AQA GCSE PHYSICS (HIGHER) · 8463

PHYSICS



EXAM QUESTION PACK

4.5.6.1.5 ACCELERATION (PACK 3)

SCORE	PERCENTAGE
/189	%

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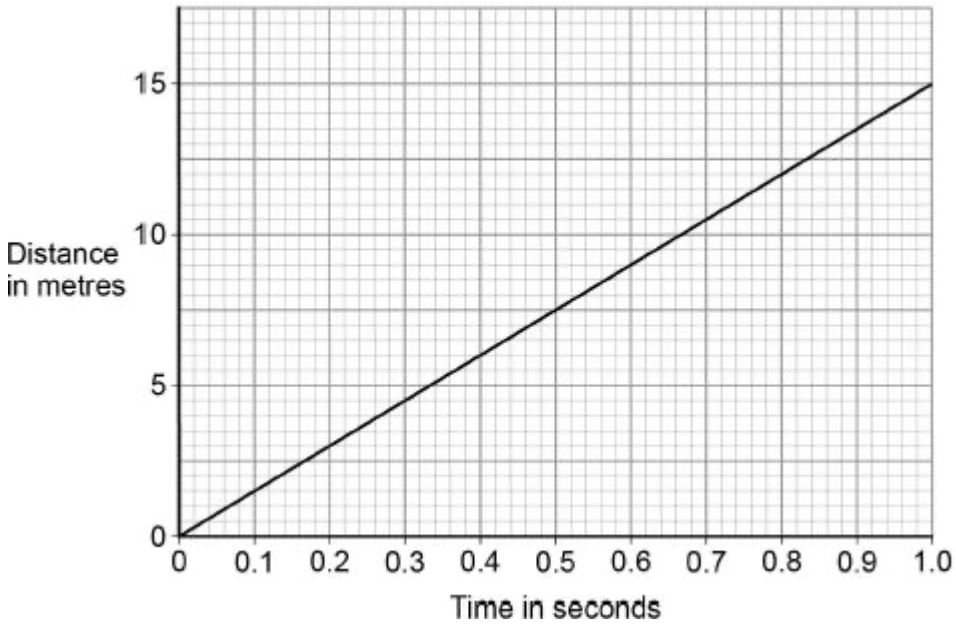
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Q1.

(a) **Figure 1** shows the distance-time graph for a car travelling at 15 m/s

Figure 1



When the driver is tired, his reaction time increases from 0.50 seconds to 0.82 seconds.

Determine the **extra** distance the car would travel before the driver starts braking.

_____

_____

_____

Distance = _____ m

(2)

(b) When the brakes are used, the temperature of the brakes increases.

Explain why. Use ideas about energy in your explanation.

_____

_____

_____

_____

(2)

(c) A lorry travels 84 m with a constant acceleration of 2.0 m/s^2 to reach a velocity of 19 m/s

Calculate the initial velocity of the lorry.

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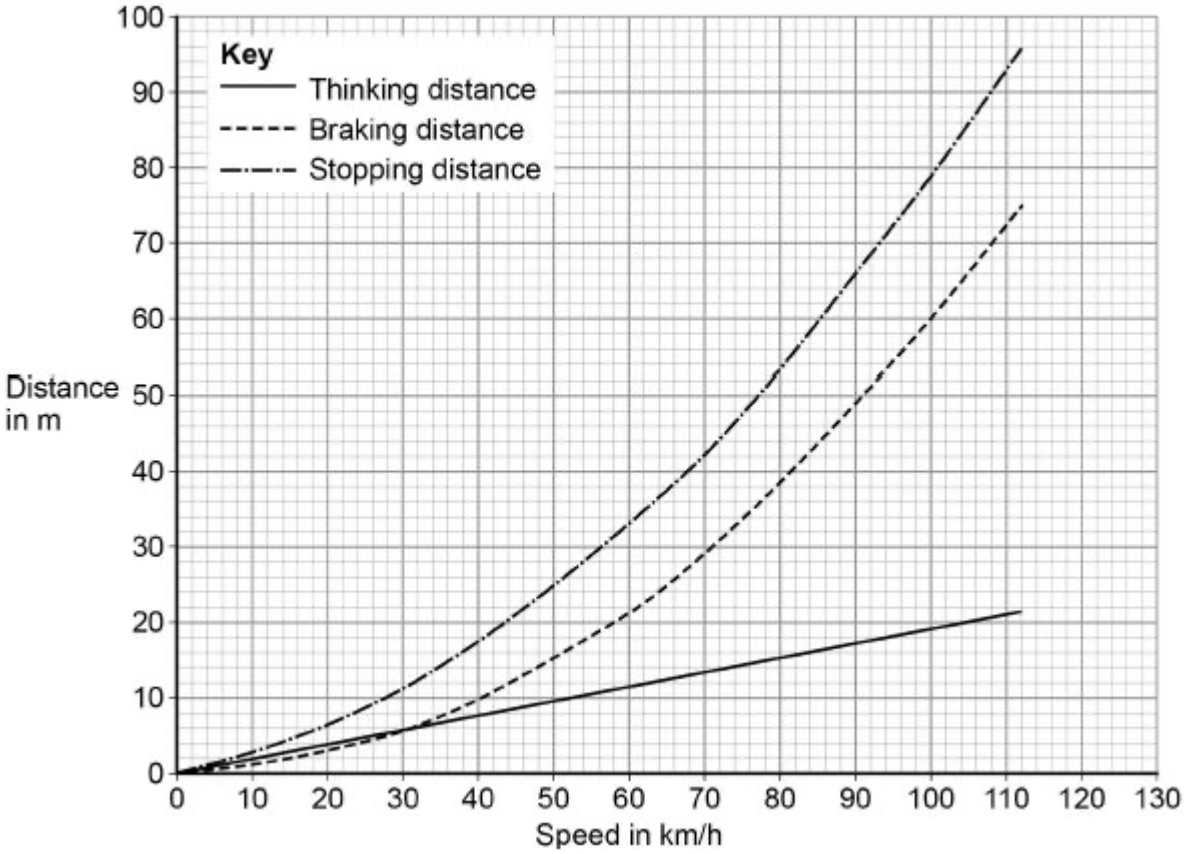
Use the Physics Equations Sheet.

Initial velocity = _____ m/s

(3)

(d) **Figure 2** shows how the thinking distance, braking distance and stopping distance for a car vary with the speed of the car.

Figure 2



Describe the relationships shown in **Figure 2**

You should include factors that would affect the gradient of the lines.

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(6)

(Total 13 marks)

Q2.

An athlete trains to improve his fitness by walking, cycling and running.

(a) What is a typical mean speed for a person walking?

Tick **one** box.

1.5 m/s ☐

3.0 m/s ☐

4.5 m/s ☐

6.0 m/s ☐

(1)

(b) What is a typical mean speed for a person cycling?

Tick **one** box.

1.5 m/s ☐

3.0 m/s ☐

4.5 m/s ☐

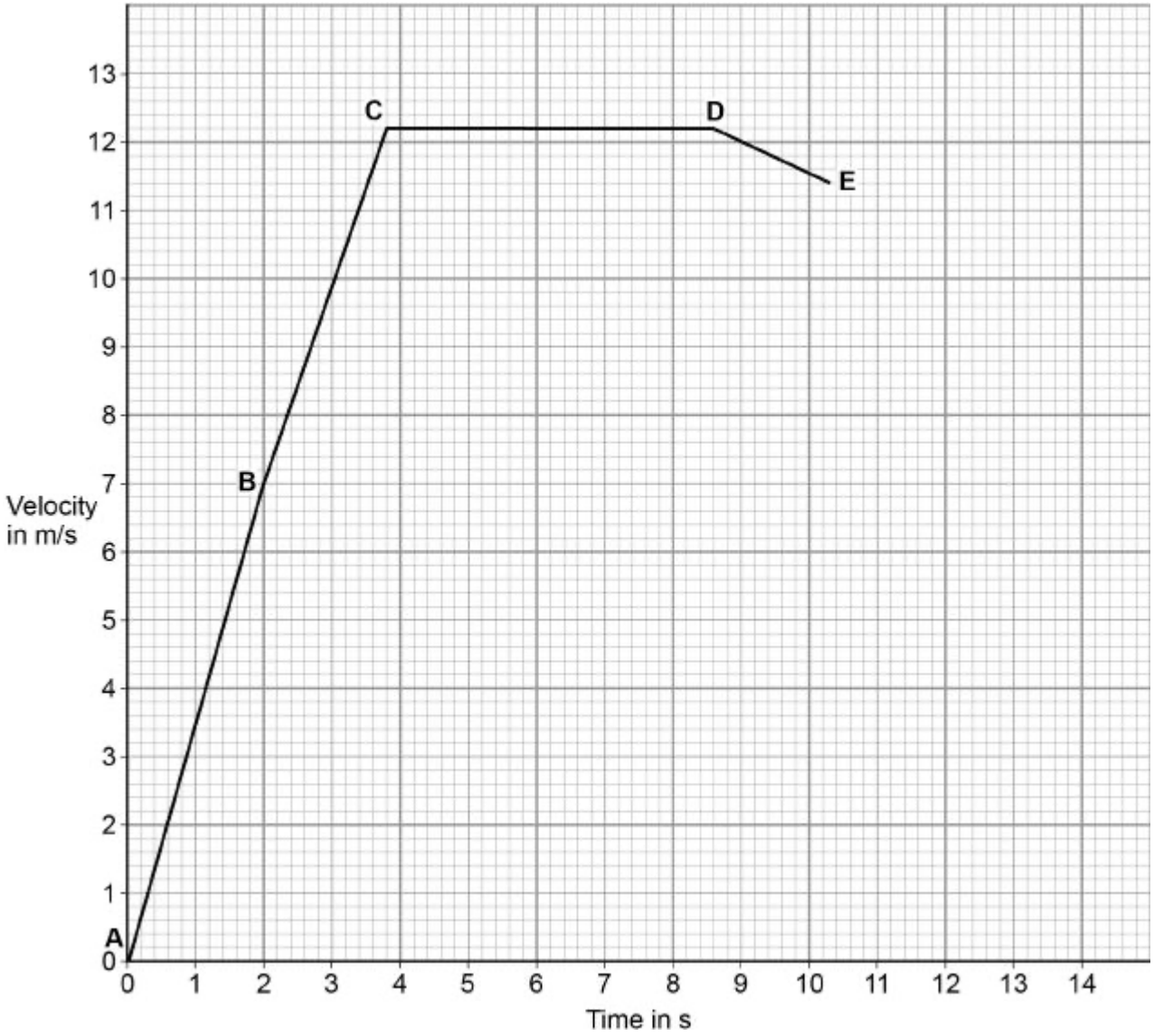
6.0 m/s ☐

(1)

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The athlete takes part in a race on a straight, horizontal running track.

The graph below shows the velocity−time graph for the athlete. **A**, **B**, **C**, **D** and **E** represent points in the race.



(c) Determine the time taken for the athlete to move between points **C** and **D**.

Time at **C** = _____ s

Time at **D** = _____ s

_____

_____

Time taken between points **C** and **D** = _____ s

(2)

(d) Point E represents the end of the race.

After point **E**, the athlete has a constant deceleration.

The athlete stops 14 seconds after the start of the race.

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Complete the graph above to show the motion of the athlete after point **E**.

(2)

(e) Which section of the graph above shows the athlete moving at constant velocity?

Tick **one** box.

A–B ☐

B–C ☐

C–D ☐

D–E ☐

(1)

(f) Which section of the graph above represents a part of the race where the resultant force on the athlete is zero?

Tick **one** box.

A–B ☐

B–C ☐

C–D ☐

D–E ☐

(1)

(g) What does the area under a velocity-time graph represent?

Tick **one** box.

Acceleration ☐

Distance travelled ☐

Energy ☐

Speed ☐

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(1)

(h) Write the equation which links acceleration, mass and resultant force.

_____

_____

(1)

(i) In another race, the athlete had a constant acceleration during the first 3.2 seconds. His velocity increased from 0 m/s to 11.6 m/s

Calculate the acceleration of the athlete.

Use the equation:

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

_____

_____

_____

_____

Acceleration = _____ m/s^2

(2)

(Total 12 marks)

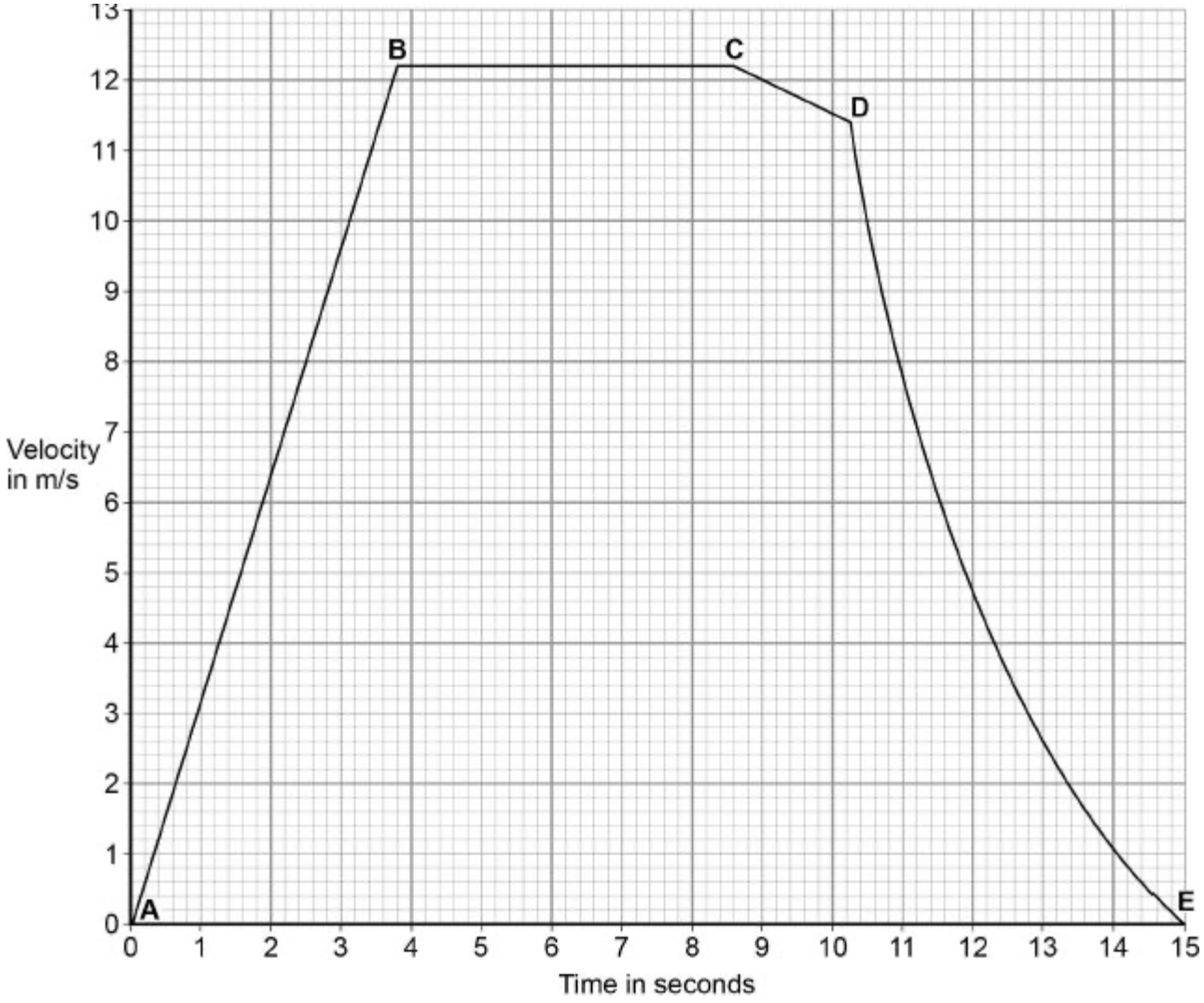
Q3.

An athlete takes part in a race on a straight, horizontal running track.

Figure 1 shows the velocity-time graph for the athlete during the race.

Figure 1

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(a) What is the main force that opposes the athlete's forward motion?

_____

_____

(1)

(b) Which section of the graph represents a part of the race where the resultant force on the athlete is zero?

Tick **one** box.

A–B	**B–C**	**C–D**	**D–E**
☐	☐	☐	☐

(1)

(c) The athlete has a mass of 94.8 kg

Calculate the momentum of the athlete at a time of 6.0 s

Use **Figure 1**.

_____

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Momentum = _____ kg m/s

(3)

(d) The acceleration is **not** constant from **D** to **E**.

Determine the acceleration at a time of 12.0 s

Use **Figure 1**.

Give the unit.

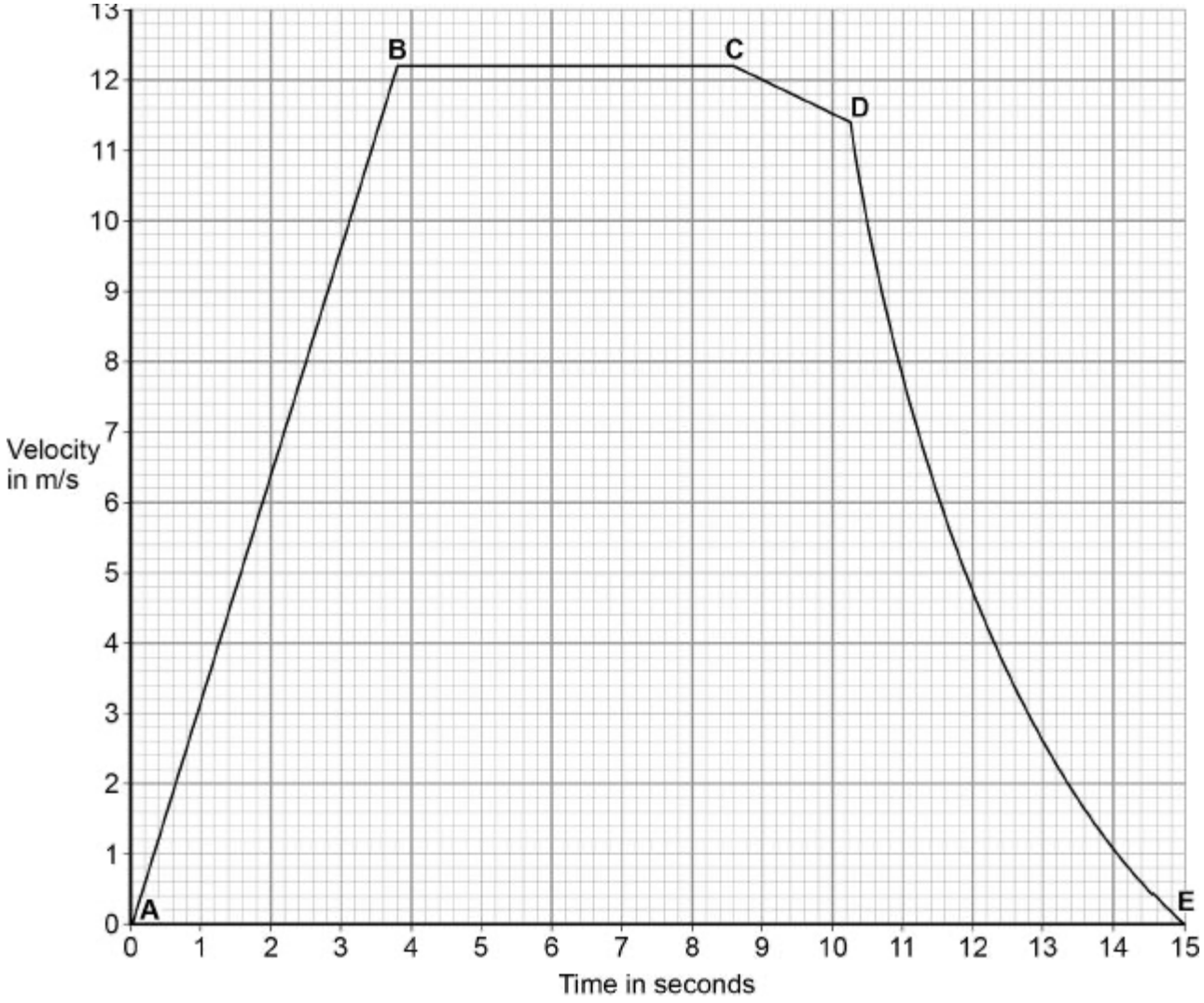
Acceleration = _____ Unit _____

(5)

Figure 2 is a copy of **Figure 1** to help you answer the following questions.

Figure 2

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A second athlete starts the race at the same time as the first athlete.

The second athlete moves with a constant acceleration of 1.6 m/s^2 for the first 6.0 seconds of the race.

The first athlete travels further than the second athlete during the first 6.0 seconds.

(e) Draw a line on **Figure 2** to represent the motion of the second athlete for the first 6.0 seconds of the race.

(2)

(f) Determine the extra distance travelled by the first athlete over the first 6.0 seconds of the race.

Use **Figure 2**.

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Extra distance travelled by first athlete = _____ m

(4)

(Total 16 marks)

Q4.

Astronauts have landed on the Moon on six separate occasions.

(a) The Moon is in a circular orbit around the Earth. The speed of the Moon is constant.

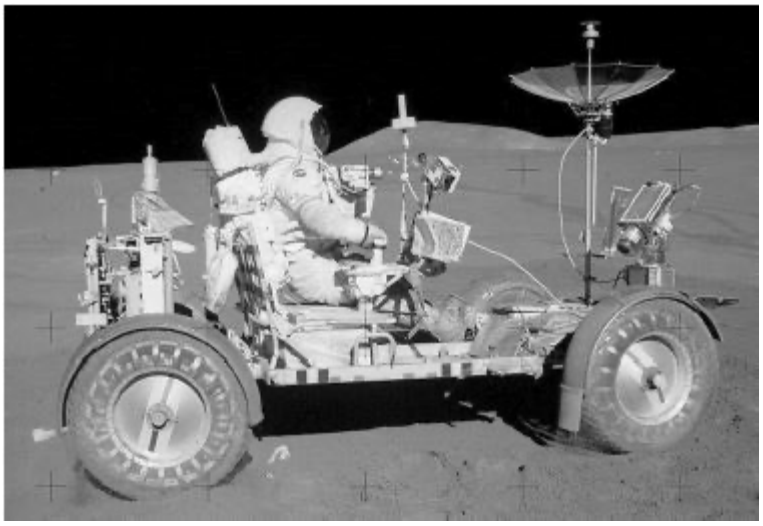
Explain why the Moon is accelerating.

(3)

The astronauts moved around the surface of the Moon in a lunar rover.

The photograph below shows a lunar rover.

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(b) At one point, the lunar rover accelerated from 1.4 m/s to 2.6 m/s

The acceleration of the lunar rover was 0.31 m/s^2

Which calculation could be used to calculate the distance travelled s during this acceleration?

Tick **one** box.

$s = \sqrt{2.6^2 - 1.4^2 - 2 \times 0.31}$ ☐

$s = \frac{1.4^2 - 2.6^2}{2 \times 0.31}$ ☐

$s = \frac{2.6^2 - 1.4^2}{2 \times 0.31}$ ☐

$s = \frac{2 \times (2.6^2 - 1.4^2)}{0.31}$ ☐

(1)

(c) The lunar rover used four electric motors connected in parallel to a 36 V battery.

The maximum output power of one motor was 190 W

The efficiency of each motor was 72%

Calculate the current drawn from the battery when all four motors were operating at maximum power.

_____

_____

_____

_____

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Current = _____ A

(6)

(d) Scientists once thought that the Moon formed elsewhere in the solar system and later came to orbit the Earth.

Studies of Moon rocks brought back by the astronauts showed that the rocks were extremely similar to those found on Earth.

This led to a new theory about how the Moon formed called the 'Giant Impact Hypothesis'.

According to the Giant Impact Hypothesis, a small planet collided with the Earth. Molten rock thrown up by the collision then formed the Moon.

Suggest why a new theory was developed.

(2)

(Total 12 marks)

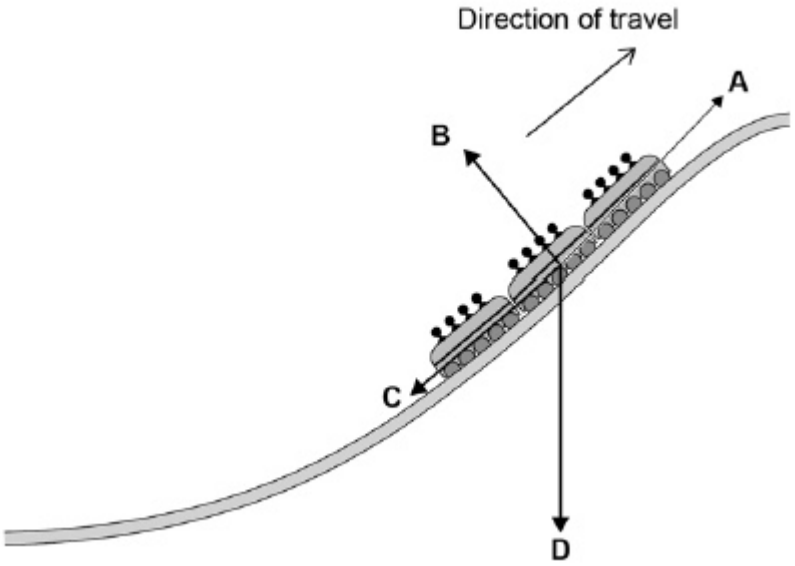
Q5.

Figure 1 shows a rollercoaster train as it is pulled up a slope on the track.

The arrows, **A**, **B**, **C** and **D**, represent the forces acting on the rollercoaster train.

Figure 1

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(a) Give **two** ways that the force arrows show that forces are vector quantities.

1. _____

2. _____

(2)

(b) Which arrow shows the weight of the rollercoaster train?

Tick **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(c) Which arrow shows the normal contact force?

Tick **one** box.

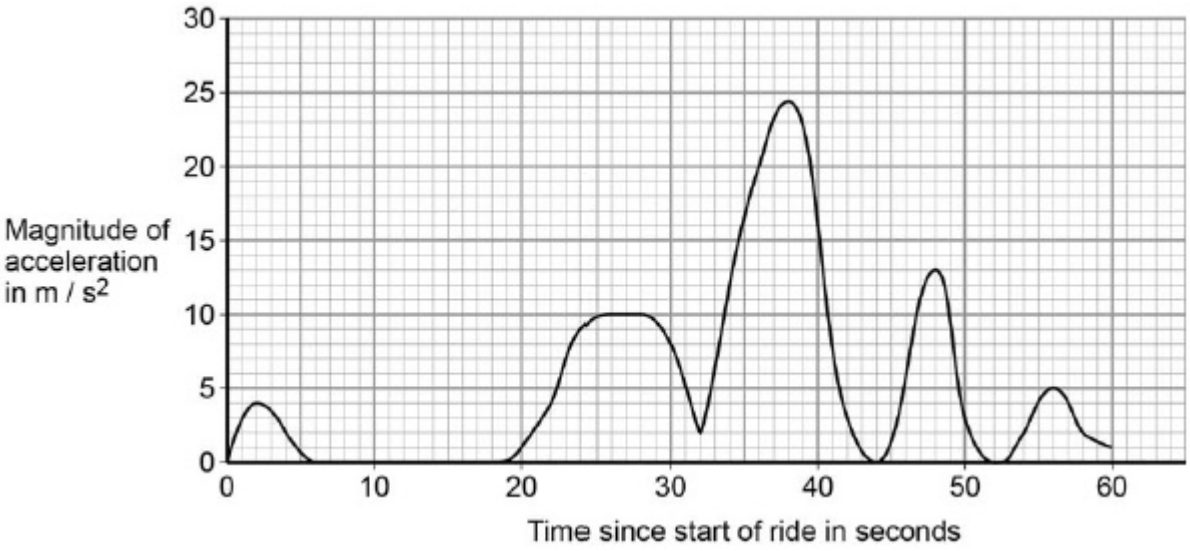
A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

Figure 2 shows the magnitude of the acceleration of the rollercoaster train during the ride.

Figure 2

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(d) Why has a line graph been drawn instead of a bar chart?

Tick **one** box.

Acceleration is a control variable. ☐

Both variables are continuous. ☐

Line graphs are easier to read. ☐

Time is a categoric variable. ☐

(1)

(e) What conclusion can be made from **Figure 2** about the motion of the rollercoaster train between 10 and 15 seconds?

Tick **one** box.

It is moving at a constant velocity. ☐

Its velocity is decreasing. ☐

Its velocity is increasing. ☐

(1)

(f) What is the maximum acceleration of the rollercoaster train?

Use **Figure 2**.

Acceleration = _____ m/s^2

(1)

(g) The maximum safe acceleration for most people is 5 times the acceleration due to gravity.

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Acceleration due to gravity = 9.8 m/s^2

Explain whether the acceleration of this rollercoaster train is safe for most people

_____

_____

_____

_____

_____

_____

(3)

(h) One of the passengers on the rollercoaster train has a mass of 58 kg

Calculate the maximum force experienced by the passenger during the ride.

Use the equation:

force = mass × acceleration

Give the unit.

_____

_____

_____

_____

_____

_____

Maximum force = _____ Unit _____

(3)

(Total 13 marks)

Q6.

Figure 1 shows an electric wheelchair.

Figure 1

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(a) The wheelchair moves at a constant speed of 2.4 m/s for 4.5 seconds.

Calculate the distance moved by the wheelchair.

Use the equation:

distance = speed × time

_____

_____

_____

_____

Distance = _____ m

(2)

(b) What could be a reason for the speed of the wheelchair decreasing?

Tick **one** box.

It started going downhill.	☐
It started going uphill.	☐
Its store of kinetic energy increased.	☐
It used more power from its battery.	☐

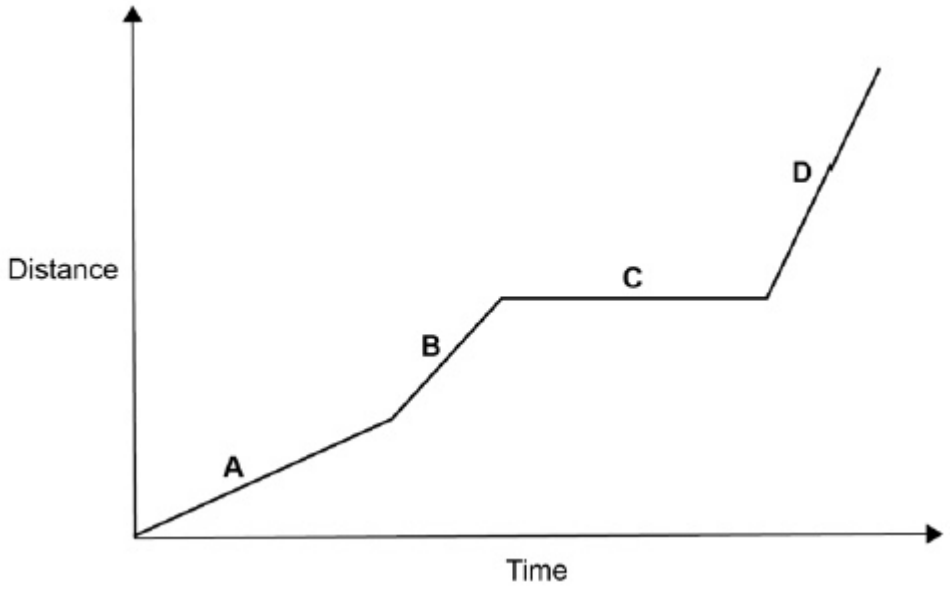
(1)

A student measured how the distance travelled by the wheelchair changed over time.

Figure 2 shows a sketch-graph of the results.

Figure 2

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(c) In which section of the graph, **A**, **B**, **C**, or **D**, did the wheelchair travel fastest?

Give the reason for your answer.

Section _____

Reason _____

_____

(2)

(d) The student used a data logger with a distance sensor to record the data.

Give **two** advantages of using a data logger rather than using a stopclock and tape measure.

1. _____

_____

2. _____

_____

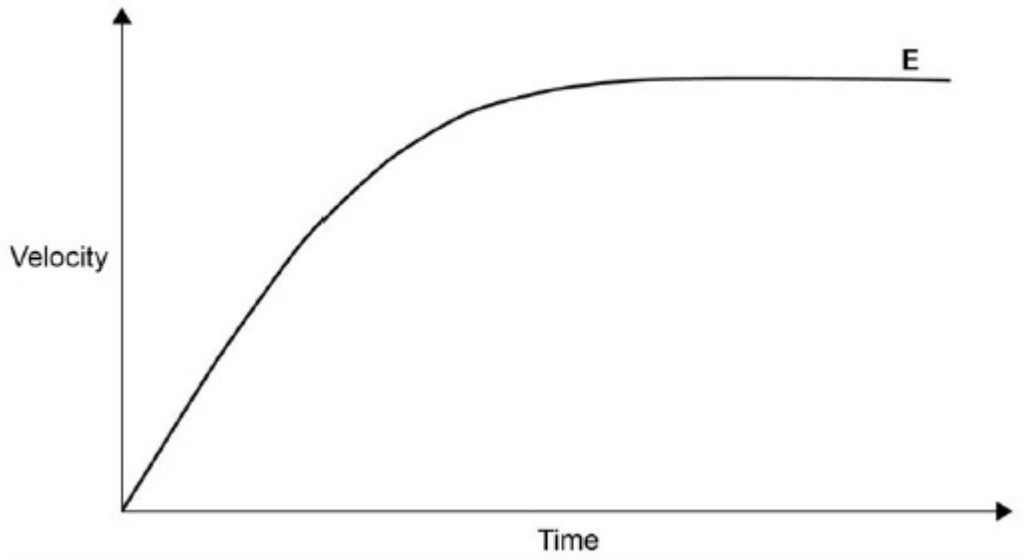
(2)

The velocity of the wheelchair changes as it accelerates to its top speed.

Figure 3 shows a sketch-graph of the changes.

Figure 3

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(e) The forward force on the wheelchair is constant as it accelerates on flat ground.

Which force reduces the acceleration?

Tick **one** box.

Air resistance ☐

Magnetism ☐

Tension ☐

Weight ☐

(1)

(f) Explain the acceleration of the wheelchair at point **E** on **Figure 3**.

_____

_____

_____

_____

(2)

(g) The wheelchair starts from rest.

It accelerates at a constant rate until it has a speed of 1.5 m/s

The wheelchair travels a distance of 2.0 m while it is accelerating.

Calculate the acceleration of the wheelchair.

Using the Physics Equations Sheet.

_____

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Acceleration = _____ m/s^2

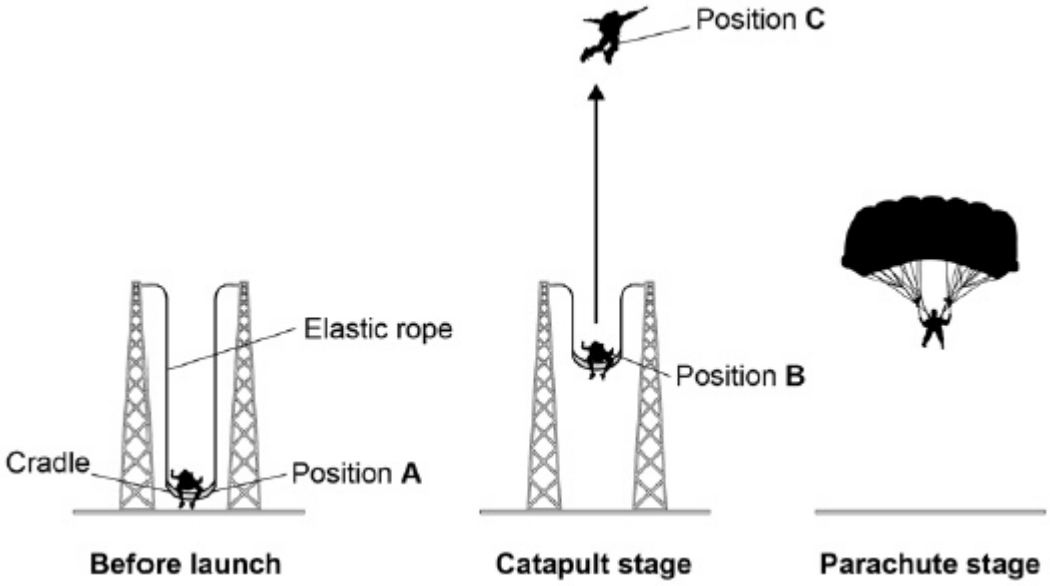
(3)

(Total 13 marks)

Q7.

The diagram shows the stages of an extreme sport called 'human catapult'.

- A person lies in a cradle which is held to the ground.
- The cradle is released.
- The person is launched vertically into the air by an elastic rope.
- The person then parachutes back to the ground.



(a) In position **A** there is a store of elastic energy.

Position **C** is the person's maximum height.

Describe the energy transfers from position **A**, through position **B**, to position **C**.

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(3)

(b) In the last few metres of his descent during the parachute stage, the person travels at a terminal velocity.

Explain why.

(2)

(c) When stretched in position **A**, the elastic rope stores 25 000 joules.

The elastic rope behaves like a spring, with a spring constant of 125 N/m

Calculate the extension of the elastic rope.

Use the Physics Equations Sheet.

Extension of elastic rope = _____ m

(4)

(d) The vertical velocity of the person at position **B** in the diagram is 26 m/s

The vertical velocity at position **C** is 0 m/s

Calculate the distance between position **B** and position **C**. Ignore the effect of air resistance.

Use the Physics Equations Sheet.

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_____

_____

_____

_____

_____

_____

_____

Distance = _____ m

(4)

(Total 13 marks)

Q8.

Speed and velocity are different quantities.

(a) Complete the sentence.

Choose the answers from the box.

distance	**direction**	**scalar**	**time**	**vector**

Velocity is a _____ quantity.

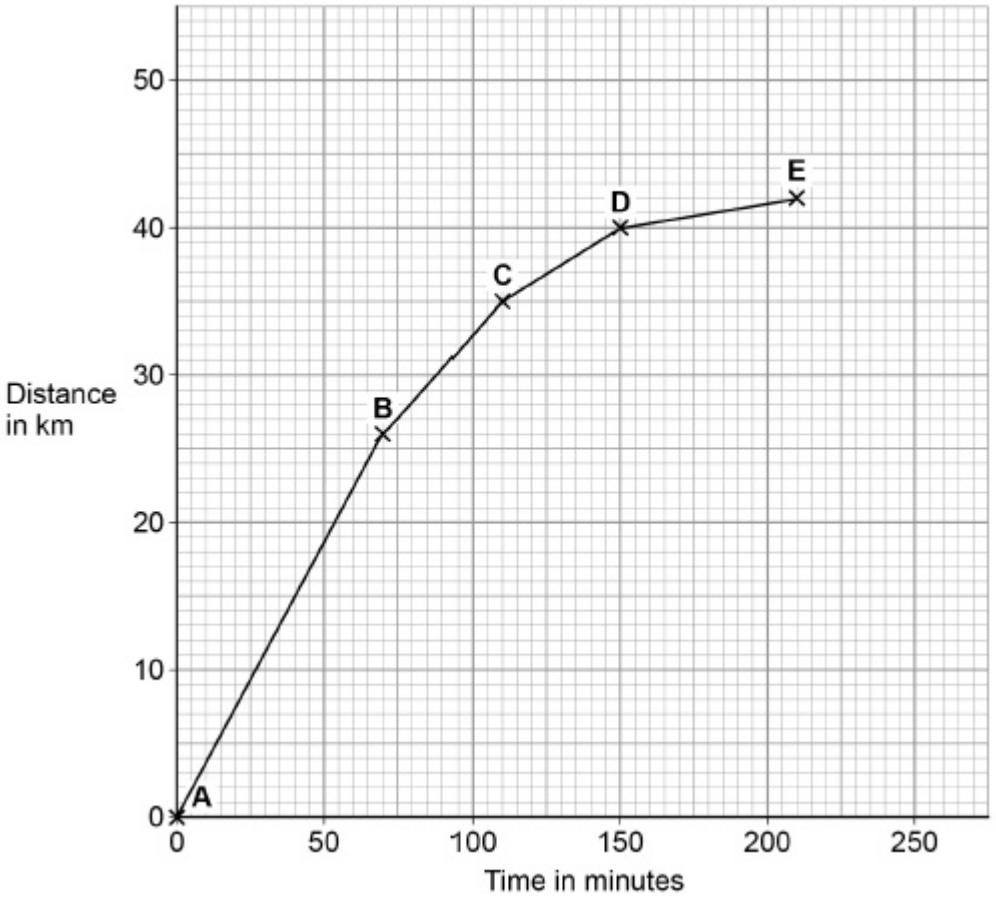
The velocity of an object is its speed in a given _____ .

(2)

Figure 1 shows the distance-time graph for an athlete in a running race.

Figure 1

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(b) Determine the:

- distance of the race
- time taken for the athlete to complete the race.

Use **Figure 1**.

_____

Distance = _____ km

Time taken = _____ minutes

(2)

(c) What is the motion of the athlete between points **B** and **C** on **Figure 1**?

Tick **one** box.

Moving at constant speed	☐
Moving with decreasing speed	☐
Moving with increasing speed	☐
Not moving	☐

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(1)

(d) Which section on **Figure 1** shows the athlete moving at the highest speed?

Tick **one** box.

A to **B** ☐

B to **C** ☐

C to **D** ☐

D to **E** ☐

(1)

(e) How does the section you gave as your answer in part (d) show the highest speed?

_____

_____

(1)

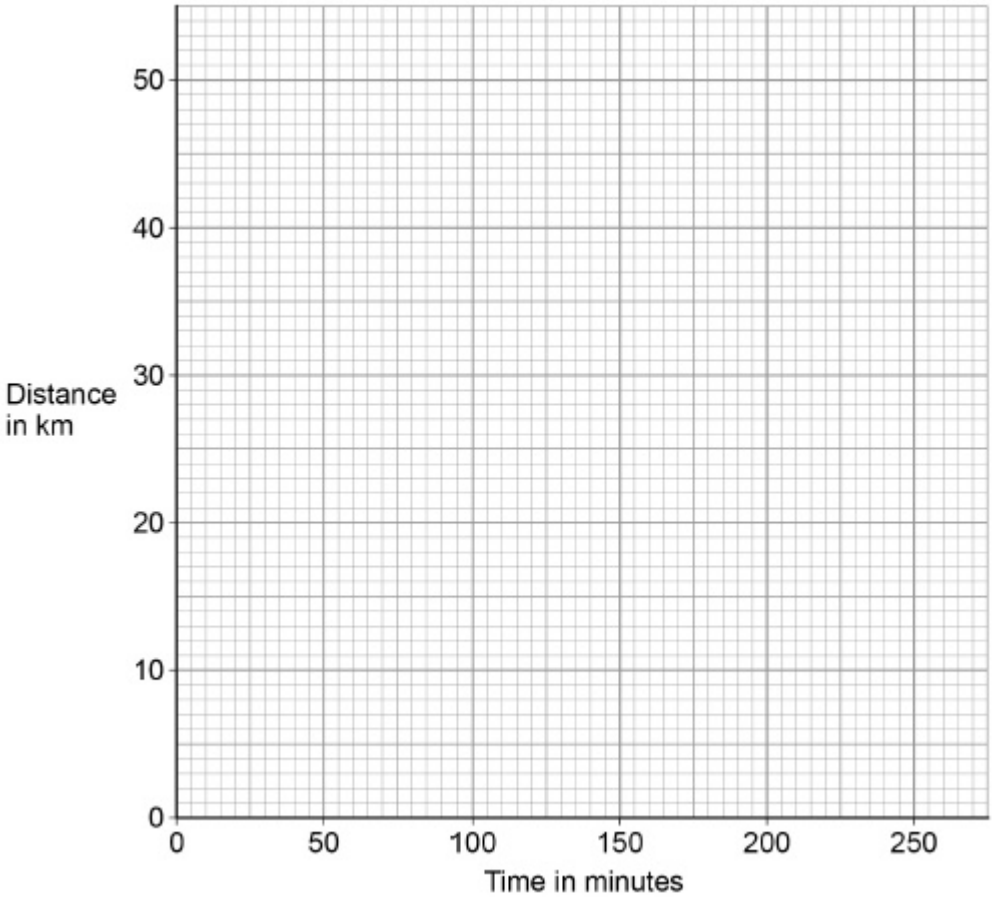
(f) A cyclist travelled the same distance as the athlete.

The cyclist travelled at a constant speed for 120 minutes.

Complete **Figure 2** to show a distance-time graph for the cyclist.

Figure 2

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(2)

A car following the race accelerates at a constant rate in a straight line.

The velocity of the car increases from 1.9 m/s to 3.4 m/s in 60 seconds.

(g) Calculate the change in velocity of the car.

_____

Change in velocity = _____ m/s

(1)

(h) Calculate the acceleration of the car.

Use your answer to part (g).

Use the equation:

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

Give the unit.

_____

_____

_____

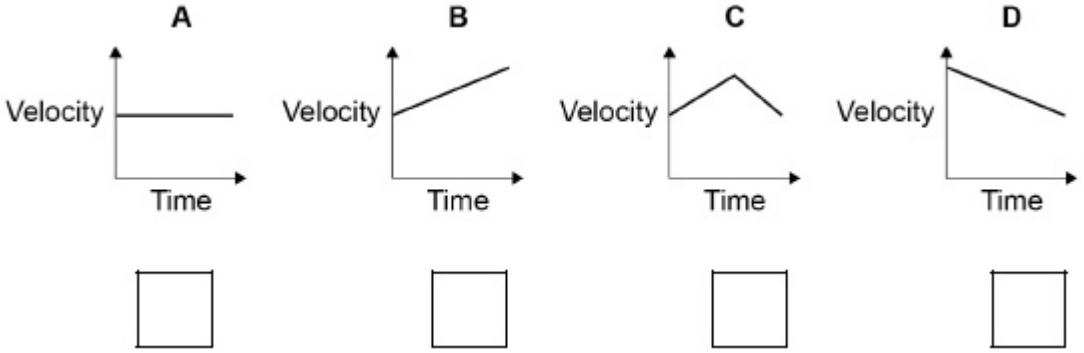
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Acceleration = _____ unit _____

(3)

(i) Which graph shows how the velocity of the car changes as the car accelerates?

Tick **one** box.



(1)

(Total 14 marks)

Q9.

Speed and velocity are different quantities.

(a) Complete the sentences.

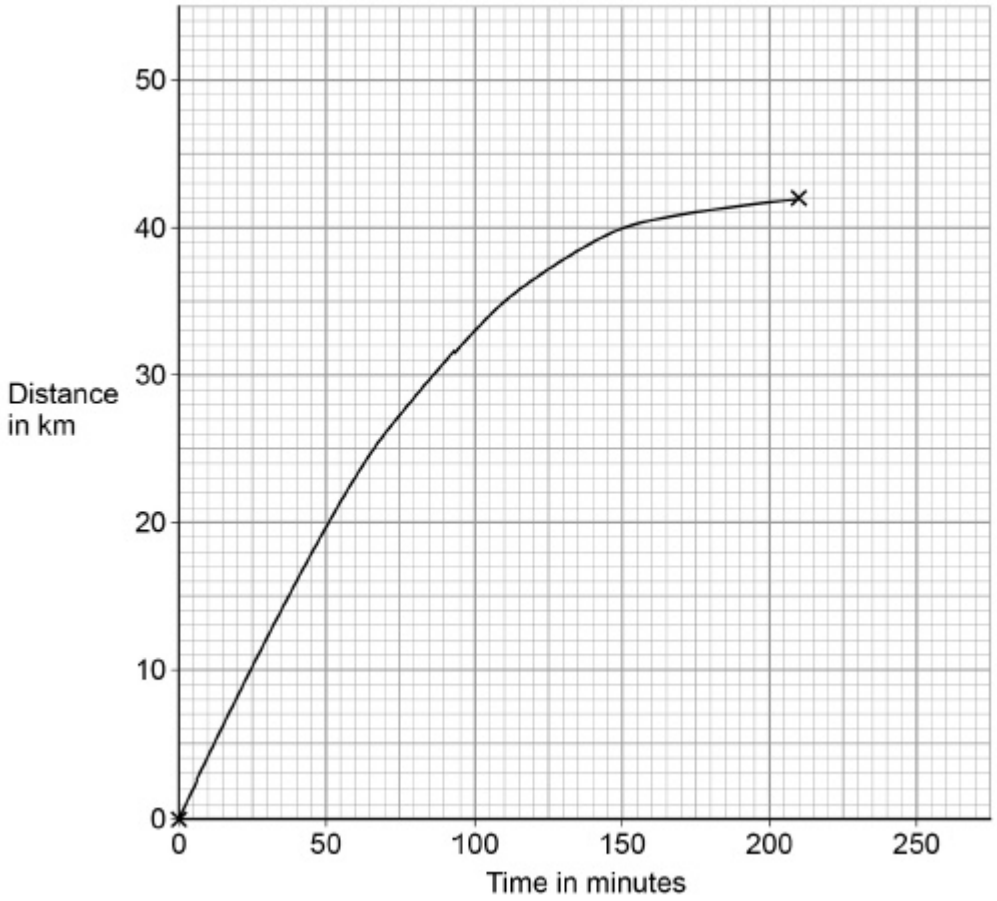
Velocity is a _____ quantity.

The velocity of an object is its speed in a given _____.

(2)

The graph shows a distance-time graph for an athlete in a race.

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(b) Determine the distance of the race and the time taken for the athlete to complete the race.

Use the graph.

_____

_____

Distance = _____

Time = _____

(1)

(c) Describe how you can use the graph to determine the velocity of the athlete 20 minutes after the start of the race.

_____

_____

_____

_____

_____

_____

(3)

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A car following the race accelerates at a constant rate in a straight line.

The velocity of the car increases from 4.9 m/s to 6.4 m/s in 3.00 minutes.

(d) Calculate the acceleration of the car.

Give your answer to 3 significant figures.

Acceleration = _____ m/s^2

(4)

(e) Sketch a velocity-time graph to represent the acceleration of the car in part (d).



(2)

(f) At the end of the race the car is travelling at 5.2 m/s

The brakes are applied causing the car to slow down and stop.

The brakes apply a constant force of 855 N in the opposite direction to the car's motion.

The mass of the car is 950 kg

Calculate the braking distance travelled by the car.

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Braking distance = _____ m

(6)

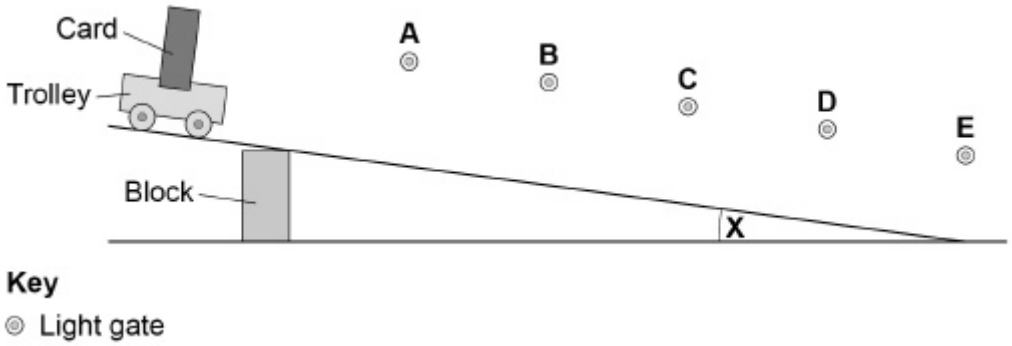
(Total 18 marks)

Q10.

A group of students investigated how the acceleration of a trolley depends on the angle of a ramp.

Figure 1 shows the apparatus.

Figure 1



The students released the trolley from the top of the ramp.

The light gates were attached to a data logger.

The data logger calculated the velocity of the trolley at each light gate.

(a) When the students released the trolley they did not push it.

Suggest why this is important.

_____

_____

(1)

(b) Measure angle **X** shown in **Figure 1**.

X = _____ degrees

(1)

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The students repeated the experiment with different angles of the ramp.

(c) Suggest how the students could increase the angle of the ramp.

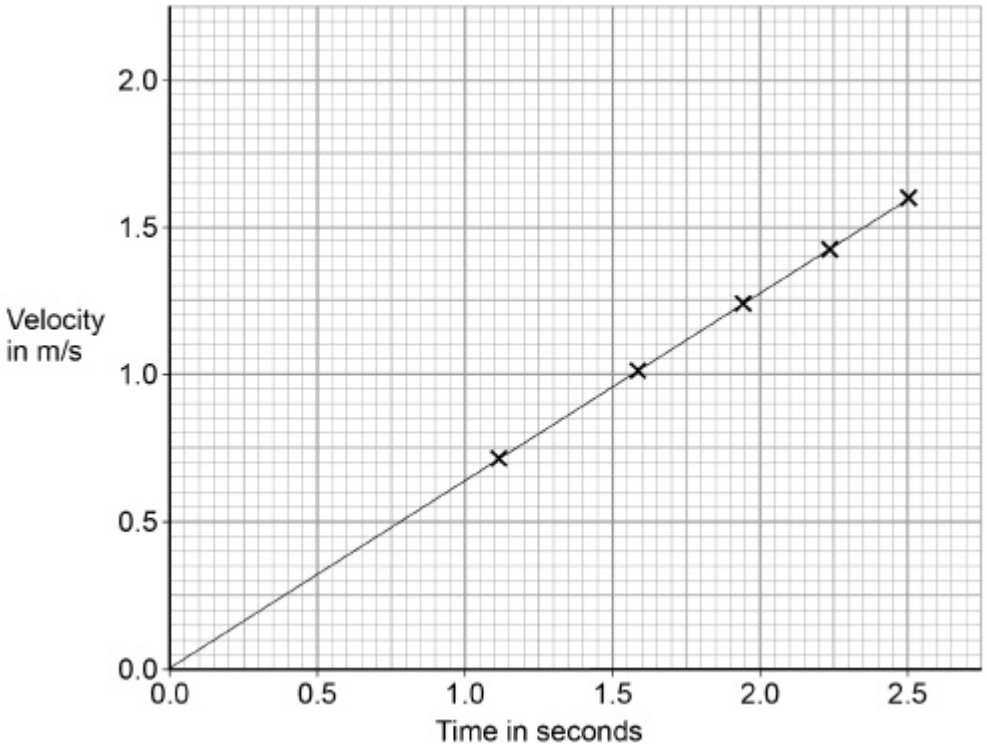
_____

_____

(1)

Figure 2 shows the velocity-time graph for the trolley when the angle of the ramp was **X**.

Figure 2



(d) The gradient of the line represents the acceleration of the trolley.

Determine the acceleration of the trolley in **Figure 2**.

_____

_____

_____

_____

Acceleration = _____ m/s^2

(3)

(e) What does the area under the graph in **Figure 2** represent?

Tick **one** box.

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Average velocity ☐

Maximum velocity ☐

Time taken ☐

Total distance travelled ☐

(1)

(f) The students repeated the measurements for each angle several times.

Suggest how the students could check the repeatability of the data.

_____

_____

_____

_____

(2)

(g) The trolley was released from a point 0.34 m above the surface the ramp was resting on.

The mass of the trolley was 0.75 kg

Gravitational field strength = 9.8 N/kg

Calculate the gravitational potential energy of the trolley before it was released.

Use the equation:

gravitational potential energy = mass × gravitational field strength × height

_____

_____

_____

Gravitational potential energy = _____ J

(2)

(Total 11 marks)

Q11.

Figure 1 shows the forces acting on a car while it is moving.

Figure 1

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(a) What is the resultant force acting on the car when it is travelling at constant velocity?

Resultant force = _____ N

(1)

(b) The car accelerates at 0.8 m/s^2

The mass of the car is 850 kg

Calculate the resultant force acting on the car while it is accelerating.

Use the equation:

resultant force = mass × acceleration

_____

_____

_____

_____

Resultant force = _____ N

(2)

(c) The driver notices a hazard and applies the brakes.

The car is travelling at 12 m/s

The driver's reaction time is 0.180 s

Calculate the distance travelled during the driver's reaction time.

Use the equation:

distance travelled = speed × time

_____

_____

_____

_____

Distance travelled = _____ m

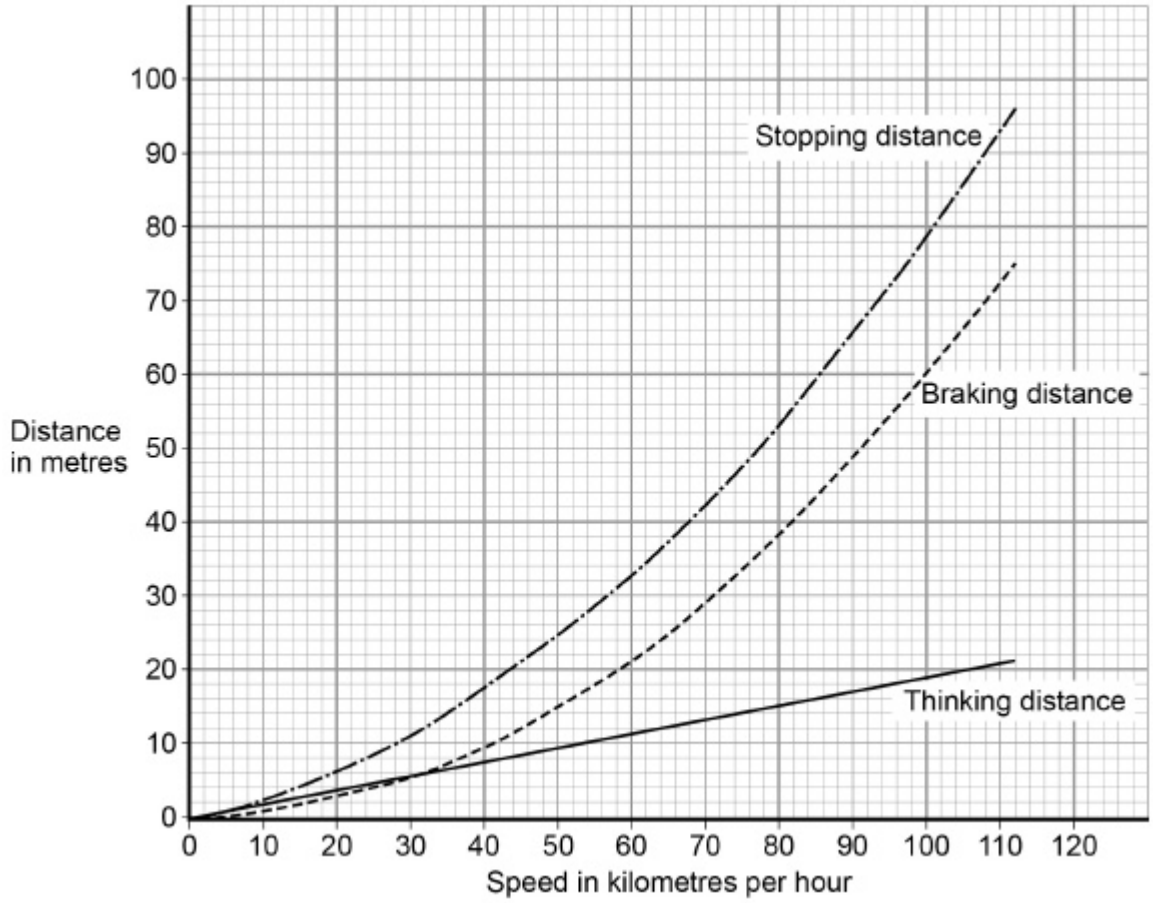
(2)

(d) **Figure 2** shows how the thinking distance, braking distance and stopping distance

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of a car change with speed.

Figure 2



Describe the trends in the data in **Figure 2**.

_____

_____

_____

_____

_____

_____

(3)

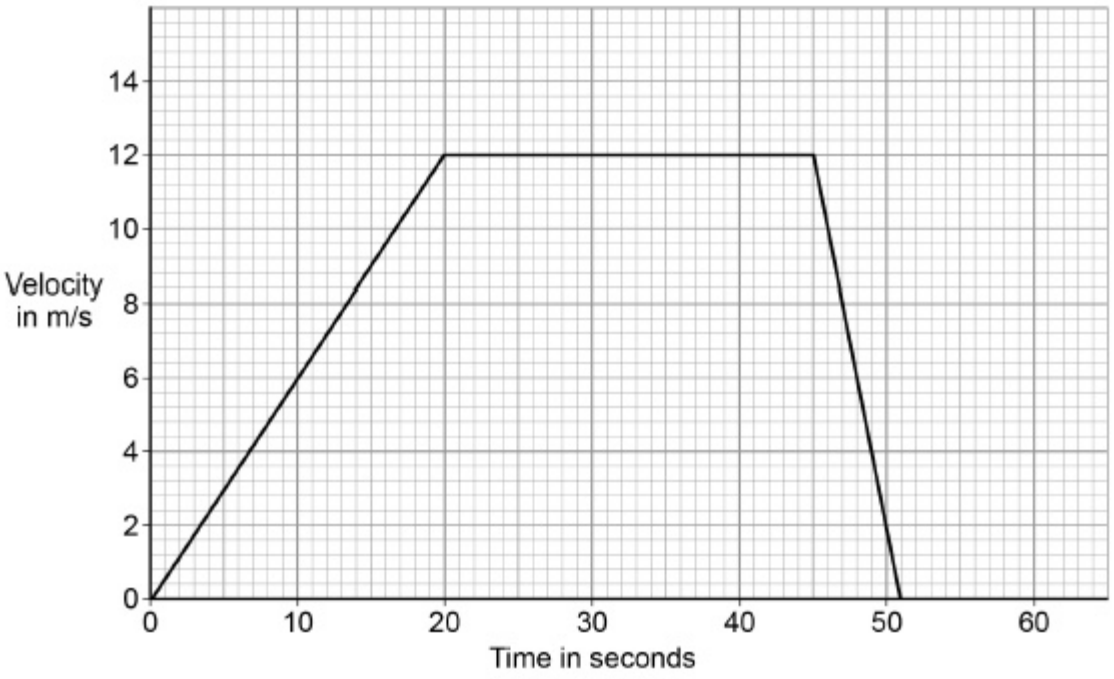
(Total 8 marks)

Q12.

Figure 1 shows a velocity–time graph for a short car journey.

Figure 1

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(a) Determine the acceleration of the car in the first 20 seconds of the journey.

Give the unit.

Acceleration = _____ Unit _____

(3)

(b) Determine the total distance travelled by the car during the journey shown in **Figure 1**.

Total distance travelled = _____ m

(4)

(c) The driver had to stop suddenly.

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The car's shock absorbers are springs.

At one point while the car was braking, one shock absorber had an elastic potential energy of 258 J

The spring constant of the shock absorber is 45 300 N/m

Calculate the extension of the shock absorber.

Use the Physics Equations Sheet.

Extension = _____ m

(3)

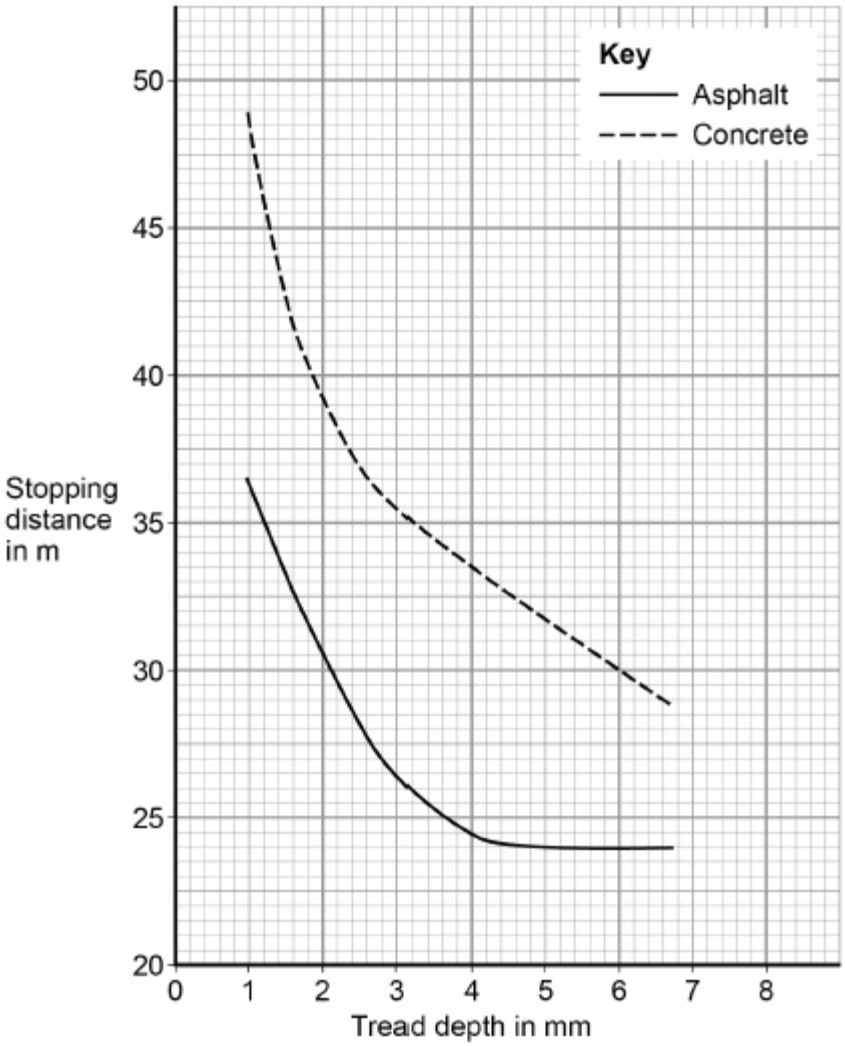
The stopping distance of a car can be affected by the condition of both the tyres and the road.

- The 'tread depth' of a tyre is the depth of the grooves in the tyre.
- Most roads have surfaces made of asphalt.
- Some roads have surfaces made of concrete.

Figure 2 shows how these factors affect the stopping distance for a car travelling at a certain speed.

Figure 2

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(d) Give **three** conclusions about the factors affecting stopping distance that can be made from **Figure 2**.

1. _____

_____

2. _____

_____

3. _____

_____

(3)

(e) The lowest stopping distance shown on **Figure 2** is 24 m

Explain why the stopping distance does not go below 24 m

_____

_____

_____

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_____

(2)

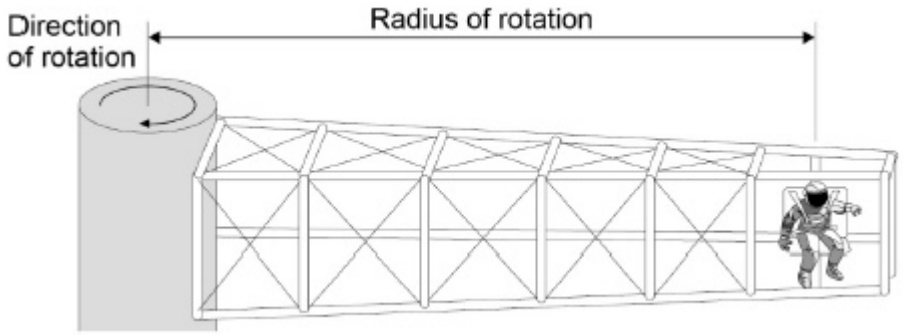
(Total 15 marks)

Q13.

Figure 1 shows a 'G-machine'.

The G-machine is used in astronaut training.

Figure 1



(a) The astronaut travels at constant speed in a circle.

Explain why the astronaut is accelerating.

_____

_____

_____

_____

_____

_____

(3)

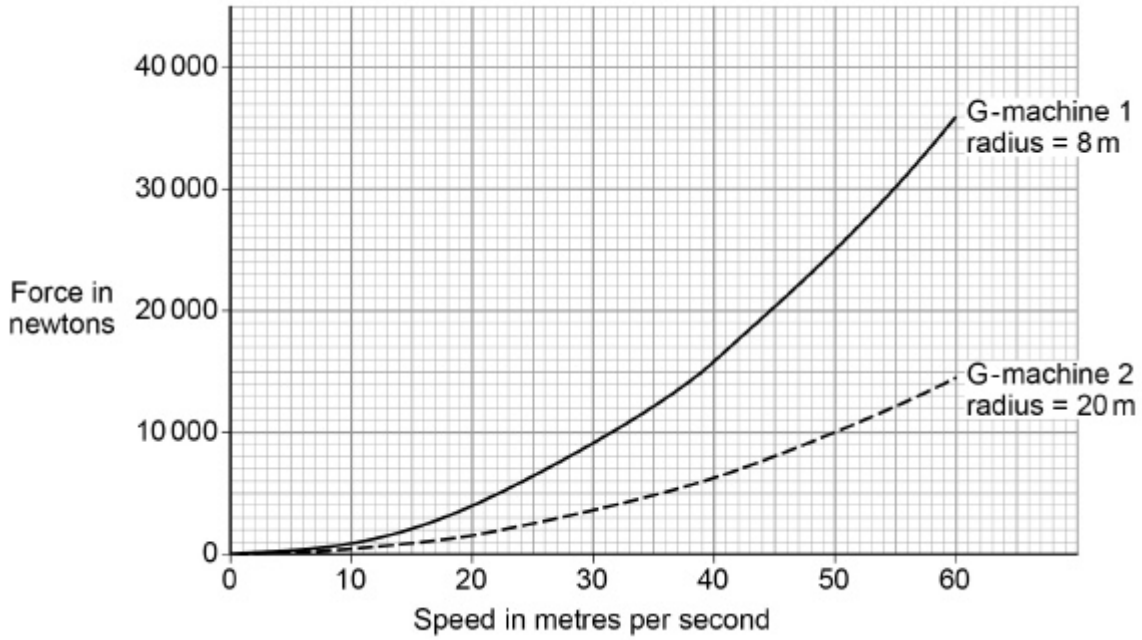
(b) The force causing the astronaut to move in a circle is measured.

Figure 2 shows how the speed of the astronaut affects the force causing the astronaut to move in a circle.

The radius of rotation of the astronaut is different for each G-machine.

Figure 2

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Give **three** conclusions about the factors affecting the size of the force required to move the astronaut in a circle.

1. _____

_____

2. _____

_____

3. _____

_____

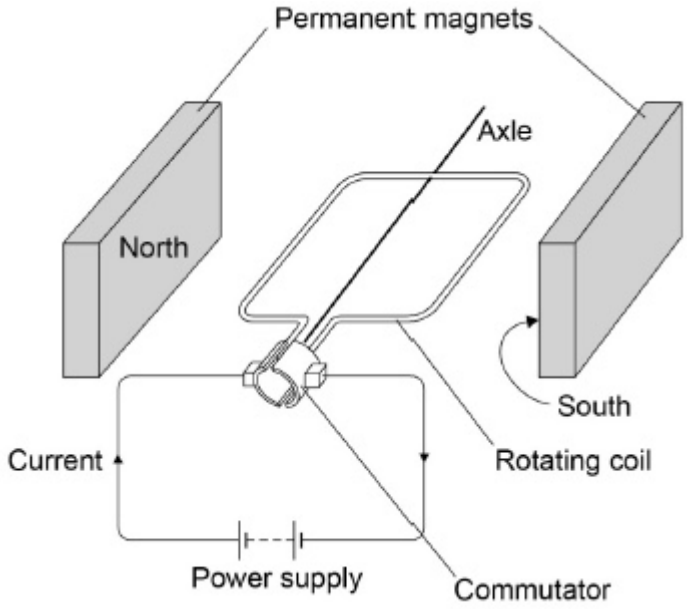
(3)

(c) Each G-machine is rotated by an electric motor.

Figure 3 shows a simple electric motor.

Figure 3

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Explain why the coil rotates when there is a current in the circuit.

_____

_____

_____

_____

_____

_____

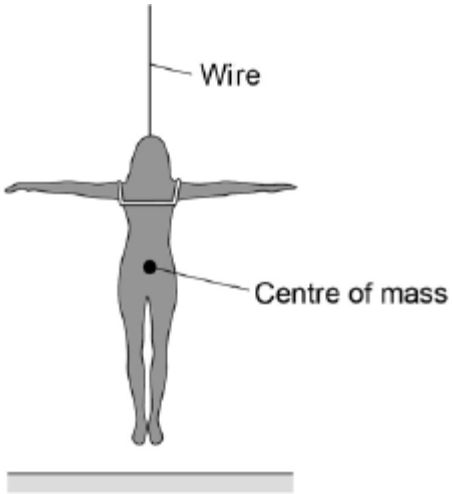
(3)

(Total 9 marks)

Q14.

An actor is attached to a wire so that she can hang above the stage.

Look at the figure below.



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(a) On The figure above draw two arrows to show the forces acting on the actor.

(2)

(b) Which **two** forces are acting on the actor?

Tick **two** boxes.

Air resistance force ☐

Electrostatic force ☐

Gravitational force ☐

Magnetic force ☐

Tension force ☐

(2)

(c) The actor hangs above the stage in a stationary position.

What is the resultant force on the actor?

Resultant force = _____ N

(1)

(d) The actor has a mass of 70 kg.

Gravitational field strength = 9.8 N / kg

Use the following equation to calculate the weight of the actor.

Weight = mass × gravitational field strength

Give your answer to 2 significant figures.

_____

_____

_____

Weight of actor = _____ N

(2)

(e) A motor pulls vertically upwards on the wire with a force of 720 N.

Calculate the resultant force on the actor.

_____

Resultant force = _____ N

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(1)

(f) Another actor has a mass of 65 kg.

This actor is attached to the wire and the motor pulls her vertically upwards.

The resultant force on the actor is 25 N.

Write down the equation that links acceleration, mass and resultant force.

Equation _____

(1)

(g) Calculate the acceleration of the actor.

_____

_____

_____

Acceleration of actor = _____ m / s^2

(3)

(Total 12 marks)

Q15.

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.

_____

(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.

(1)

(d) Friction reduces the speed of the skater.

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

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.

(4)

(Total 10 marks)

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