CHAPTER 3 – DYNAMICS

Solved Numerical Questions

Q1.

A boy is holding a book of mass 2 kg. How much force is he applying on the book? If he moves it upward with acceleration of 3 m/s², how much total force should he apply on the book?

(a) When the book is at rest

Given Data:

Mass of the book

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

Acceleration due to gravity

$$g = 9.8\ \text{m/s}^2$$

To Find:

Force applied on the book = ?

Explanation:

When the book is held at rest, the applied force is equal to the **weight of the book**.

We know that,

$$\text{Weight} = mg$$

Solution:

$F = 2 \times 9.8\ F = 19.6\ \text{N}$

Answer:

$$\boxed{19.6\ \text{N}}$$

(b) When the book is moving upward

Given Data:

Mass

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

Acceleration

$$a = 3\,\text{m/s}^2$$

Gravity

$$g = 9.8\,\text{m/s}^2$$

To Find:

Total applied force = ?

Explanation:

When the book moves upward, the applied force must overcome gravity and also produce acceleration.

We know from Newton's Second Law,

$$F = m(g + a)$$

Solution:

$F = 2(9.8 + 3)\ F = 2 \times 12.8\ F = 25.6\,\text{N}$

Answer:

$$\boxed{25.6\,\text{N}}$$

Q2.

A girl of mass 30 kg is running with a velocity of 4 m/s. Find her momentum.

Given Data:

Mass

$$m = 30\,\text{kg}$$

Velocity

$$v = 4\,\text{m/s}$$

To Find:

Momentum = ?

Explanation:

Momentum is defined as the product of mass and velocity.

We know that,

$$p = mv$$

Solution:

$p = 30 \times 4\ p = 120$ kg m/s

Answer:

$$\boxed{120 \text{ kg m/s}}$$

Q3.

A 2 kg steel ball is moving with a speed of 15 m/s. It hits a bulk of sand and comes to rest in 0.2 s. Find the force applied by sand on the ball.

Given Data:

Mass

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

Initial velocity

$$u = 15 \text{ m/s}$$

Final velocity

$$v = 0 \text{ m/s}$$

Time

$$t = 0.2 \text{ s}$$

To Find:

Force applied = ?

Explanation:

Force is the rate of change of momentum.

We know that,

$$F = \frac{m(v-u)}{t}$$

Solution:

$F = \frac{2(0-15)}{0.2}\, F = \frac{-30}{0.2}\, F = -150\ \text{N}$

(The negative sign indicates that the force acts opposite to the direction of motion.)

Answer:

$$\boxed{-150\ \text{N}}$$

Q4.

A 100 g bullet is fired from a 5 kg gun. The muzzle velocity of the bullet is 20 m/s. Find the recoil velocity of the gun.

Given Data:

Mass of bullet

$$m_b = 100\ \text{g} = 0.1\ \text{kg}$$

Mass of gun

$$m_g = 5\ \text{kg}$$

Velocity of bullet

$$v_b = 20\ \text{m/s}$$

To Find:

Recoil velocity of the gun = ?

Explanation:

According to the law of conservation of momentum, total momentum before and after firing remains the same.

Initial momentum = 0

$$m_b v_b = m_g v_g$$

Solution:

$v_g = \frac{m_b v_b}{m_g} v_g = \frac{0.1 \times 20}{5} v_g = 0.4\ \text{m/s}$

(The gun recoils in the opposite direction.)

Answer:

$\boxed{0.4\ \text{m/s}}$

Q5.

A robotic car of mass 15 kg is moving with a speed of 25 m/s. Brakes apply a constant force of 50 N. How long does the car take to stop?

Given Data:

Mass

$$m = 15\ \text{kg}$$

Initial velocity

$$u = 25\ \text{m/s}$$

Final velocity

$$v = 0\ \text{m/s}$$

Force

$$F = 50\ \text{N}$$

To Find:

Time taken to stop = ?

Explanation:

First we find acceleration using Newton's Second Law.

We know that,

$$F = ma$$

Then we use the equation of motion.

Solution:

$a = \frac{50}{15} = 3.33\ \text{m/s}^2\ a = \frac{v-u}{t} \Rightarrow t = \frac{u}{a} t = \frac{25}{3.33} t = 7.5\ \text{s}$

Answer:

$\boxed{7.5\ \text{s}}$

