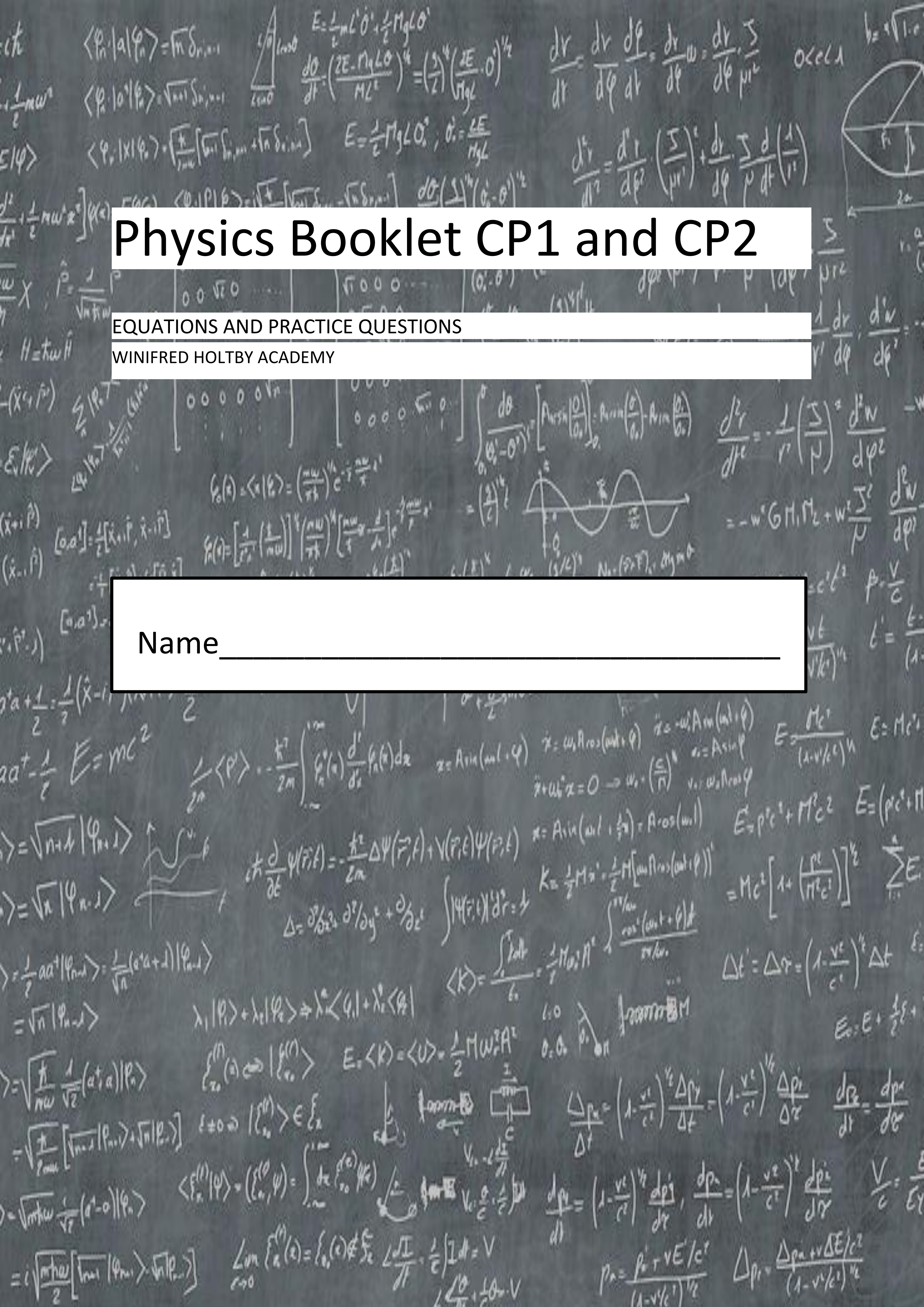


# Physics Booklet CP1 and CP2

EQUATIONS AND PRACTICE QUESTIONS

WINIFRED HOLTBY ACADEMY

Name________________________________________

Write as many of the equations as you can remember in this box. Correct them in green pen using the equations sheet on the back.

CP1b.6

**1** Emma is running for the bus. She runs 100 metres in 25 seconds. Calculate her speed.

**2** A jogger runs at a speed of 3 m/s. How far does he run in 120 seconds?

**3** Mr Smith is walking his dog. He walks for 5 minutes (300 seconds) at a speed of 1.5 m/s. His dog runs at a speed of 5 m/s for the same time.

  **a** How far does Mr Smith walk?

  **b** How far does the dog run?

**4** The table shows some results from an athletics event. Copy the table and fill in the missing values.

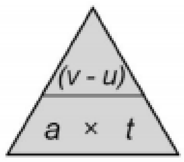
**5** The winner of a 10 km road race took half an hour to complete the race. Calculate her average speed. Give your answer in metres per second.

| | Distance (m) | Time (s) | Speed (m/s) |
|---|---|---|---|
| **a** | 100 | 12 | |
| **b** | | 25 | 8 |
| **c** | 400 | | 8 |
| **d** | 800 | 125 | |
| **e** | 1000 | 160 | |
| **f** | 2000 | | 6.25 |
| **g** | | 500 | 6 |

CP1c.3

**E1** A train is travelling at 35 m/s. It slows down with an acceleration of –0.5 m/s². How much time does it take to stop and how far does it travel while it is stopping?

**1** **a** Rearrange the equation to make *t* the subject (cover the *t* with your finger, and what you can see gives you the right hand side of your equation).




  **b** What is the starting velocity ($u$) in the question?

  **c** What is the final velocity ($v$) in the question?

  **d** What is the change in velocity ($v – u$)?

  **e** What does the minus sign in your answer to part **d** indicate?

  **f** Calculate the time it takes the train to stop.

**2** The box on the right shows the equation relating velocities, acceleration and distance.

$$x = \frac{v^2 - u^2}{2 \times a}$$

  **a** Calculate the value of $v^2$ and $u^2$.

  **b** Substitute the values of $v^2$, $u^2$ and $a$ into the equation and calculate the distance.

**3** A car accelerates from 0 km/h to 100 km/h (28 m/s) in 5 s. It can decelerate at 5 m/s² if the driver applies the brakes fully.

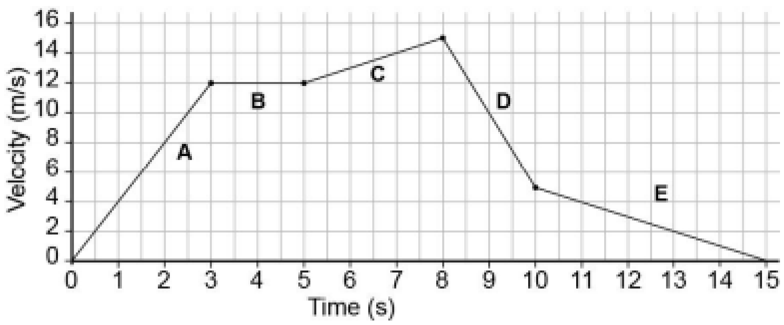
  **a** What is the acceleration of the car?

  **b** How long does it take the car to stop from a speed of 100 km/h if the driver applies the brakes fully?

CP1d.6

**1** Calculate the acceleration for each of the sections labelled A to D in the graph on the right.

**2** Calculate the distance travelled in the first 5 seconds shown on the graph.



Answer the questions using the F.R.S.A.U format and a calculator.

CP2a.5

3 For each of the following situations:

- sketch the situation and draw arrows to represent the forces
- state the size and direction of the resultant force
- say whether the forces on the object are balanced or unbalanced.

**a** There is an upthrust on a boat of 500 N. The weight of the boat is 550 N.

**b** A man throws a ball upwards. The weight of the ball is 2 N and the force from his hand is 5 N.

**c** The ball in part **b** is moving up through the air.

**d** A girl is standing on a cliff-top on a windy day when the force of the wind on her is 50 N. The forces on her are balanced.

**e** A boat sailing on a lake has a weight of 50 000 N and the forwards force from its sails is 200 N. The drag is 150 N.

**f** A cannonball with a weight of 40 N is flying horizontally through the air. The air resistance on it is 200 N.

Write as many of the equations as you can remember in this box. Correct them in green pen using the equations sheet on the back.

CP2c.4

**E1** Write an encyclopaedia entry that explains the difference between **mass** and **weight**.

1 Include all the words in the box in your answer.

You could structure your entry like this:

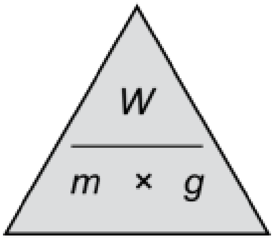
- explain what mass is and the units used for measuring it
- explain what weight is and the units for measuring it
- describe the factors that affect the weight of an object.
- make the difference clear by describing one way in which you can change the mass of an object and one way you can change the weight of an object *without* changing its mass.

**gravitational field strength**
10 N/kg Earth force
mass matter newtons
gravity kilograms
planet weight

**E2** A space probe on Titan has a weight of 280 N. Calculate its mass and its weight on Earth. The gravitational field strength on Titan is 1.4 N/kg.

2 **a** First calculate the mass of the probe. You could use this triangle to help you make *m* the subject of the formula.

**b** Now you know the mass of the probe, you can calculate its weight on Earth. Use a value of 10 N/kg for the gravitational field strength on Earth.




In 2005 the Huygens space probe descended through Titan's atmosphere under a parachute, gathering data as it fell. The mass of the probe was 319 kg.

3 Calculate the weight of the probe on Titan and on Earth.

4 The probe falls at a constant speed once the forces of weight and air resistance are balanced.

**a** Explain how this constant speed under the parachute in Titan's atmosphere would compare with its speed if it were falling through Earth's atmosphere. For this question, assume that the two atmospheres have the same pressure and density, so that air resistance depends only on the area of the parachute and its speed.

**b** The atmosphere of Titan is actually denser than Earth's atmosphere. Suggest how this fact affects your answer to part **a**.

5 The gravitational field strength on Mars is 3.7 N/kg. The density of Mars' atmosphere is much less than the density of Earth's atmosphere.

What can you say about the sizes of the parachutes needed to give the probe the same landing speed on Titan, Earth and Mars?

CP2c.7

1 Calculate the weights of the following objects. Use a value of 10 N/kg for the gravitational field strength.

**a** a 5 kg bag of bird seed
**b** a car with a mass of 1200 kg
**c** a suitcase with a mass of 15 kg
**d** a 200 g piece of meat
**e** an apple with a mass of 100 g
**f** a tablet with a mass of 50 mg

2 Calculate the masses of the following objects. Use a value of 10 N/kg for the gravitational field strength.

**a** a girl with a weight of 400 N
**b** a man with a weight of 850 N
**c** a biscuit with a weight of 0.2 N
**d** a fully loaded truck with a weight of 125 000 N
**e** a rocket with a weight of 8000 kN
**f** a car with a weight of $1.5 \times 10^4$ N

Answer the questions using the F.R.S.A.U format and a calculator.

CP2d.7

**1** A car has a mass of 1500 kg. What is the resultant force on the car when its acceleration is:

**a** 2 m/s$^2$ **b** 1.5 m/s$^2$ **c** 3 m/s$^2$ **d** 4 m/s$^2$?

**2** The table shows information about the force, mass and acceleration of different cars.

Calculate the missing values in the table.

| | Resultant force on car (N) | Mass of car (kg) | Acceleration (m/s$^2$) |
|---|---|---|---|
| **a** | | 1000 | 3.0 |
| **b** | 3750 | | 2.5 |
| **c** | 1500 | 1000 | |
| **d** | 2400 | | 1.2 |
| **e** | 1500 | 3000 | |

**3** The mass of an ejector seat in a jet fighter is 45 kg. The mass of the pilot and her clothing is 80 kg. When she ejects, she is subjected to an acceleration of 120 m/s$^2$. Calculate the force acting on the pilot and the ejector seat.

**4** A 50 g stone is fired from a catapult. The elastic in the catapult provides a force of 30 N. Calculate the acceleration of the stone.

**5** A flea accelerates at 1200 m/s$^2$ when it jumps. The mass of a flea is approximately 1 mg. Calculate the force the flea's legs produce.

**6** A car brakes with a deceleration of 5 m/s$^2$. The mass of the car is 1200 kg.

**a** Calculate the braking force on the car.

**b** What braking force is needed to give the same deceleration if the car is towing a trailer with a mass of 500 kg?

**7** A lorry has a mass of 15 tonnes when it is empty. 1 tonne = 1000 kg. Calculate the mass of the load being carried under the following conditions:

**a** it accelerates at 0.1 m/s$^2$ when the resultant force is 3000 N

**b** acceleration is 0.05 m/s$^2$ when the resultant force is 1750 N

**c** a 4000 N force accelerates it at 0.2 m/s$^2$.

**8** The acceleration of a bullet as it is fired is $2.5 \times 10^5$ m/s$^2$. The bullet has a mass of 4 g.

**a** Calculate the size of the force that accelerates the bullet.

**b** The same force is used to fire a bullet with a mass of 1.6 g. What is the acceleration of this bullet?

**9** The main engine of an Ariane V rocket produces a thrust of 1015 kN and its booster rockets produce a total thrust of 13 300 kN. If it has a launch mass of 780 tonnes, calculate its initial acceleration.

Write as many of the equations as you can remember in this box. Correct them in green pen using the equations sheet on the back.

CP2f.3

**S1** Two 5000 kg railway trucks are travelling at 5 m/s in opposite directions when they collide. After the collision they are stationary. Show that **momentum** is conserved.

1 Truck A has a mass of 5000 kg and a velocity of +5 m/s. Calculate its momentum.

2 a Explain why we say that truck B has a velocity of –5 m/s.

b Calculate the momentum of truck B.

3 What is the total momentum of the two trucks before they collide?

4 a What is the momentum of the two trucks after the collision?

b Explain how your answers show that momentum has been conserved.

Edgar the Emperor penguin has a mass of 14 kg and Manuel the Magellan penguin has a mass of 6 kg.

Their velocities are shown before and after they crash into each other. The negative sign indicates a velocity to the left whereas positive values show velocities to the right.

5 a What is Edgar's momentum before the collision?

b What is Manuel's momentum before the collision?

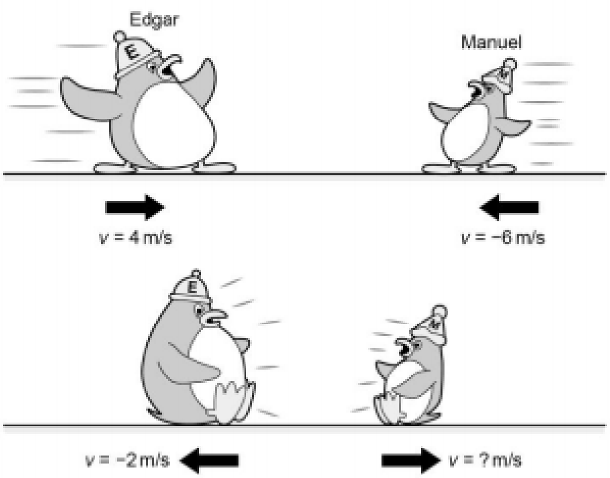
c How are the directions of their momentums different before the collision?

d What is the total momentum before the collision?

e What is Edgar's momentum after the collision?

f Explain why Manuel's momentum is 48 kg m/s after the collision.

g How fast is Manuel moving?




6 A trolley with a mass of 4 kg accelerates from rest to 3 m/s in 2 seconds. What force is needed to produce this acceleration?

7 A 20 N force accelerates a 5 kg trolley from 2 m/s to 5 m/s. How long does this change of velocity take?

CP2f.4

**E1** A 1 g bullet is travelling at 300 m/s when it enters a stationary 1 kg block of wood. The impact of the bullet makes the wood move. What is the speed of the block immediately after the impact? Explain how you worked out your answer.

1 a Calculate the **momentum** of the bullet.

b Calculate the total mass of the bullet and the block of wood after the collision.

c What is the momentum of the bullet and wood after the collision? Explain your answer.

d The equation for momentum can be rearranged to give velocity = momentum ÷ mass. Substitute the numbers into the equation to find the velocity.

2 A billiard ball of mass 0.01 kg moves at a velocity of 12 m/s and hits a stationary ball that has twice the mass of the moving ball. The moving billiard ball comes to a halt. What is the new velocity of the larger ball?

3 A man of mass 80 kg is running at a steady velocity of 4 m/s. He doesn't watch where he is going and bumps into a shopping trolley full of shopping, getting stuck to it in the process. The trolley and shopping have a mass of 40 kg. What velocity do the man, the trolley and the shopping have now?

4 A driver of mass 100 kg gets into a bumper car (mass 100 kg) and reaches a velocity of +3 m/s. He drives straight into another bumper car (again of mass 100 kg), which is driving straight at him 'head on' at a velocity of –2 m/s. The mass of the occupant of this car is 30 kg. What happens in this case?

Answer the questions using the F.R.S.A.U format and a calculator.

CP2g.5

Here is a table of thinking, **braking** and **stopping distances** for a vehicle at various speeds in normal conditions, with an alert driver.

| Speed (m/s) | Thinking time (s) | Thinking distance (m) | Braking distance (m) | Overall stopping distance (m) |
|---|---|---|---|---|
| 5 | 1 | 5 | 2 | 7 |
| 10 | 1 | | 8 | |
| 15 | 1 | | 17 | |
| 20 | 1 | | | |
| 25 | 1 | | 48 | |
| 30 | 1 | | 70 | |

1. Make a copy of the table and complete the **thinking distance** column. (Remember, distance = speed × time)
2. Calculate the overall stopping distance in each case to complete the last column of the table (omit the information for 20 m/s for now).
3. **a** Plot a graph of overall stopping distance against speed to show how they are connected. Speed should be on the horizontal axis. Your vertical axis should go as far as 140 m.

   **b** Use your graph to find the overall stopping distance at a speed of 20 m/s and use this to help you to work out the **braking distance** at that speed.
4. Recalculate all of the thinking and total stopping distances for a drunk driver who takes 1.8 s to react.
5. On the same axes as the graph in question **3**, plot the stopping distance against speed for the drunk driver. Include a key to show what each line represents.
6. Recalculate all of the braking and total stopping distances for an alert driver in a car with worn brakes. Worn brakes mean the braking distance is 20% greater at all speeds.
7. Add another line to your graph to show the effect of worn brakes.
8. Compare the effects of a drunk driver and worn brakes on the stopping distance.

CP2h.4

**E1** **H** Use calculations to show the effects of speed, mass and **crumple zones** on the forces acting in a road collision.

You can show the effects of speed on forces in a road crash by working out the force for two objects which have the same mass and take the same time to stop but are travelling at different speeds.

1. **H** A small car has a mass of 1000 kg and takes 0.05 seconds to stop. Calculate the force on it when it stops from a speed of

   **a** 15 m/s

   **b** 30 m/s.
2. **H** How do your answers to question **1** compare with each other? Is there a relationship between speed and force? Try to use some of the quantitative terms in the box in your answer.

   | | |
   |---|---|
   | double | directly proportional |
   | inversely proportional | half |
3. **H** Now compare the effects of mass in the same way. Use a speed of 15 m/s and the same stopping time, and compare a 1000 kg car with a 2000 kg car. (*Hint*: you only need to carry out one more calculation.)
4. **H** How does the force on a 1000 kg car travelling at 15 m/s change if it has a longer crumple zone and takes 0.1 seconds to stop?

| | | |
|---|---|---|
| | distance travelled = average speed × time | |
| | acceleration = $\frac{\text{change in velocity}}{\text{time taken}}$ | $a = \frac{(v - u)}{t}$ |
| | force = mass × acceleration | $F = m \times a$ |
| | weight = mass × gravitational field strength | $W = m \times g$ |
| | efficiency = $\frac{\text{(useful energy transferred by the device)}}{\text{(total energy supplied to the device)}}$ | |
| **HT** | **momentum = mass × velocity** | $p = m \times v$ |
| | wave speed = frequency × wavelength | $v = f \times \lambda$ |
| | wave speed = distance ÷ time | $v = \frac{x}{t}$ |
| | density = mass ÷ volume | $\rho = \frac{m}{V}$ |
| | work done = force × distance moved in direction of force | $E = F \times d$ |
| | change in gravitational potential energy = mass × gravitational field strength × change in vertical height | $\Delta GPE = m \times g \times \Delta h$ |
| | kinetic energy = ½ × mass × (speed)² | $KE = \frac{1}{2} \times m \times v^2$ |
| | power = work done ÷ time taken | $P = \frac{E}{t}$ |
| | energy transferred = charge moved × potential difference | $E = Q \times V$ |
| | charge = current × time | $Q = I \times t$ |
| | potential difference = current × resistance | $V = I \times R$ |
| | power = energy transferred ÷ time taken | $P = \frac{E}{t}$ |
| | electrical power = current × potential difference | $P = I \times V$ |
| | electrical power = current squared × resistance | $P = I^2 \times R$ |
| | force exerted on a spring = spring constant × extension | $F = k \times x$ |

## **GCSE (9–1) Physics**, you also need to learn these extra equations:

| | |
|---|---|
| moment of a force = force × distance normal to the direction of the force | |
| pressure = force normal to surface ÷ area of that surface | $P = \frac{F}{A}$ |