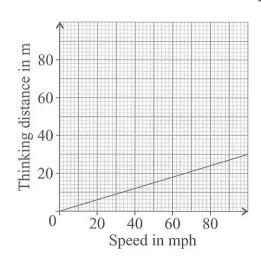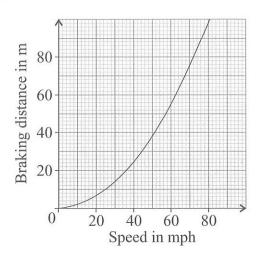# Stopping Distances and Momentum

1   **Figure 1** shows two graphs that illustrate how the thinking distance and braking distance of a moving car vary with the speed of the car in good driving conditions.

Figure 1

a)* Explain the shapes of the graphs shown in **Figure 1**.
In your answer you should refer to relevant equations of motion and energy transfers.

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[6]

b) Using **Figure 1**, estimate the stopping distance of a car when it is travelling at 33 m/s.
1 mph = 0.447 m/s.

Stopping distance = ... m

[3]

c) Explain how the two graphs in **Figure 1** would be different
for driving conditions where the road is slippery.

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[4]

[Total 13 marks]

2   Two people are investigating each other's reactions times.

Person 1 measures the reaction time of Person 2 by dropping a ruler between their thumb and
index finger. Person 2 has to catch the ruler as soon as possible after noticing that it is falling.

Person 2's arm is resting on the table with their hand free to catch the ruler.
The 0.0 cm mark on the ruler is initially held level with Person 2's thumb.

a) Person 1 measures Person 2's reaction time to be 0.20 s.
Calculate the distance the ruler fell before Person 2 caught it.
Give your answer in centimetres. Acceleration due to gravity = 10 m/s².

Distance = ... cm

[5]

b) Suggest **two** changes that could be made to improve the experiment.
Explain your answers.

1. ....

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2. ....

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[4]

[Total 9 marks]

Section 1 — Motion, Forces and Conservation of Energy

3   **Figure 2** shows Marble A and Marble B colliding at the base of a ramp.

Figure 2

Before the collision, Marble A travels with a speed of 2.9 m/s and Marble B is stationary. After the collision, Marble B travels fast enough to just reach the top of the ramp, 25 cm above the ground.

a) Calculate the speed of Marble B immediately after the collision.
   Acceleration due to gravity = 10 m/s². Assume that there are no resistive forces.

Speed = ... m/s

[4]

b) Immediately after the collision Marble A continues towards the ramp with a speed of 0.7 m/s. Using conservation of momentum, calculate the ratio of the masses of the two marbles, $\frac{m_A}{m_B}$, where m_A = mass of Marble A and m_B = mass of Marble B.

$\frac{m_A}{m_B}$ = ...

[4]

c) A student drops Marble B from a height of 1.0 m onto several types of surface. Explain why the marble experiences a larger average force during impact when it falls onto carpet than when it falls onto a soft sponge. The marble does not bounce off either surface.

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[2]

[Total 10 marks]

Section 1 — Motion, Forces and Conservation of Energy

4   A 1500 kg car is travelling in a straight line along a flat road.

a)   The car is moving with a constant speed of 27.0 m/s when a hazard appears,
     causing the driver to perform an emergency stop.
     The driver's reaction time is 1.50 s and car's total stopping distance is 113 m.
     Calculate the resultant force acting on the car whilst its brakes are applied.

Force = ... N

[6]

b)   Which of the following factors would increase the amount of work required to bring the car to a
     complete stop?

☐   **A**   Worn out brake pads.

☐   **B**   A heavily loaded car boot.

☐   **C**   Poor weather conditions.

☐   **D**   Loose gravel on the road.

[1]

c)   The car is equipped with regenerative brakes.
     When the brakes are applied, the car's motion is used to charge the car's battery.
     The regenerative brakes are 18% efficient.
     Describe which energy stores energy is transferred between when the brakes are used.

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[2]

[Total 9 marks]

Exam Practice Tip

You may need to do multiple calculations before you get your final answer. It can be easy to make a
mistake if you try to juggle all that information around just on your calculator screen or, worse still, in
your head. Write down all your working — it may get you marks even if you get the answer wrong.

Score: ☐

41

☺☐   ☺☐   ☺☐