Contact and Non-Contact Forces

Warm-Up

Each quantity below is either a scalar or a vector.
Write each word in the correct place in the table.

acceleration time temperature mass velocity force

Scalar	Vector

1 Which of the following correctly describes a vector? Tick **one** box. Grade 1-3

Vector quantities only have magnitude. ☐
Vector quantities have direction but not magnitude. ☐
Vector quantities have both magnitude and direction. ☐

[Total 1 mark]

2 A child is pulling a toy train along the floor using a piece of string.
State **one** contact force and **one** non-contact force that acts on the toy. Grade 4-5

Contact force: .....

Non-contact force: .....

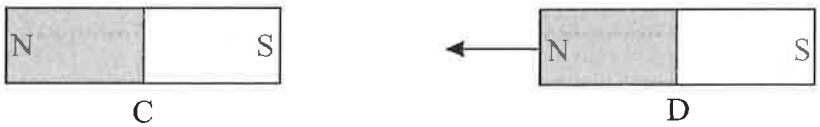
[Total 2 marks]

3 **Figure 1** shows two pairs of identical magnets. There is a force of repulsion between Magnet A and Magnet B. There is a force of attraction between Magnet C and Magnet D. Grade 4-5

Figure 1

Magnet A and Magnet B

Magnet C and Magnet D



Complete the diagram in **Figure 1** by drawing an arrow that represents the force Magnet D exerts on Magnet C.

[Total 2 marks]

Weight, Mass and Gravity

1 Draw **one** line from each property to the unit it is measured in. Grade 1-3

Property	Unit
mass	kilograms
weight	newtons

[Total 1 mark]

2 Which of the following correctly describes the relationship between mass and weight? Tick **one** box. Grade 3-4

- Mass and weight are inversely proportional. ☐
- Mass and weight are directly proportional. ☐
- Mass and weight are the same thing. ☐
- There is no relationship between mass and weight. ☐

[Total 1 mark]

3 Opportunity is a robot which is currently on the surface of the planet Mars. The total mass of Opportunity is 185 kg. Grade 4-5

3.1 Write down the equation that links weight, mass and gravitational field strength.

.....

[1]

3.2 Calculate the weight of Opportunity when it was on the Earth.
(The gravitational field strength on the surface of Earth = 9.8 N/kg.)
Give your answer to 2 significant figures.

Weight = ... N

[2]

3.3 The weight of Opportunity on Mars is 703 N.
Calculate the gravitational field strength on the surface of Mars.

Gravitational Field Strength = ... N/kg

[3]

[Total 6 marks]

Exam Practice Tip

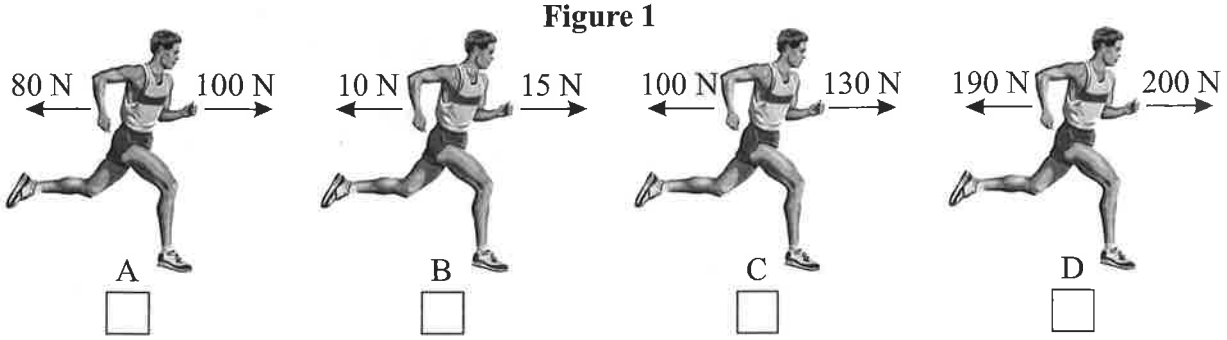
Outside of physics, people often use the term weight when they mean mass. Make sure you understand the difference. You measure mass on a balance, but weight is a force measured by a spring-balance (newtonmeter).

Resultant Forces and Work Done

1 **Figure 1** shows four runners who are running in windy weather.
Tick the box under the runner who is experiencing the largest resultant force.

Grade 3–4

Figure 1

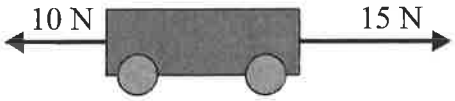


[Total 1 mark]

2 **Figure 2** shows two forces acting on a trolley.
A force of 10 N acts to the left and 15 N acts to the right.

Grade 3–4

Figure 2



Calculate the resultant force on the trolley. Give its size and direction.

Size of resultant force = ... N

Direction = ...

[Total 2 marks]

3 A woman pulls a 20 kg suitcase along a 15 m corridor using a horizontal force of 50 N.

Grade 4–5

3.1 Calculate the work done by the woman. Use the equation:

Work done = force × distance

Work done = ... Nm

[2]

3.2 Work is done against frictional forces acting on the wheels of the suitcase.
Describe the effect this has on the temperature of wheels. Explain this in terms of energy transfer.

.....

.....

[2]

[Total 4 marks]

Forces and Elasticity

1 A student hangs masses from a string. This causes the spring to stretch. Grade 3–4

1.1 Two forces are being applied to the spring to make it stretch.
Explain why more than one force is needed to make the spring stretch.

.....

.....

[1]

1.2 The student removes the masses. The spring returns to its original length and shape.
Name this type of deformation.

.....

[1]

1.3 The student adds more masses to the spring.
When the masses are removed, the spring doesn't return to its original shape.
Name this type of deformation.

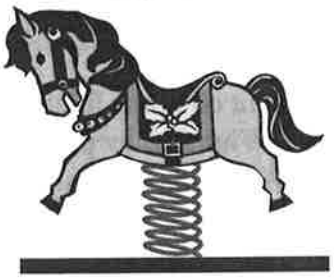
.....

[1]

[Total 3 marks]

2 A child sits on the toy horse in **Figure 1**. His feet don't touch the floor. Grade 4–5

Figure 1



The child exerts a force of 240 N on the horse.
The height of the toy horse decreases by 0.20 m.
Calculate the spring constant of the spring.
Use the equation:

force = spring constant × extension

Choose the correct unit from the box.

N/m	**N/kg**	**kg m^3**

Spring constant = ... Unit = ...

[Total 4 marks]

Investigating Springs

PRACTICAL

1 A student investigated the relationship between the force exerted on, and the extension of, a spring. He hung different numbers of masses from the bottom of the spring. Each time he measured the extension of the spring with a ruler. His set up is shown in **Figure 1**.

Grade 4-5

Figure 1

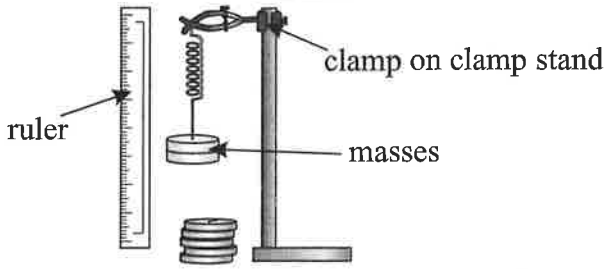
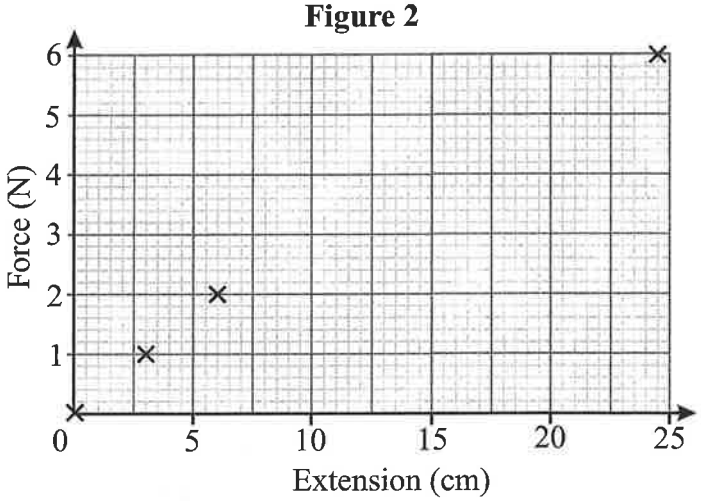


Table 1

Force (N)	Extension (cm)
0	0
1	3.0
2	6.0
3	9.0
4	12.0
5	16.5
6	24.5

Figure 2



1.1 **Table 1** shows the results that the student obtained in his investigation. Complete the force-extension graph in **Figure 2** by plotting the **three** missing points from **Table 1** and drawing a line of best fit.

[3]

1.2 What name is given to the point on the graph where force and extension stop being directly proportional?

.....

[1]

[Total 4 marks]

2 A spring is extended elastically by 8.0 cm. The spring constant of the spring is 25 N/m.

Grade 4-5

Calculate the work done on the spring. Use an equation from the Equations List.

Work done = ... J

[Total 3 marks]

Exam Practice Tip

You need to know the practical above really well — you could be asked about it in the exam. And make sure you draw graphs accurately with a sharp pencil. It'll really help if you need to use the graph to work something out.

Distance, Displacement, Speed and Velocity

1 **Figure 1** shows the path taken by a football kicked by a child. When it is kicked at point A, the ball moves horizontally to the right until it hits a vertical wall at point B. The ball then bounces back horizontally to the left and comes to rest at point C.

Grade 3-4

Figure 1

Scale 1 cm = 1 m

1.1 What is the total distance travelled by the ball as it moves from A to B?

Distance = ... m
[1]

1.2 Calculate the total distance travelled by the ball.

Distance = ... m
[1]

1.3 What is the magnitude of the displacement of the ball after it has come to rest?

Displacement = ... m
[1]

[Total 3 marks]

2 A man has just got a new job and wants to know how long it will take to get to work. His route to work is along a 6 km path.

Grade 4-5

2.1 What is the typical walking speed of a person?

Typical speed = ... m/s
[1]

2.2 Give **three** factors that can affect a person's walking speed.

1. .....

2. .....

3. .....

[3]

2.3 Write down the formula that links distance travelled, speed and time.

.....
[1]

2.4 Estimate how long it would take the man to walk to work.

Time taken = ... s
[3]

[Total 8 marks]

Acceleration

Warm-Up

Circle the value below that is the acceleration of an object falling freely on Earth.

9800 m/s² 98 m/s² 0.0098 m/s² 9.8 m/s²

1 An object is decelerating. Tick **one** box which describes its motion. Grade 1-3

Moving with increasing velocity ☐
Moving with decreasing velocity ☐
Moving with a uniform velocity ☐
Stationary ☐

[Total 1 mark]

2 **Table 1** shows how the velocity of a car changes with time as it accelerates uniformly. Grade 3-4

Table 1

Time (s)	0	1	2	3
Velocity (m/s)	0	4	8	12

2.1 Write down the formula that links acceleration, velocity and time.

.....

[1]

2.2 Calculate the acceleration of the car.

Acceleration = ... m/s²

[2]

[Total 3 marks]

3 A train is travelling at 18 m/s. It speeds up to 32 m/s over a distance of 350 m. Calculate the acceleration of the train over this distance. Use an equation from the Equations List. Grade 4-5

Acceleration = ... m/s²

[Total 3 marks]

Distance-Time Graphs

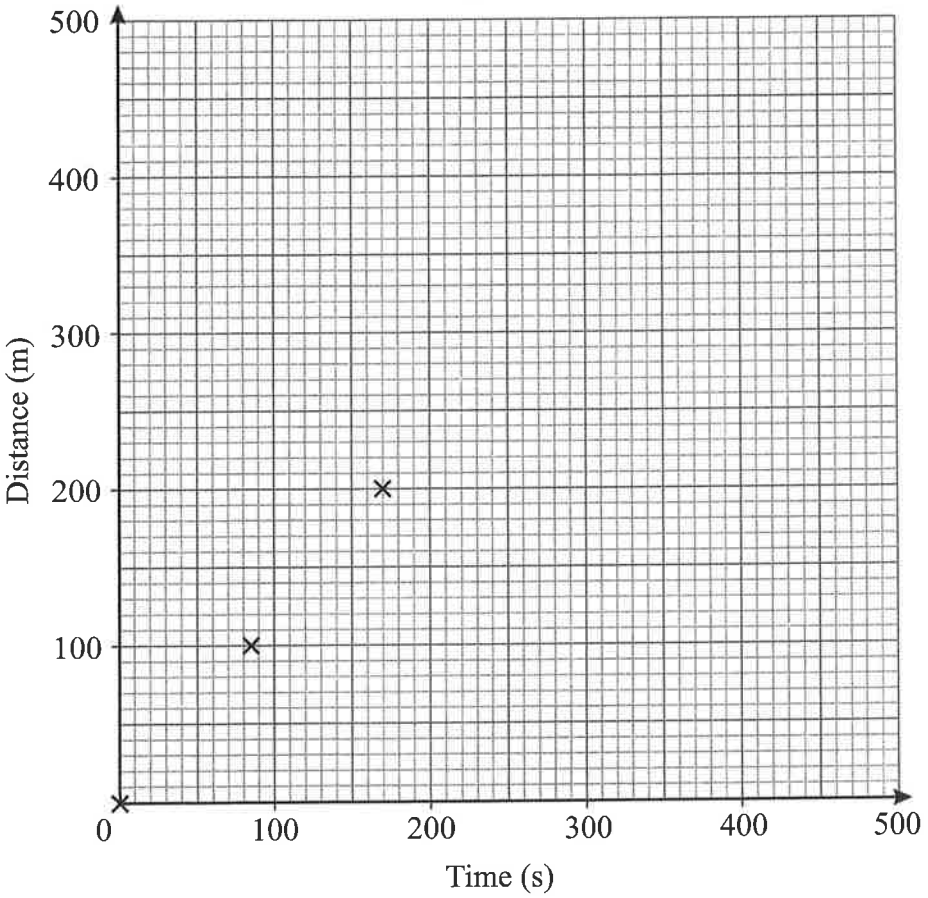
1 A boat is being rowed along a straight canal. Some students use a watch to time how long after setting off the boat passes markers spaced 100 metres apart. **Table 1** shows their results.

Grade 4–5

Table 1

Distance (m)	0	100	200	300	400	500
Time (s)	0	85	170	255	340	425

Figure 1



1.1 Complete the distance-time graph in **Figure 1** using the results in **Table 1**.

[3]

1.2 Using the graph in **Figure 1**, estimate how far the boat travelled in 300 s.

Distance = ... m

[1]

1.3 Using the graph in **Figure 1**, estimate how long it took the boat to travel 250 m.

Time = ... s

[1]

1.4 Describe the boat's speed during the first 500 m of its journey.

.....

[1]

[Total 6 marks]

Velocity-Time Graphs and Terminal Velocity

1 Any object falling for long enough reaches its terminal velocity.
Which statements correctly describe terminal velocity? Tick **two** boxes.

Grade 3–4

Terminal velocity is the minimum velocity an object can fall at. ☐

The resultant vertical force on an object falling at its terminal velocity is zero. ☐

The resultant vertical force on an object falling at its terminal velocity equals its weight. ☐

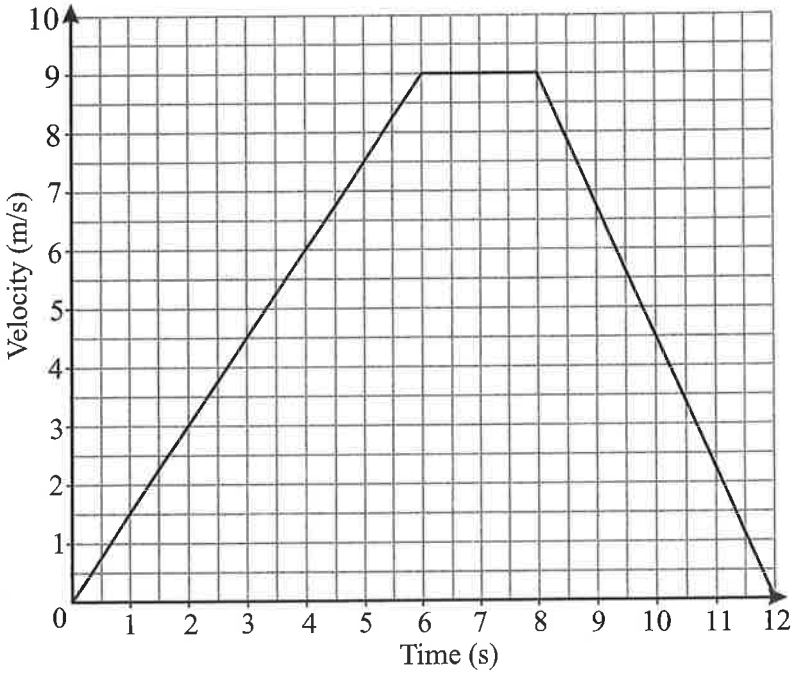
Terminal velocity is the maximum velocity an object can fall at. ☐

[Total 1 mark]

2 **Figure 1** shows a velocity-time graph for a roller coaster car.

Grade 4–5

Figure 1



2.1 The car is accelerating between 0 s and 6 s.
Using the graph in **Figure 1**, calculate the acceleration for the ride between 0 s and 6 s.

Acceleration = ... m/s^2
[3]

2.2 Between what times is the car travelling at a constant speed?

.....
[1]

[Total 4 marks]

☹ ☐ 😐 ☐ 🙂 ☐

Newton's First and Second Laws

1 State Newton's First Law for a stationary object. Grade 3-4

.....

.....

[Total 1 mark]

2 The passage below describes Newton's Second Law. Use words from the box below to complete the passage. Grade 3-4

area	weight	mass	driving	resistive	resultant

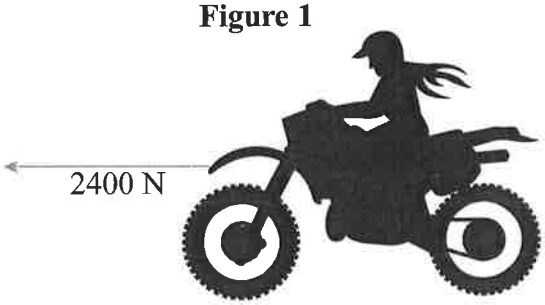
Newton's Second Law states that the acceleration of an object is directly proportional to the ..... force acting on the object.

Newton's Second Law also says that the acceleration is inversely proportional to the ..... of the object.

[Total 2 marks]

3 **Figure 1** shows an accelerating motorbike. It shows the resultant force acting on the motorbike. The motorbike and rider have a combined mass of 400 kg. Grade 4-5

Figure 1



Calculate the acceleration of the motorbike. Use the equation:

Force = mass × acceleration

Choose the correct unit from the box.

N	kg	m/s^2

Acceleration = ... Unit = ...

[Total 4 marks]

Newton's Third Law

Warm-Up

Which of the following is Newton's Third Law? Tick **one** box.

A resultant force is inversely proportional to the mass of an object. ☐

When two objects interact, they exert equal and opposite forces on each other. ☐

A resultant force of zero leads to an equilibrium situation. ☐

1 **Figure 1** shows skater A pushing on skater B with a force of 100 N. Using Newton's Third Law, what force does skater B exert on skater A? Tick **one** box.

Grade 1-3

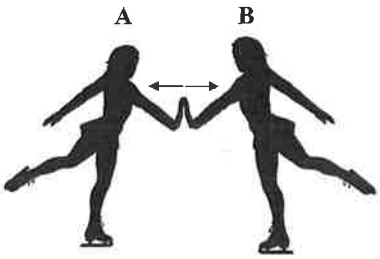
50 N ☐

150 N ☐

200 N ☐

100 N ☐

Figure 1

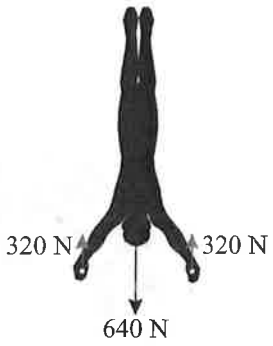


[Total 1 mark]

2 **Figure 2** shows the forces acting on a gymnast balancing on two beams. The gymnast is in equilibrium.

Grade 4-5

Figure 2



2.1 State the size of the force exerted by each of the gymnast's hands on the balance beams.

Force = ... N

[1]

2.2 State the size of the attractive force exerted on the Earth by the gymnast.

Force = ... N

[1]

[Total 2 marks]

Exam Practice Tip

If you're struggling to see what's going on in a question, try drawing a quick diagram. Make sure it shows all the forces mentioned in the question. Then look at each force one at a time to work out what effect it's having.

Investigating Motion

PRACTICAL

1 **Figure 1** shows the equipment used by a student to investigate how changing the force on a trolley changes its acceleration. The trolley is on a frictionless, flat surface.

Grade 4–5

Figure 1

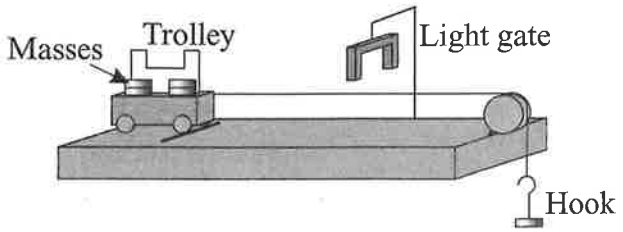
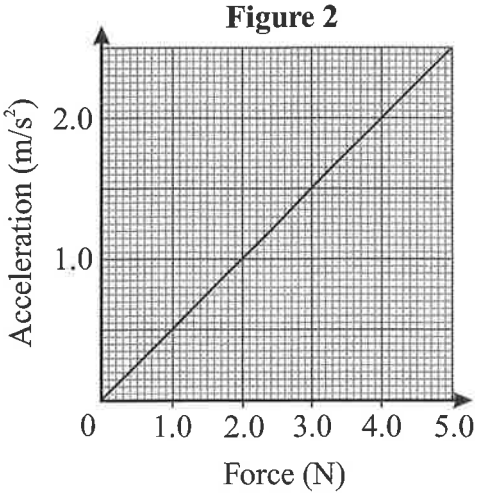


Figure 2



The student changes the force on the trolley by moving a mass from the trolley to the hook. The acceleration for different forces is recorded.
Figure 2 is a graph of acceleration against force for the trolley.

1.1 For this experiment, what is the mass being accelerated? Tick **one** box.

The mass of the hook. ☐

The mass of the hook and the trolley. ☐

The mass of the trolley. ☐

[1]

1.2 Give **one** conclusion that can be made from **Figure 2**.

.....

.....

[1]

1.3 Using **Figure 2**, calculate the mass being accelerated. Use the equation:

Force = mass × acceleration

Mass = ... kg

[3]

1.4 The mass on the hook was kept the same. 50 g of mass was added to the trolley. What effect will this have on the acceleration of the trolley?

.....

[1]

[Total 6 marks]

Stopping Distance and Thinking Distance

1 A car is travelling at 40 mph. The thinking distance of the driver is 12 m. The braking distance of the car is 24 m. Calculate the car's stopping distance when it is travelling at 40 mph. Tick **one** box.

Grade 1-3

36 m ☐

12 m ☐

24 m ☐

[Total 1 mark]

2 Define the following terms:

Grade 3-4

2.1 Thinking distance

.....

[1]

2.2 Braking distance

.....

[1]

[Total 2 marks]

3 Give **three** things that could affect a person's reaction time.

Grade 3-4

1. .....

2. .....

3. .....

[Total 3 marks]

4 Explain why a driver with a slower than average reaction time has an increased risk of being in an accident.

Grade 4-5

.....

.....

.....

[Total 2 marks]

☹ ☐ 😐 ☐ 🙂 ☐

Braking Distance

Warm-Up

Circle the factors below which affect the braking distance of a vehicle.

Drinking alcohol Broken headlights Snow on the road

Bald tyres Drug use

Driver distractions

Ice on the road Smooth road surface

1 A heavy vehicle travelling quickly can have a very large deceleration. State **two** dangers of large decelerations.

Grade 1-3

1. .....

2. .....

[Total 2 marks]

2 When a vehicle's brakes are applied, friction between the wheels and brakes causes work to be done. Explain how this affects the temperature of the brakes. You should include a description of the energy transfers that occur.

Grade 4-5

.....

.....

.....

.....

[Total 2 marks]

3* Explain the importance of car tyres that are in good condition when driving in the rain. Explain the effect this will have on the stopping distance and the overall safety of the car.

Grade 4-5

.....

.....

.....

.....

.....

.....

.....

.....

.....

[Total 4 marks]

Reaction Times

1 What is the typical reaction time for a person? Tick **one** box. Grade 1-3

☐ 1.3 – 1.8 s ☐ 0.2 – 0.9 s ☐ 0.01 – 0.02 s ☐ 2.0 – 3.0 s

[Total 1 mark]

2 A teacher tests the reaction times of three of her students.
She measures how far a ruler vertically falls before the student catches it. Grade 4-5

2.1 Describe **one** other method that can be used to test people's reaction times.

.....

.....

[1]

2.2 **Table 1** shows the teacher's results.
The values in the table show the distance the ruler falls in cm during each attempt.
Complete the table by working out the average distance fallen by the ruler for each student.

Table 1

	Attempt 1	Attempt 2	Attempt 3	Average
Student A	7.0	7.1	6.9	.....
Student B	8.4	8.2	8.3	.....
Student C	6.5	7	6	6.5

[2]

2.3 Which student has the fastest average reaction time?

.....

[1]

2.4 Suggest **two** ways the teacher could make the experiment a fair test.

1. .....

2. .....

[2]

2.5 The teacher then repeats the experiment. This time, she has a fourth student talk to the student being tested. Suggest how you would expect this to affect the reaction times of the students.

.....

[1]

[Total 7 marks]