite moving around the earth in a circular orbit is positive.
- C** work done by tension on an object tied to a string and moving in a horizontal circle is negative.
- D** work done by gravity on an object thrown downward is negative.

Solution



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$$\begin{aligned}W_{gravity} &= F.S \cos 180^\circ \\&= FS(-1) \\&= -FS\end{aligned}$$

$W_{gravity}$ is downward

Answer A



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5. A man is standing on a spring scale in an elevator. When the elevator is at rest, the scale reads 560N. When the elevator starts to move, the scale reads 600N. The elevator has, (2008 E.C)
- A** An upward acceleration
 - B** A constant down ward speed.
 - C** A constant upward speed
 - D** A constant upward speed

Solution



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$$W_{true} = 560N, \quad W_{apparent} = 600N, \quad g = 10 \text{ m/s}^2$$

$$W_{apparent} = W_{true} + ma$$

$$W_{apparent} > W_{true}$$

a is positive and hence the elevator is upward

or

$$m = \frac{W_{true}}{g} = \frac{560N}{10 \text{ m/s}^2} = 56Kg$$

$$a = \frac{W_{apparent} - W_{true}}{m}$$

$$= \frac{600N - 560N}{56} = 0.71 \text{ m/s}^2$$

Answer A



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6. A diode is an electronic component that

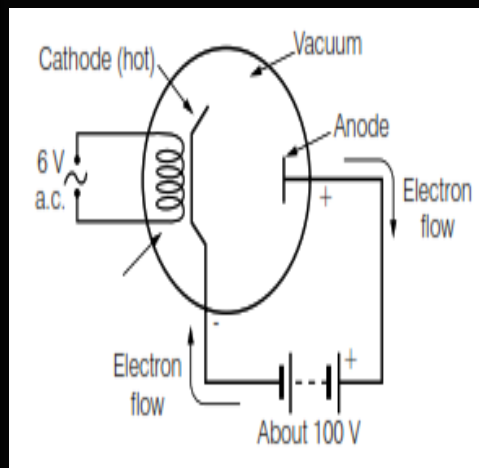
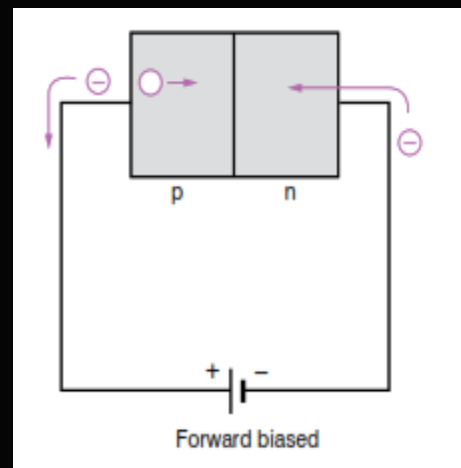
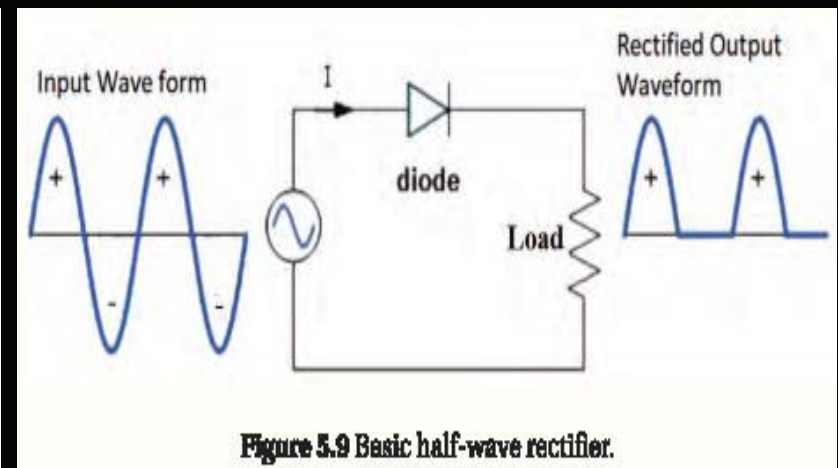
- A** allows electric current to pass through it in one direction.
- B** is useful to convert a DC voltage to AC voltage.
- C** allows current to pass through it either from cathode to anode or from anode to cathode.
- D** allows the flow of current when its p-type region is connected to the negative terminal of a cell. (2014/15 E.C)

Solution



Physics Q&A for ESSLCE Preparation

- A diode allows current in one direction



Answer A



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7. A torque τ rotates an object of mass m and moment of inertia I through an angle Θ . The work done on the object by the torque is _____ (2014/15 E.C)

A $m\Theta$

B $I\Theta$

C τI

D $\tau\Theta$

Solution



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$$\begin{aligned} W &= FS \\ &= ma\Theta r \\ &= mar\Theta r \\ &= mar^2\Theta \\ &= mr^2\alpha\Theta \\ &= I\alpha\Theta \\ &= \tau\Theta \end{aligned}$$

Answer D



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8. Moving 2.5×10^{-6} Coulomb of charge from point A to point B in an electric field requires 6.3×10^{-4} Joule of work. The potential difference between point A and B is approximately _____
(2006 E.C)

A $4 \times 10^{-3} \text{ V}$

B $1.6 \times 10^{-19} \text{ V}$

C $2.5 \times 10^2 \text{ V}$

D $1.0 \times 10^{-14} \text{ V}$

Solution



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$$Q = 2.5 \times 10^{-6} \text{ C} \quad W = 6.3 \times 10^{-4} \text{ J} \quad V_{AB} = ?$$

$$W = Q V_{AB} \quad V_{AB} = \frac{W}{Q}$$

$$= \frac{6.3 \times 10^{-4} \text{ J}}{2.5 \times 10^{-6} \text{ C}}$$

$$= 2.5 \times 10^2 \text{ V}$$

Answer C



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9. A driver of an automobile travelling at a constant speed of 20 m/s suddenly applies a brake and the automobile comes to rest in 2.0 seconds after skidding for a certain distance. What is the length of the skid distance? (2011 E. C)

A 400 m

B 40 m

C 20 m

D 10 m

Solution



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$$u = 20 \text{ m/s}, v = 0 \quad t = 2 \text{ sec} \quad S = ?$$

Constant linear acceleration

$$v = u + at$$

$$s = \frac{1}{2}(u + v)t$$

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

$$s = vt - \frac{1}{2}at^2$$

$$\begin{aligned} S &= \frac{1}{2}(u + v)t \\ &= \frac{1}{2}(20 + 0)(2) \\ &= 20 \text{ m/s} \end{aligned}$$

Answer C



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10. A parallel plate capacitor has a capacitance of $10\mu\text{F}$. If the distance between the plates is doubled, keeping all other quantities constant, what is the new capacitance of the capacitor ? (2007 E. C)

A $0.2\ \mu\text{F}$

B $5\ \mu\text{F}$

C $10\ \mu\text{F}$

D $20\ \mu\text{F}$

Solution



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$$C_1 = 10\mu F$$

$$C_2 = 0 \quad d_2 = 2d_1$$

$$C_1 = \frac{\epsilon A_1}{d_1}$$

$$C_2 = \frac{\epsilon A_2}{d_2}$$
$$= \frac{\epsilon A_2}{2d_1}$$

$$= \frac{1}{2} \frac{\epsilon A_2}{d_1} = \frac{1}{2} C_1$$

$$= \frac{1}{2} 10\mu F = 5\mu F$$



Answer B

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11. Let $C = A \times B$ and $\Theta \neq 90^\circ$, where Θ is the smaller angle between A and B when they are drawn with their tails at the same point. Which of the following is not true ? (2011 E. C)

A $-C = B \times A$

C $A \cdot C = 0$

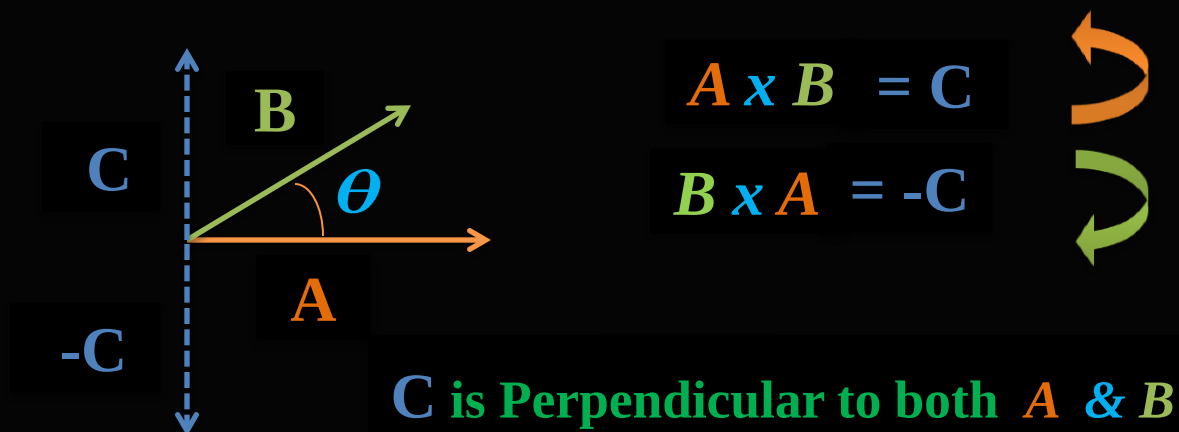
B $A \cdot B = 0$

D $|C| = |A||B| \sin \Theta$

Solution



Physics Q&A for ESSLCE Preparation



$$A \times B = |A||B| \sin \theta$$

$$B \times A = |B||A| \sin \theta$$

$$A \cdot B = |A||B| \cos \theta$$

$$A \cdot B = 0 \Leftrightarrow A \text{ is perpendicular to } B$$

Answer B



Physics Q&A for ESSLCE Preparation

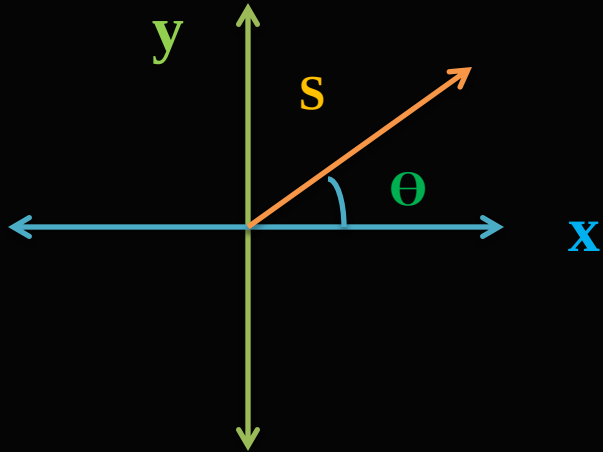
12. Position vector of an object (2010 E.C)

- A** is the measure of how fast it is moving relative to stationary reference frame
- B** is independent of the origin from which it is measured
- C** describes its distance from which it is measured
- D** describes its distance from a point in specified direction

Solution



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Position vector or displacement



Answer D

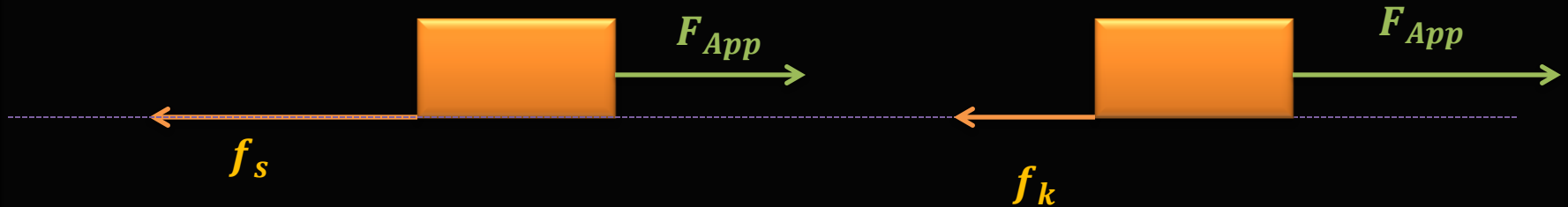
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13. Which one of the following is NOT correct about the concept and units of coefficient of friction ? (2013 E. C)
- A** The coefficient of friction is always less or equal to unity
 - B** Coefficient of static friction has no unit
 - C** Coefficient of static friction is less than its value of kinetic friction
 - D** Coefficient of friction is the ratio of frictional force to normal force

Solution



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$$f = \mu N, \quad f < 1$$

$$f_s > f_k \text{ Or } f_k < f_s$$

Answer C



Physics Q&A for ESSLCE Preparation

14. A car is traveling at constant velocity along a straight line. Which statement is correct ? (2013 E. C)

- A** The acceleration of the car is in opposite direction
- B** The net force on the car is different from zero
- C** The displacement of the car is in opposite direction.
- D** The displacement of the car increases linearly with time

Solution



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$$F_{net} = ma, u = V = \text{constant}, a = 0$$

$$F_{net} = 0$$

$$S = ut + \frac{1}{2}at^2$$

$$S = ut$$

Answer D



Physics Q&A for ESSLCE Preparation

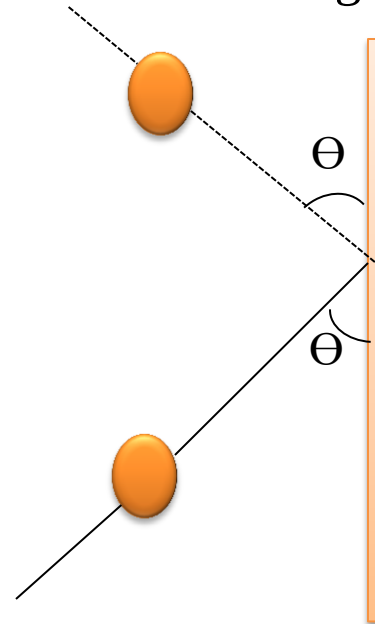
15. A ball of mass m moving with a speed v strikes a hard ball at an angle Θ with the wall. It is reflected with the same speed at the same angle as shown in the figure below. (2014/15 E. C)

A $\frac{2mv}{t} \cos \Theta$

B $\frac{2mv}{t} \sin \Theta$

C $\frac{mv}{t} \cos \Theta$

D $\frac{mv}{t} \sin \Theta$



Solution



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$$\text{Impulse} = \Delta P = F_{av}t$$

$$p_f - p_i = -F_{av}t$$

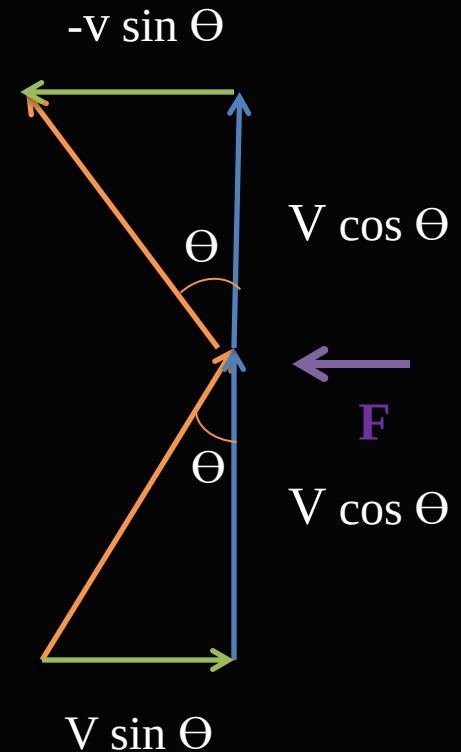
$$\begin{bmatrix} -mv \sin \Theta \\ mv \cos \Theta \end{bmatrix} - \begin{bmatrix} mv \sin \Theta \\ mv \cos \Theta \end{bmatrix} = -F_{av}t$$

$$-F_{av}t = \begin{bmatrix} -2mv \sin \Theta \\ 0 \end{bmatrix}$$

$$-F_{av}t = -2mv \sin \Theta$$

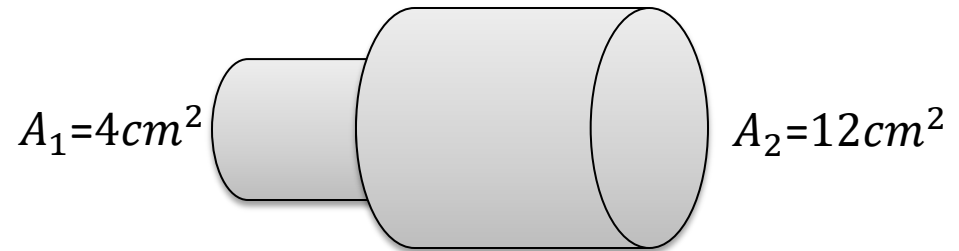
$$F_{av} = \frac{2mv \sin \Theta}{t}$$

Answer B



Physics Q&A for ESSLCE Preparation

16. In the figure below what is the speed of water as it leaves A_2 ,
2010 E.C



- A** 0.3m/s
- B** 0.9 m/s
- C** 3.3 m/s
- D** 3.6 m/s

Solution



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$$A_1 = 4\text{cm}^2, A_2 = 12\text{cm}^2 \quad v_1 = 0.9\text{ m/s} \quad v_2 = ?$$

$$\begin{aligned} A_1 v_1 &= A_2 v_2 \\ &= \frac{A_1 v_1}{A_2} \\ &= \frac{(4\text{cm}^2)(0.9\frac{\text{m}}{\text{s}})}{12\text{cm}^2} \\ &= 0.3\text{ m/s} \end{aligned}$$



Answer A

Physics Q&A for ESSLCE Preparation

17. Which of the following is a correct statement about the first condition of equilibrium? (2010 E.C)

- A** The net force on an object must be zero.
- B** The sum of all torques must be zero.
- C** Clockwise moments should balance counter clockwise moments.
- D** The torque produced by a force should be perpendicular to the force.

Solution



Physics Q&A for ESSLCE Preparation

First Condition

- The net force on an object must be zero

Second Condition

- Must satisfy first condition
- The sum of all torques must be zero

Answer A



Physics Q&A for ESSLCE Preparation

18. A crane raises 75.0 kg of bricks from the ground to a height of 45.0 m in 52.0 s at a constant speed. The average power of the crane is (2012 E.C)

A 649 W

B 14.4 W

C 144 W

D 3,375 W

Solution



Physics Q&A for ESSLCE Preparation

$g = 10\text{m/s}^2$, $m = 75\text{Kg}$, $h = 45\text{ m}$, $t = 52\text{ sec}$, $P_{av}=?$

$$P_{av} = \frac{mgh}{t} = \frac{(75)(10)(45)}{52} = 649\text{W}$$

Answer A



Physics Q&A for ESSLCE Preparation

19. A spring with spring constant of 300 N/m is stretched 20 cm in 2 seconds . What is the power applied to stretch the spring? (2012 E.C)

A 3 W

B 6 W

C 30 W

D 60 W

Solution



Physics Q&A for ESSLCE Preparation

$K = 300 \text{ N/m}$, $x = 20\text{cm} = 0.2\text{m}$, $t = 2 \text{ sec}$, $P = ?$

$$P_{av} = \frac{EPE}{t}$$

$$EPE = \frac{1}{2} kx^2 = \frac{1}{2} (300)(0.2)^2 = 6J$$

$$P_{av} = \frac{6J}{2 \text{ sec}} = 3W$$

Answer A

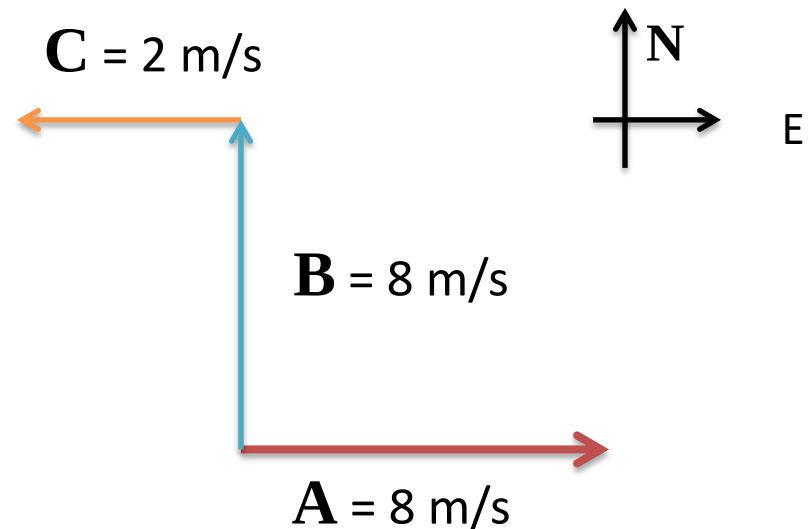


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20. Three vectors **A**, **B** and **C** are arranged as shown in the figure below with a reference direction indicator. (2011 E.C, 9th)

The resultant vector is most nearly

- A** 10 m/s North-East
- B** 6 m/s, East
- C** 18 m/s, North
- D** 10 m/s, North-West

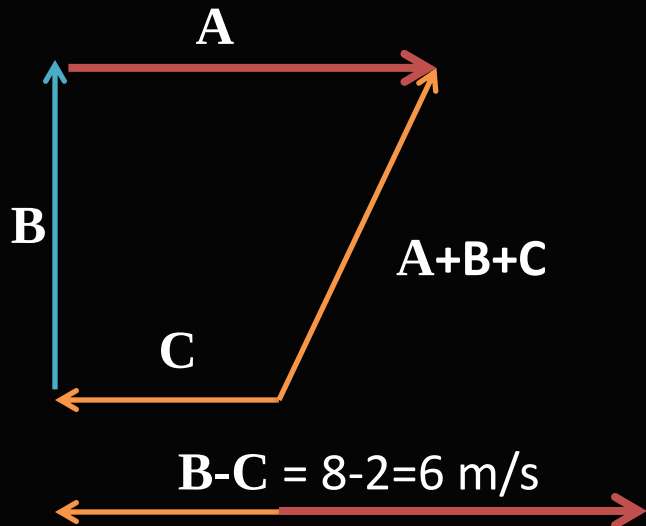


Solution



Physics Q&A for ESSLCE Preparation

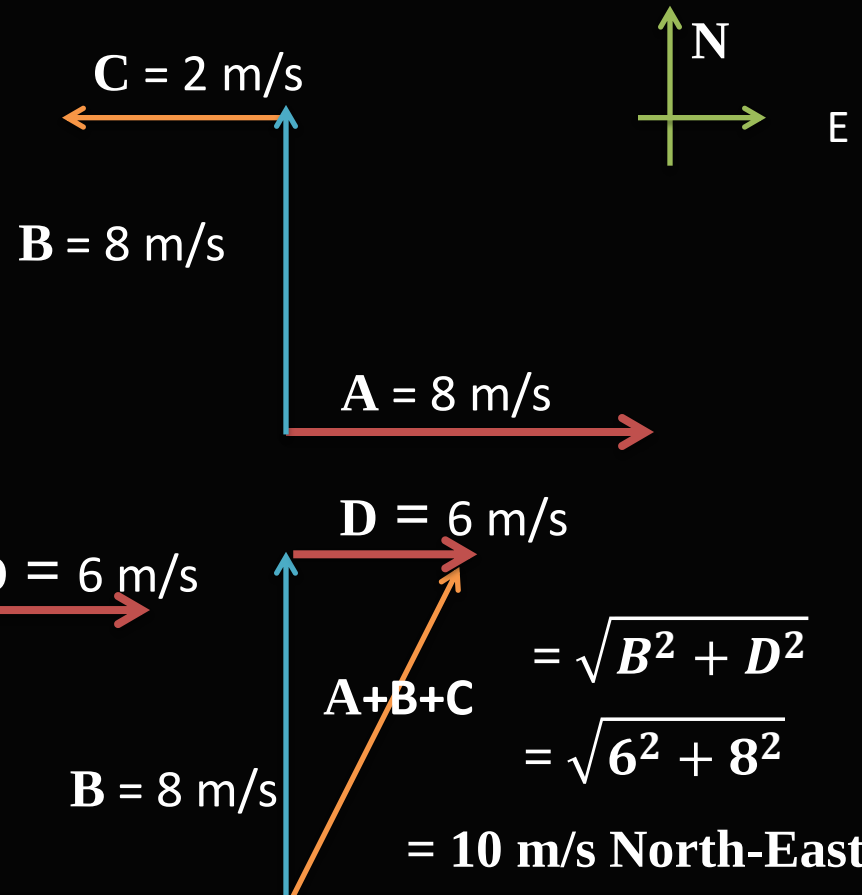
Join the vectors head to tail



$$B - C = 8 - 2 = 6 \text{ m/s}$$



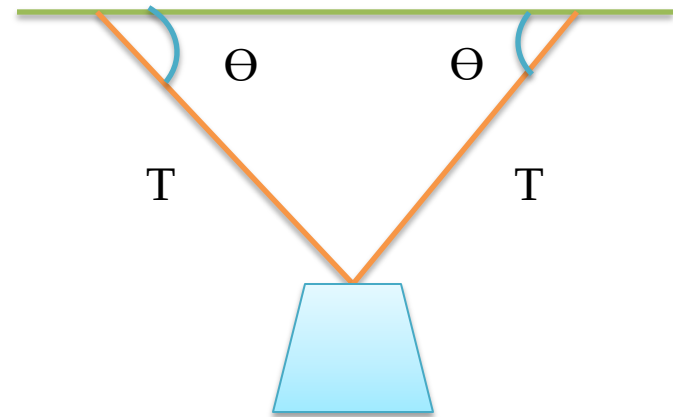
Answer A



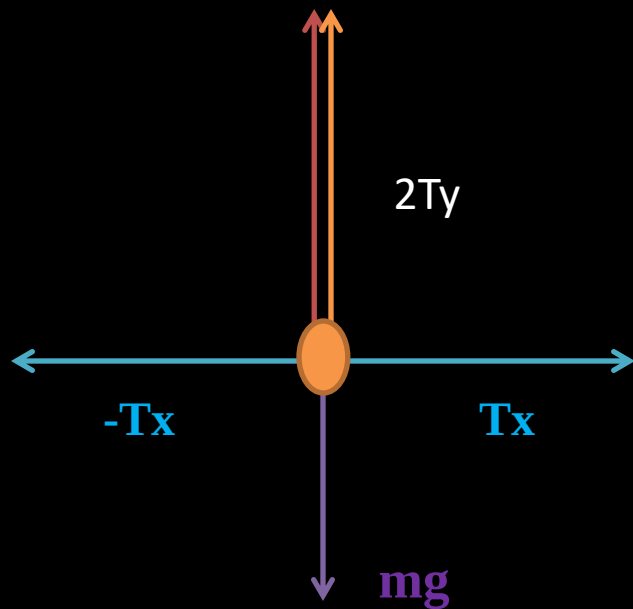
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21. A concrete block of mass m hangs from two wires. The wires make the same angle with the horizontal and the tension in them is the same as shown below. If the system is in equilibrium, what will be the tension in each wire?

- A. $T = \frac{mg}{\cos\theta}$
- B. $T = \frac{mg}{2\sin\theta}$
- C. $T = \frac{mg}{\sin\theta}$
- D. $T = \frac{mg}{2\cos\theta}$



Physics Q&A for ESSLCE Preparation



$$\sum T_x = 0 \text{ and } \sum T_y = 0$$

$$T_x + (-T_x) = 0$$

$$2T_y - mg = 0$$

$$2T_y = mg$$

$$2T \sin \theta = mg$$

$$T = \frac{mg}{2 \sin \theta}$$

Answer B

Physics Q&A for ESSLCE Preparation

22. The acceleration due to gravity on earth surface is 10 m/s^2 . What is the acceleration due to gravity on the surface of a planet $\frac{1}{5}$ the mass and $\frac{1}{2}$ radius of the earth?
- A. 8 m/s^2
 - B. 6 m/s^2
 - C. 4 m/s^2
 - D. 12 m/s^2

Physics Q&A for ESSLCE Preparation

$$M_p = \frac{1}{5} M_E$$

$$r_p = \frac{1}{2} r_E$$

- m is a small mass as a testing mass on both planets

$$F_p = \frac{GmM}{r^2}$$

$$mg_p = \frac{GmM_p}{r_p^2}$$

$$g_p = \frac{GM_p}{r_p^2}$$

$$= \frac{G \frac{1}{5} M_E}{\left(\frac{1}{2} r_E\right)^2} = \frac{\frac{1}{5}}{\frac{1}{4}} \frac{GM_E}{r_E^2} = \frac{4}{5} g_E = \frac{4}{5} 10 \text{ m/s}^2 = 8 \text{ m/s}^2$$

Answer A

Physics Q&A for ESSLCE Preparation

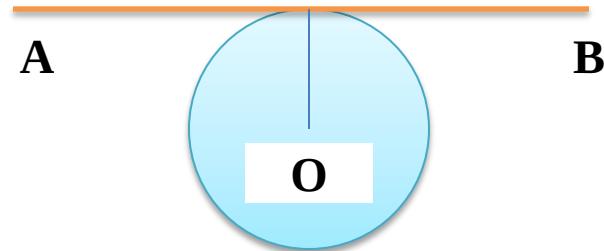
23. A thin wire of length L and uniform linear mass density ρ is bent into a circular loop with center at O . The moment of Inertia of the loop about AB is (Use: $I_{cm} = \frac{1}{2} MR^2$)

A. $2\rho L^3$

B. $\frac{3}{8} \frac{\rho L^3}{\pi^2}$

C. $\frac{3}{4} \frac{\rho L^3}{\pi^2}$

D. $3\rho L^3$



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$$\rho = \frac{M}{L}, M = \rho L \text{ and } C \text{ or } L = 2\pi R, R = \frac{L}{2\pi}$$

- According to parallel axis theorem

$$I_{AB} = I_{cm} + MR^2$$

$$= \frac{1}{2} MR^2 + MR^2$$

$$= \frac{3}{2} MR^2,$$

$$= \frac{3}{2} (\rho L) \left(\frac{L}{2\pi}\right)^2$$

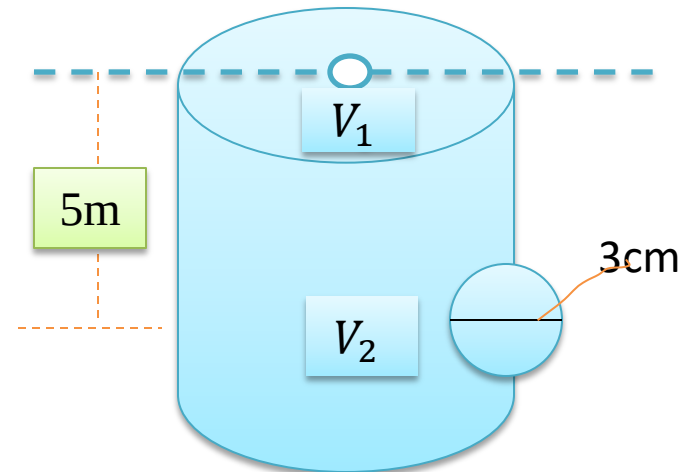
$$= \frac{3}{8} \frac{\rho L^3}{\pi^2}$$

Answer B

Physics Q&A for ESSLCE Preparation

24. What volume of water will escape per second from a hole of 3cm in diameter that is 5m below the water level in the tank?

- A. $1.5 \times 10^{-3} \text{ m}^3/\text{s}$
- B. $4.7 \times 10^{-4} \text{ m}^3/\text{s}$
- C. $4.7 \times 10^{-3} \text{ m}^3/\text{s}$
- D. $3.14 \times 10^{-4} \text{ m}^3/\text{s}$



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$$h_1 = 0, h_2 = 5m, V_1 = 0, P_1 = P_2 = P_{atm}, d=3cm$$

$$r = \frac{3cm}{2} = 1.5 \times 10^{-2}m$$

- From Bernoulli's equation;

$$= \frac{P_1}{\rho} + gh_1 + \frac{V_1^2}{2} = \frac{P_2}{\rho} + gh_2 + \frac{V_2^2}{2}$$

$$= \frac{P_{atm}}{\rho} + 0 + \frac{V_1^2}{2} = \frac{P_{atm}}{\rho} + gh_2 + \frac{V_2^2}{2}$$

$$V_2 = \sqrt{2gh_2} = \sqrt{2(10)(5)} = 10m/s$$

$$Q_2 = V_2 A_2 = (10)(\pi)(1.5 \times 10^{-2})^2$$

$$= 4.7 \times 10^{-3} m^3/s$$

Answer C

Physics Q&A for ESSLCE Preparation

25. A body floats with $\frac{1}{3}$ of its volume outside water and $\frac{3}{4}$ of its volume outside another liquid. The density of the other liquid in g/cm^3 is

A. $\frac{9}{4}$

B. $\frac{4}{9}$

C. $\frac{3}{9}$

D. $\frac{8}{3}$

Physics Q&A for ESSLCE Preparation

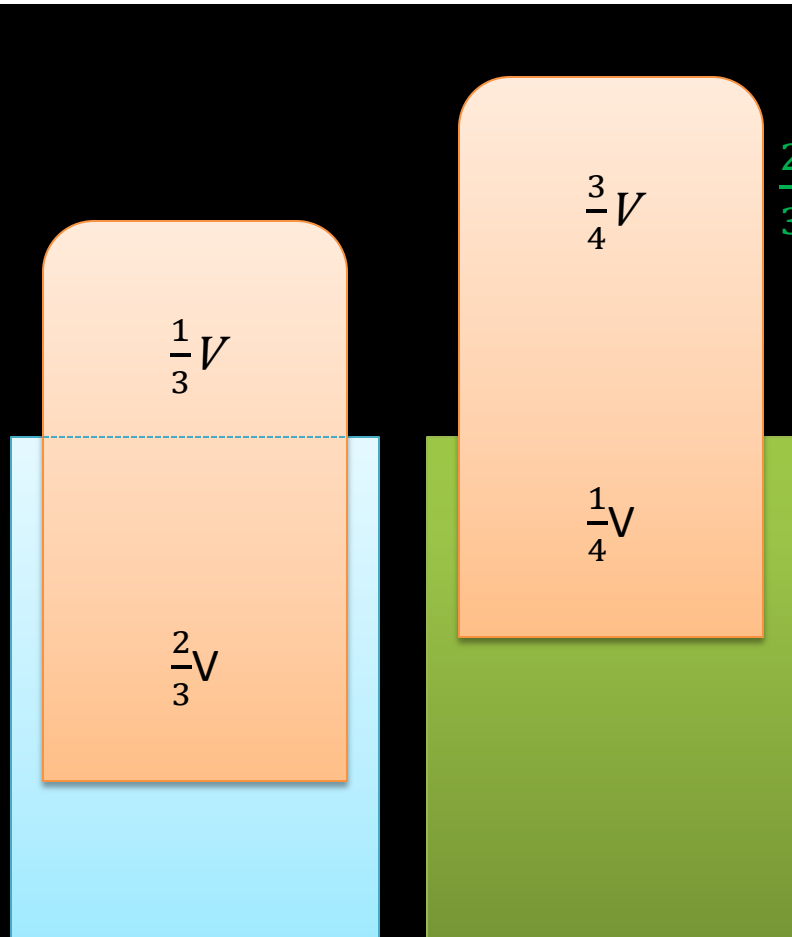


Diagram illustrating two blocks in different fluids:

- Block 1 (Left): Submerged in a light blue fluid. The volume above the surface is $\frac{1}{3}V$ and the volume submerged is $\frac{2}{3}V$.
- Block 2 (Right): Submerged in a green fluid. The volume above the surface is $\frac{3}{4}V$ and the volume submerged is $\frac{1}{4}V$.

Archimedes Principle

$$F_b = W_{\text{displaced fluid}} = mg = \rho V g$$

$\frac{2}{3}$ rd and $\frac{1}{4}$ th of is totally submerged

$$F_b = \rho_w \left(\frac{2}{3}V \right) = \rho_o \left(\frac{1}{4}V \right)$$

$$= \frac{2}{3} \rho_w = \frac{1}{4} \rho_o, \quad \rho_w = 1g/cm^3$$

$$\rho_o = 4 \left(\frac{2}{3} \right) (1g/cm^3)$$

$$= \frac{8}{3} g/cm^3$$

Answer D