GCSE Physics

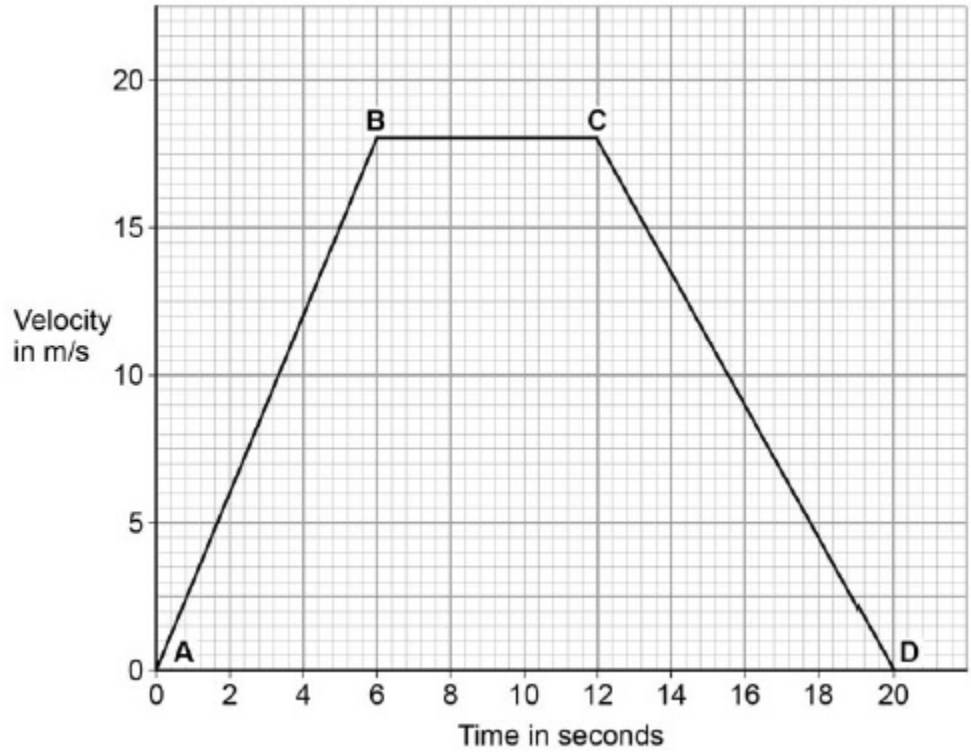
Forces and Motion

Question Paper

Time available: 70 minutes
Marks available: 67 marks

1. **Figure 1** shows the velocity-time graph for a car driven along a straight road.

Figure 1



(a) From **B** to **C** the car is moving at a constant velocity.

Complete the sentence.

Choose the answer from the box.

equal to	**greater than**	**less than**

From **B** to **C** the forward driving force is _____ the backward resistive force.

(1)

(b) From **C** to **D** the car is slowing down.

What word is used to describe the motion of an object that is slowing down?

_____

(1)

(c) Between **A** and **B** the car is accelerating.

Calculate the acceleration of the car between **A** and **B**.

Use the equation:

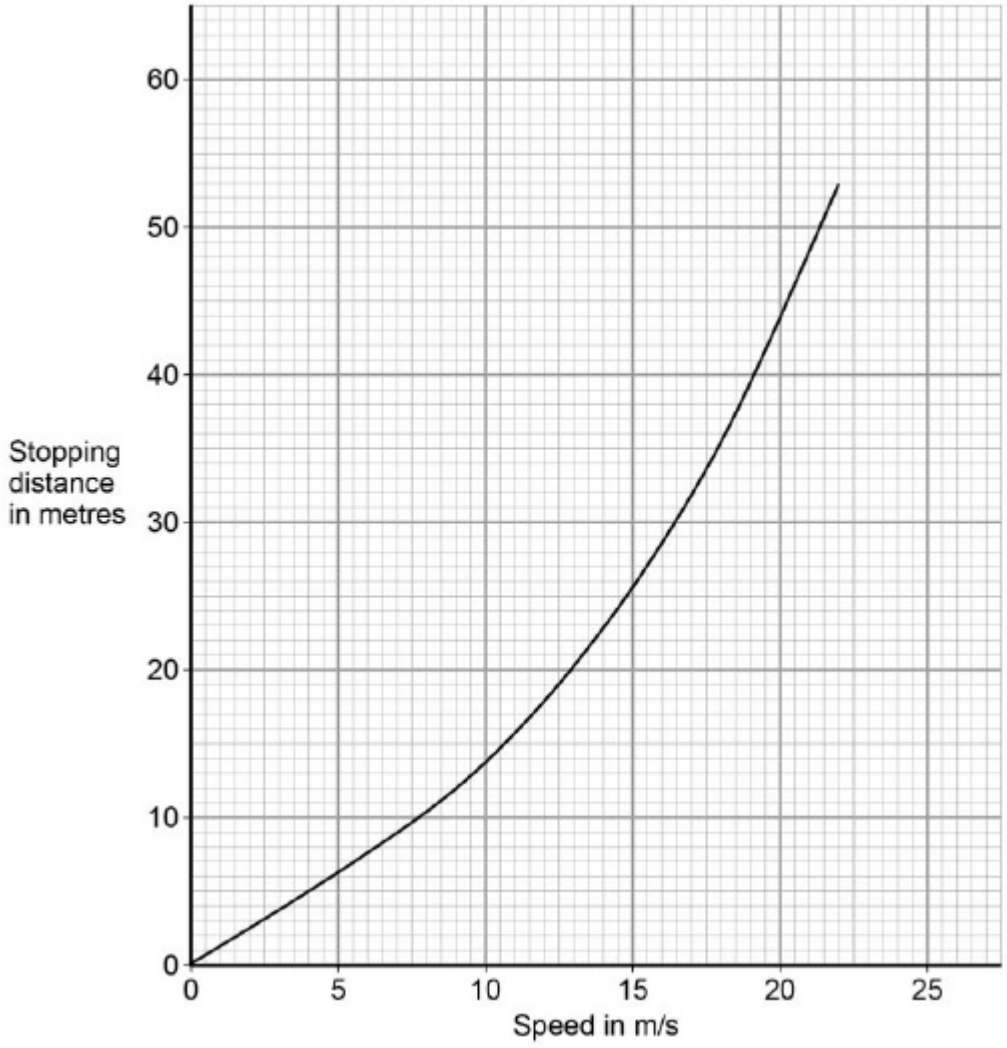
$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$$

Acceleration = _____ m/s^2

(2)

(d) **Figure 2** shows how the stopping distance of a car depends on the speed of the car.

Figure 2



Describe what happens to the stopping distance of the car when the speed of the car doubles.

_____

_____

_____

_____

(2)

(Total 6 marks)

2. Two students investigated how the acceleration of a trolley depends on the force applied to the trolley.

Before starting the investigation, each student wrote a hypothesis.

Hypothesis of student **A**:

'The acceleration of the trolley is directly proportional to the force applied to the trolley.'

Hypothesis of student **B**:

'Changing the force applied to the trolley will change the acceleration of the trolley.'

(a) Consider the hypothesis of student **A**.

Predict what would happen to the acceleration of the trolley if the force applied to the trolley is doubled.

_____

_____

(1)

(b) Why is it difficult to make a valid prediction using the hypothesis of student **B**?

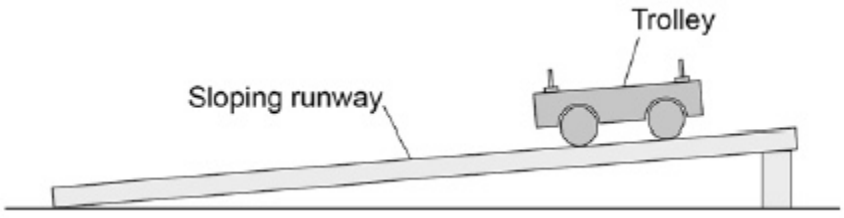
_____

_____

(1)

Figure 1 shows some of the equipment used by the students.

Figure 1



(c) Write a list of any other equipment the students will need to complete the investigation.

_____

_____

_____

_____

_____

(2)

(d) Why should the students use a sloping runway?

Tick **one** box.

To reduce the effect of friction on the trolley. ☐

To decrease the acceleration of the trolley. ☐

To stop the trolley rolling back up the runway. ☐

(1)

(e) Describe a method the students could have used for their investigation.

(6)

(f) The students used the same trolley throughout the investigation.

Suggest why.

_____

_____

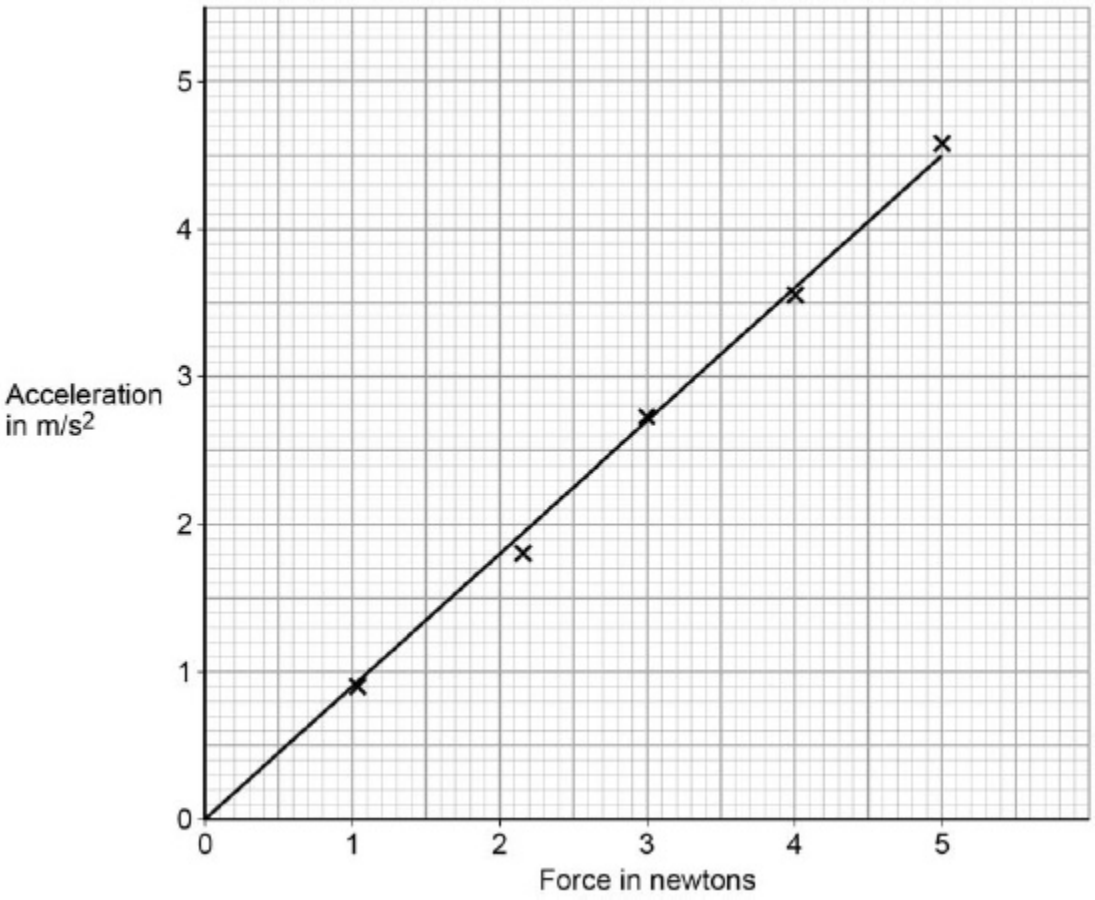
_____

_____

(2)

The students' results are shown as a graph in **Figure 2**.

Figure 2



(g) Explain why hypothesis **A** gives a better explanation of the results.

_____

_____

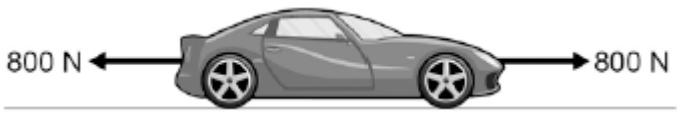
_____

_____

(2)

(Total 8 marks)

3. The figure below shows the horizontal forces acting on a car.



(a) Which **one** of the statements describes the motion of the car?

Tick **one** box.

It will be slowing down. ☐

It will be stationary. ☐

It will have a constant speed. ☐

It will be speeding up. ☐

(1)

(b) During part of the journey the car is driven at a constant speed for five minutes.

Which one of the equations links distance travelled, speed and time?

Tick **one** box.

distance travelled = speed + time ☐

distance travelled = speed × time ☐

distance travelled = speed − time ☐

distance travelled = speed ÷ time ☐

(1)

(c) During a different part of the journey the car accelerates from 9 m/s to 18 m/s in 6 s.

Use the following equation to calculate the acceleration of the car.

$$\text{acceleration} = \frac{\text{change in velociy}}{\text{time taken}}$$

_____

_____

acceleration = _____ m/s^2

(2)

(d) Which equation links acceleration, mass and resultant force?

Tick **one** box.

resultant force = mass + acceleration ☐

resultant force = mass × acceleration ☐

resultant force = mass − acceleration ☐

resultant force = mass ÷ acceleration ☐

(1)

(e) The mass of the car is 1120 kg. The mass of the driver is 80 kg.

Calculate the resultant force acting on the car and driver while accelerating.

_____

_____

Resultant force = _____ N

(2)

(f) Calculate the distance travelled while the car is accelerating.

Use the correct equation from the Physics Equation Sheet.

_____

_____

_____

Distance = _____ m

(3)

(g) A car driver sees a fallen tree lying across the road ahead and makes an emergency stop.

The braking distance of the car depends on the speed of the car.

For the same braking force, explain what happens to the braking distance if the speed doubles.

You should refer to kinetic energy in your answer.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 14 marks)

4. A number of different forces act on a moving vehicle.

(a) A car moving at a steady speed has a driving force of 3000 N.

(i) What is the value of the resistive force acting on the car?

Tick (✓) **one** box.

	Tick (✓)
2000 N	
3000 N	
4000 N	

(1)

(ii) What causes most of the resistive force?

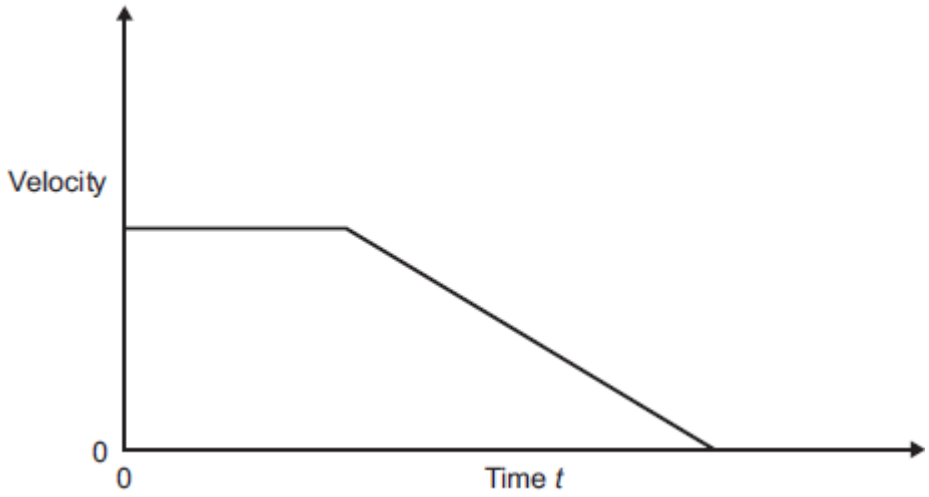
Tick (✓) **one** box.

	Tick (✓)
Air resistance	
Faulty brakes	
Poor condition of tyres	

(1)

(b) A car is moving along a road. The driver sees an obstacle in the road at time $t = 0$ and applies the brakes until the car stops.

The graph shows how the velocity of the car changes with time.



(i) Which feature of the graph represents the negative acceleration of the car?

Tick (✓) **one** box.

	Tick (✓)
The area under the graph	
The gradient of the sloping line	
The intercept on the y-axis	

(1)

(ii) Which feature of the graph represents the distance travelled by the car?

Tick (✓) **one** box.

	Tick (✓)
The area under the graph	
The gradient of the sloping line	
The intercept on the y-axis	

(1)

(iii) On a different journey, the car is moving at a **greater** steady speed.

The driver sees an obstacle in the road at time $t = 0$ and applies the brakes until the car stops.

The driver's reaction time and the braking distance are the same as shown the graph above.

On the graph above draw another graph to show the motion of the car.

(3)

(c) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

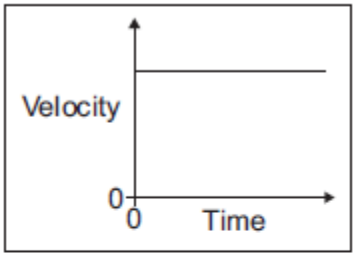
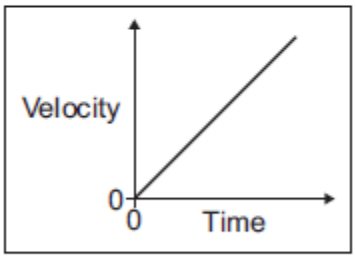
Thinking distance and braking distance affect stopping distance.

Explain how the factors that affect thinking distance and braking distance affect stopping distance.

(6)

(Total 13 marks)

5. (a) Draw **one** line from each velocity−time graph to the statement describing the motion shown by the graph.

Velocity–time graph	Motion shown by graph
	Constant acceleration
	Not moving
	Constant deceleration
	Constant velocity

(2)

(b) Use the correct answer from the box to complete the sentence.

energy	**momentum**	**speed**

The velocity of an object includes both the _____ of the object and the direction the object is moving.

(1)

(c) At the start of a race, a horse accelerates from a velocity of 0 m/s to a velocity of 9 m/s in 4 seconds.

(i) Calculate the acceleration of the horse.

_____

_____

Acceleration = _____ m/s^2

(2)

(ii) When the horse accelerates, what, if anything, happens to the air resistance acting against the horse?

Tick (✓) **one** box.

The air resistance decreases ☐

The air resistance is constant ☐

The air resistance increases ☐

(1)

(d) A horse and a pony walk across a field at the same constant speed.

The horse has 4000 joules of kinetic energy.

The pony is **half** the mass of the horse.

What is the kinetic energy of the pony?

Draw a ring around the correct answer

2000 J **4000 J** **8000 J**

Give a reason for your answer.

_____

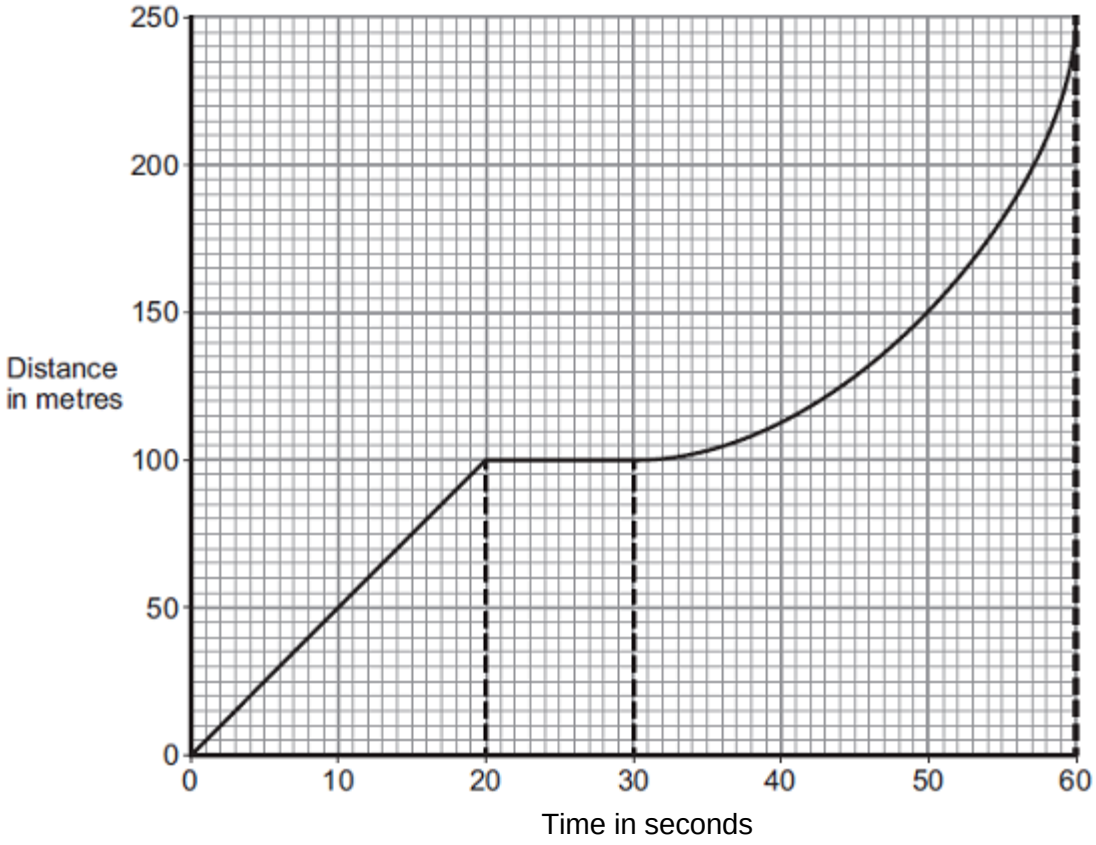
_____

(2)

(Total 8 marks)

6. A bus is taking some children to school.

(a) The bus has to stop a few times. The figure below shows the distance–time graph for part of the journey.



(i) How far has the bus travelled in the first 20 seconds?

Distance travelled = _____ m

(1)

(ii) Describe the motion of the bus between 20 seconds and 30 seconds.

_____

_____

(1)

(iii) Describe the motion of the bus between 30 seconds and 60 seconds.

Tick (✓) **one** box.

	Tick (✓)
Accelerating	
Reversing	
Travelling at constant speed	

(1)

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(iv) What is the speed of the bus at 45 seconds?

Show clearly on the figure above how you obtained your answer.

Speed = _____ m / s

(3)

(b) Later in the journey, the bus is moving and has 500 000 J of kinetic energy.

The brakes are applied and the bus stops.

(i) How much work is needed to stop the bus?

Work = _____ J

(1)

(ii) The bus stopped in a distance of 25 m.

Calculate the force that was needed to stop the bus.

Force = _____ N

(2)

(iii) What happens to the kinetic energy of the bus as it is braking?

(2)

(Total 11 marks)