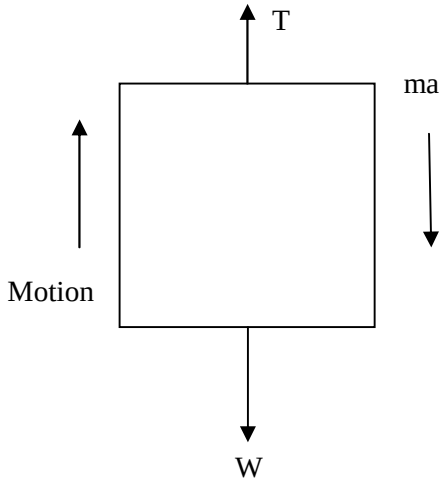
$$T = 1.305 \text{ kN}$$



Kinetics of Particles-Newton's Law of Motion

Newton's Second Law of Motion

The rate of change of momentum of a body is directly proportional to the applied force and motion takes place in the direction in which the force acts.

Force ∝ Rate of change of momentum

Where momentum = Mass × Velocity

$$= m \times v$$

Rate of change of momentum= Mass × Rate of change of velocity

$$= m \times a$$

$$F \propto ma$$

$$F = kma$$

By substituting the unit it us found that k=1

$$F = ma$$

D' Alembert's Principle

It is the application of Newton's second law

The system of forces acting on a body in motion is in dynamic equilibrium with the inertia force of the body.

$$F = ma$$

$$F - ma = 0$$

This equilibrium is called as equation of dynamic equilibrium.

In this equation 'ma' is called as an imaginary force (or) opposition force which is applied opposite to the direction of F or direction of motion. This force is called as 'Inertia force'.

Tips for solving the problems:

Step 1: Draw the free body diagram and kinetic diagram of the given system

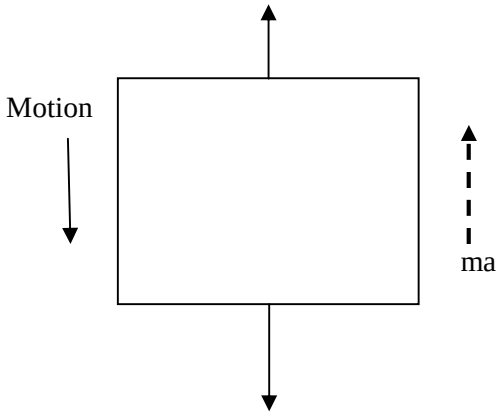
Step 2: Resolve all the forces and inertia force

Step 3: Apply equation of motion and find out the unknowns

Problem:

A block weighting 2500N rests on a horizontal plane for which co-efficient of friction is 0.20. The block is pulled by a force 1000N, which is acting at an angle of 30 to the horizontal. Find the velocity of the block after it moves 30m starting from the rest.

Case 2: Lift moving downwards



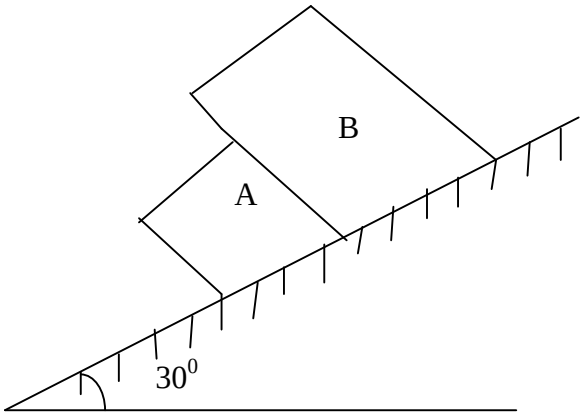
$$T + ma - w = 0$$

$$T + \left(\frac{1}{9.81}\right) \times 3 - 1 = 0$$

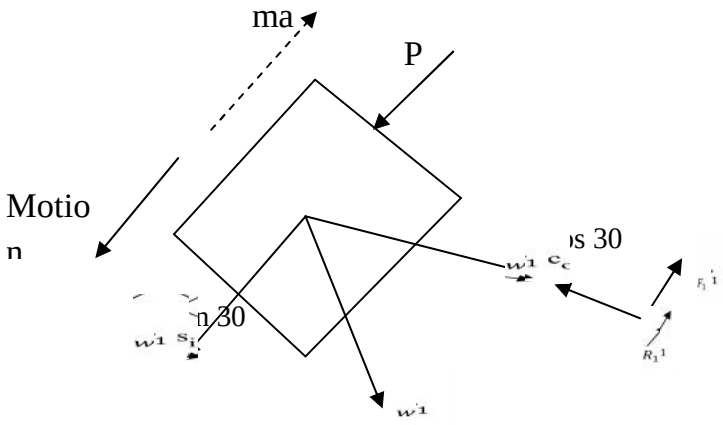
$$T = 0.694\ kN$$

Problem:

Masses A and B are 10 kg and 30 kg respectively. The co-efficient of friction between A and Plane is 0.25 and between B and plane is 0.15. What is the force between the two as they slide down. What is the acceleration of masses?



Solution:



Resolving forces perpendicular to the plane

$$R_1 = w_1 \cos 30 = 10 \cos 30 \times 9.81$$

$$= 8.667 \times 9.81$$

$$R_1 = 84.957\ N$$

Frictional force

$$F_1 = \mu_A R_1 = 0.25 \times 84.157$$

$$F_1 = 21.24\ N$$

Resolving forces parallel to the plane

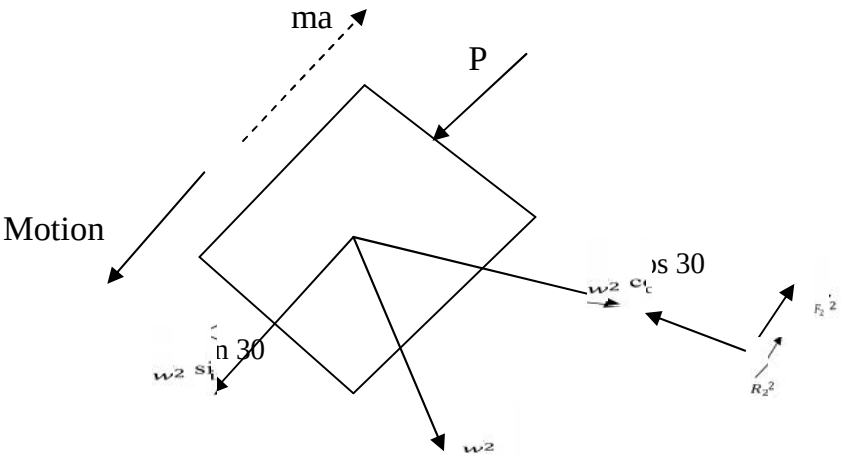
$$-p - w_1 \sin 30 + ma + F_1 = 0$$

$$-p - 10 \times 9.81 \times \sin 30 + 10 \times a - 21.24 = 0$$

$$-p - 27.31 + 10a = 0$$

$$p - 10a + 27.81 = 0 \rightarrow (1)$$

Free body diagram of block B with inertia force



Resolving forces vertically

$$R_2 - w_2 \cos 30 = 0$$

$$R_2 = 30 \times 9.81 \times \cos 30$$

$$R_2 = 254.87\ N$$

Frictional Force

$$F_2 = \mu_2 \times R_2 = 0.15 \times 254.87$$

$$F_2 = 38.23\ N$$

Resolving the forces parallel to the plane

$$-w_2 \sin 30 - p + ma + F_2 = 0$$

$$-30 \times 9.81 \sin 30 - p + 30a + 38.23 = 0$$

$$p - 30a - 108.92 = 0 \rightarrow (2)$$

Resolving Eq (1) & (2)

$$p - 10a + 27.81 = 0$$
$$p - 30a + 108.92 = 0$$

(-) (+) (+)

$$20a = 136.73$$
$$a = 6.836\ m/sec^2$$

Sub a in (1)

$$p - 10 \times 6.386 + 27.81 = 0$$

$$p = 36.05\ N$$