Motion along a line

Questions

Name: _____

Class: _____

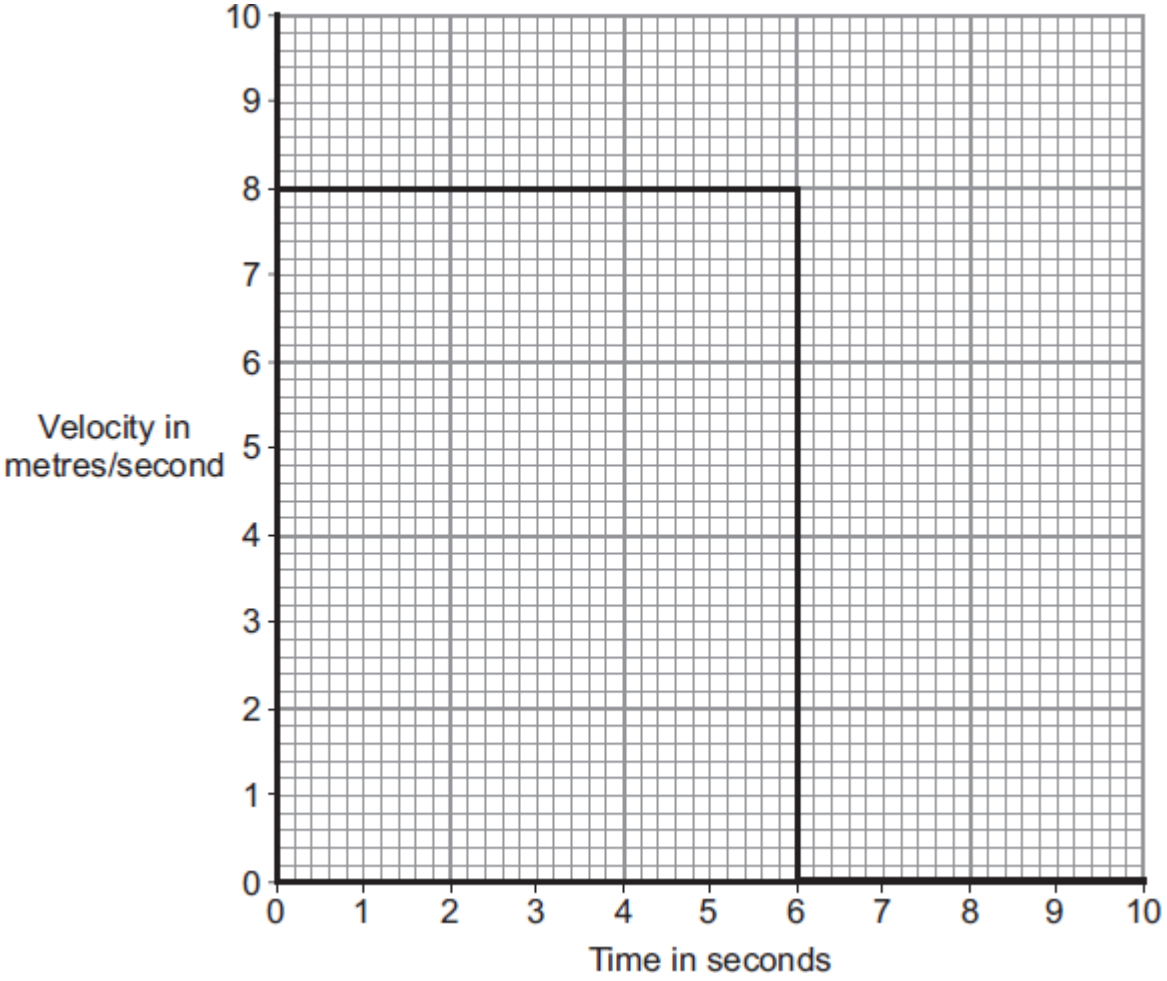
Date: _____

Time: **76 minutes**

Marks: **75 marks**

Comments:

1 The diagram shows the velocity-time graph for an object over a 10 second period.



(a) Use the graph to calculate the distance travelled by the object in 10 seconds.

Show clearly how you work out your answer.

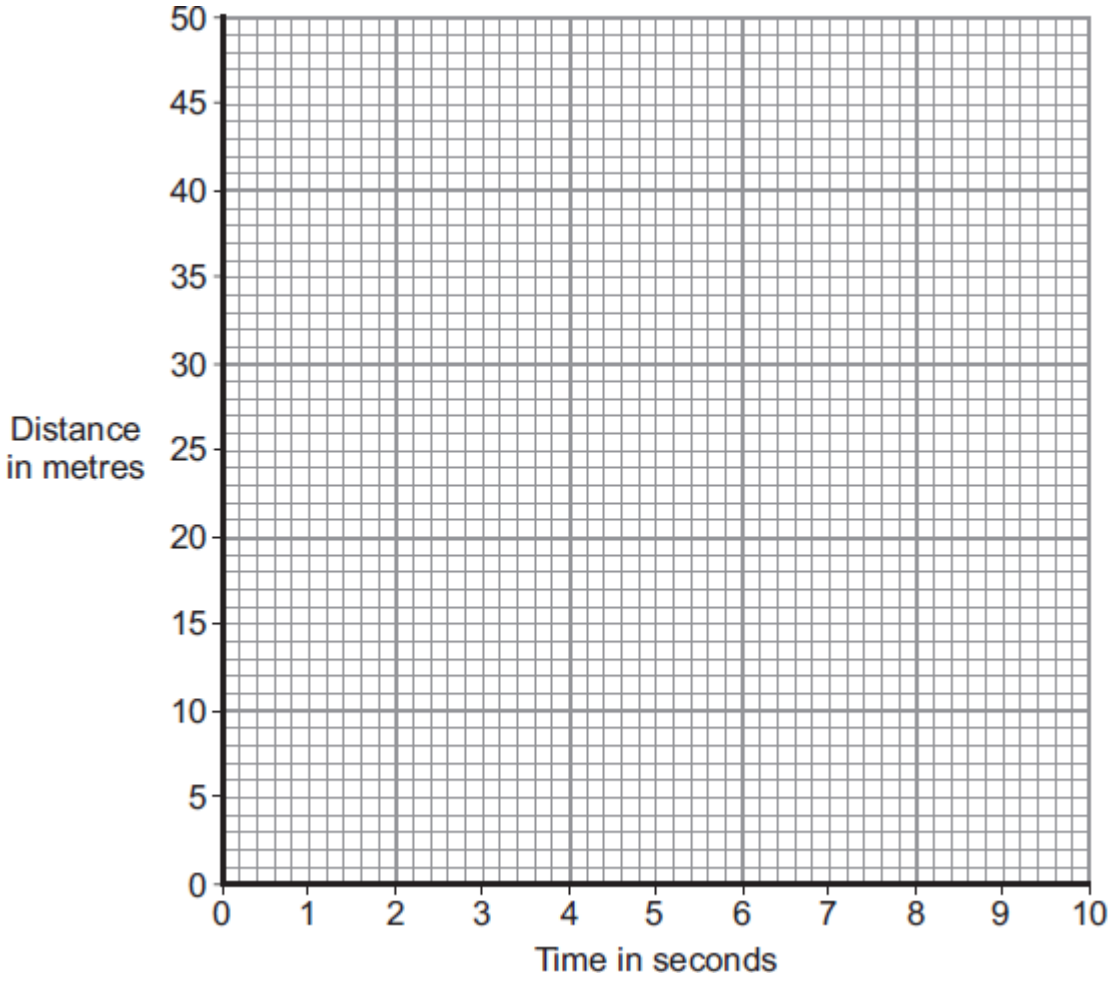
_____

_____

Distance = _____ m

(2)

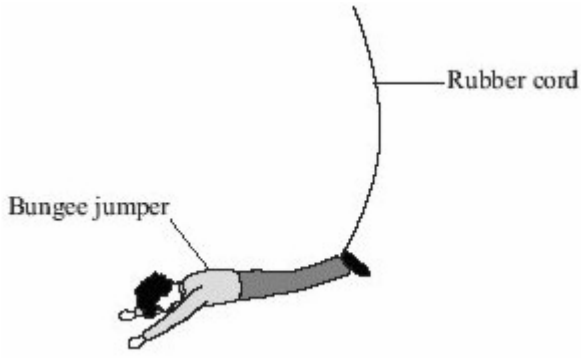
(b) Complete the distance-time graph for the object over the same 10 seconds.



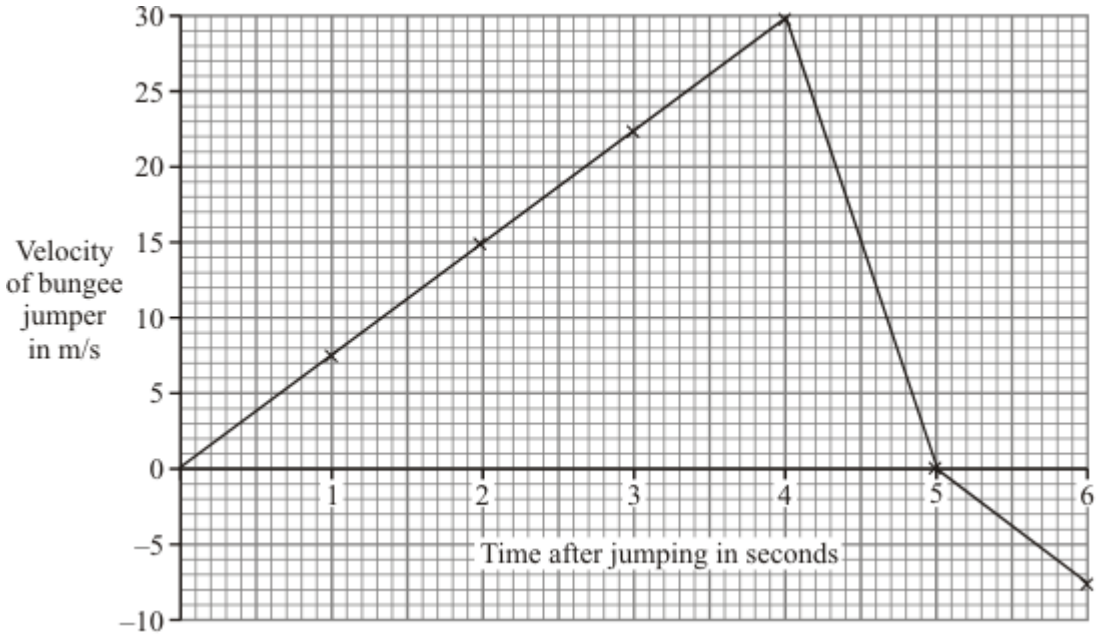
(2)

(Total 4 marks)

2 In bungee jumping, a fixed rubber cord is fastened to the jumper's ankles.



The graph shows how the bungee jumper's velocity changes during part of the jump.



(a) Calculate the acceleration of the bungee jumper between 2 and 4 seconds. Show your working.

Acceleration = _____ m/s^2

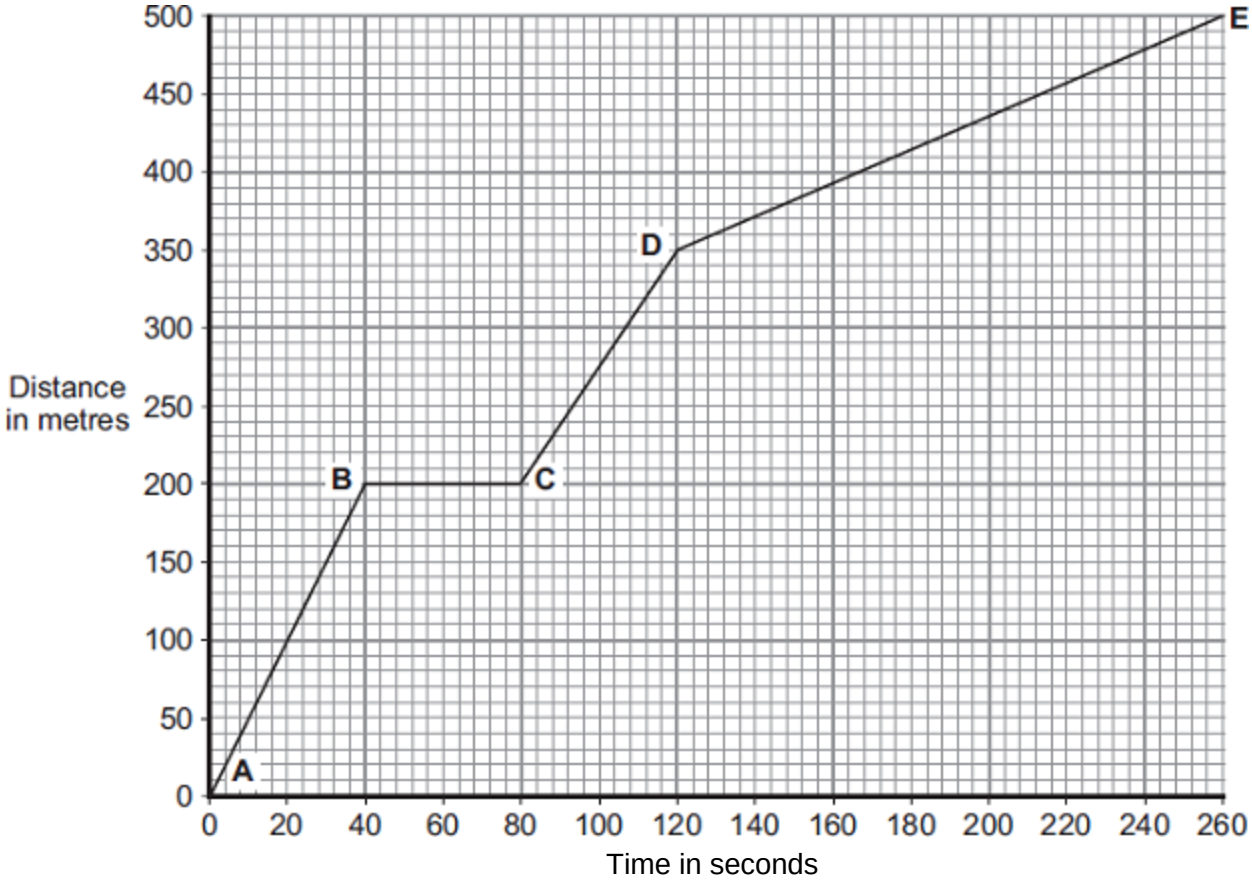
(3)

(b) Describe, in as much detail as you can, what happens to the bungee jumper after 4 seconds.

(3)

(Total 6 marks)

3 Part of a bus route is along a high street.
The distance-time graph shows how far the bus travelled along the high street and how long it took.



(a) Between which two points was the bus travelling the slowest?

Put a tick (✓) in the box next to your answer.

Points	Tick (✓)
A – B	
C – D	
D – E	

Give a reason for your answer.

_____

_____

(2)

(b) The bus travels at 5 m/s between points **A** and **B**.
The bus and passengers have a total mass of 16 000 kg.

Use the equation in the box to calculate the momentum of the bus and passengers between points **A** and **B**.

momentum = mass x velocity

Show clearly how you work out your answer.

_____

_____

Momentum = _____ kg m/s

(2)

(c) A cyclist made the same journey along the high street.
The cyclist started at the same time as the bus and completed the journey in 220 seconds.
The cyclist travelled the whole distance at a constant speed.

(i) Draw a line on the graph to show the cyclist's journey.

(2)

(ii) After how many seconds did the cyclist overtake the bus?

The cyclist overtook the bus after _____ seconds.

(1)

(Total 7 marks)

4 The London Eye is one of the largest observation wheels in the world.

© Angelo Ferraris/Shutterstock

The passengers ride in capsules. Each capsule moves in a circular path and accelerates.

(a) Explain how the wheel can move at a steady speed and the capsules accelerate at the same time.

_____

_____

_____

(2)

(b) In which direction is the resultant force on each capsule?

_____

(1)

(c) The designers of the London Eye had to consider **three** factors which affect the resultant force described in part (b).

Two factors that increase the resultant force are:

- an increase in the speed of rotation
- an increase in the total mass of the wheel, the capsules and the passengers.

Name the other factor that affects the resultant force and state what effect it has on the resultant force.

_____

_____

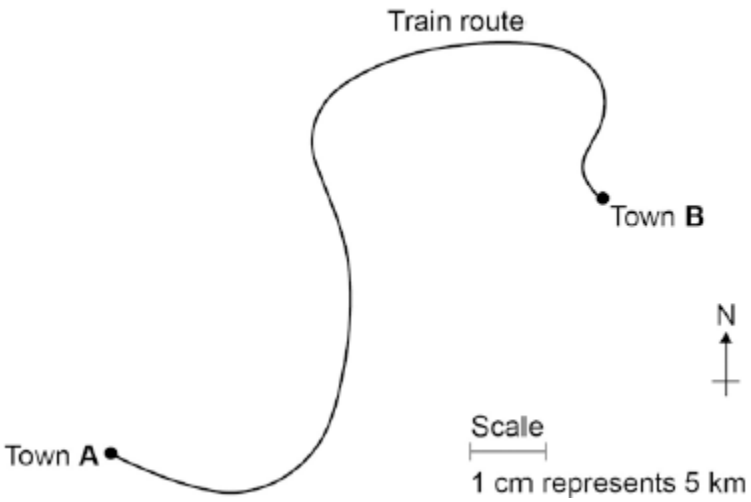
(1)

(Total 4 marks)

5 A train travels from town **A** to town **B**.

Figure 1 shows the route taken by the train.
Figure 1 has been drawn to scale.

Figure 1



(a) The distance the train travels between **A** and **B** is not the same as the displacement of the train.

What is the difference between distance and displacement?

_____

_____

_____

(1)

(b) Use **Figure 1** to determine the displacement of the train in travelling from **A** to **B**.

Show how you obtain your answer.

_____

_____

Displacement = _____ km

Direction = _____

(2)

(c) There are places on the journey where the train accelerates without changing speed.

Explain how this can happen.

_____

_____

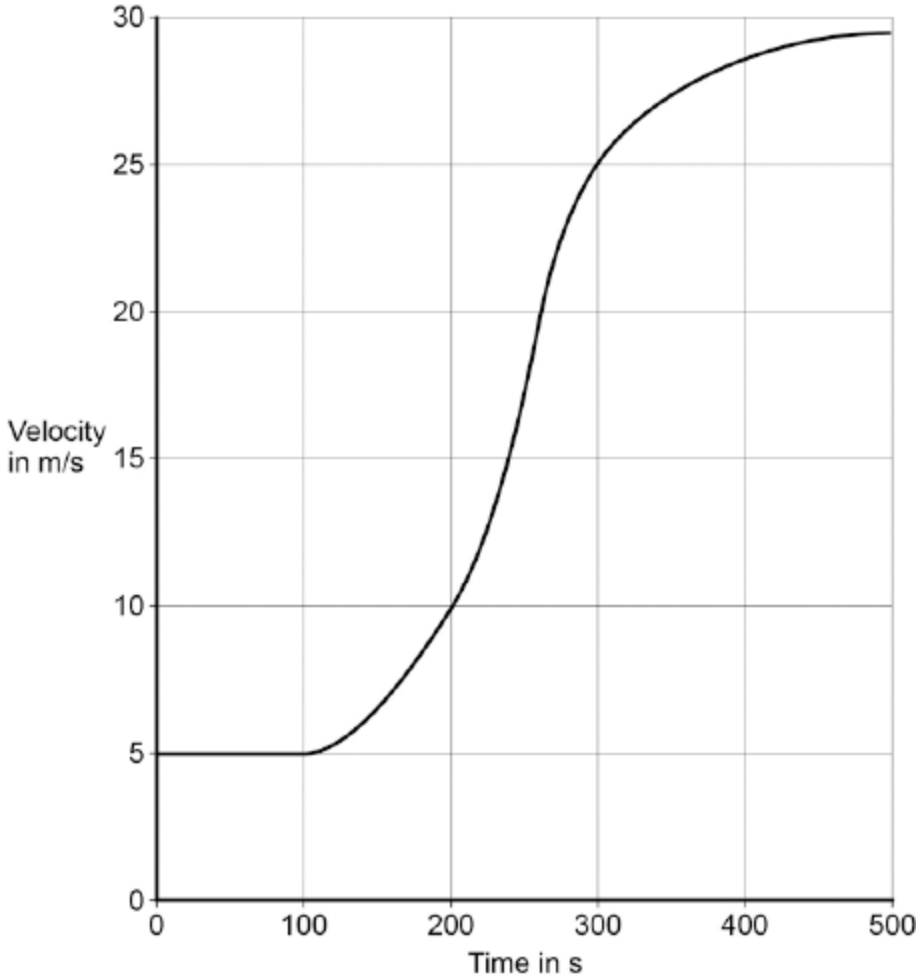
_____

_____

(2)

(d) **Figure 2** shows how the velocity of the train changes with time as the train travels along a straight section of the journey.

Figure 2



Estimate the distance travelled by the train along the section of the journey shown in **Figure 2**.

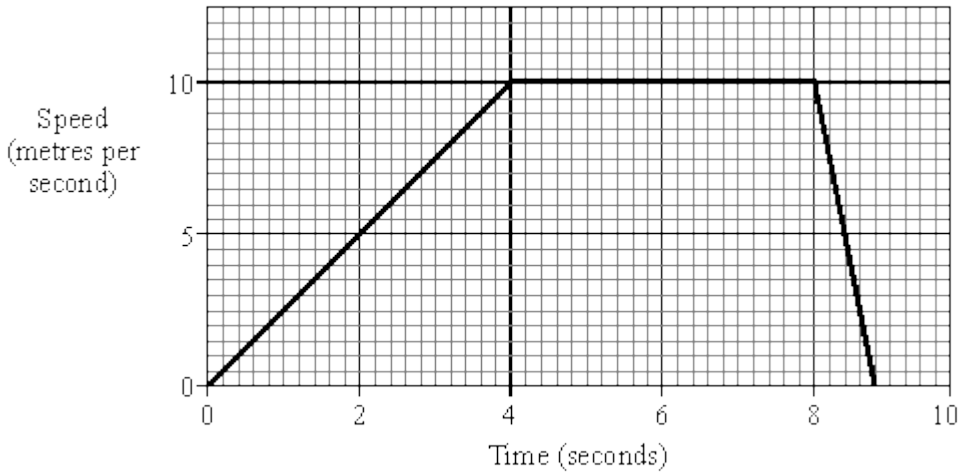
To gain full marks you must show how you worked out your answer.

Distance = _____ m

(3)

(Total 8 marks)

6 The graph shows the speed of a runner during an indoor 60 metres race.



(a) Calculate the acceleration of the runner during the first four seconds.
(Show your working.)

(3)

(b) How far does the runner travel during the first four seconds?
(Show your working.)

(3)

(c) At the finish, a thick wall of rubber foam slows the runner down at a rate of 25 m/s^2.
The runner has a mass of 75kg.
Calculate the average force of the rubber foam on the runner.
(Show your working.)

Answer _____ newtons (N)

(2)

(Total 8 marks)

7 In 2011, some of the scientists working at the CERN particle laboratory published the results of experiments they had conducted over the previous three years.

The scientists said that the results had shown that a particle, called a neutrino, was able to travel faster than the speed of light.

These unexpected results challenged the physics theory that nothing can travel faster than the speed of light.

(a) Suggest why most other scientists thought that the experimental results were unbelievable.

_____

_____

(1)

(b) The scientists at CERN believed their results were correct but could not explain them.

Suggest **two** reasons why the scientists decided to publish their results.

1. _____

_____

2. _____

_____

(2)

(c) The experiments conducted by the scientists involved measuring the time it took neutrinos to travel from CERN to another laboratory 730 000 m away.

Using the data, the speed of the neutrinos was calculated to be 300 007 400 m/s.

Calculate the time it would take the neutrinos to travel 730 000 m at a speed of 300 007 400 m/s.

Give your answer in standard form.

_____

_____

_____

_____

Time = _____ s

(3)

(d) In 2012, the scientists found that the unexpected results were caused by a timing error.

The error meant that the time recorded was always 60 nanoseconds less than the actual time.

Which **one** of the following is the same as 60 nanoseconds?

Tick **one** box.

60×10^{-3} s ☐

60×10^{-6} s ☐

60×10^{-9} s ☐

(1)

(e) What name is given to the type of error made by the scientists?

_____

(1)

(f) Suggest what the scientists should do to calculate an accurate value for the speed of a neutrino.

_____

_____

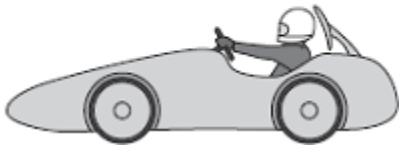
(1)

(Total 9 marks)

8 (a) Some students have designed and built an electric-powered go-kart. After testing, the students decided to make changes to the design of their go-kart.

First design **X**

Final design **Y**



The go-kart always had the same mass and used the same motor.

The change in shape from the first design (**X**) to the final design (**Y**) will affect the top speed of the go-kart.

Explain why.

_____

_____

_____

_____

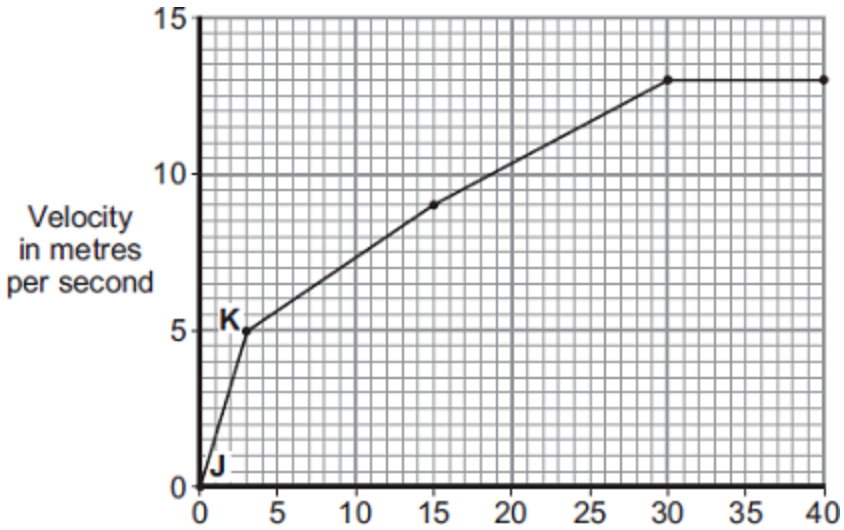
_____

_____

(3)

(b) The final design go-kart, **Y**, is entered into a race.

The graph shows how the velocity of the go-kart changes during the first 40 seconds of the race.



(i) Use the graph to calculate the acceleration of the go-kart between points **J** and **K**.

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

_____

_____

_____

Acceleration = _____ m/s^2

(2)

(ii) Use the graph to calculate the distance the go-kart travels between points **J** and **K**.

_____

_____

_____

Distance = _____ m

(2)

(iii) What causes most of the resistive forces acting on the go-kart?

_____

(1)

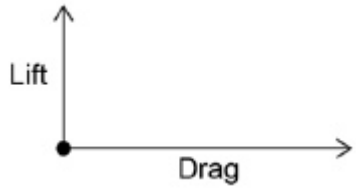
(Total 8 marks)

9 (a) **Figure 1** shows an aircraft flying at a constant velocity and at a constant height above the ground.

Figure 1

Complete the free body diagram in **Figure 2** to show the other two forces acting on the aircraft.

Figure 2



(2)

(b) A small aircraft accelerated down a runway at 4.0 m/s^2

The aircraft started from rest and reached a speed of 34 m/s just before take-off.

Calculate the distance the aircraft travelled while accelerating.

Give your answer to 2 significant figures.

_____

_____

_____

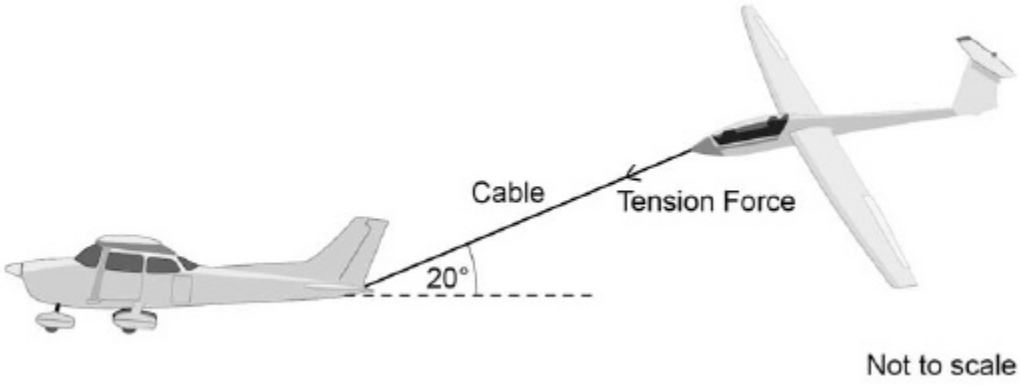
_____

Distance = _____ m

(4)

(c) **Figure 3** shows the small aircraft being used to tow a glider.

Figure 3



The tension force in the cable can be resolved into a horizontal component and a vertical component.

The tension in the cable is 2000 N

The cable makes an angle of 20° with the horizontal.

Draw a vector diagram to determine the magnitude of the two components of the tension force in the cable.

Magnitude of the horizontal component = _____ N

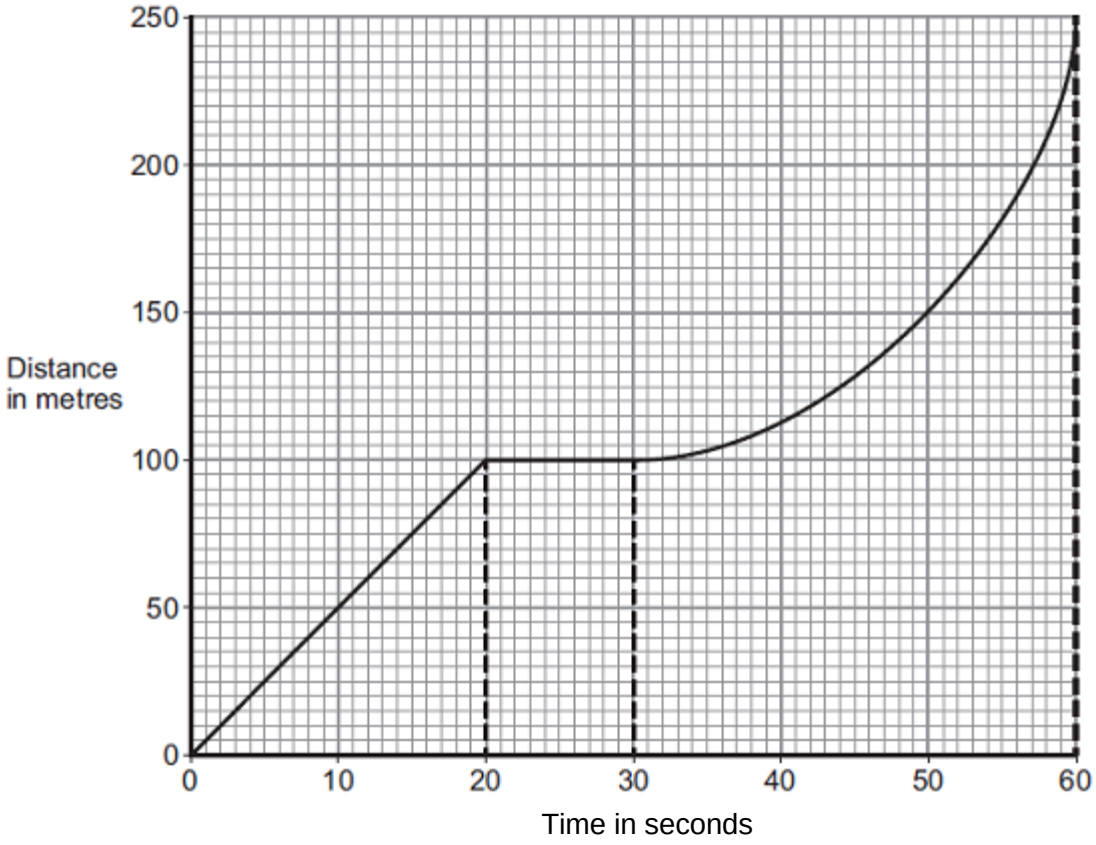
Magnitude of the vertical component = _____ N

(1)

(Total 10 marks)

10 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)

(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)