UNIT 3
DYNAMICS

PROBLEMS

3.1 20 N force moves a body with an acceleration of 2 ms^{-2}. What is it its mass? (LHR 2013)

Given Data

Force acting on the body = F = 20 N

Acceleration of the body = a = 2 ms^{-2}

Required

Mass of the body = m = ?

Solution

From Newton's second law of motion

$$F = ma$$

So $$m = \frac{F}{a}$$

By putting the values, we have

$$m = \frac{20}{2}$$

$$m = 10 \text{ kg}$$

Result

Mass of the body = m = 10 kg

3.2 The weight of a body is 147 N. What is its mass? (LHR 2013, 2015)

Given Data

Weight of the body = w = 147 N

Gravitational acceleration = g = 10 ms^{-2}

Required

Mass of the body = m = ?

Solution

As we know that

$$w = mg$$

So $$m = \frac{w}{g}$$

By putting the values, we have

$$m = \frac{147}{10}$$

$$m = 14.7 \text{ kg}$$

Result

Mass of the body = m = 14.7 kg

3.3 How much force is needed to prevent a body of mass 10 kg from falling?

Given Data

Mass of the body = 10 kg
Gravitation acceleration = g = 10 ms^{-2}

Required

Force required to prevent the body from falling = R = ?

Solution

As we know that in stable position,

$R = w = mg$

By putting the values, we have

$R = w = 10 \times 10$

$R = 100$ N

Result

Force required to prevent the body from falling = R = 100 N

3.4 Find the acceleration produced by a force of 100 N in a mass of 50 kg. (GRW 2013)

Given Data

Force acting on the body = F = 20 N
Mass of the body = m = 50 kg

Required

Acceleration of the body = a = ?

Solution

From Newton's second law of motion

$F = ma$

So $a = \frac{F}{m}$

By putting the values, we have

$a = \frac{100}{50}$

$a = 2\ ms^{-2}$

Result

Acceleration of the body = a = 2 ms^{-2}

3.5 A body has weight 20 N. How much force is required to move it vertically upwards with an acceleration of 2 ms^{-2}.

Given Data

Weight of the body = 20 N
Acceleration of the body = a = 2 ms^{-2}
Gravitational acceleration = g = 10 ms^{-2}
Normal reaction = R = w = 20 N

Required

Force acting on the body moving vertical upward = F = ?

Solution

As we know that

$w = mg$

So $m = \frac{w}{g}$

By putting the values, we have

$m = \frac{20}{10}$

$m = 2$ kg

From Newton's second law of motion

$F = ma$

By putting the values, we have

$F = 2 \times 2$

$F = 4$ N

Now net force required to move the body upward
= normal reaction + force producing acceleration

$= 20\ N + 4\ N = 24\ N$

Result

Force acting on the body moving vertical upward = F = 24 N

3.6 Two masses 52 kg and 48 kg are attached to the ends of a string that passes over a frictionless pulley. Find the tension in the string and acceleration in the bodies.

Mass of first body = $m_1 = 52$ kg
Mass of second body = $m_2 = 48$ kg
Gravitational acceleration = $g = 10\ ms^{-2}$

Required

Acceleration of the bodies = a = ?
Tension in the string = T = ?

Solution

When the two bodies are moving vertically then acceleration of the bodies is as,

$$a = \frac{(m_1 - m_2)g}{m_1 + m_2}$$

By putting the values in above equation, we have

$$a = \frac{(52-48)\times 10}{52+48}$$

$$a = \frac{40}{100}$$

$$a = 0.4\ ms^{-2}$$

When the two bodies are moving vertically then tension in the string is as,

$$a = \frac{2m_1 m_2 g}{m_1 + m_2}$$

By putting the values in above equation, we have

$$T = \frac{2\times 52\times 48\times 10}{52+48}$$

$$T = \frac{49920}{100}$$

$$T = 499.2\ N = 500\ N$$

Result

Acceleration of the bodies = a = 0.4 ms^{-2}
Tension in the string = T = 500 N

3.7 Two masses 26 kg and 24 kg are attached to the ends of a string which passes over a frictionless pulley. 26 kg is lying over a smooth horizontal table. 24 kg mass is moving vertically downward. Find the tension in the string and the acceleration in the bodies.

Given Data

Mass of the block moving vertically = $m_1 = 24$ kg
Mass of the block moving along table = $m_2 = 26$ kg
Gravitational acceleration = $g = 10\ ms^{-2}$

Required

Acceleration of the bodies = a = ?
Tension in the string = T = ?

Solution

When one body is moving vertically and other body is moving horizontally then acceleration of the bodies is as,

$$a = \frac{m_1 g}{m_1 + m_2}$$

By putting the values in above equation, we have

$$a = \frac{24\times 10}{24+26}$$

$$a = \frac{240}{50}$$

$$a = 4.8\ ms^{-2}$$

When the two bodies are moving vertically then tension in the string is as,

$$T = \frac{m_1 m_2 g}{m_1 + m_2}$$

By putting the values in above equation, we have

$$T = \frac{24 \times 26 \times 10}{24 + 26}$$

$$T = \frac{6240}{50}$$

$$T = 124.8 \text{ N} = 125 \text{ N}$$

Result

Acceleration in bodies = a = 4.8 ms^{-2}

Tension in the string = T = 125 N

3.8 How much time is required to change 22 Ns momentum by a force of 20 N? (LHR 2014)

Given Data

Change in momentum = $P_f - P_i$ = 22 Ns

Force applied = F = 20 N

Required

Time required = t = ?

Solution

As we know that

$$F = \frac{P_f - P_i}{t}$$

So $$t = \frac{P_f - P_i}{F}$$

By putting the values, we have

$$t = \frac{22}{20}$$

$$t = 1.1 \text{ s}$$

Result

Time required = t = 1.1 s

3.9 How much is the force of friction between a wood block of mass 5 kg and the horizontal marble floor? The coefficient of friction between wood and marble is 0.6.

Given Data

Mass of the block = m = 5 kg

Coefficient of friction = μ_s = 0.6

Required

Force of friction = F_s = ?

Solution

As we know that

$$F_s = \mu_s mg$$

By putting the values, we have

$$F_s = 0.6 \times 5 \times 10$$

$$F_s = 30 \text{ N}$$

Result

Force of friction = F_s = 30 N

3.10 How much centripetal force is needed to make a body of 0.5 kg to move in a circle of radius 50 cm with a speed of 3 ms^{-1}? (LHR 2012)

Given Data

Mass of the body = m = 0.5 kg

Radius of the circle = r = 50 cm = 0.5 m

Speed of the body = v = 3 ms^{-1}

Required

Centripetal force = F_c = ?

Solution

As we know that

$$F_c = \frac{mv^2}{r}$$

By putting the values, we have

$$F_c = \frac{0.5 \times (3)^2}{0.5}$$

$$F_c = 9 \text{ N}$$

Result

Centripetal force = F_c = 9 N