Section 2: Applying Newton's second law

Section test

Throughout this test, take g = 9.8 ms^{-2}.

1. A force of 200 N acts on a car of mass 800 kg. Find the acceleration of the car.

2. A lift of mass 200 kg is moving upwards at a constant velocity of 2 ms^{-1}. Find the tension in the rope lifting the lift.

3. Two forces act on a particle of mass 5 kg which has acceleration of $2\mathbf{i} - 3\mathbf{j}$ ms^{-2}. One of the forces is $8\mathbf{i} + \mathbf{j}$ N. What is the other force?

4. The tension in a cable, which is lifting a load with an acceleration of 1.2 ms^{-2}, is 11000 N. What is the mass of the load?

5. During lift-off an astronaut of mass 100 kg experiences a contact force of 8000 N from the seat. What is the acceleration of the rocket?

6. Find the force required to accelerate a car of mass 800 kg at 2 ms^{-2} against a resistance of 1000 N.

7. A force of $6\mathbf{i} + \mathbf{j}$ N acts on a particle of mass 2 kg. The initial velocity of the particle is $2\mathbf{i} - 5\mathbf{j}$ ms^{-1}. What is its velocity after 4 seconds?

8. A lorry weighing 3 tonnes is travelling at 10 ms^{-1}. Find the force needed to stop it in 10 seconds.

9. A lorry weighing 3 tonnes is travelling at 10 ms^{-1}. Find the force needed to stop it in 10 m.

10. A miners' cage of mass 420 kg contains 3 miners of total mass 280 kg. The cage is lowered from rest by a cable. For the first 10 seconds the cage accelerates uniformly and descends a distance of 75 m. What is the force in the cable during the first 10 seconds?

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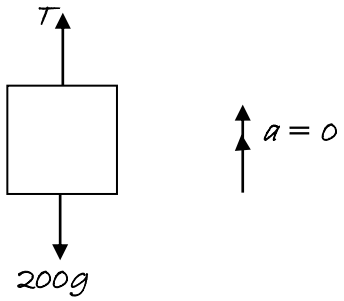
Solutions to section test

1. $F = ma$

   $200 = 800a$

   $a = 0.25$

   The acceleration of the car is $0.25\ ms^{-2}$.

2. 

   Since the lift is moving at constant velocity, the acceleration is 0.

   $T - 200g = 0$

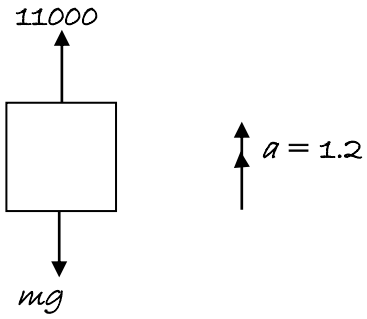
   $T = 200 \times 9.8 = 1960$

   The tension in the rope is 1960 N.

3. $\underset{\sim}{F} + 8\underset{\sim}{i} + \underset{\sim}{j} = 5(2\underset{\sim}{i} - 3\underset{\sim}{j})$

   $\underset{\sim}{F} + 8\underset{\sim}{i} + \underset{\sim}{j} = 10\underset{\sim}{i} - 15\underset{\sim}{j}$

   $\underset{\sim}{F} = 2\underset{\sim}{i} - 16\underset{\sim}{j}$

4. 

   $F = ma$

   $11000 - mg = m \times 1.2$

   $11000 - 9.8m = 1.2m$

   $11000 = 11m$

   $m = 1000$

   The mass of the load is 1000 kg.

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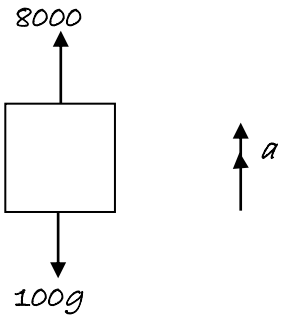
5.



$F = ma$

$8000 - 100g = 100a$

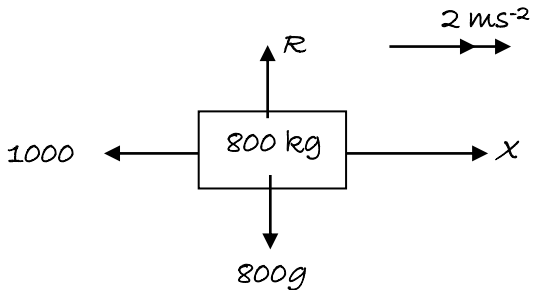
$8000 - 980 = 100a$

$7020 = 100a$

$a = 70.2$

Acceleration is $70.2\ ms^{-2}$.

6.



Horizontally: $F = ma$

$X - 1000 = 800 \times 2$

$X = 2600$

The force required is 2600 N.

7. $\underset{\sim}{F} = m\underset{\sim}{a}$

$6\underset{\sim}{i} + \underset{\sim}{j} = 2\underset{\sim}{a}$

$\underset{\sim}{a} = 3\underset{\sim}{i} + \frac{1}{2}\underset{\sim}{j}$

$\underset{\sim}{v} = \underset{\sim}{u} + \underset{\sim}{a}t$

$= 2\underset{\sim}{i} - 5\underset{\sim}{j} + 4(3\underset{\sim}{i} + \frac{1}{2}\underset{\sim}{j})$

$= 14\underset{\sim}{i} - 3\underset{\sim}{j}$

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8. $u = 10$ $\quad v = u + at$

$v = 0$ $\quad 0 = 10 + 10a$

$t = 10$ $\quad a = -1$

$a = ?$

$F = ma$

$= 3000 \times -1$

$= -3000$

The force needed to stop the lorry is 3000 N.

The acceleration is negative as it is slowing down. The force is negative as it is against the direction of motion.

9. $u = 10$ $\quad v^2 = u^2 + 2as$

$v = 0$ $\quad 0 = 10^2 + 2 \times 10a$

$s = 10$ $\quad -20a = 100$

$a = ?$ $\quad a = -5$

$F = ma$

$= 3000 \times -5$

$= -15000$

The force needed to stop the lorry is 15000 N.

10. $u = 0$ $\quad s = ut + \frac{1}{2}at^2$

$t = 10$ $\quad 75 = 0 \times 10 + \frac{1}{2}a \times 10^2$

$s = 75$ $\quad 75 = 50a$

$a = ?$ $\quad a = 1.5$

Total mass = 700 kg

$F = ma$

$700g - T = 700 \times 1.5$

$T = 700 \times 9.8 - 700 \times 1.5$

$T = 5810$