Force and Motion GCSE AQA Higher Physics Past Papers Questions

01.

The stopping distance of a car is the sum of the thinking distance and the braking distance.

Table 4 shows how the thinking distance and braking distance vary with speed.

Table 4

Speed in m/s	Thinking distance in m	Braking distance in m
10	6	6.0
15	9	13.5
20	12	24.0
25	15	37.5
30	18	54.0

1 What is meant by the braking distance of a vehicle?

[1 mark]

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2 The data in **Table 4** refers to a car in good mechanical condition driven by an alert driver.

Explain why the stopping distance of the car increases if the driver is very tired.

[2 marks]

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3 A student looks at the data in **Table 4** and writes the following:

thinking distance ∝ speed

braking distance ∝ speed

Explain whether the student is correct.

[2 marks]

Applying the brakes with too much force can cause a car to skid.

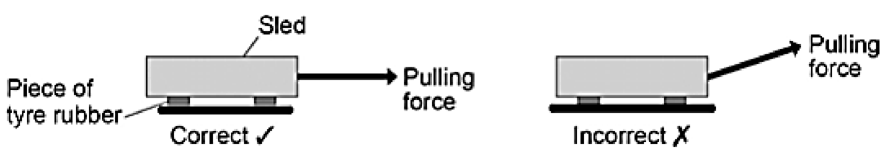
The distance a car skids before stopping depends on the friction between the road surface and the car tyres and also the speed of the car.

Friction can be investigated by pulling a device called a 'sled' across a surface at constant speed.

Figure 16 shows a sled being pulled correctly and incorrectly across a surface.

The constant of friction for the surface is calculated from the value of the force pulling the sled and the weight of the sled.

Figure 16



4 Why is it important that the sled is pulled at a constant speed?

[1 mark]

Tick **one** box.

If the sled accelerates it will be difficult to control. ☐

If the sled accelerates the value for the constant of friction will be wrong. ☐

If the sled accelerates the normal contact force will change. ☐

5 If the sled is pulled at an angle to the surface the value calculated for the constant of friction would not be appropriate.

Explain why.

[2 marks]

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6 By measuring the length of the skid marks, an accident investigator determines that the distance a car travelled between the brakes being applied and stopping was 22 m.

The investigator used a sled to determine the friction. The investigator then calculated that the car decelerated at 7.2 m/s^2.

Calculate the speed of the car just before the brakes were applied.

Give your answer to two significant figures.

Use the correct equation from the Physics Equation Sheet.

[3 marks]

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Speed = ______________________ m/s

02.

Figure 8 shows a boat floating on the sea. The boat is stationary.

Figure 8

1 **Figure 9** shows part of the free body diagram for the boat.

Complete the free body diagram for the boat.

[2 marks]

Figure 9

2 Calculate the mass of the boat.

Use the information given in **Figure 9**.

gravitational field strength = 9.8 N/kg

Give your answer to **two** significant figures.

[4 marks]

Mass = ______________________ kg

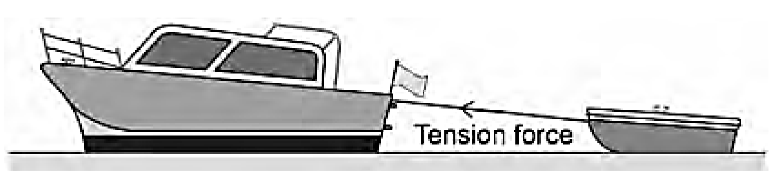
3 When the boat propeller pushes water backwards, the boat moves forwards.
The force on the water causes an equal and opposite force to act on the boat.

Which law is this an example of?

[1 mark]

4 **Figure 10** shows the boat towing a small dinghy.

Figure 10



The tension force in the tow rope causes a horizontal force forwards and a vertical force upwards on the dinghy.

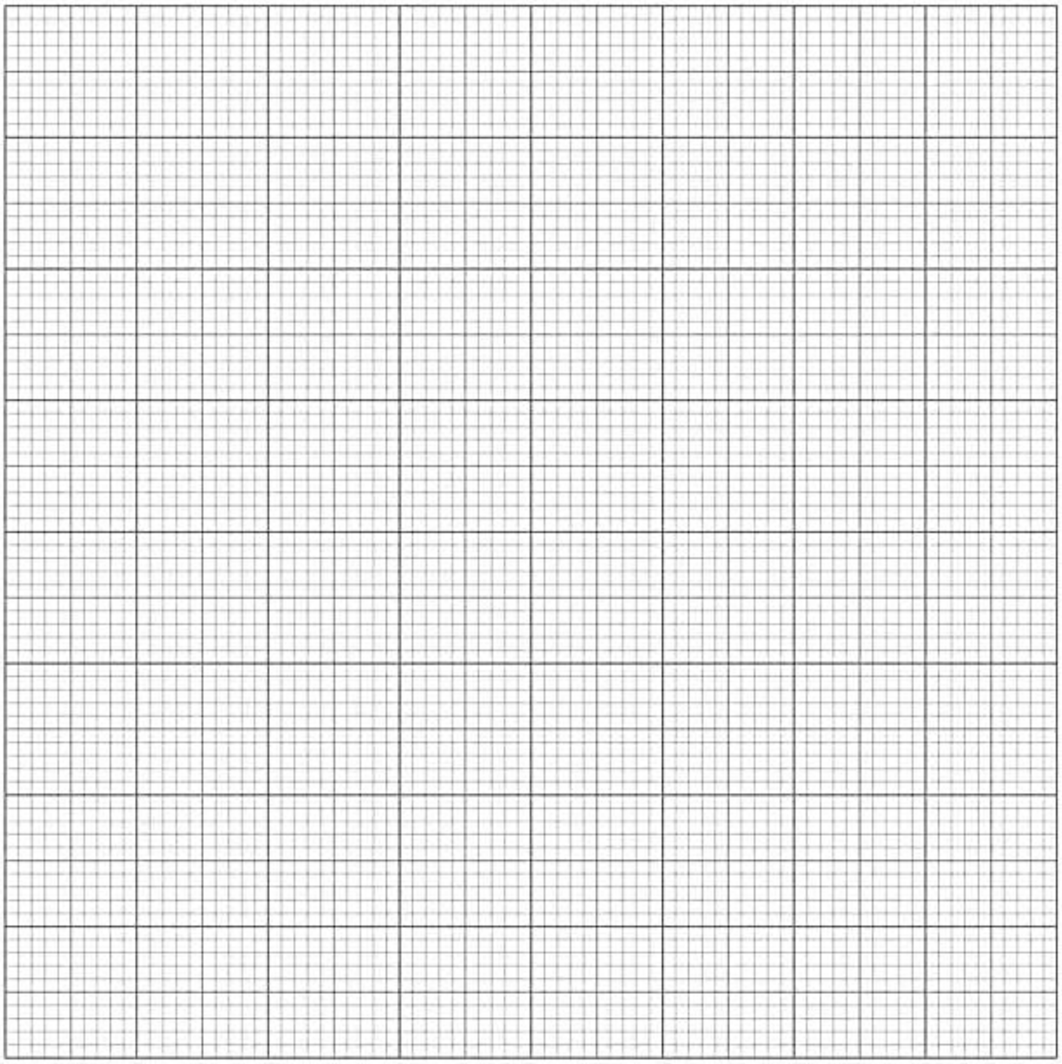
horizontal force forwards = 150 N
vertical force upwards = 50 N

Figure 11 shows a grid.

Draw a vector diagram to determine the magnitude of the tension force in the tow rope and the direction of the force this causes on the dinghy.

[4 marks]

Figure 11



Magnitude of the tension force in the tow rope = ____________________ N

Direction of the force on the dinghy caused by the tension force in the tow rope = ____________________

11

03.

1 An adult of mass 80 kg has more inertia than a child of mass 40 kg

What is inertia?

[1 mark]

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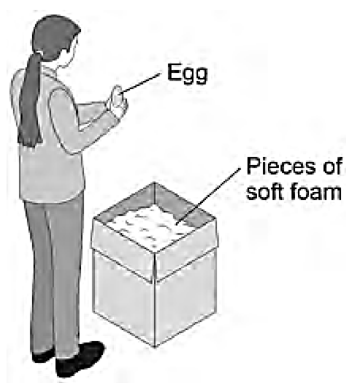
2 A teacher demonstrated the idea of a safety surface.

She dropped a raw egg into a box filled with pieces of soft foam.

The egg did not break.

Figure 10 shows the demonstration.

Figure 10



Explain why the egg is less likely to break when dropped onto soft foam rather than onto a concrete floor.

[3 marks]

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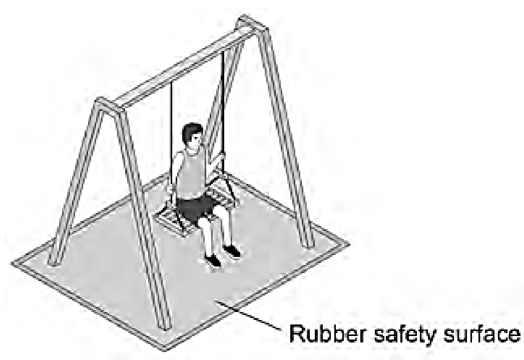
3 **Figure 11** shows a child on a playground swing. The playground has a rubber safety surface.

Figure 11



A child of mass 32 kg jumped from the swing.

When the child reached the ground she took 180 milliseconds to slow down and stop.

During this time an average force of 800 N was exerted on her by the ground.

Calculate the velocity of the child when she first touched the ground.

Use the Physics Equations Sheet.

[4 marks]

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Velocity = ____________________ m/s

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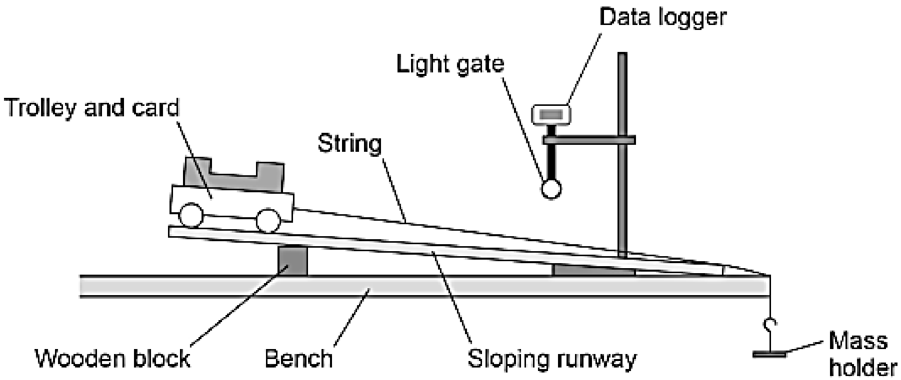
8

04.

A student investigated the acceleration of a trolley.

Figure 1 shows how the student set up the apparatus.

Figure 1



. 1 Before attaching the mass holder the student placed the trolley at the top of the runway. The trolley rolled down the runway without being pushed.

What change to the apparatus in **Figure 1** could be made to prevent the trolley from starting to roll down the runway?

[1 mark]

Tick (✓) **one** box.

Move the wooden block to the left. ☐

Shorten the length of the runway. ☐

Use a taller wooden block. ☐

2 The student attached the mass holder to the string.

The string rubbed along the edge of the bench as the mass holder fell to the floor.

Suggest what the student could do to prevent the string from rubbing.

[1 mark]

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The light gate and data logger were used to determine the acceleration of the trolley.

The student increased the resultant force on the trolley and recorded the acceleration of the trolley.

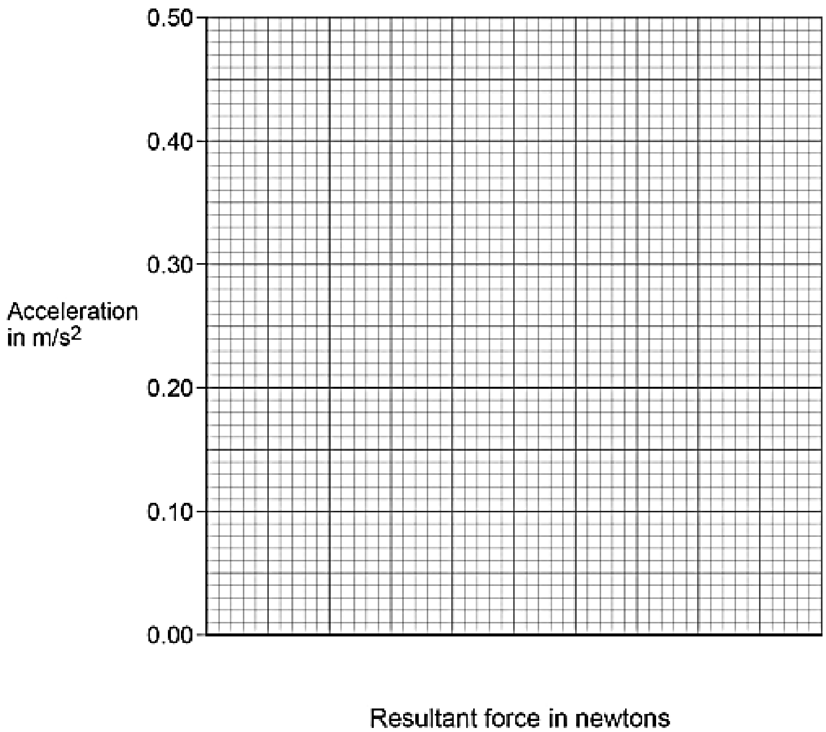
Table 1 shows the results.

Table 1

Resultant force in newtons	Acceleration in m/s^2
0.05	0.08
0.10	0.18
0.15	0.25
0.20	0.32
0.25	0.41

Figure 2 is an incomplete graph of the results.

Figure 2



3 Complete **Figure 2**.

- Choose a suitable scale for the x-axis.
- Plot the results.
- Draw a line of best fit.

[4 marks]

. 4 Describe the relationship between the resultant force on the trolley and the acceleration of the trolley.

[1 mark]

. 5 Describe how the investigation could be improved to reduce the effect of random errors.

[2 marks]

. 6 Write down the equation that links acceleration (a), mass (m) and resultant force (F).

[1 mark]

7 The resultant force on the trolley was 0.375 N.

The mass of the trolley was 0.60 kg.

Calculate the acceleration of the trolley.

Give your answer to 2 significant figures.

[4 marks]

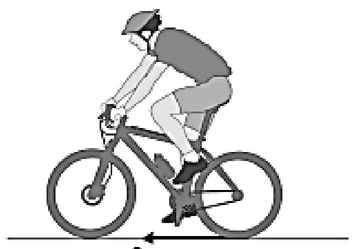
Acceleration (2 significant figures) = ______________________ m/s^2

14

05. **Figure 11** shows a cyclist riding a bicycle.

Force **A** causes the bicycle to accelerate forwards.

Figure 11



1 What name is given to force **A**?

[1 mark]

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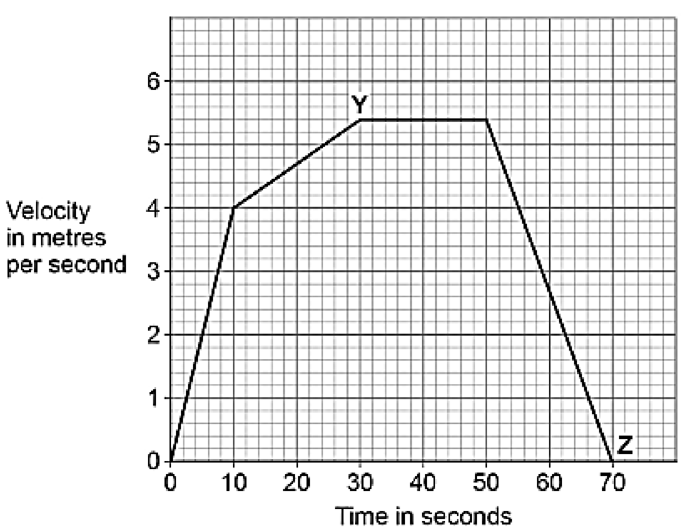
Figure 12 shows how the velocity of the cyclist changes during a short journey.

Figure 12



2 Determine the distance travelled by the cyclist between **Y** and **Z**.

[3 marks]

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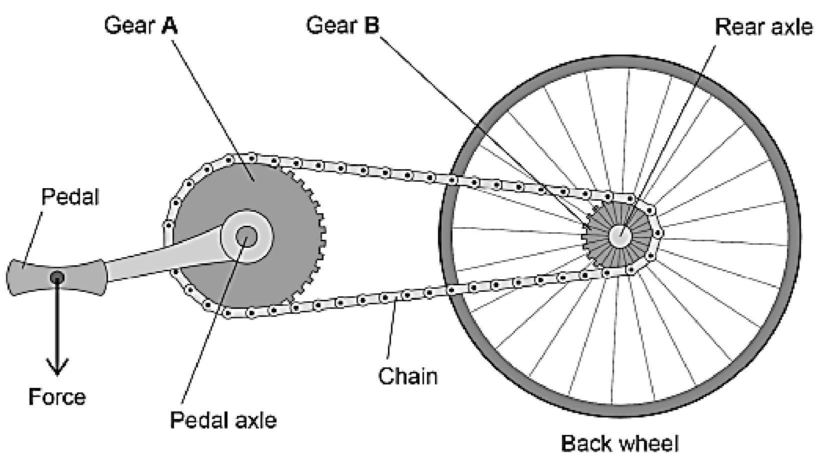
Distance travelled by the cyclist between **Y** and **Z** = ________________ m

3 **Figure 13** shows the gears on the bicycle.

Figure 13



Describe how the force on the pedal causes a moment about the rear axle.

[2 marks]

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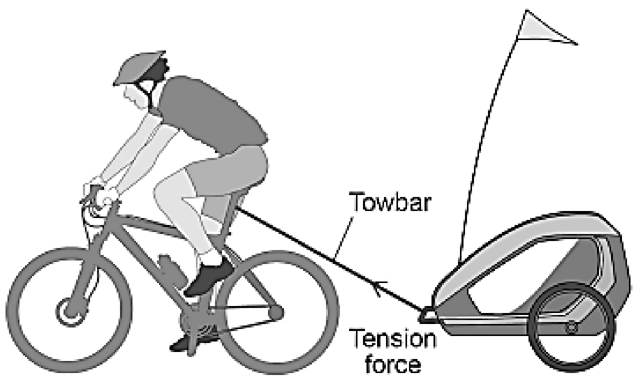
Figure 14 shows a different cyclist towing a trailer.

Figure 14



4 The speed of the cyclist and trailer increased uniformly from 0 m/s to 2.4 m/s.

The cyclist travelled 0.018 km while accelerating.

Calculate the initial acceleration of the cyclist.

[3 marks]

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Acceleration = ____________________ m/s^2

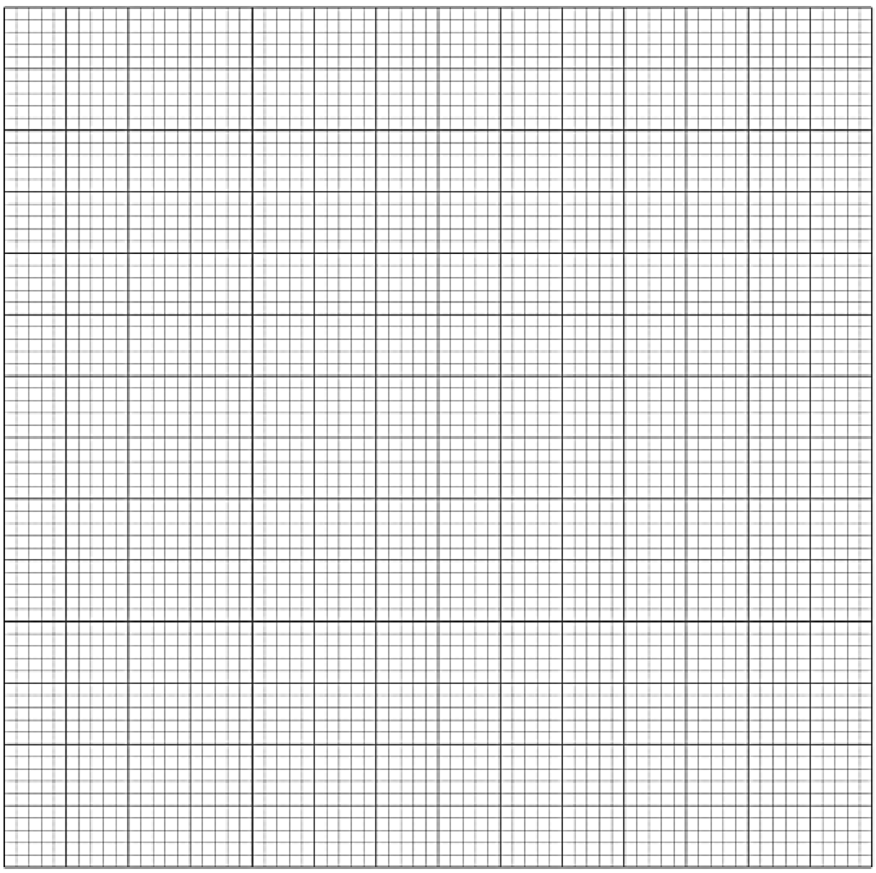
5 The resultant force of the towbar on the trailer has a horizontal component and a vertical component.

horizontal force = 200 N

vertical force = 75 N

Determine the magnitude and direction of the resultant force of the towbar on the trailer by drawing a vector diagram.

[4 marks]



Magnitude of force = ______________ N

Direction of force = __________ degrees

13

06. **Figure 1** shows an electric super-car.

Figure 1

1 The battery in an electric car needs to be recharged.

Suggest **two** factors that affect the distance an electric car can travel before the battery needs to be recharged.

[2 marks]

1 ______________________________

2 ______________________________

2 Write down the equation which links acceleration (a), change in velocity (Δv) and time taken (t).

[1 mark]

____

3 The maximum acceleration of the car is 20 m/s^2.

Calculate the time taken for the speed of the car to change from 0 m/s to 28 m/s at its maximum acceleration.

[3 marks]

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Time taken = ______________ s

4 In a trial run, the car accelerates at 10 m/s^2 until it reaches its final velocity.

distance travelled by the car = 605 m

initial velocity of the car = 0 m/s

Calculate the final velocity of the car.

Use the Physics Equations Sheet.

[3 marks]

Final velocity = ____________________ m/s

5 Write down the equation which links distance (s), force (F) and work done (W).

[1 mark]

6 When travelling at its maximum speed the air resistance acting on the car is 4000 N.

Calculate the work done against air resistance when the car travels a distance of 7.5 km at its maximum speed.

[3 marks]

Work done = ____________________ J

13

07.

Hailstones are small balls of ice. Hailstones form in clouds and fall to the ground.

Figure 7 shows different-sized hailstones.

Figure 7

A hailstone falls from a cloud and accelerates.

1 Why does the hailstone accelerate?

[1 mark]

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2 The hailstone stops accelerating and reaches terminal velocity.

Explain why the hailstone reaches terminal velocity.

[3 marks]

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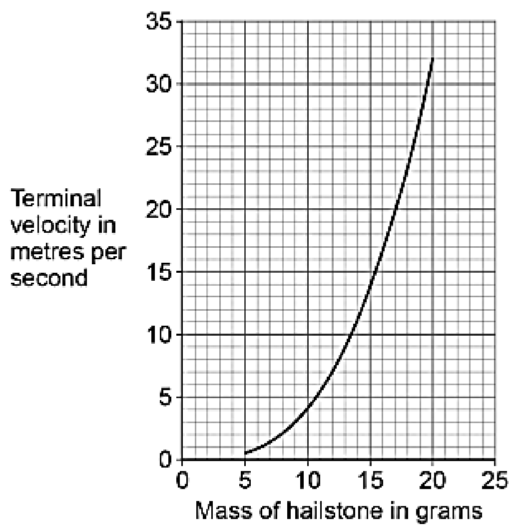
A scientist investigated how the mass of hailstones affects their terminal velocity.

Figure 8 shows the results.

Figure 8



3 Why does terminal velocity increase with mass?

[1 mark]

Tick (✓) **one** box.

As mass increases the cross-sectional surface area of a hailstone increases. ☐

As mass increases the volume of a hailstone increases. ☐

As mass increases the weight of a hailstone increases. ☐

4 Explain the difference in the maximum kinetic energy of a hailstone with a mass of 10 g and a hailstone with a mass of 20 g.

[3 marks]

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5 The kinetic energy of a hailstone is measured in joules.

Which of the following is the same as 1 joule?

[1 mark]

Tick (✓) **one** box.

1 N m ☐

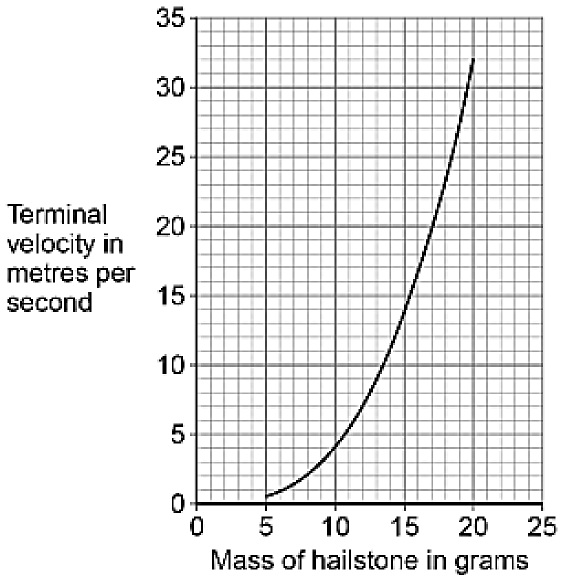
1 N/m ☐

1 N/m^2 ☐

1 $N m^2$ ☐

Figure 8 is repeated below.

Figure 8



6 A hailstone hit the ground at its terminal velocity of 25 m/s.

The hailstone took 0.060 s to stop moving.

Determine the average force on the hailstone as it hit the ground.

Use information from **Figure 8**.

Use the Physics Equations Sheet.

[3 marks]

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Average force = ____________ N

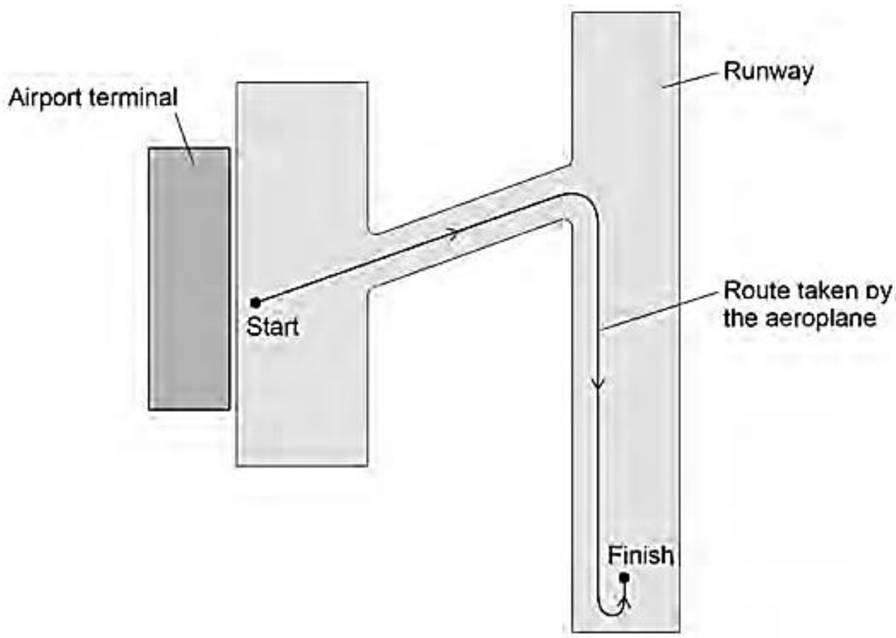
12

08.

Figure 3 shows the route an aeroplane takes as it travels from an airport terminal to the runway.

Figure 3 has been drawn to scale.

Figure 3



Scale: 1 cm represents 70 m

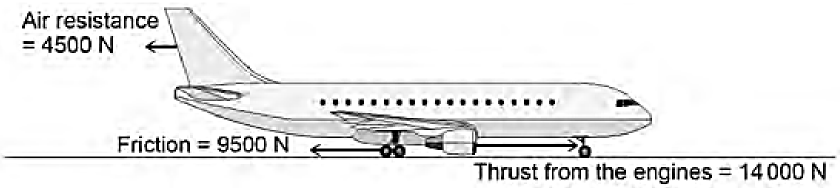
. 1 Determine the magnitude of the aeroplane's displacement from the start point to the finish point on **Figure 3**.

[2 marks]

Displacement = ______________________ m

Figure 4 shows the direction of the horizontal forces acting on the aeroplane as it moves in a straight line towards the runway.

Figure 4



2 Determine the magnitude of the resultant horizontal force on the aeroplane.

[1 mark]

____

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Resultant horizontal force = ____________ N

3 Describe the motion of the aeroplane as it moves towards the runway.

[1 mark]

____

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4 Air resistance and friction are contact forces.

Give **one** other example of a contact force.

[1 mark]

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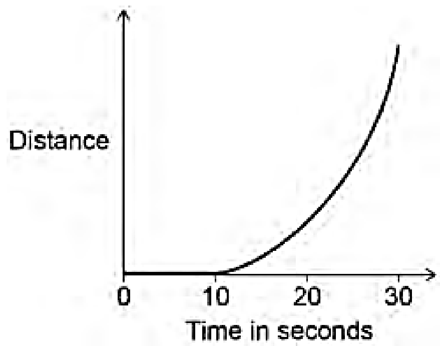
5 The aeroplane stops for a short time and then accelerates along the runway.

Figure 5 shows a distance–time sketch-graph for this stage of the journey.

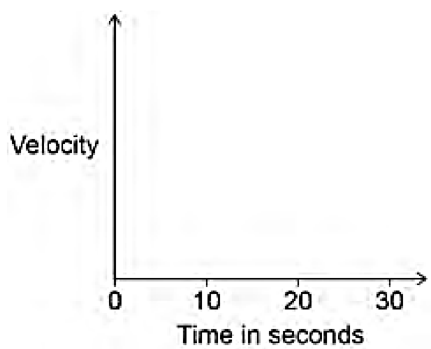
Figure 5



Draw the velocity–time sketch-graph for this stage of the journey on **Figure 6**.

[2 marks]

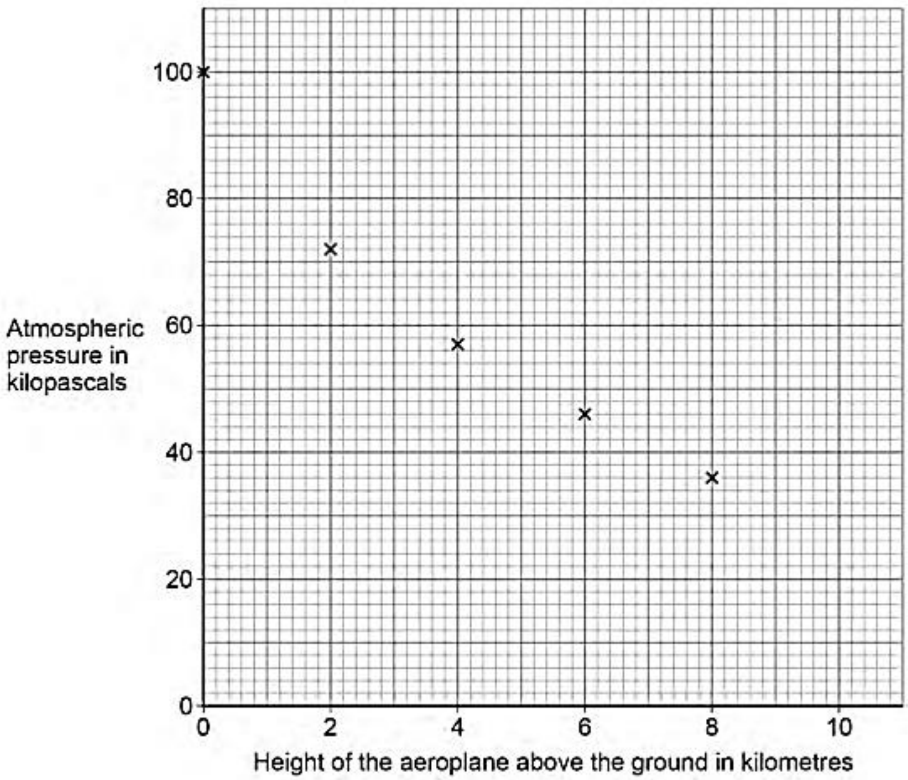
Figure 6



6 The aeroplane takes off from the runway, so its height above the ground increases.

Figure 7 shows how atmospheric pressure varies with the height of the aeroplane above the ground.

Figure 7



Estimate the atmospheric pressure when the height of the aeroplane above the ground is 10 km.

[2 marks]

Atmospheric pressure = ______________________ kPa

7 What happens to the air surrounding the aeroplane as the height of the aeroplane above the ground increases?

[1 mark]

Tick (✓) **one** box.

The average density of the air above the aeroplane decreases. ☐

The mass of air above the aeroplane increases. ☐

The temperature of the air increases. ☐

The volume of air below the aeroplane decreases. ☐

___ / **10**