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Newton's laws of motion

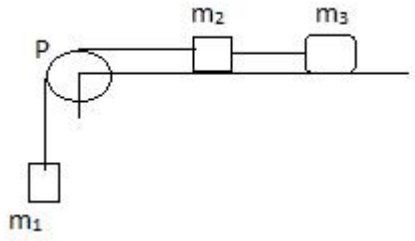
* A plank with a box on it at one end is slowly raised about the other end. As the angle with the horizontal slowly reaches 30^0 the block starts to slip and covers 4 m down the plank in 4 sec. The coefficient of static and kinetic friction between the block and the plank will be respectively,

(A) 0.6 and 0.5 (B) 0.5 and 0.6

(C) 0.4 and 0.3 (D) 0.6 and 0.6

The beauty of this problem is, it can be solved by Newton's laws as well as W.E theorem. It also helps the student understand when to take the friction as static and when as kinetic.

Ans: (A)



* System consisting of three masses connected by a string passing over a pulley P is as shown. The table is rough with coefficient of friction μ. The pulley is frictionless and of negligible mass. The downward acceleration of m_1 is (take the three masses to be equal)

(A) $\frac{g}{9}(1-g«)$ (B) $\frac{2g«}{3}$

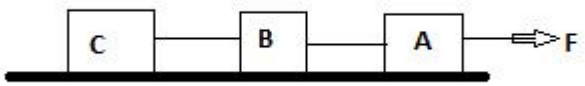
(C) $\frac{g}{3}(1-2«)$ (D) $\frac{g}{2}(1-2«)$

Ans: (C)

* A light string passing over a smooth light pulley connects two blocks of masses m_1 and m_2 vertically. If the acceleration of the system is g/8, then the ratio of the masses is

(A) 8: 1 (B) 9: 7 (C) 4: 3 (D) 5: 3

Ans: (B)



* Three identical blocks of masses 2 kg each are drawn by a force F = 10.2 N with an acceleration of 0.6 m/s^2 on a frictionless surface. What is the tension in the string between the blocks B and C?

(A) 1.2 N (B) 7.8 N (C) 4 N (D) 9.8 N

Ans: (A)

* A block of mass m is connected to another block of mass M by a massless spring of constant k. The blocks are kept on a smooth horizontal plane. Initially the blocks are at rest and the spring is unstretched. A constant horizontal force F starts acting on the block of mass M pulling it on the surface. Find the force on m.

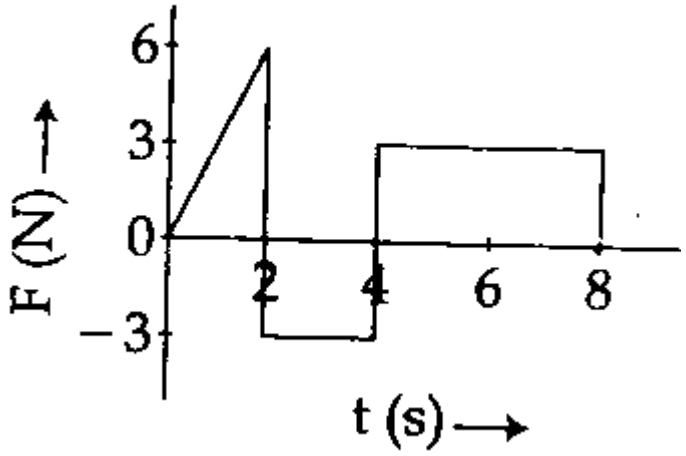
(A) $\frac{mF}{M}$ (B) $\frac{(m+M)F}{m}$ (C) $\frac{mF}{m+M}$ (D) $\frac{MF}{m+M}$

Ans: (C)

* A block of mass M is pulled along a horizontal frictionless surface by a rope of mass m. If the force P is applied at the free end of the rope, the force exerted by the rope on the block is

(A) $\frac{Pm}{M+m}$ (B) $\frac{Pm}{M-m}$ (C) P (D) $\frac{PM}{M+m}$

Ans: (D)



* The force F acting on a particle of mass m is indicated by the force-time diagram as shown. The change in momentum of the particle over the time interval from 0 to 8 sec is

(A) 24 Ns (B) 20 Ns (C) 12 Ns (D) 6 Ns

Ans: (C)

The message in this problem is about impulse.

*** Remember that F.t is impulse and it is the change in momentum. It is also area under the F-t curve.**

* A balloon of mass m is descending with an acceleration a less than g. How much mass must be removed from it so that it starts moving up with the same acceleration?

(A) $\frac{2ma}{g+a}$ (B) $\frac{2ma}{g-a}$ (C) $\frac{ma}{g+a}$ (D) $\frac{ma}{g-a}$

Ans: (A)

* A body of mass 0.05 kg is found to fall with an acceleration of 9.5 ms^{-2}. The opposing force of air on the body is (g = 9.8 ms^{-2})

(a) 0.15 N (b) 0.03 N (c) zero (d) 0.015 N

Ans: (D)

* A stone of mass 0.05 kg is thrown vertically upwards. What is the direction and magnitude of the net force on the stone during its upward motion?

(a) 0.49 N vertically upwards (b) 0.49 N vertically downwards

(c) 9.8 N vertically downwards (d) 0.98 N vertically downwards

Ans: (B)

The purpose of taking this problem is to make the student understand, what does it mean when he writes, F = ma

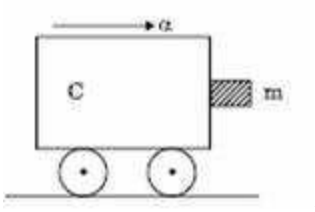
*** It means the positive direction of the force has to be always the direction of acceleration.**

* The upper half of an inclined plane of inclination θ smooth while lower half is rough. A block starting from rest from the top of the plane comes to rest at the bottom of the plane if the coefficient of friction between the block and the lower half of the plane is

(A) $« = \frac{1}{\tan^{-}}$ (B) $« = \frac{2}{\tan^{-}}$ (C) $« = 2\tan^{-}$ (D) $« = \tan^{-}$

Ans: (C)

This problem can also be solved by Newton's laws as well as W.E theorem.

* 

A block of mass m is in contact with cart C as shown. The coefficient of friction between the block and the cart is μ. The acceleration a of the cart that will prevent the block from falling satisfies,

(A) $a > \frac{mg}{«}$ (B) $a > \frac{g}{m«}$ (C) $a \geq \frac{g}{«}$ (D) $a < \frac{g}{«}$

Ans: (C)

* A body of mass 1 kg is thrown upwards with a speed of 20 m/s. It momentarily comes to rest after reaching a height of 18 m. How much energy in joules is lost due to air friction ($g = 10\ ms^{-2}$)

(A) 30 (B) 40 (C) 10 (D) 20

Ans: (D)

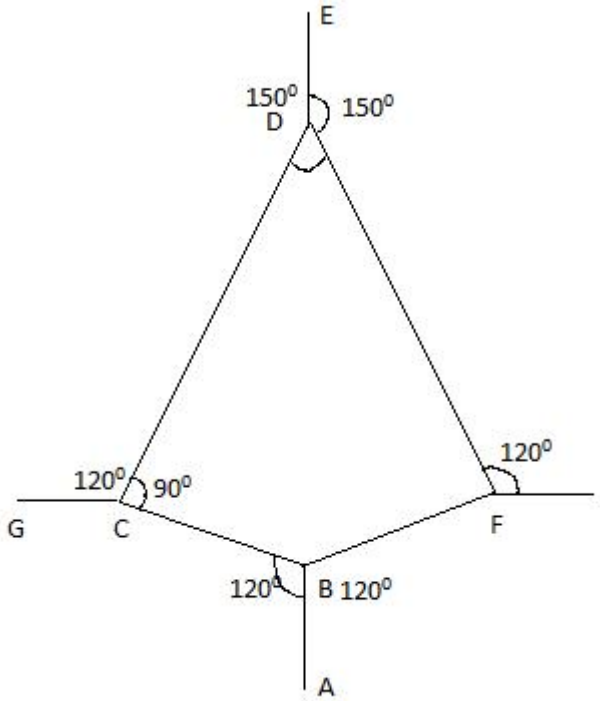
This can also be solved by Newton's laws as well as W.E theorem.

* A roller coaster is designed such that the riders experience weightlessness as they go round the top of the hill with radius of curvature 20 m. The speed of the car at the top of the hill in m/s is in between

(A) 13 & 14 (B) 14 & 15 (C) 15 & 16 (D) 16 & 17

Ans: (B)

This problem is taken to let you know what weightlessness is.



* The adjacent figure is a part of horizontally stretched net. The tension in the part AB is 10 N. What are the tensions in BC and BF?

(a) 10 N, 11 N (b) 10 N, 6 N (c) 10 N, 10 N (d) can't calculate

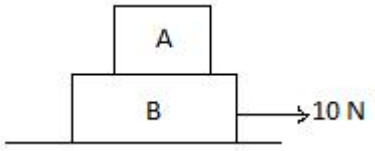
Ans: (C)

* A mass of m kg is suspended by a massless string. The horizontal force that is required to displace it until the string makes an angle of 45^0 with the vertical is

(A) $mg\left(\sqrt{2}+1\right)$ (B) mg (C) $\frac{mg}{\sqrt{2}}$ (D) $mg\left(\sqrt{2}-1\right)$

Ans: (B)

This helps you understand F.B.D and resolving of forces or Lami's theorem to get the resultant.



* A block A of mass 2 kg is placed over block B of mass 8 kg. The combination is placed over a rough horizontal surface. Coefficient of friciton between B and the floor is 0.5 and between A and B is 0.4. A horizontal force of 10 N is applied on B as shown. The force of friciton between A and B is

(a) 100 N (b) 40 N (c) 50 N (d) zero

Ans: (D)

* A horizontal force of 10 N is necessary to just hold a block stationary against a wall. The coefficient of friction between the block and the wall is 0.2. The weight of the block is

(A) 20 N (B) 50 N (C) 100 N (D) 2 N

Ans: (D)

A beautiful problem on friction.

* A lift is moving down with an acceleration 'a'. A man in the lift drops a ball inside the lift. The acceleration of the ball as observed by the man in the lift and a man standing on the ground are respectively

(A) g, g (B) g – a, g – a (C) g – a, g (D) a, g

Ans: (C)

* A spring balance is attached to the ceiling of a lift. A man hangs his bag on the spring and it reads 49 N when the lift is stationary. If the lift moves downward with an acceleration of 5 m/s^2 the reading of the spring balance will be

(A) 24 N (B) 74 N (C) 15 N (D) 49 N

Ans: (A)

This problem will make you understand the importance of deciding the frame of reference before solving the problem.