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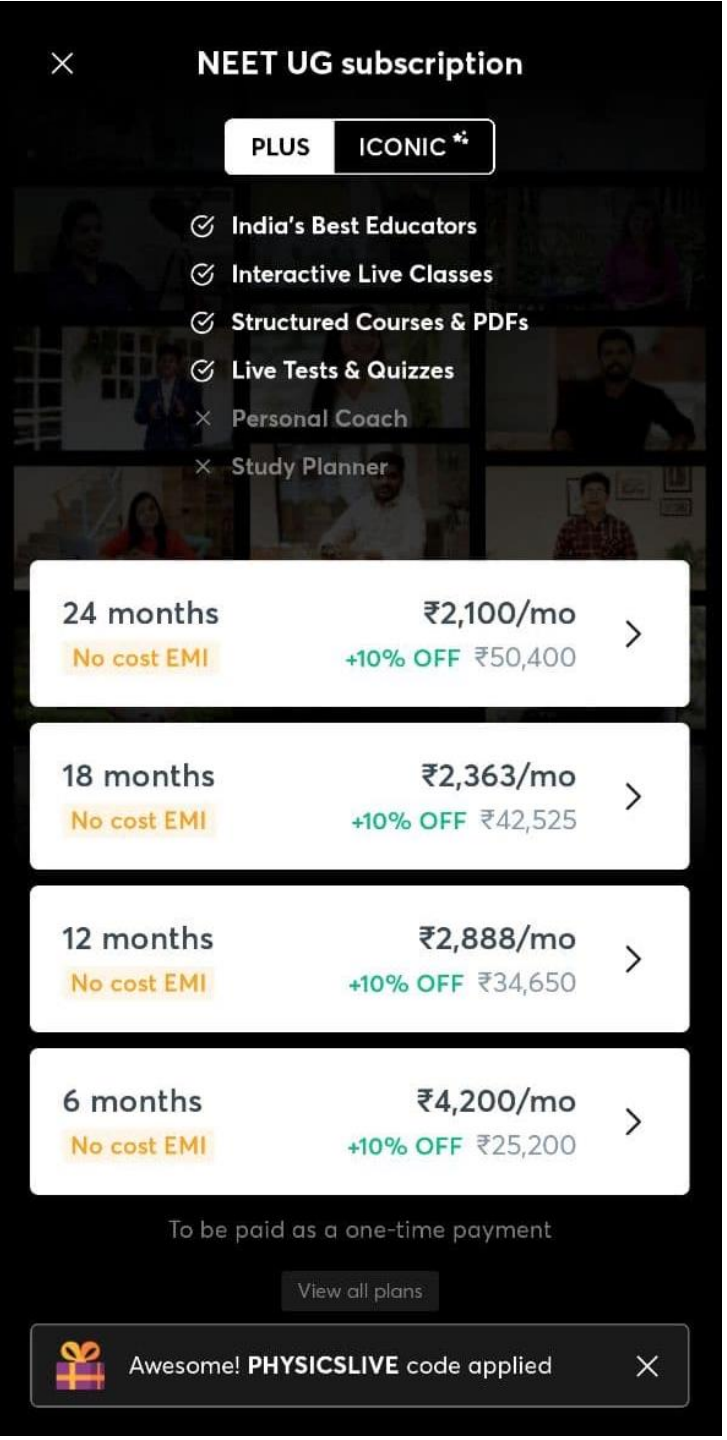

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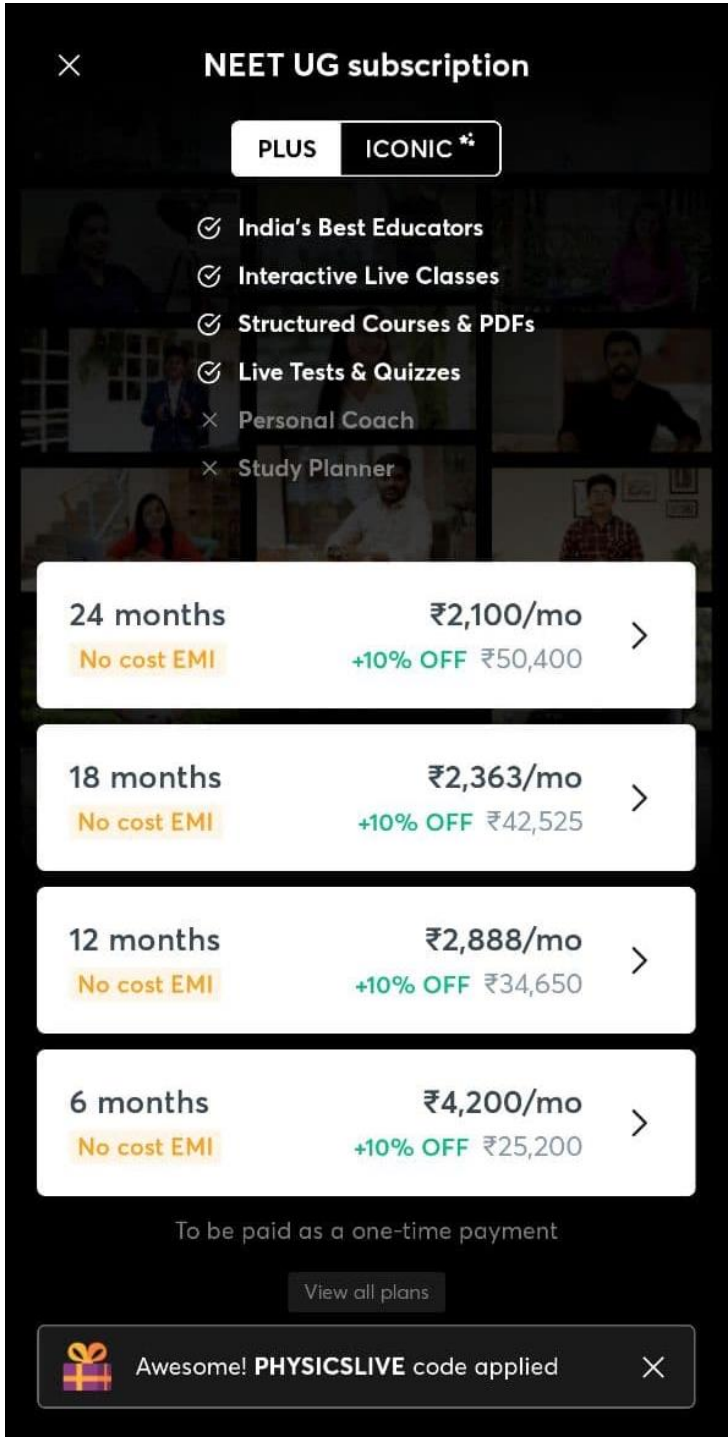

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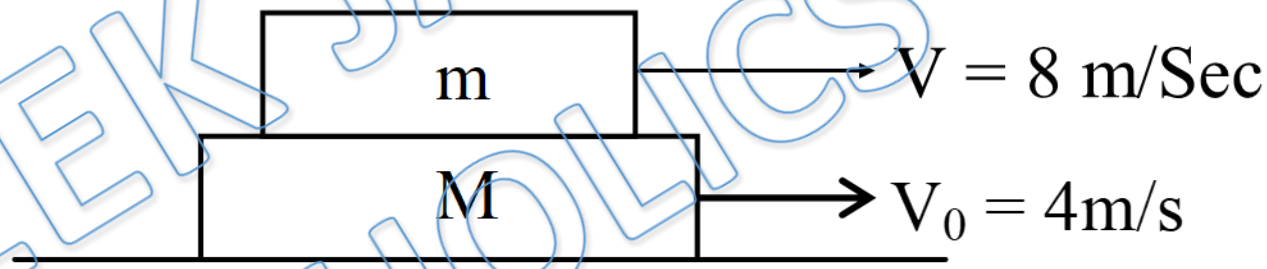
Physics DPP

DPP- 1 Friction: Static & Kinetic Friction

By Physicsaholics Team

Q) Direction of friction on upper surface of M is (all surfaces are rough)



(a) Towards right

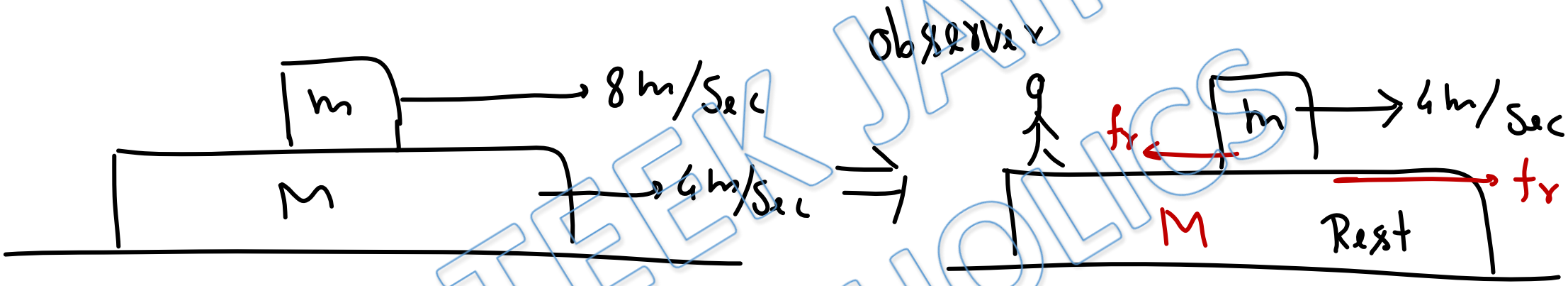
(b) Towards left

(c) Friction is zero

(d) None of above

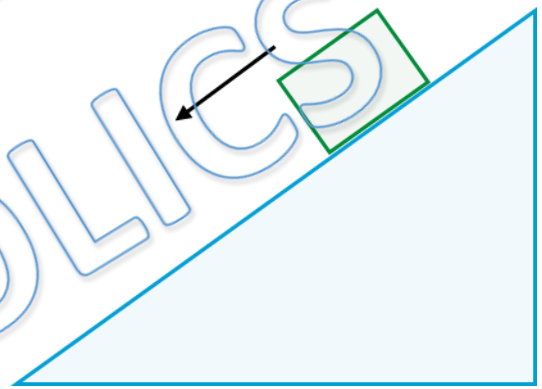
Ans. a

Solution:



friction on M is towards right ?

Q) A block of mass 0.5kg has an initial velocity of 10m/s down an inclined plane of inclination 30°, the coefficient of friction between the block and the inclined surface is 0.2. The velocity of the block after it travel a distance of 10m along the incline is nearly: (g = 10 m/s^2)



(a) 13 m/s

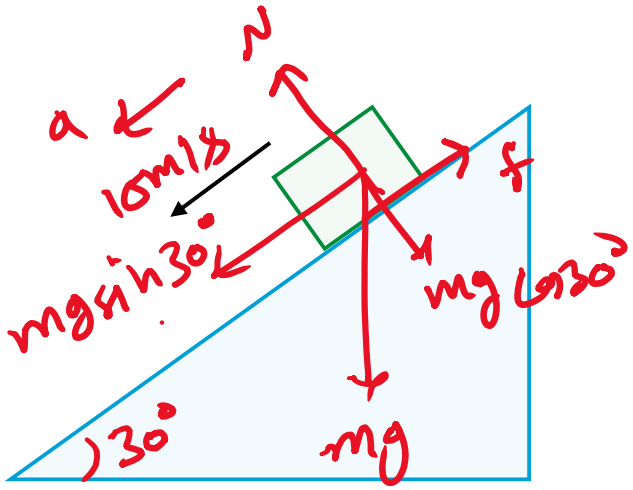
(b) 17 m/s

(c) 24 m/s

(d) 8 m/s

Ans. a

Solution:



$$a = \frac{mg\sin 30^\circ - f}{m}$$

$$f = \mu mg\cos 30^\circ$$

$$a = \frac{mg\sin 30^\circ - \mu mg\cos 30^\circ}{m}$$

$$a = g(\sin 30^\circ - \mu\cos 30^\circ)$$

$$a = g\left(\frac{1}{2} - 0.2\times\frac{\sqrt{3}}{2}\right)$$

$$a = 3.27\ m/s^2$$

$$s = 10\ m$$

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

$$v^2 = (10)^2 + 2(3.27)(10)$$

$$v^2 = 100 + 65.35$$

$$v = \sqrt{165.35}$$

$$\boxed{v = 12.86\ m/s}\ \text{Ans}$$

$$\boxed{v \simeq 13\ m/s}\ \text{Ans}$$

Q) A box is projected along a line of greatest slope up a rough plane inclined at an angle of 45° with the horizontal. If the coefficients of friction is 1/2, then the retardation is:-

(a) $\frac{g}{\sqrt{2}}$

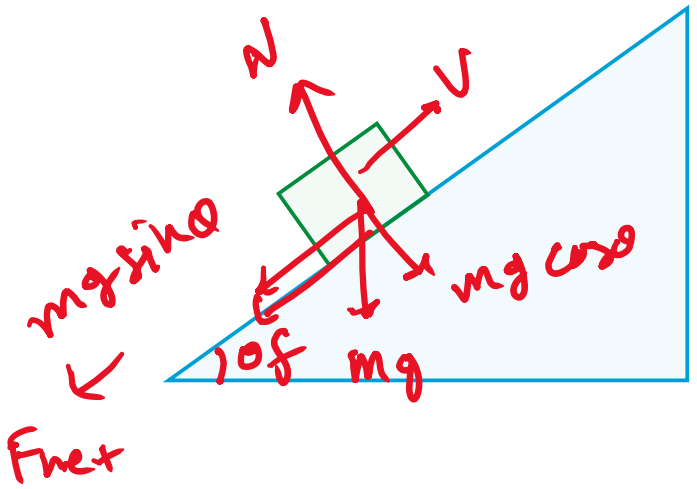
(b) $\frac{g}{2\sqrt{2}}$

(c) $\frac{g}{2\sqrt{3}}$

(d) $\frac{3g}{2\sqrt{2}}$

Ans. d

Solution:



$F_{net} = mg\sin\theta + f$

$= mg\sin\theta + \mu mg\cos\theta$

$= mg\left(\sin 45^\circ + \frac{1}{2}\cos 45^\circ\right)$

$= mg\left(\frac{1}{\sqrt{2}} + \frac{1}{2\sqrt{2}}\right)$

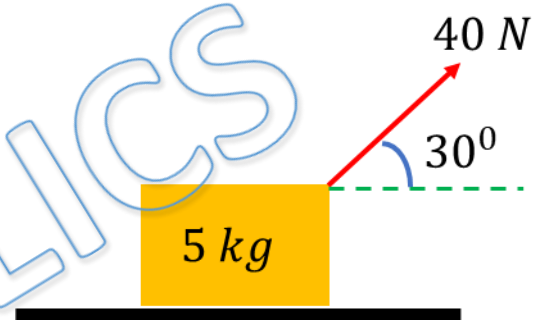
$$\boxed{F_{net} = \frac{3mg}{2\sqrt{2}}}$$

Retardation

$$a = \frac{F_{net}}{m}$$

$$\boxed{a = \frac{3g}{2\sqrt{2}}} \quad \text{Ans.}$$

Q) A block of mass M = 5 kg is resting on a rough horizontal surface for which the coefficient of friction is 0.2. When a force F = 40N is applied as shown, the acceleration of the block will be then (g = 10m/s^2).



(a) 5.73 m/s^2

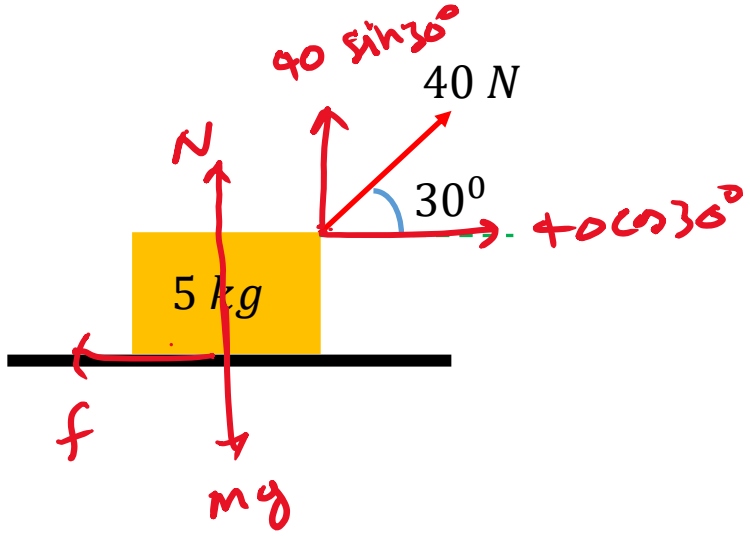
(b) 8.0 m/s^2

(c) 3.17m/s^2

(d) 10.0 m/s^2

Ans. a

Solution:



$N + 40\sin30° = mg = 50$

$N = 50 - 40\sin30° = 50 - 40\times\frac{1}{2}$

$\boxed{N = 30\,N}$

$f = \mu N = 0.2 \times 30$

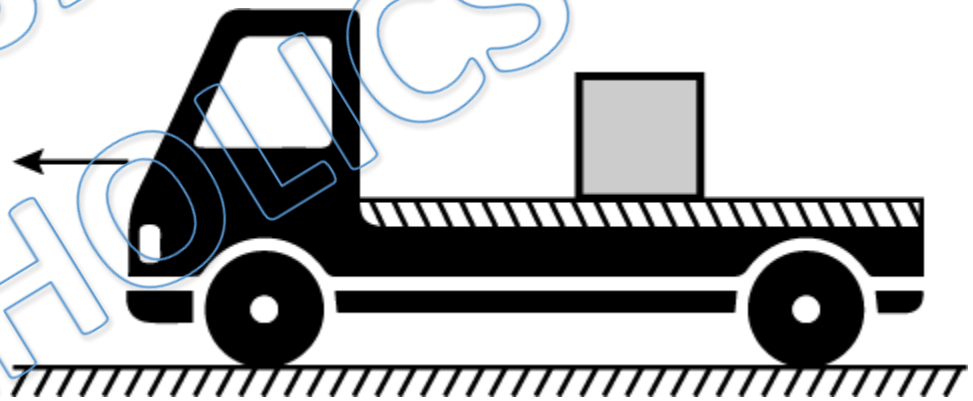
$\boxed{f = 6N}$

$a = \frac{40\cos30° - 6}{m} = \frac{40\left(\frac{\sqrt{3}}{2}\right) - 6}{5}$

$a = \frac{34.64 - 6}{5} = \frac{28.64}{5}$

$\boxed{a = 5.73\ m/s^2}$ Ans.

Q) The rear side of a truck is open and a box of 40kg mass is placed 5m away from the open end as shown in figure. The coefficient of friction between the box and the surface below it is 0.15. On a straight road, the truck starts from rest and accelerates with 2 m/s^2. At what distance from its starting point does the box fall off the truck? (Ignore the size of the box)



(a) 25 m

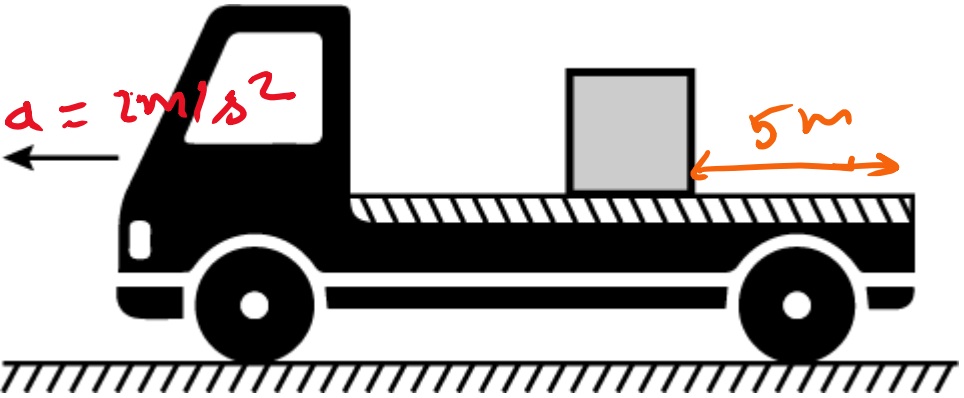
(b) 15 m

(c) 20 m

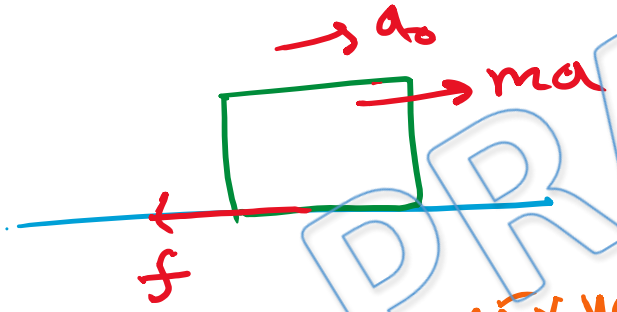
(d) 10 m

Ans. b

Solution:



w.r.t. truck



$f = \mu mg = 0.15 \times 40 \times 10 = 60\,N$

$$a_0 = \frac{ma - f}{m}$$

$$a_0 = \frac{40 \times 2 - 60}{40} = \frac{20}{40} = 0.5\,m/s^2$$

$s = \frac{1}{2}at^2$ [$\because u = 0$]

$5 = \frac{1}{2} \times 0.5\, t^2$

$t^2 = 20\ sec$

$t = \sqrt{20}\ sec$

displacement of truck

$s_T = \frac{1}{2}at^2$

$s_T = \frac{1}{2} \times 2 \times (\sqrt{20})^2$

$s_T = 20m$ Ans

∵ Truck moves 20m but block also moved 5m back on truck.

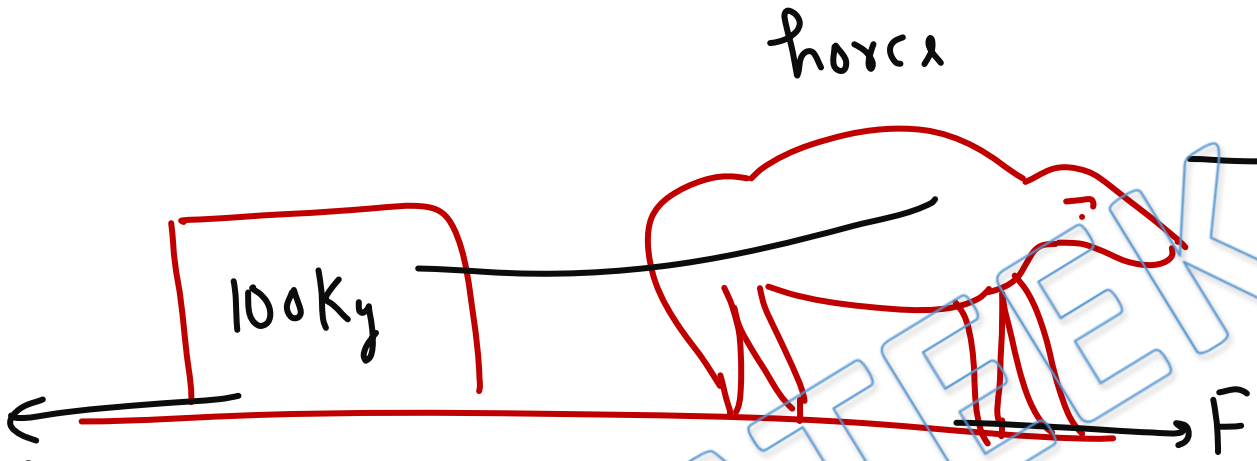
So; block will fall at $20 - 5 = 15\,m$ from its starting point

Q) A 500 kg horse pulls a block of mass 100 kg along a horizontal rough road with an acceleration of 1 m/Sec^2, μ = 0.8. The forward force on the horse is [Take g = 10 m/Sec^2]

(a) zero
(b) 2000 N
(c) 1400 N
(d) 600 N

Ans. c

Solution:



$f_y = \mu mg$

$= 0.8 \times 1000$

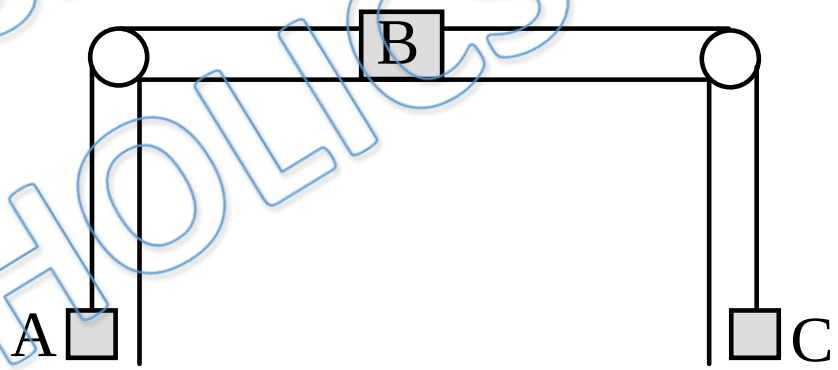
$= 800\,N$

$F - 800 = 600 \times 1$

$F = 1400\,N.$

Ans (c)

Q) Block A has a mass of 2kg and block B has 20 kg. If the coefficient of kinetic friction between block B and the horizontal surface is 0.1, and B is accelerating towards the right with a = 2 m/s^2, then the mass of the block C will be-

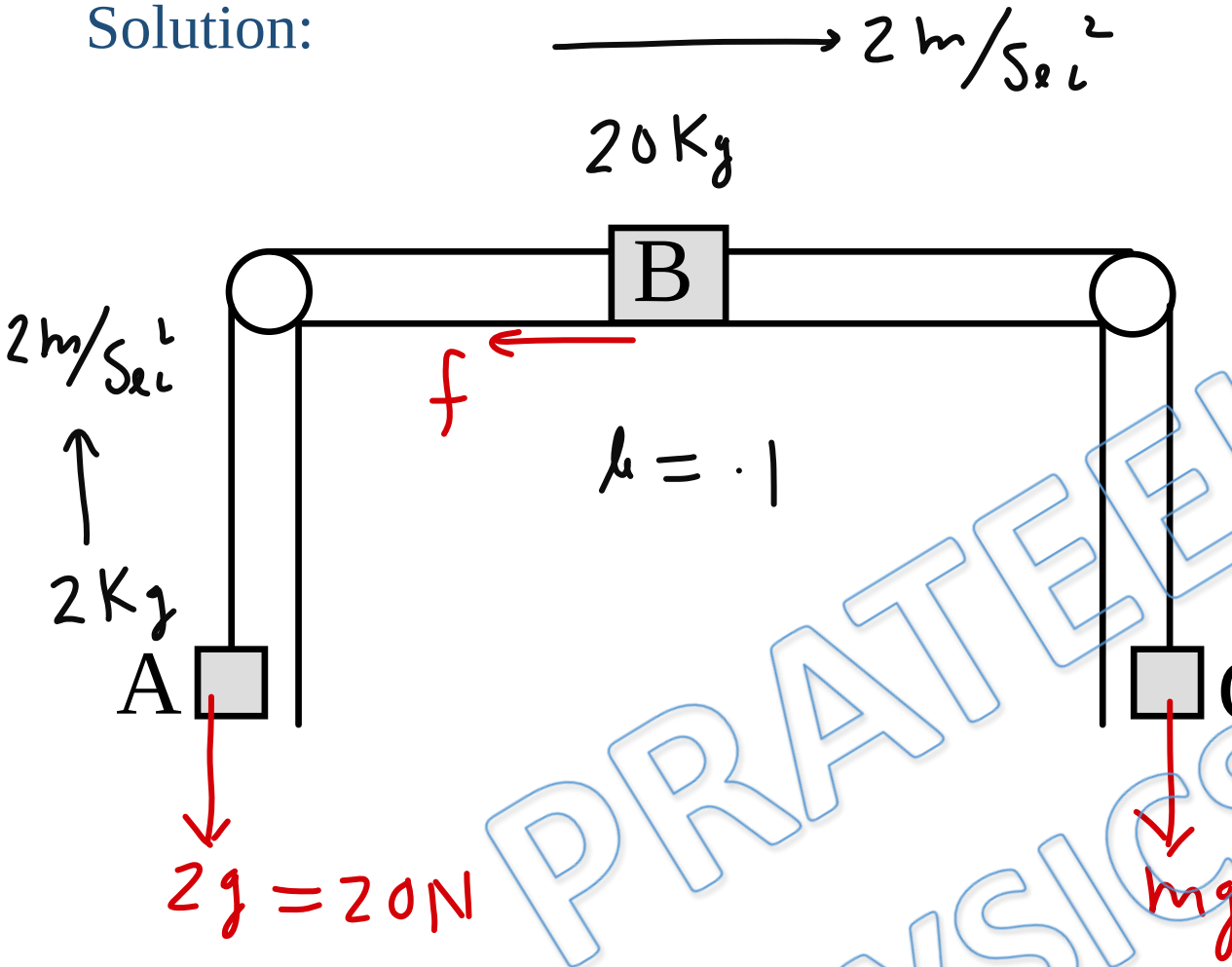


(a) 15 kg (b) 12.5 kg

(c) 5.7 kg (d) 10.5 kg

Ans. d

Solution:



friction on B

$= .1 \times 20g$

$= 20N$

$2m/Sec^2$

$a = \frac{\text{supporting} - \text{opposing}}{\text{total mass}}$

$2 = \frac{mg - 20 - 20}{m + 20 + 2}$

$\Rightarrow 2m + 44 = 10m - 40$

$8m = 84$

$m = 10.5\ kg.$

Ans (d)

Q) An object is placed on the surface of a smooth inclined plane of inclination θ. It takes time t to reach to bottom. If the same object is allowed to slide down a rough inclined plane of same inclination θ, it takes time nt to reach the bottom where n is a number greater than 1. The coefficient of friction μ is given by –

(a) $\mu = \tan\theta\,(1 - 1/n^2)$

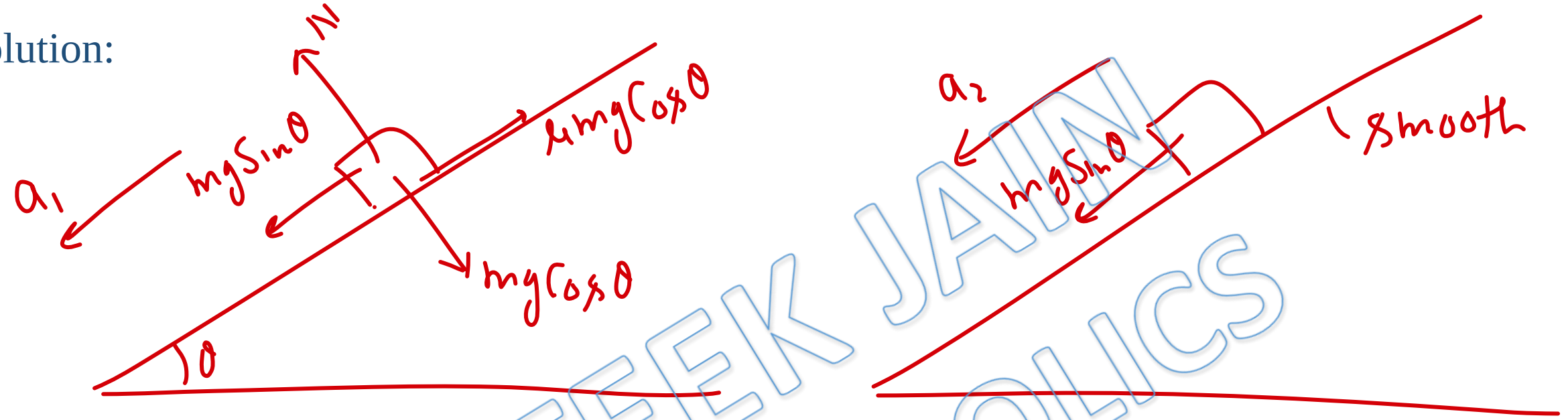
(b) $\mu = \cot\theta\,(1 - 1/n^2)$

(c) $\mu = \tan\theta\,(1 - 1/n^2)^{1/2}$

(d) $\mu = \cot\theta\,(1 - 1/n^2)^{1/2}$

Ans. a

Solution:



$$ma_1 = mg\sin\theta - \mu mg\cos\theta$$

$$a_1 = g(\sin\theta - \mu\cos\theta)$$

$$x = \frac{1}{2}a_1(nt)^2 \quad --(II)$$

$$a_2 = g\sin\theta$$

$$x = \frac{1}{2}a_2t^2 \quad --(I)$$

$$\Rightarrow \quad n^2a_1 = a_2 \Rightarrow n^2g(\sin\theta - \mu\cos\theta) = g\sin\theta$$

$$n^2 \sin\theta - \mu n^2 \cos\theta = \sin\theta$$

$$\Rightarrow \quad \mu n^2 \cos\theta = \sin\theta \cdot (n^2 - 1)$$

$$\Rightarrow \quad \mu = \tan\theta \left(1 - \frac{1}{n^2}\right)$$

Ans (a)

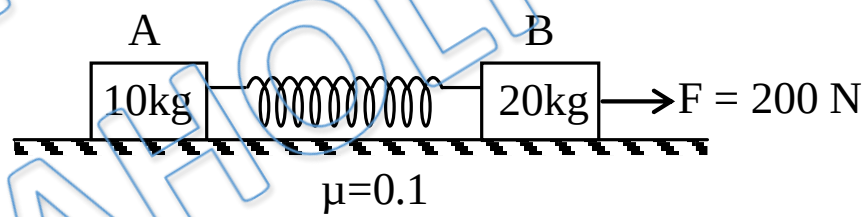
Q) Two blocks A and B attached to each other by a massless spring, are kept on a rough horizontal surface ($\mu = 0.1$) and pulled by a force F = 200 N as shown in figure. If at some instant the 10 kg mass has acceleration of 12 m/s^2, what is the acceleration of 20 kg mass ?

(a) 2.5 m/s^2

(b) 4.0 m/s^2

(c) 3.6 m/s^2

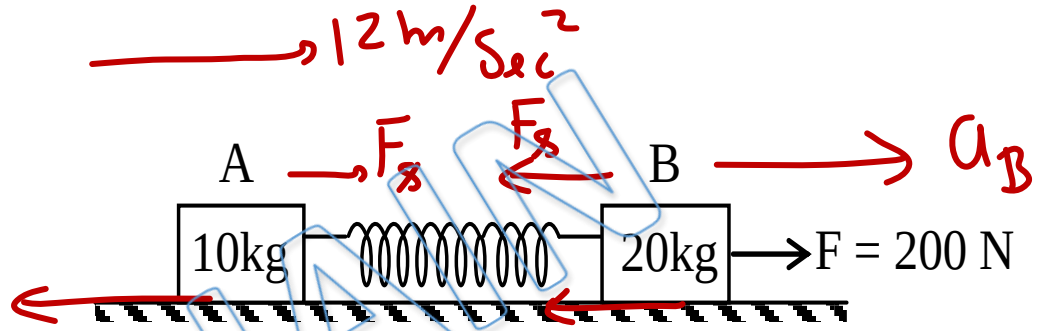
(d) 1.2 m/s^2



Ans. a

Solution:

$F_s \rightarrow$ spring force



$f_r = .1 \times 10g = 10N$

$f_r = .1 \times 20g = 20N$

from F.B.D of A

$$F_s - 10 = 10 \times 12 \Rightarrow F_s = 130N$$

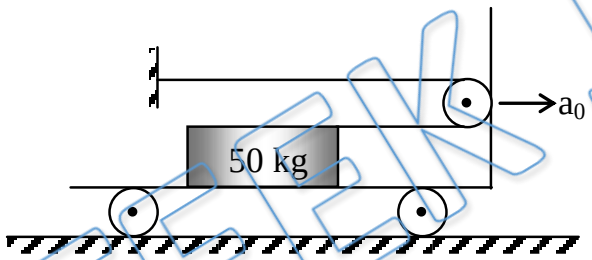
from F.B.D of B

$$200 - F_s - 20 = 20\,a_B \Rightarrow 20\,a_B = 50$$

$$\Rightarrow a_B = 2.5\ m/sec^2$$

Ans(a)

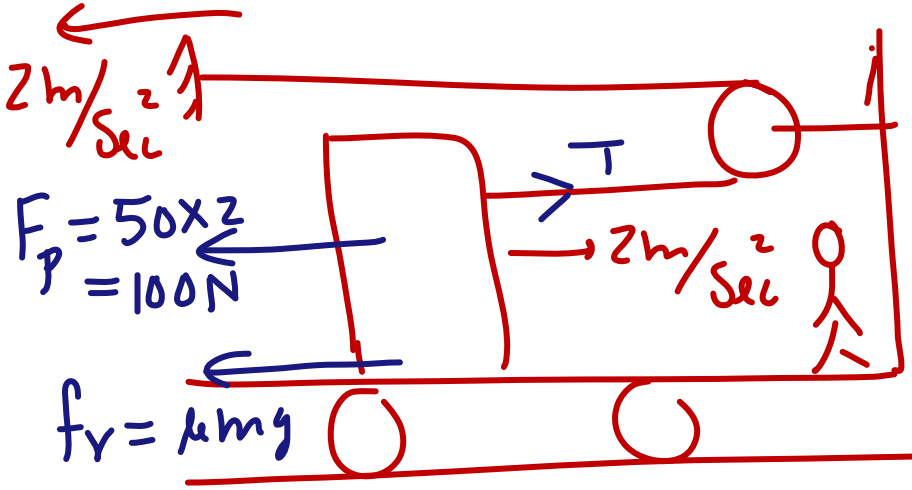
Q) A flat car is given an acceleration $a_0 = 2m/s^2$ starting from rest. A cable is connected to a crate A of weight 50kg as shown. Neglect friction between the floor and the car wheels and also the mass of the pulley. Calculate corresponding tension in the cable if $\mu = 0.30$ between the crate and the floor of the car –



(a) 350 (b) 250 (c) 300 (d) 400

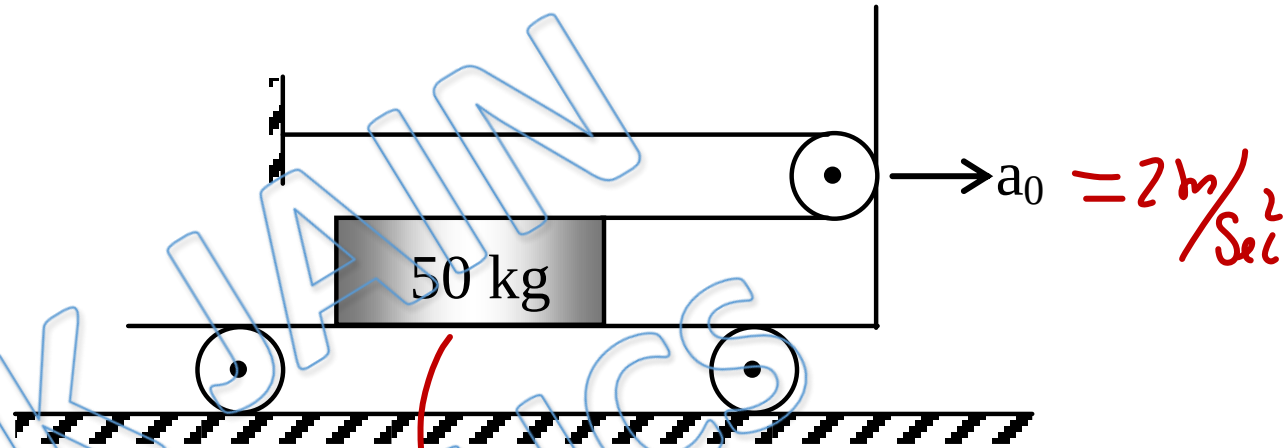
Ans. a

Solution:



$= \cdot 3 \times 50g$

$= 150N$



$T - 150 - 100 = 50 \times 2$

$T = 350N$

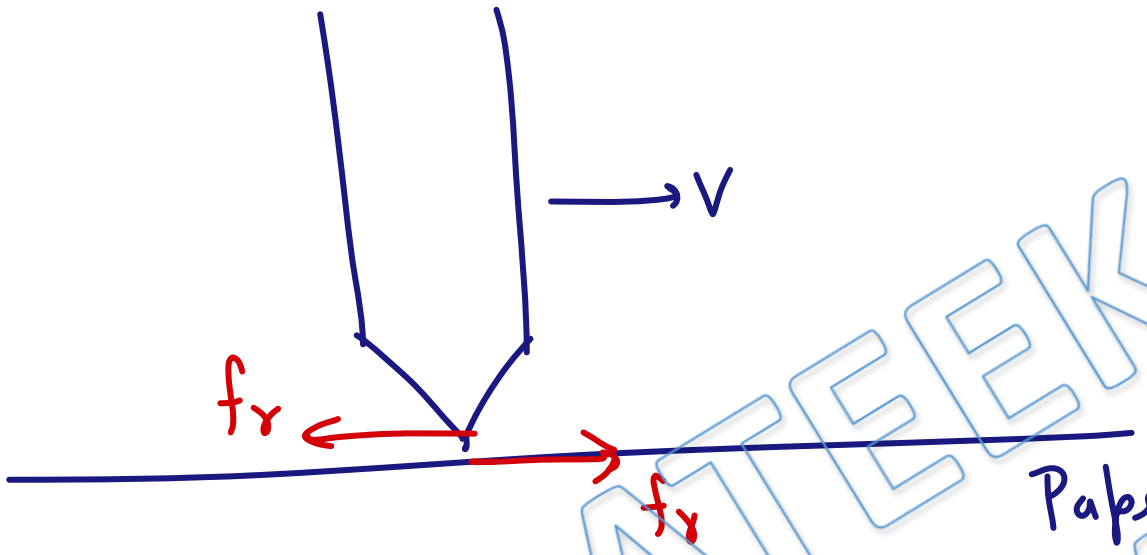
Ans (a)

Q) **STATEMENT-1 :** While drawing a line on a paper, friction force acts on paper in the same direction along which line is drawn on the paper.
STATEMENT-2 : Friction always opposes motion.

(a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(b) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(c) Statement-1 is True, Statement-2 is False
(d) Statement-1 is False, Statement-2 is True

Ans. c

Solution:



friction on tip is just opposite to V.

$\Rightarrow$ " " " paper is along V.

☆ friction opposes relative motion (not motion)

Q) A man is running on ground with increasing speed. Friction acting on man is

(a) Static

(b) Kinetic

(c) No friction acts on man

(d) None of these

Ans. a

Solution:

Since surfaces of Contact are not sliding on each other. friction is static.

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Chalo Niklo