

Forces 2

Name: _____

Class: _____

Date: _____

Time: **71 minutes**

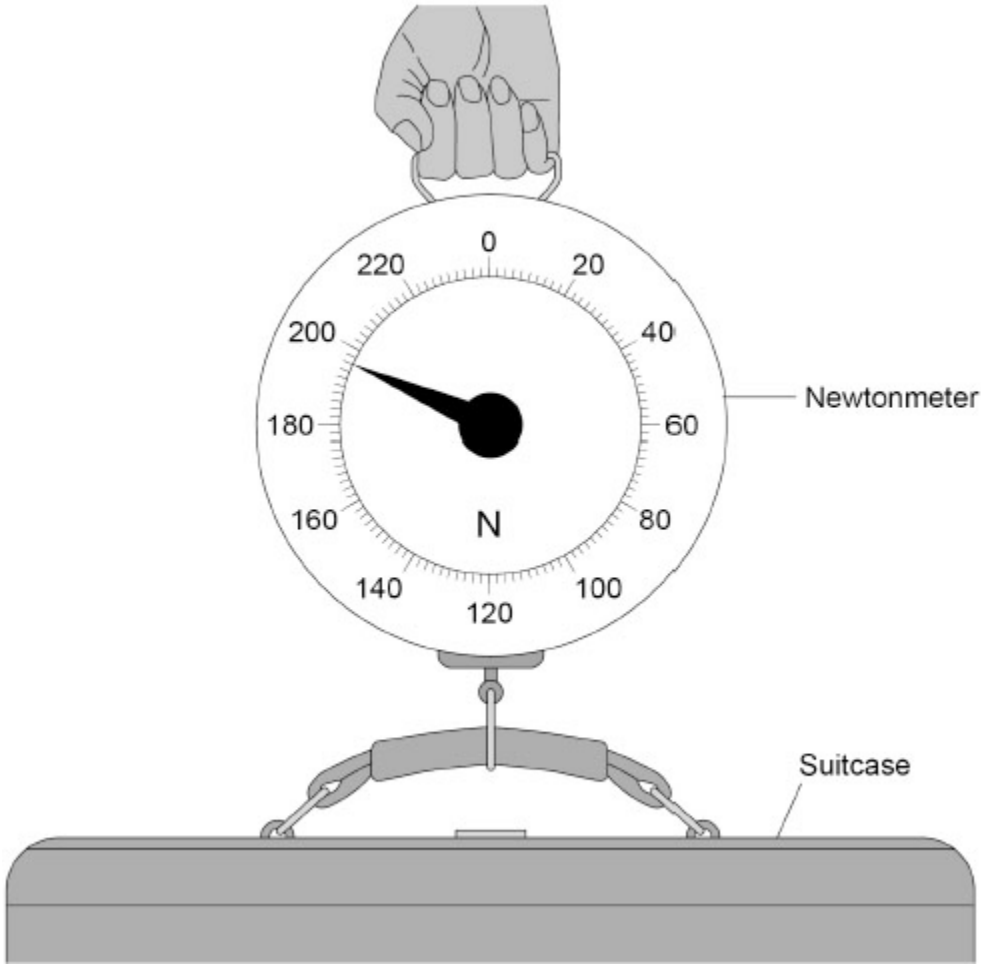
Marks: **65 marks**

Comments:

1.

Figure 1 shows a person using a newtonmeter to measure the weight of a suitcase.

Figure 1



There is a pair of forces acting between the suitcase and the newtonmeter.

(a) How does the force on the suitcase compare with the force on the newtonmeter?

Tick (✓) **one** box.

The force on the suitcase is smaller.

The forces are the same size.

The force on the suitcase is bigger.

(1)

(b) Which sentence describes the directions in which the pair of forces act?

Tick (✓) **one** box.

They act in opposite directions.

They act in the same direction.

They act in perpendicular directions.

(1)

(c) What is the weight of the suitcase shown on the newtonmeter in **Figure 1**?

Weight = _____ N

(1)

(d) Calculate the mass of the suitcase.

gravitational field strength = 9.8 N/kg

Use your answer from part (c) and the equation:

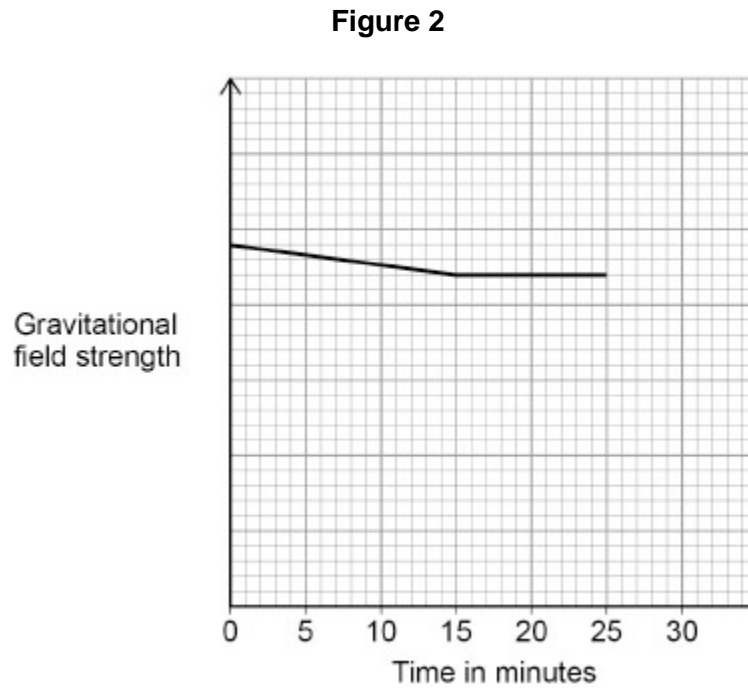
$$\text{mass} = \frac{\text{weight}}{\text{gravitational field strength}}$$

Mass = _____ kg

(2)

- (e) The suitcase is loaded into an aeroplane. The aeroplane takes off and its height above the ground increases. The aeroplane then flies at a constant height.

Figure 2 shows how the gravitational field strength in the aeroplane varies for the first 25 minutes of the flight.



Describe how the weight of the suitcase will change during the first 25 minutes of the flight.

Use **Figure 2**.

(3)
(Total 8 marks)

2.

Figure 1 shows an electronic whistle used by a referee in a football match.

Figure 1



When the button is pressed the whistle emits sound waves that travel through the air.

(a) What is transferred by the sound waves as they travel through the air?

Tick (✓) **one** box.

- Energy
- Mass
- Temperature

(1)

(b) What is a typical value for the speed of sound in air?

Tick (✓) **one** box.

33 m/s

330 m/s

3300 m/s

33 000 m/s

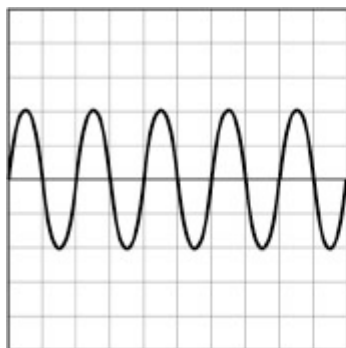
(1)

The whistle can emit two different sound waves, **A** and **B**.

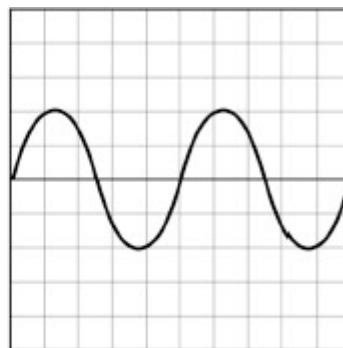
Figure 2 shows the two different sound waves as displayed on a screen.

The sound waves are drawn to the same scale.

Figure 2



Wave A



Wave B

(c) Complete the sentences to describe a difference and a similarity between the two waves.

Choose answers from the box.

amplitude	frequency	wavelength	period
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Difference

Wave **A** has a greater _____ than wave **B**.

Similarity

Wave **A** has the same _____ as wave **B**.

(2)

(d) Wave **A** has a frequency of 4.0 kHz.

Which of the following is the same as 4.0 kHz?

Tick (✓) **one** box.

4.0 Hz

4000 Hz

4 000 000 Hz

4 000 000 000 Hz

(1)

(e) Calculate the period of wave **A**.

Use your answer from part (d) and the equation:

$$\text{period} = \frac{1}{\text{frequency}}$$

Period = _____ s

(2)

(f) Sound waves in air are longitudinal waves.

Complete the sentence to describe a sound wave.

Choose answers from the box.

compression	deflection	diffraction	rarefaction	reflection
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When sound waves travel through air they create areas

of _____ and _____ .

(2)

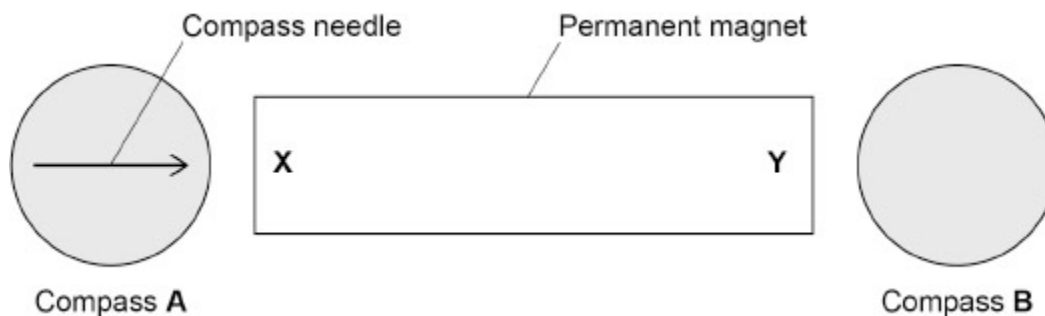
(Total 9 marks)

3.

Figure 1 shows a permanent magnet and two magnetic compasses.

The poles of the magnet are labelled **X** and **Y**.

Figure 1



(a) The direction of the compass needle in compass **A** is shown.

Give the names of the poles labelled **X** and **Y** in **Figure 1**.

X _____

Y _____

(2)

(b) Draw an arrow on compass **B** in **Figure 1** to show the direction of the magnetic field at that position.

(1)

Figure 2 shows security tags on some clothes in a shop.

Security tags can be detected if clothes are taken out of the shop with tags still attached.

Figure 2



The tags are attached to the clothes by pins made from a magnetic material.

A shop assistant can use a magnet to remove the pins.

(c) Which of the following are magnetic materials?

Tick (✓) **two** boxes.

- Aluminium
- Copper
- Iron
- Lead
- Nickel
- Tin

(2)

(d) Which of the following describes the force between a magnetic material and a magnet?

Tick (✓) **one** box.

The force is always attractive.

The force is always repulsive.

The force can be either attractive or repulsive.

(1)

(e) The shop assistant removes a security tag and drops the tag into a collecting bin.

As it falls, the tag accelerates at 9.8 m/s^2 .

The mass of the tag is 0.030 kg.

Calculate the resultant force acting on the tag.

Use the equation:

$$\text{resultant force} = \text{mass} \times \text{acceleration}$$

Resultant force = _____ N

(2)

(Total 8 marks)

4.

The stopping distance of a car depends on the thinking distance and the braking distance.

(a) Which of the following affects the thinking distance?

Tick (✓) **one** box.

Condition of the brakes

Icy road conditions

Reaction time of the driver

(1)

A car manufacturer tested three different types of tyre which were fitted to three identical cars.

This is the method used.

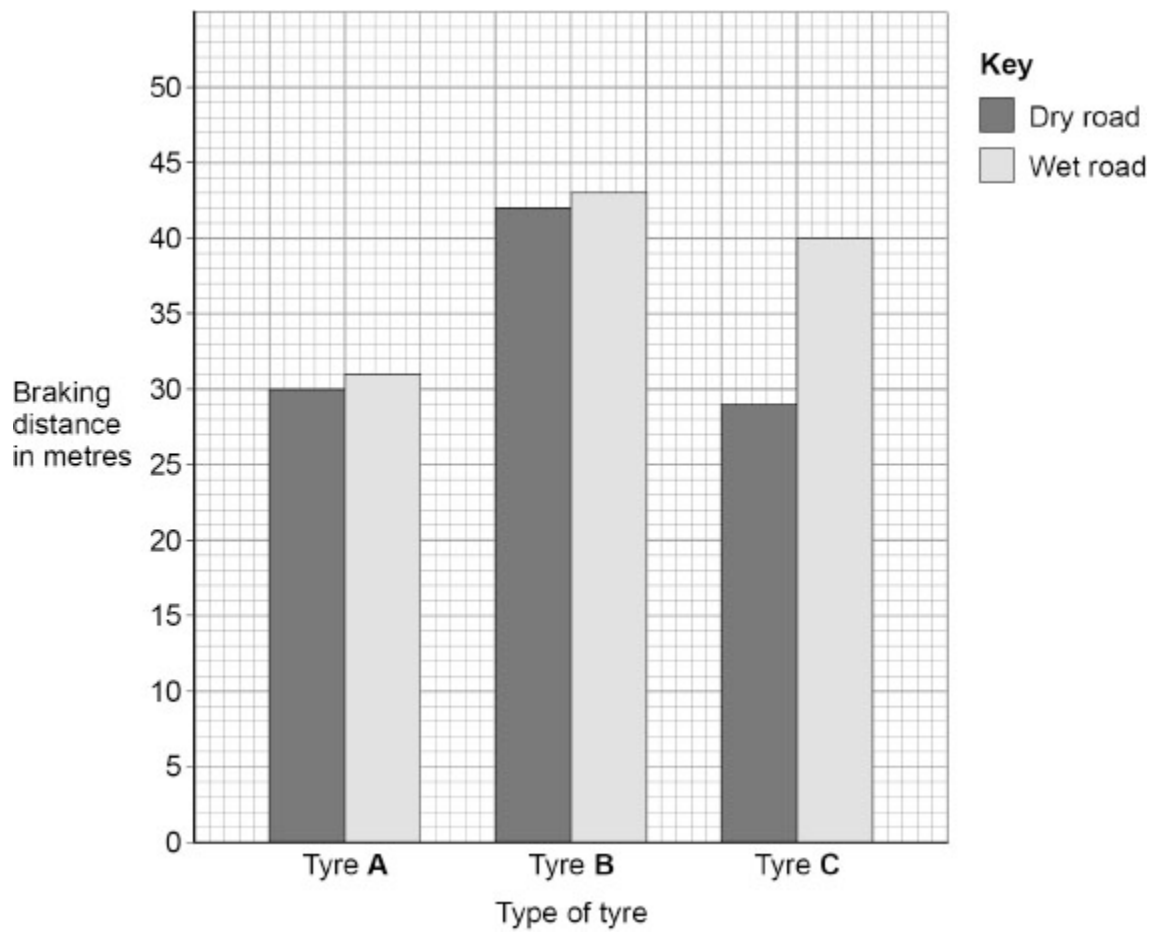
1. Drive the car along a road.
2. Apply the brakes until the car stops.
3. Measure the distance travelled while braking.
4. Repeat steps 1 to 3 for each car when the road is dry and when the road is wet.

(b) The brakes were applied with the same force for each test.

Give **one other** variable that should have been kept the same for each test.

(1)

The figure below shows the results.



(e) The braking force acting on a car is 6000 N.

The work done to stop the car is 300 000 J.

Calculate the braking distance of the car.

Braking distance = _____ m

(3)

(f) Explain how the force applied by the brakes affects the braking distance of the car.

(2)

(Total 14 marks)

5.

Figure 1 shows an Olympic gymnast performing a floor routine.

Figure 1



The floor contains springs.

When the gymnast lands on the floor, a force compresses the springs in the floor.

- (a) When a spring is compressed, the elastic potential energy of the spring increases.

Explain why compressing the springs in the floor helps the gymnast to jump higher.

Use ideas about energy in your answer.

(2)

- (b) When the gymnast lands on the floor, one of the springs compresses by 1.2 cm.

spring constant = 8500 N/m

Calculate the elastic potential energy stored in the spring.

Use the Physics Equations Sheet.

Give the unit.

Elastic potential energy = _____ Unit

(4)

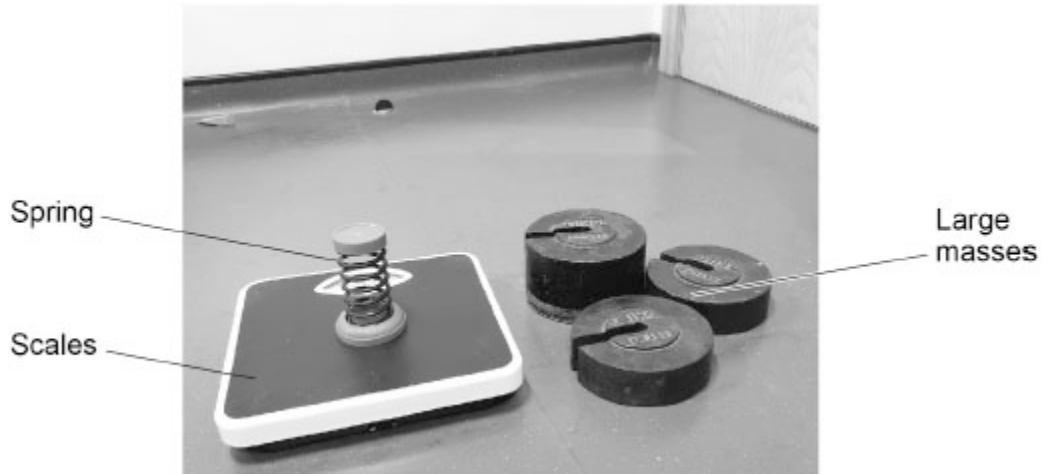
A student investigated a spring with a different spring constant.

When masses are placed on the spring it compresses.

The student measured the compression of the spring for different masses.

Figure 2 shows some of the equipment used.

Figure 2



(c) Describe how the compression of the spring could be determined.

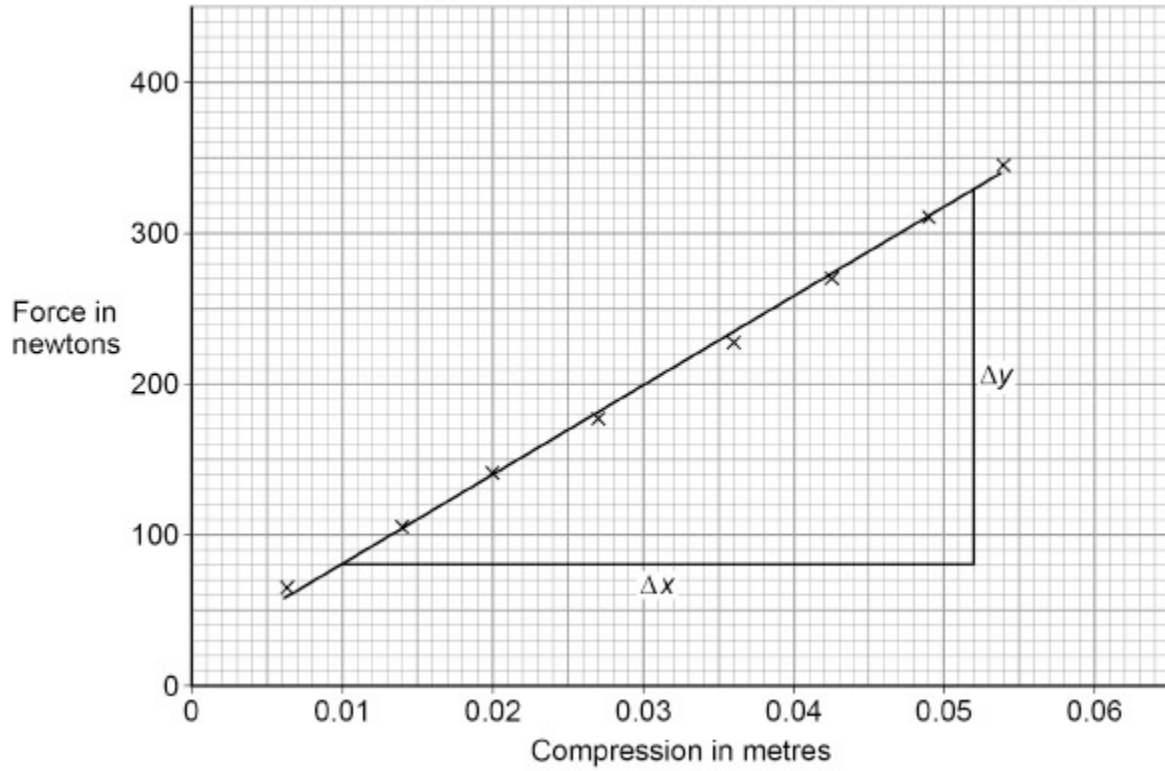
(2)

(d) Explain why the investigation should be done on the laboratory floor rather than on a table.

(2)

Figure 3 shows the results.

Figure 3



The spring constant is the gradient of the line of best fit shown on **Figure 3**.

(e) Determine the value Δy on **Figure 3**.

$$\Delta y = \text{_____} \text{ N}$$

(1)

(f) Determine the value Δx on **Figure 3**.

$$\Delta x = \text{_____} \text{ m}$$

(1)

(g) Determine the spring constant of the spring.

Use your answers to part (e) and part (f).

Give your answer to 3 significant figures.

Spring constant (3 significant figures) = _____ N/m

(2)

(Total 14 marks)

6.

A safety test was carried out to determine how the speed of a car affects the stopping distance of the car.

(a) At the start of the test the car was moving slowly.

Then the car accelerated at 5.8 m/s^2 for 2.5 s.

The final velocity of the car was 20 m/s.

Calculate the initial velocity of the car.

Use the Physics Equations Sheet.

Initial velocity = _____ m/s

(4)

(b) The reaction time of the driver was measured.

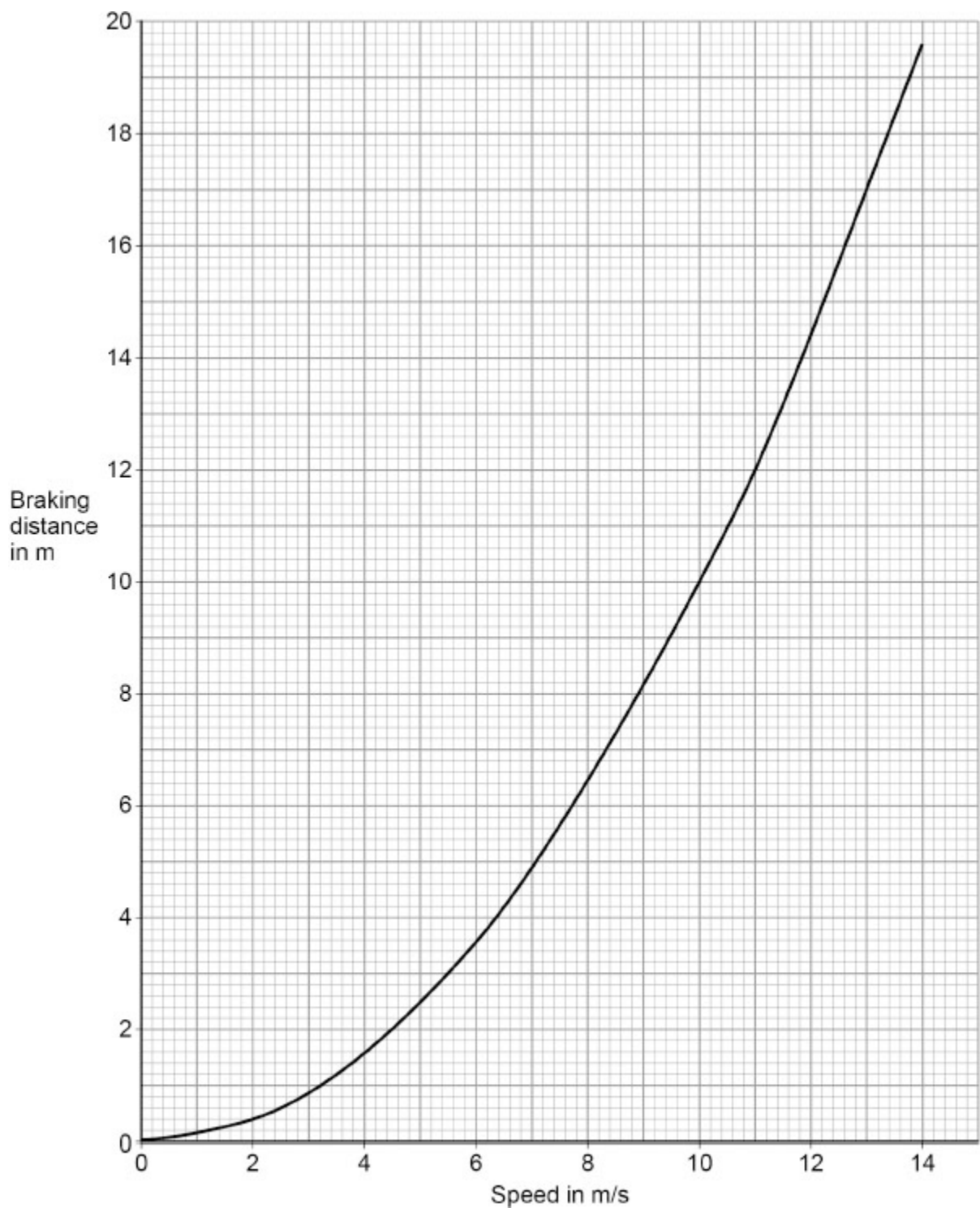
How can the reaction time of the driver be used to calculate the thinking distance?

(1)

The car was driven at a constant speed. The driver applied the maximum braking force, and the braking distance was measured.

The test was repeated at different speeds.

The figure below shows the results.



Mark schemes

- 1.** (a) the forces are the same size 1
- (b) they act in opposite directions 1
- (c) 196 (N) 1
- (d) $m = \frac{196}{9.8}$ 1
- 20 (kg)
allow ecf from part (c) 1
- (e) the weight will decrease (as the gravitational field strength decreases) 1
- the weight will then become constant 1
- at 15 mins
dependent on MP1 or MP2
allow a value in the range 14 to 16 mins
allow for the last 10 minutes
allow at the maximum height 1
- [8]**
- 2.** (a) energy 1
- (b) 330 m/s 1
- (c) frequency 1
- amplitude 1
- (d) 4000 Hz 1
- (e) $T = \frac{1}{4000}$ 1
- 0.00025 (s)
allow ecf from question (d) 1

(f) compression

1

rarefaction

either order

1

[9]

3.

(a) X = south

allow S for south

1

Y = north

allow N for north

allow 1 mark if they are the wrong way round

1

(b)



1

(c) iron

1

nickel

1

(d) the force is always attractive

1

(e) $F = 0.030 \times 9.8$

1

0.294 (N)

allow 0.29 (N)

1

[8]

4.

(a) reaction time of the driver

1

(b) (initial) speed

allow section of road used

ignore condition of road without further qualification

1

(c) **Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.

5-6

Level 2: Some logically linked reasons are given. There may also be a simple judgement.

3-4

Level 1: Relevant points are made. They are not logically linked.

1-2

No relevant content

0

Indicative content

- tyre A braking distance is 30 m on dry road and 31 m on wet road
- tyre A has the shortest braking distance on wet road
- tyre B braking distance is 42 m on dry road and 43 m on wet road
- tyre B has the longest braking distance on both wet and dry road
- tyre C braking distance is 29 m on dry road and 40 m on wet road
- tyre C has the shortest braking distance on dry road
- the difference between braking distance on wet and dry roads for tyre A and tyre B is 1m
- the difference between braking distance on wet and dry roads for tyre C is 11m

Judgements

- the shorter the braking distance the safer the tyre
- tyre A is 1 m longer on dry road, but is 9 m shorter on wet road than tyre C
- tyre A has the shortest combined / average braking distance
- overall tyre A is the safest
- tyre C is safest on a dry road
- tyre B is the least safe tyre
- the manufacturer should not choose tyre B

allow use of stopping distance for braking distance throughout

(d) work done = force \times distance

or

$$W = Fs$$

1

(e) 300 000 = 6000 \times s

1

$$s = \frac{300\,000}{6000}$$

1

$$s = 50 \text{ (m)}$$

1

(f) the greater the force the shorter the braking distance

1

(because) deceleration will be greater

or

(because) the work done to stop the car will be the same

1

[14]

5.

(a) (as a spring decompresses) the elastic potential energy of the spring decreases

1

(as the gymnast leaves the floor) the kinetic energy of the gymnast increases

or

the gravitational potential energy of the gymnast increases

1

OR

(as a spring decompresses) the spring exerts a force on the gymnast (1)

(so) work is done on the gymnast (1)

(b) $e = 0.012 \text{ m}$

1

$$E_e = 0.5 \times 8500 \times 0.012^2$$

allow a correct substitution using an incorrectly / not converted value of e

1

$$E_e = 0.612$$

allow 0.61

allow a correct calculation using an incorrectly / not converted value of e

1

J or joule

1

(c) measure the original length of the spring **and** the compressed length of the spring (using a metre rule)

compression = original length - compressed length

1

OR

calculate / measure the weight of the mass on the spring (1)

use the equation

$$e = \frac{F}{k} \quad (1)$$

1

(d) masses could fall (off the spring)

1

(so) less likely to cause injury / damage (if done on the floor)

allow less hazardous

allow lower risk (of injury)

allow specific cause of injury eg landing on foot

1

(e) $\Delta y = (330 - 80 =) 250$ (N)

1

(f) $\Delta x = (0.052 - 0.010 =) 0.042$ (m)

1

(g)

$$k = \frac{250}{0.042}$$

allow ecf from part (e) and part (f)

allow $k = 5952.38$

1

5950 (N/m)

allow their calculated gradient to 3 significant figures

1

[14]

6.

(a)

$$5.8 = \frac{\Delta v}{2.5}$$

1

$$\Delta v = 5.8 \times 2.5$$

1

$$\Delta v = 14.5$$

1

$$v = (20 - 14.5) = 5.5$$
 (m/s)

allow use of an incorrectly calculated Δv if the correct equation has been used

1

(b) multiply the speed of the car by the reaction time

1

(c) braking distance \propto speed²

1

(d) $6250 = m \times 5.0$

1

$$m = \frac{6250}{5.0}$$

1

$$m = 1250 \text{ (kg)}$$

1

$$v = 12 \text{ (m/s)}$$

1

$$p = 1250 \times 12$$

allow a substitution using a value of v in the range 11.8 to 12.2

allow a correct substitution using their incorrectly calculated value for m using the correct equation

1

$$p = 15\,000 \text{ (kg m/s)}$$

allow a calculation using a value of v in the range 11.8 to 12.2

allow a correct calculation using their incorrectly calculated value for m using the correct equation

1

[12]