DPP – 2 (WEP)

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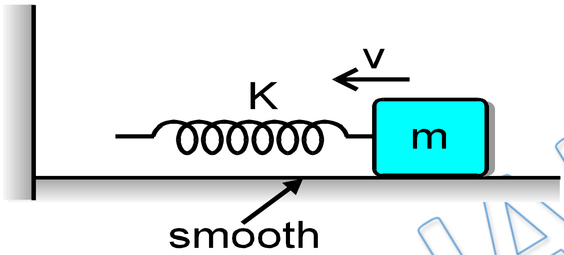
Q 1. A block is attached with a spring and is moving towards a fixed wall with speed v as shown in figure. As the spring reaches the wall, it starts compressing. The work done by the spring on the wall during the process of compression is :

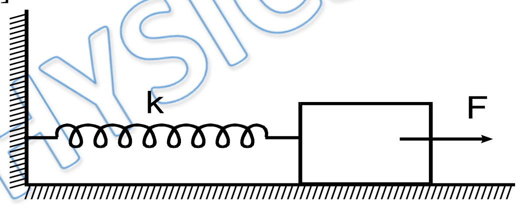


(a) $1/2\ mv^2$ (b) mv^2 (c) Kmv (d) zero

Q 2. A ship of mass 3×10^7 kg, initially at rest is pulled by a force of 5×10^4 N through a distance of 3 m. Assuming that the resistance due to water is negligible, the speed of the ship is:

(a) 1.5 m/s (b) 60 m/s (c) 0.1 m/s (d) 5 m/s

Q 3. A block attached to a spring, pulled by a constant horizontal force, is kept on a smooth surface as shown in the figure. Initially, the spring is in the natural state. Then the maximum positive work that the applied force F can do is : [Given that spring does not break]



(a) $\frac{F^2}{K}$ (b) $\frac{2F^2}{K}$ (c) ∞ (d) $\frac{F^2}{2K}$

Q 4. The minimum work done required to accelerate a truck on a horizontal road from rest to speed v

(a) is less than that required to accelerate if from v to 2v.

(b) is equal than that required to accelerate it from v to 2v.

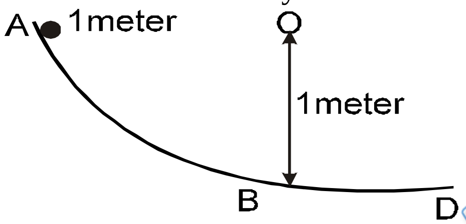
(c) is more than that required to accelerate it from v to 2v.

(d) may be any one of the above since it depends on the force acting on the truck and the distance over which it acts.

Q 5. A moving particle is acted upon by several forces F_1, F_2, F_3, ... etc. One of the forces is chosen, say F_2, then which of the following statement about F_2 will be true.

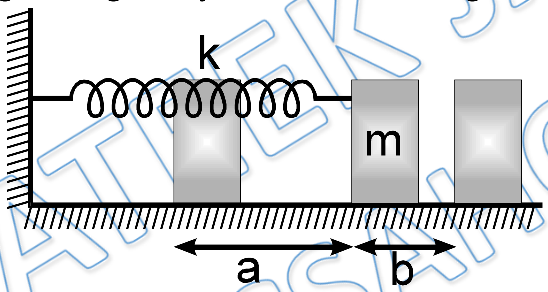
(a) Work done by F_2 will be negative if speed of the particle decreases.
(b) Work done by F_2 will be positive if speed of the particle increases
(c) Work done by F_2 will be equal to the work done by other forces if speed of the particle does not change
(d) Work done by F_2 may be zero.

Q 6. In the track shown in figure section AB is a quadrant of a circle of 1 meter radius. A block is released at A and slides without friction until it reaches B. After B it moves on a rough horizontal floor and comes to rest at distance 3 meters from B. What is the coefficient of friction between floor and body?



(a) 1/3 (b) 2/3 (c) 1/4 (d) 3/8

Q 7. The spring is compressed by a distance a and released. The block again comes to rest when the spring is elongated by a distance b. During this



(a) work done by spring on the block = $\frac{1}{2}$ k $(a + b)^2$
(b) work done by spring on the block = $\frac{1}{2}$ k $(a^2 – b^2)$
(c) co-efficient of friction = $\frac{k(a-b)}{2mg}$
(d) co-efficient of friction = $\frac{k(a+b)}{2mg}$

Q 8. A block of mass m starts at rest at height h on a frictionless inclined plane. The block slides down the plane, travels across a rough horizontal surface with coefficient of kinetic friction m, and compresses a spring with force constant k a distance x before momentarily coming to rest. Then the spring extends and the block travels back across the rough surface, sliding up the plane. The block travels a total distance d on rough horizontal surface. The correct expression for the maximum height h' that the block reaches on its return is:

(a) mgh' = mgh – mmgd (b) mgh' = mgh + mmgd
(c) mgh' = mgh + mmgd + kx^2 (d) mgh' = mgh – mmgd – kx^2

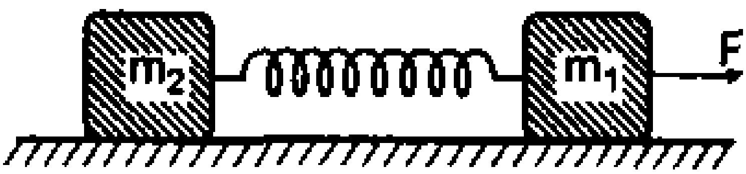
Q 9. There are two massless springs A and B of spring constant K_A and K_B respectively and $K_A > K_B$. If W_A and W_B be denoted as work done on A and work done on B respectively, then
(a) If they are compressed to same distance, $W_A > W_B$
(b) If they are compressed by same force (upto equilibrium state) $W_A < W_B$
(c) If they are compressed by same distance, $W_A = W_B$
(d) If they are compressed by same force (upto equilibrium state) $W_A > W_B$

Q 10. The mean kinetic energy of a particle of mass m moving under a constant acceleration in any interval of time when initial and final velocities are u_1 and u_2
(a) $\frac{1}{2}m(u_1^2 + u_2^2)$
(b) $\frac{1}{2}m(u_1^2 - u_2^2)$
(c) $\frac{1}{2}m(u_1^2 + u_2^2 + u_1 u_2)$
(d) Zero

Q 11. An object of mass m slides down a hill of height h of arbitrary shape and after travelling a certain horizontal path stops because of friction. The friction coefficient is different for different segments for the entire path but is independent of the velocity and direction of motion. The work that a force must perform to return the object to its initial position along the same path is:
(a) mgh (b) 2mgh (c) 4mgh (d) – mgh

Q 12. A 1.5 kg block is initially at rest on a horizontal frictionless surface when a horizontal force in the positive direction of x-axis is applied to the block. The force is given by $\vec{F} = (4 - x^2)\hat{\imath}$ N, where x is in metre and the initial position of the block is x = 0. The maximum kinetic energy of the block between x = 0 and x = 2.0 m is:
(a) 2.33 J (b) 8.67 J (c) 5.33 J (d) 6.67 J

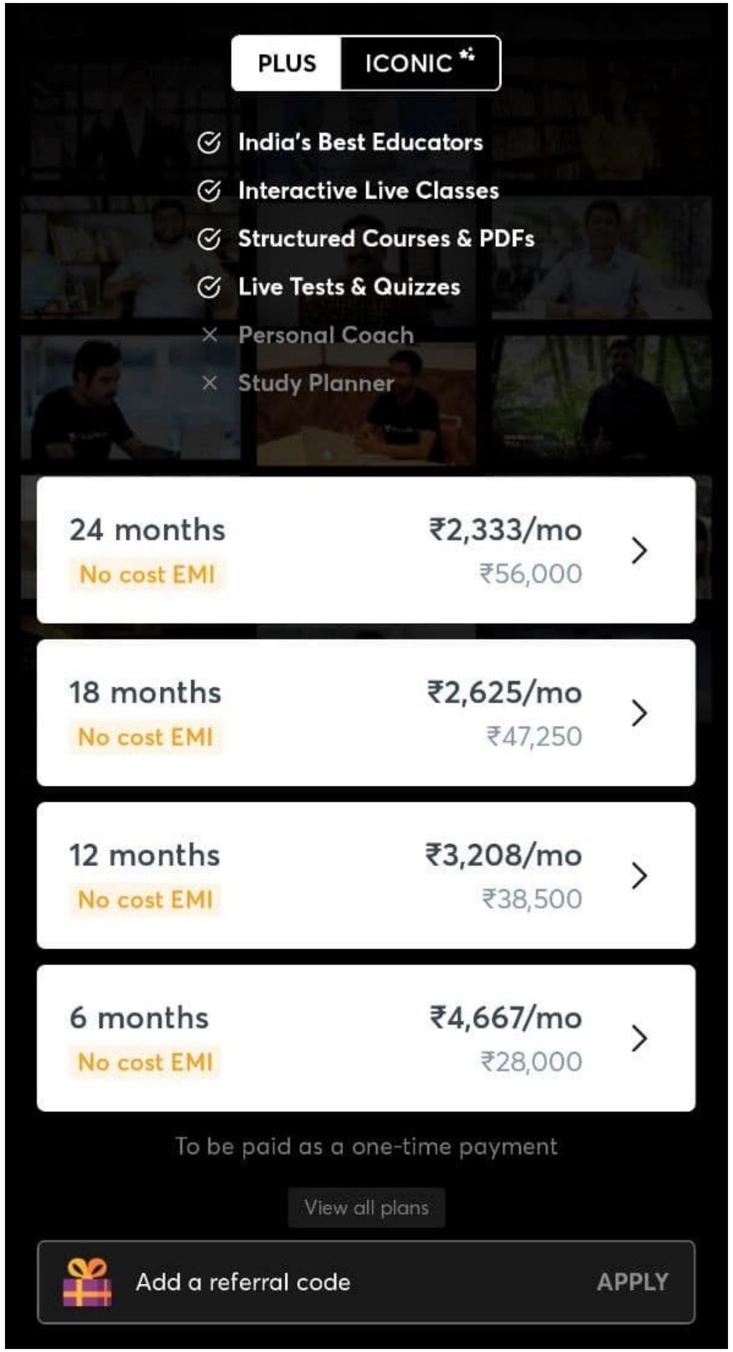
Q 13. Two blocks of masses $m_1 = 1$ kg and $m_2 = 2$kg are connected by a non-deformed light spring. They are lying on a rough horizontal surface. The coefficient of friction between the blocks and the surface is 0.4. What minimum constant force F has to be applied in horizontal direction to the block of mass m_1 in order to shift the other block? ($g = 10$ m/s^2)



(a) 8 N (b) 15 N (c) 10 N (d) 25 N

Answer Key

Q.1 d	Q.2 c	Q.3 b	Q.4 a	Q.5 d
Q.6 a	Q.7 b, c	Q.8 a	Q.9 a, b	Q.10 c
Q.11 b	Q.12 c	Q.13 a		



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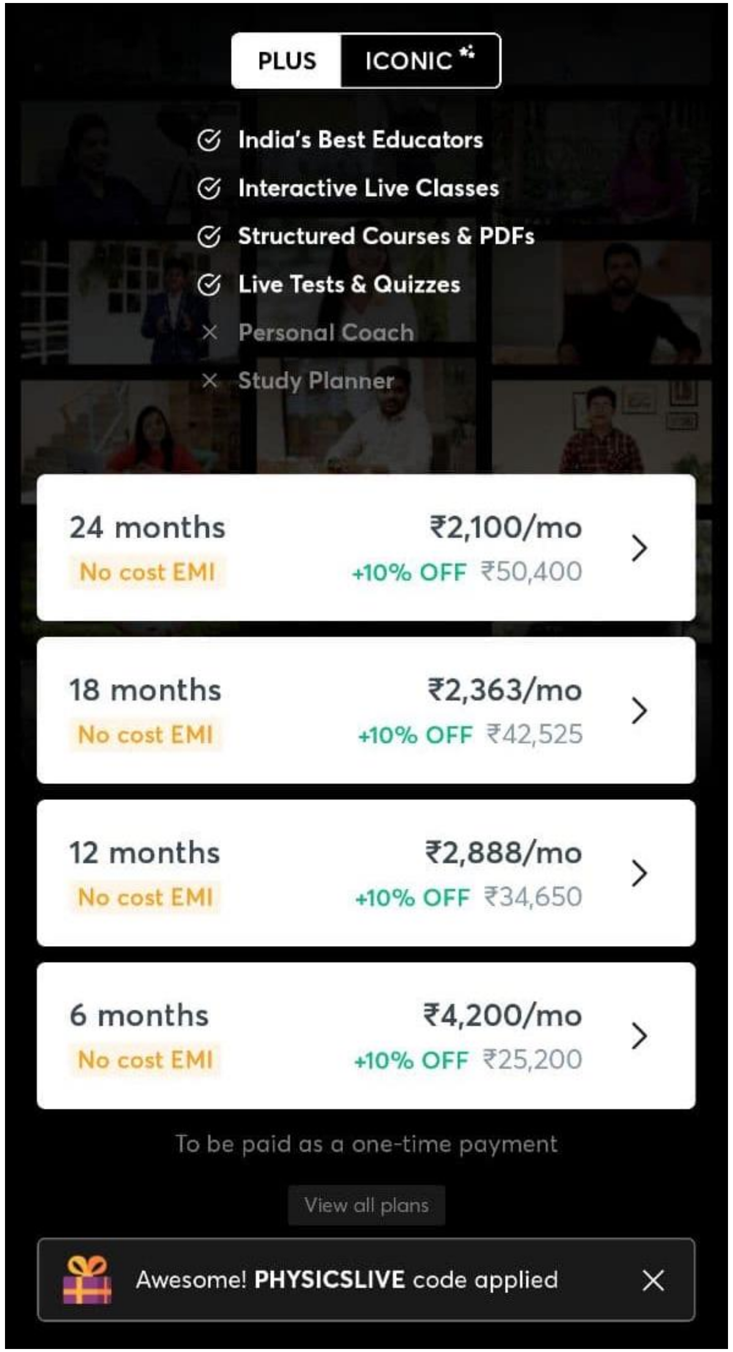

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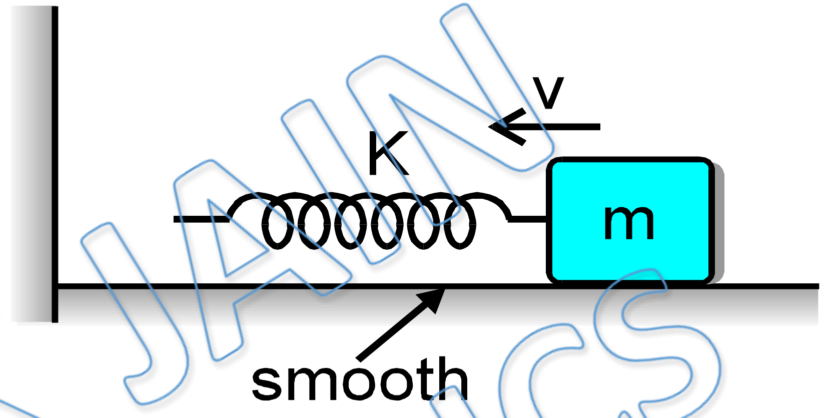
Written Solution

DPP- 2 WEP- Work Done by Spring Force, Work Energy Theorem

By Physicsaholics Team

Solution:1

Since point of application of spring force on wall is not moving.



$W = 0$

Ans(d)

Solution:2 by Using work energy theorem

$$W_{all} = K - K_i$$

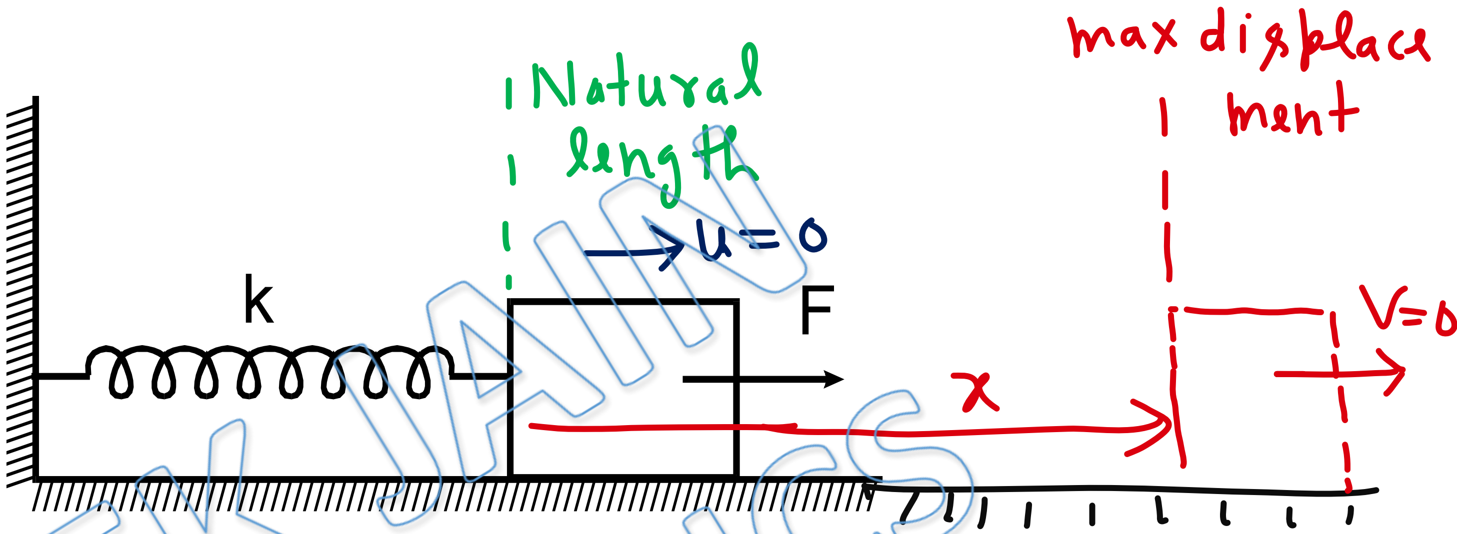
$$\Rightarrow \quad 5 \times 10^4 \times 3 = \frac{1}{2} \times 3 \times 10^7 \, V^2 - 0$$

$$V^2 = 10^{-2}$$

$$V = .1 \, m/sec$$

Ans(c)

Solution:3



At max displacement

$$\frac{dx}{dt} = 0 \Rightarrow V = 0$$

by Using work-Energy theorem →

$$W_F + W_{S.F.} = K_f - K_i \Rightarrow Fx - \frac{1}{2}k(0^2 - x^2) = 0 - 0$$

$$\Rightarrow x = 2F/k$$

Maximum work by F = F. max Displacement

$$= F \times 2F/k = \frac{2F^2}{k}$$

Ans(b)

Solution:4 by using work-Energy theorem →

work to accelerate from rest to $V = \frac{1}{2}m\left((V)^2 - 0^2\right) = \frac{1}{2}mV^2$

" " " " V to $2V = \frac{1}{2}m\left((2V)^2 - V^2\right) = \frac{3}{2}mV^2$

Ans (a)

Solution:5

V is decreasing ⇒ K.E. is decreasing ⇒ net work done by all forces = −ve

V is increasing ⇒ KE is increasing ⇒ net ,, ,, ,, = +ve

V is constant ⇒ KE is constant ⇒ $W_{all} = 0$

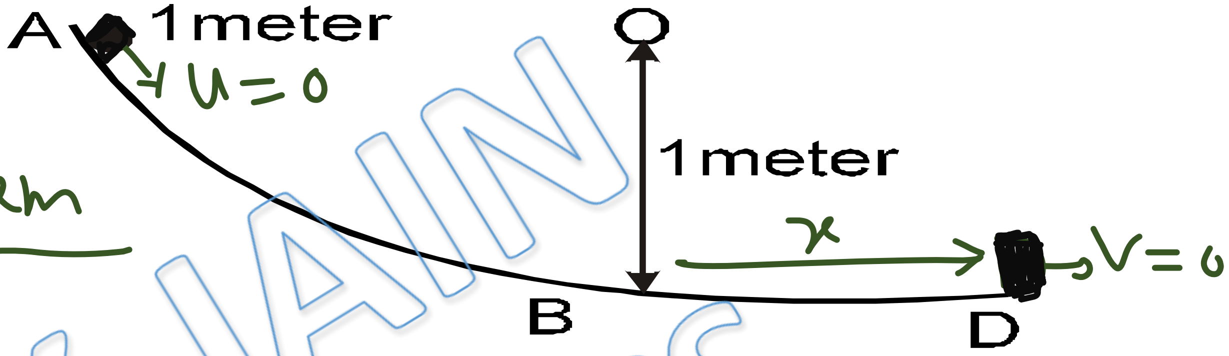
$\Rightarrow W_{F_2} + W_{other\ forces} = 0$

$\Rightarrow W_{F_2} = -W_{other\ forces}$

W_{F_2} will be zero if $\vec{F_2} \perp \vec{\Delta r}$

Ans (d)

Solution:6



by Using work-Energy theorem

$$W_N + W_{mg} + W_{fr} = K_f - K_i$$

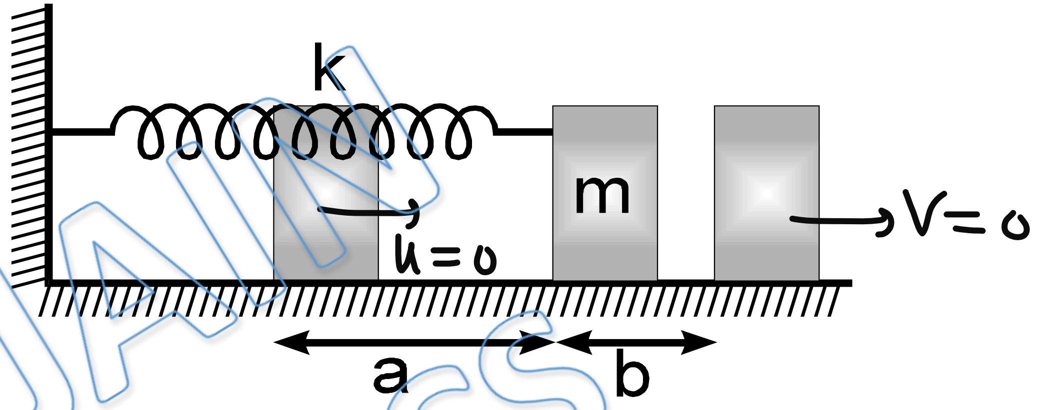
$$\Rightarrow 0 + mg \times 1 - \mu mgx = 0 - 0$$

$$\Rightarrow \mu mgx = mg$$

$$\Rightarrow \mu = 1/x = 1/3$$

Ans.a

Solution:7



work done by spring on block

$$= \frac{1}{2}K\left(x_i^2 - x_f^2\right) = \frac{1}{2}K\left(a^2 - b^2\right)$$

by Using work Energy theorem

$$W_{SF} + W_{fr} = K_f - K_i$$

$$\Rightarrow \frac{1}{2}K\left(a^2 - b^2\right) - \mu mg(a+b) = 0 - 0$$

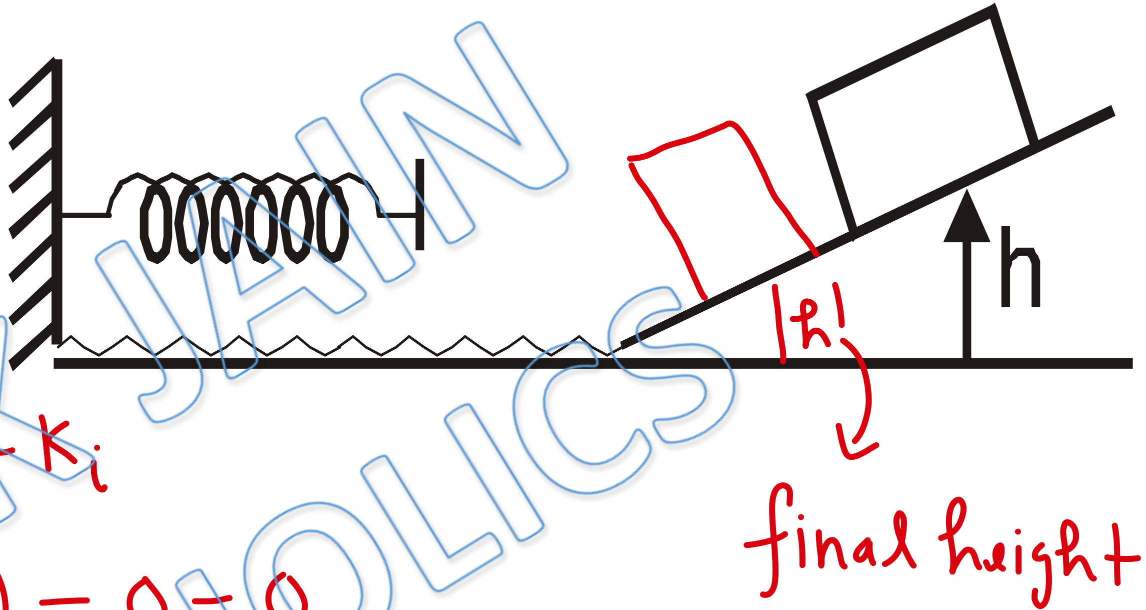
$$\Rightarrow \frac{1}{2}K(a-b)(a+b) = \mu mg(a+b)$$

$$\Rightarrow \mu = \frac{K(a-b)}{2mg}$$

ANS (b, c)

Solution: 8

by Using Work-Energy theorem



$$W_N + W_{fr} + W_{SF} + W_{mg} = K_f - K_i$$

$$\Rightarrow 0 - \mu mgd + 0 + mg(h - h') = 0 - 0$$

$$\Rightarrow mgh' = mgh - \mu mgd$$

Ans (a)

Solution:9 given → $K_A > K_B$

Work done on spring

= − Work done by spring

$= \frac{1}{2}K(x_f^2 - x_i^2) = \frac{1}{2}Kx^2$ (If spring is compressed from natural length to x)

$= \frac{F^2}{2K}$ (If spring is compressed by force F)

If springs are compressed through same distance $W_A > W_B$

" " " by same force $W_B > W_A$

Ans (a,b)

Solution:10 Since acceleration is Constant,

Velocity at $t = t$ is $V = u_1 + at$ and $u_2 = u_1 + at_0$

t_0 → time at which $V = u_2$

$\Rightarrow$ K.E. at $t = t$ is $\frac{1}{2}m(u_1 + at)^2$

$$\langle KE \rangle = \frac{\int_0^{t_0} \frac{1}{2}m(u_1+at)^2\,dt}{\int_0^{t_0} dt}$$

$$= \frac{m}{2t_0}\left[\frac{(u_1+at)^3}{3a}\right]_0^{t_0} = \frac{m}{2at_0}\left[(u_1+at_0)^3 - u_1^3\right]$$

$$= \frac{m}{2at_0}(u_2^3 - u_1^3) = \frac{m}{2at_0}(u_2 - u_1)(u_2^2 + u_1^2 + u_1u_2)$$

$$= \frac{m}{2}(u_1^2 + u_2^2 + u_1u_2)$$

Ans (C)

Solution:11

for motion from top of hill to comming to rest →

$$W_{fr} + W_{mg} = K_f - K_i \quad \text{--- (work Energy theorem)}$$

$$\Rightarrow \quad W_{fr} = -mgh.$$

for return journey →

$$W_{fr} + W_{mg} + W_F = K_f - K_i \quad \text{--- (work Energy theorem)}$$

$$-mgh - mgh + W_F = 0$$

$$W_F = 2mgh$$

Ans (b)

Solution:12

At $V = V_{max}$, $\frac{dv}{dt} = 0 \Rightarrow a = 0 \Rightarrow F = 0$

$\Rightarrow 4 - x^2 = 0 \Rightarrow x = 2$

V is maximum at $x = 2 \Rightarrow$ K.E. is maximum at $x = 2$

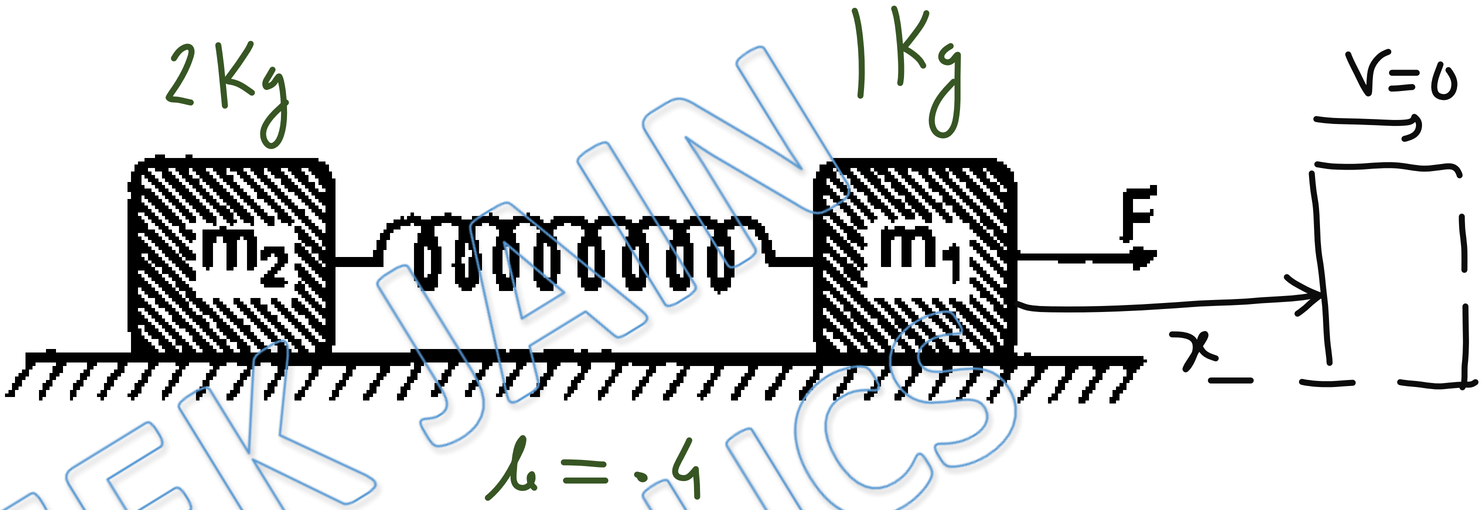
KE at $x = 2$

= work done from $x = 0$ to $x = 2$

$= \int_0^2 (4 - x^2)\,dx = \left[4x - \frac{x^3}{3}\right]_0^2 = 8 - \frac{8}{3} = 16/3\ J = 5.33\ J$

Ans(c)

Solution:13



Limitting friction on

$m_2 = \mu m_2 g = .4 \times 2 \times 10$

$= 8N$

required elongation in spring to move m_2, $x = \frac{8}{K}$ → spring Constant

Using work energy theorem ⟹

$W_{SF} + W_{fr} + W_F = K_f - K_i$

$\Rightarrow \frac{1}{2}K(0^2 - x^2) - \mu mgx + Fx = 0 - 0$

$$F x = \mu m g x + \frac{1}{2} K x^2$$

$$F = \mu m g + \frac{K x}{2}$$

$$= .4 \times 1 \times 10 + \frac{8}{2}$$

$$= 8 N$$

Ans (a)

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Chalo Niklo