

Unit 3: Dynamics

Problems

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

(LHR 2013)

Given Data

Force acting on the body = $F = 20 \text{ N}$

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

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 = $m = 10 \text{ kg}$

3.2 The weight of a body is 147 N. What is its mass?

(LHR 2013, 2015)

Given Data

Weight of the body = $w = 147 \text{ N}$

Gravitational acceleration = $g = 10 \text{ ms}^{-2}$

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 = $m = 14.7 \text{ kg}$

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 = $g = 10 \text{ ms}^{-2}$

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

$$R = w = 10 \times 10$$

$$R = 100 \text{ N}$$

Result

Force required to prevent the body from falling = $R = 100 \text{ N}$

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 = $F = 20 \text{ N}$

Mass of the body = $m = 50 \text{ kg}$

Required

Acceleration of the body = $a = ?$

Solution

From Newton's second law of motion

$$F = ma$$

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

By putting the values, we have

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

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

Result

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

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

Gravitational acceleration = $g = 10 \text{ ms}^{-2}$

Normal reaction = $R = w = 20 \text{ N}$

Required

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

Solution

As we know that

$$w = mg$$

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

By putting the values, we have

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

$$m = 2 \text{ kg}$$

From Newton's second law of motion

$$F = ma$$

By putting the values, we have

$$F = 2 \times 2$$

$$F = 4 \text{ N}$$

Now net force required to move the body upward

= normal reaction + force producing acceleration

$$= 20 \text{ N} + 4 \text{ N} = 24 \text{ N}$$

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 = $m_1 = 52 \text{ kg}$

Mass of second body = $m_2 = 48 \text{ kg}$

Gravitational acceleration = $g = 10 \text{ ms}^{-2}$

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

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

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

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

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

$$a = \frac{2m_1m_2g}{m_1 + m_2}$$

By putting the values in above equation, we have

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

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

$$T = 499.2 \text{ N} = 500 \text{ N}$$

Result

Acceleration of the bodies = $a = 0.4 \text{ ms}^{-2}$

Tension in the string = $T = 500 \text{ N}$

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

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

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

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

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 = $t = 1.1 \text{ s}$

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 = $m = 5 \text{ kg}$
Coefficient of friction = $\mu_s = 0.6$

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 = $F_s = 30 \text{ N}$

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 = $m = 0.5 \text{ kg}$
Radius of the circle = $r = 50 \text{ cm} = 0.5 \text{ m}$
Speed of the body = $v = 3 \text{ ms}^{-1}$

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 = $F_c = 9 \text{ N}$

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Report any mistake at freeilm786@gmail.com

