Acceleration

1. State the definition for acceleration and the SI unit for acceleration.

   Acceleration is the rate of change in velocity, measured in m/s^2

2. State the three different ways an objects velocity may change.
   - **Speed up**
   - **Slow down**
   - **Change direction**

3. State the equation used to calculate acceleration, with the units for each quantity.

   $$a = \frac{\Delta v}{t}$$

4. Calculate the acceleration of the following objects:

   a. A car that goes from 0 to 30 m/s in 5 seconds

   $$a = \frac{\Delta v}{t}$$

   $$a = \frac{30\ m/s - 0\ m/s}{5}$$

   $a = 6\ m/s^2$ (forwards/in direction of motion)

   b. A runner that goes from 4m/s to 8 m/s in 10 seconds

   $$a = \frac{\Delta v}{t}$$

   $$a = \frac{8\ m/s - 4\ m/s}{10}$$

   $a = 0.4\ m/s^2$ (forwards/in direction of motion)

   c. A car travelling at 10 m/s that comes to a stop at traffic lights in 3 seconds

   $$a = \frac{\Delta v}{t}$$

   $$a = \frac{0\ m/s - 10\ m/s}{3}$$

   $a = -3.33\ m/s^2$ (forwards/in direction of motion)

or 3.33 m/s² backwards (this means the direction of acceleration is backwards but it does not mean the car is moving backwards)

d. A dog walking at 3 m/s suddenly spotting a squirrel and starts chasing it at 12 m/s in 1.5 seconds

a = $\frac{\Delta v}{t}$

a = $\frac{12 \text{ m/s} - 3 \text{ m/s}}{1.55}$

a = 6 m/s² (forwards/in direction of motion)

e. A train travelling at 50 m/s slows down to stop in 1 minute

a = $\frac{\Delta v}{t}$

a = $\frac{0 \text{ m/s} - 50 \text{ m/s}}{60}$

a = -0.83 m/s² (forwards/in direction of motion)

or 0.83 m/s² backwards/in the opposite direction

5. Explain what it means for an object to have a negative acceleration.

That the object is slowing down.

6. Calculate the final velocity of:

a. A train that accelerates from rest at 10 m/s² for 8 seconds.

a = $\frac{\Delta v}{t}$

10 m/s² = $\frac{\text{final velocity} - 0 \text{ m/s}}{8 \text{ s}}$

80 = final velocity – 0

Final velocity = 80 m/s

b. An eagle that accelerates from 6 m/s at 2 m/s^2 for 5 seconds.

$a = \frac{\Delta v}{t}$

$2\ m/s^2 = \frac{\text{final velocity} - 6\ m/s}{5\ s}$

10 = final velocity – 6

Final velocity = 16 m/s

7. Calculate the initial velocity of:

a. an object that accelerates at 4 m/s^2 for 5 seconds and reaches a final velocity of 100 m/s.

$a = \frac{\Delta v}{t}$

$4\ m/s^2 = \frac{100 - \text{initial velocity}}{5\ s}$

20 = 100 – initial velocity

Final velocity = 80 m/s

b. an aeroplane that accelerates at 50 m/s^2 for 10 seconds and reaches a new velocity of 1000 m/s.

$a = \frac{\Delta v}{t}$

$50\ m/s^2 = \frac{1000 - \text{initial velocity}}{10\ s}$

500 = 1000 – initial velocity

Final velocity = 500 m/s

8. Calculate how long it takes for:

a. A jet to reach 600 m/s if it started from rest and accelerated at 30 m/s^2.

$a = \frac{\Delta v}{t}$

$30\ m/s^2 = \frac{600\ m/s - 0\ m/s}{time}$

$30\ t = 600$

$t = 20$ seconds

b. A dog to reach 15 m/s from 5 m/s, accelerating at 2 m/s^2.

$a = \frac{\Delta v}{t}$

$2\ m/s^2 = \frac{15\ m/s - 5\ m/s}{time}$

$2\ t = 10$

$t = 5$ seconds