# Newton's Second Law

## Question Paper1

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| **Level** | GCSE (9-1) |
| **Subject** | Combined Science: Trilogy - Physics |
| **Exam Board** | AQA |
| **Topic** | 6.5 Forces |
| **Sub-Topic** | Newton's Second Law |
| **Difficulty Level** | Silver Level |
| **Booklet** | Question Paper 1 |

**Time Allowed:** **58 minutes**

**Score:** **/56**

**Percentage:** **/100**

**Grade Boundaries:**

**Q1.** Four students tested their reaction times using a computer program.

When a green light appeared on the screen the students had to press a key.

**Table 1** shows their results.

**Table 1**

| Student | Reaction time in s | | | Mean reaction time in s |
|---|---|---|---|---|
| | Test 1 | Test 2 | Test 3 | |
| Boy 1 | 0.28 | 0.27 | 0.26 | 0.27 |
| Boy 2 | 0.28 | 0.47 | 0.22 | 0.29 |
| Girl 1 | 0.31 | 0.29 | 0.27 | 0.29 |
| Girl 2 | 0.32 | 0.30 | 0.29 | 0.30 |

(a) What is meant by 'reaction time' in this experiment?

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**(1)**

(b) Boy 2 had an anomalous result in **Test 2**.

Suggest a reason why.

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**(1)**

(c) Give **one** conclusion that can be made from the results in **Table 1**.

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**(1)**

(d) Suggest further evidence that you could collect to support your conclusion.

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**(1)**

(e) Reaction time is important at the start of a race.

**Table 2** shows the time taken by a boy to run different distances.

**Table 2**

| Distance in m | Time in s |
|---|---|
| 100 | 12.74 |
| 200 | 25.63 |
| 800 | 139.46 |

Reaction time is more important in a 100 m race than in an 800 m race.

Explain why.

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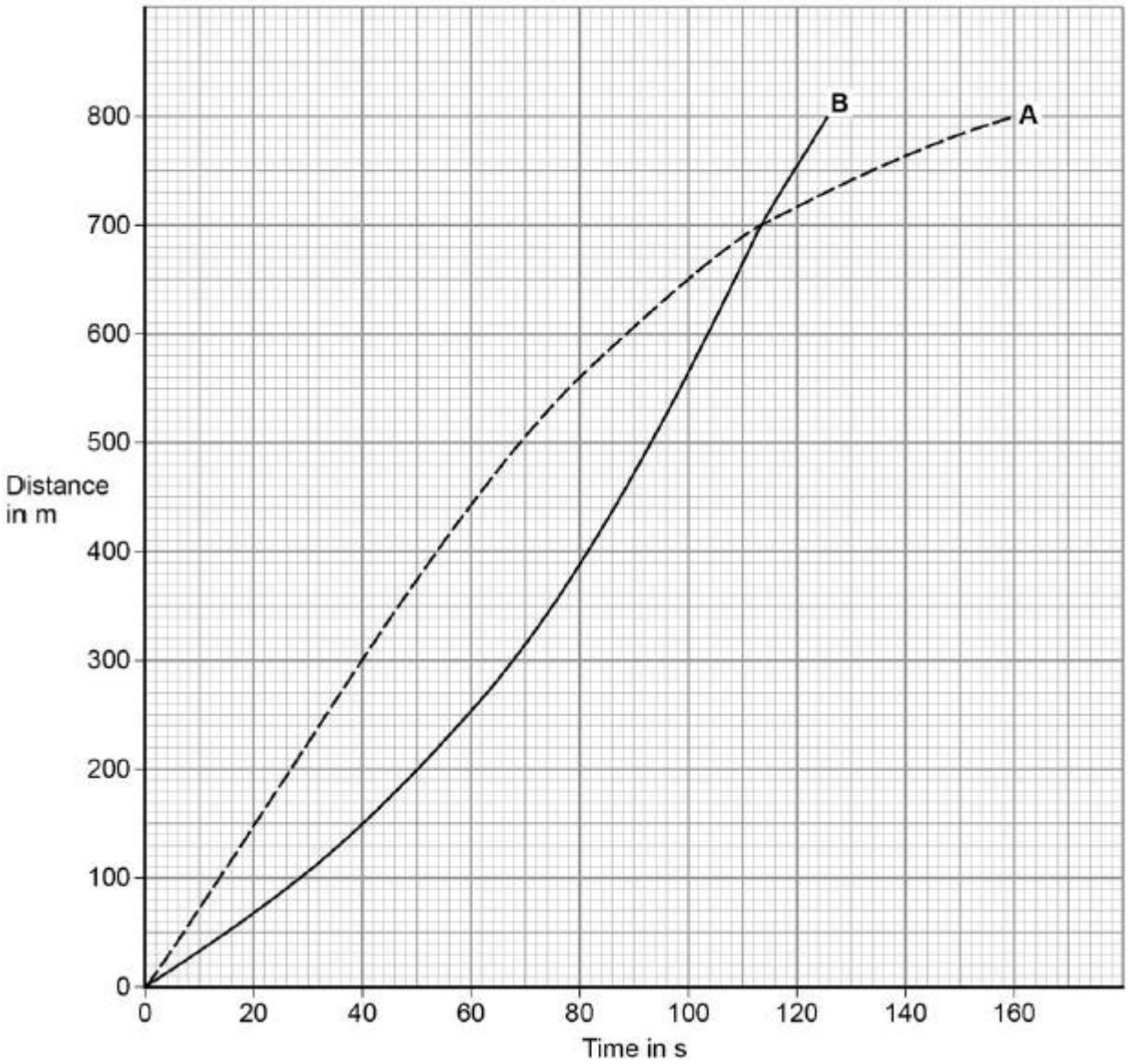
**(2)**

(f) Two girls, **A** and **B**, ran an 800 m race.

The figure below shows how the distance changed with time.




Compare the motion of runners **A** and **B**.

Include data from the figure above.

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**(6)**

(g) Use above **Figure** to determine Girl **B**'s speed at 60 s.

Show how you use the graph to obtain your answer.

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Speed = ..... m / s

**(3)**

**(Total 15 marks)**

**Q2.**The figure below shows an ice skater standing on the ice.

Mass
70 kg

(a) Write down the equation that links acceleration, change in velocity and time.

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**(1)**

(b) As the skater pushes away across the ice there is a small frictional force.

After pushing, the skater starts to move with a velocity of 5 m / s.

He slows to 3 m / s in 6 seconds.

Calculate the acceleration of the skater.

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Acceleration = ..... m / $s^2$

**(2)**

(c) Write down the equation that links acceleration, force and mass.

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**(1)**

(d) Friction reduces the speed of the skater.

Calculate the frictional force acting on the skater to slow him down.

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Frictional force = ..... N

**(2)**

(e) The skater stands still on the ice.

He throws his bag to a friend.

As he throws his bag forwards, the skater moves backwards across the ice.

Use the idea of conservation of momentum to explain why he moves backwards.

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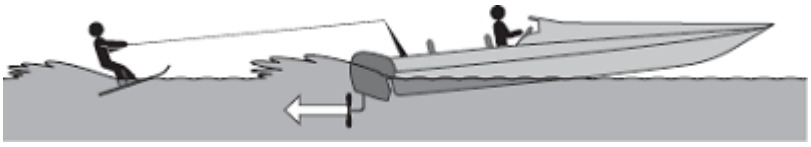
**(4)**
**(Total 10 marks)**

**Q3.**The diagram shows a boat pulling a water skier.



(a) The arrow represents the force on the water produced by the engine propeller. This force causes the boat to move.

Explain why.

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**(2)**

(b) The boat accelerates at a constant rate in a straight line. This causes the velocity of the water skier to increase from 4.0 m/s to 16.0 m/s in 8.0 seconds.

(i) Calculate the acceleration of the water skier and give the unit.

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Acceleration = .....

**(3)**

(ii) The water skier has a mass of 68 kg.

Calculate the resultant force acting on the water skier while accelerating.

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Resultant force = ..... N

**(2)**

(iii) Draw a ring around the correct answer to complete the sentence.

The force from the boat pulling the water skier forwards

will be | less than / the same as / greater than | the answer to part **(b)(ii)**.

Give the reason for your answer.

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**(2)**
**(Total 9 marks)**

**Q4.** (a) A car is being driven along a straight road. The diagrams, **A**, **B** and **C**, show the horizontal forces acting on the moving car at three different points along the road.

Describe the motion of the car at each of the points, **A**, **B** and **C**.


A .....

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B .....

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C .....

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**(3)**

(b) The diagram below shows the stopping distance for a family car, in good condition, driven at 22 m/s on a dry road. The stopping distance has two parts.

(i) Complete the diagram below by adding an appropriate label to the second part of the stopping distance.

The distance the car travels during the driver's reaction time

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**(1)**

(ii) State **one** factor that changes both the first part **and** the second part of the stopping distance.

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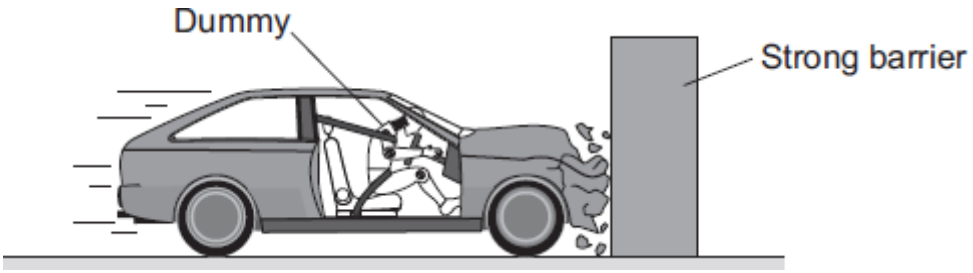
**(1)**

(c) The front crumple zone of a car is tested at a road traffic laboratory. This is done by using a remote control device to drive the car into a strong barrier. Electronic sensors are attached to the dummy inside the car.




(i) At the point of collision, the car exerts a force of 5000 N on the barrier.

State the size and direction of the force exerted by the barrier on the car.

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**(1)**

(ii) Suggest why the dummy is fitted with electronic sensors.

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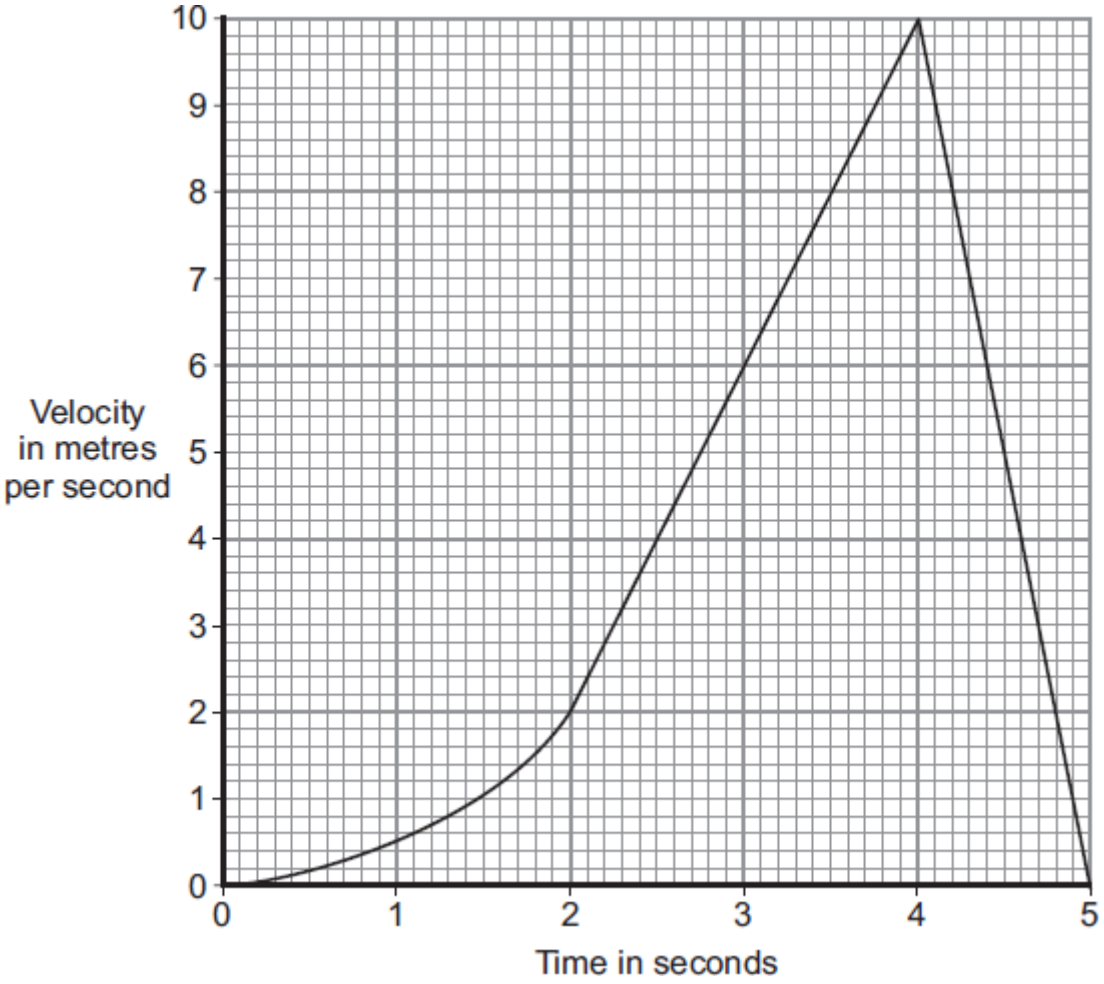
**(1)**

(iii) The graph shows how the velocity of the car changes during the test.




Use the graph to calculate the acceleration of the car just before the collision with the barrier.

Show clearly how you work out your answer, including how you use the graph, and give the unit.

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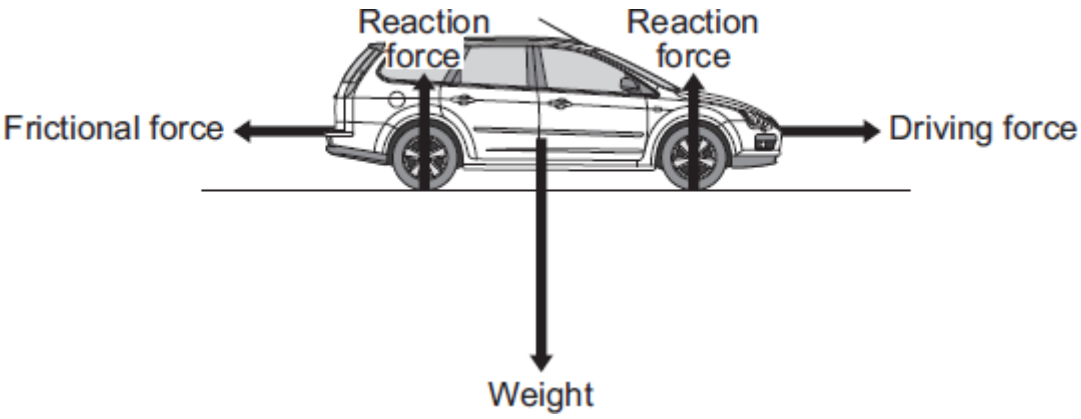
Acceleration = .....

**(3)**

**(Total 10 marks)**

**Q5.** The diagram shows the forces acting on a car. The car is being driven along a straight, level road at a constant speed of 12 m/s.




(a) The driver then accelerates the car to 23 m/s in 4 seconds.

Use the equation in the box to calculate the acceleration of the car.

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

Show clearly how you work out your answer and give the unit.

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Acceleration = .....

**(3)**

(b) Describe how the horizontal forces acting on the car change during the first **two** seconds of the acceleration.

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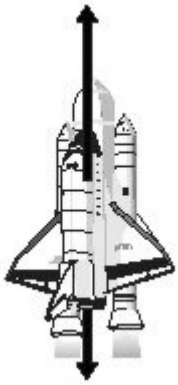
**(3)**

**(Total 6 marks)**

**Q6.** (a) The arrows in the diagram represent the size and direction of the forces on a space shuttle, fuel tank and booster rockets one second after launch. The longer the arrow the bigger the force.

Thrust force



Weight of shuttle, fuel tanks and booster rockets plus air resistance

(i) Describe the upward motion of the space shuttle one second after launch.

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**(1)**

(ii) By the time it moves out of the Earth's atmosphere, the total weight of the space shuttle, fuel tank and booster rockets has decreased and so has the air resistance.

How does this change the motion of the space shuttle? (Assume the thrust force does not change).

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**(1)**

(b) The space shuttle takes 9 minutes to reach its orbital velocity of 8100 m/s.

(i) Write down the equation that links acceleration, change in velocity and time taken.

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**(1)**

(ii) Calculate, in $m/s^2$, the average acceleration of the space shuttle during the first 9 minutes of its flight. Show clearly how you work out your answer.

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average acceleration = ..... $m/s^2$

**(2)**

(iii) How is the velocity of an object different from the speed of an object?

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**(1)**

**(Total 6 marks)**