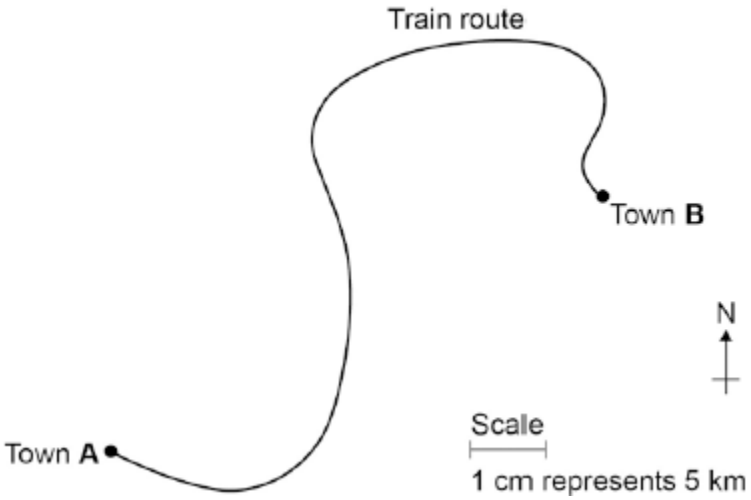
1 A train travels from town **A** to town **B**.

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.

.....

.....

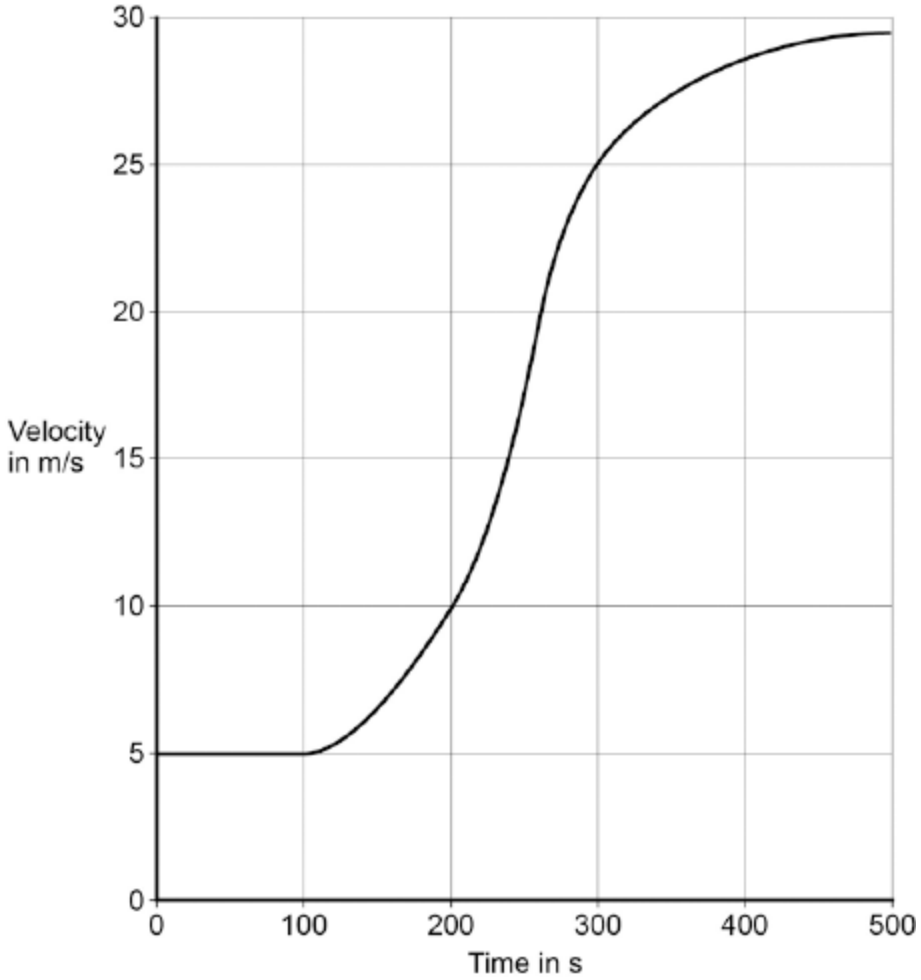
.....

.....

(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.

.....

.....

.....

.....

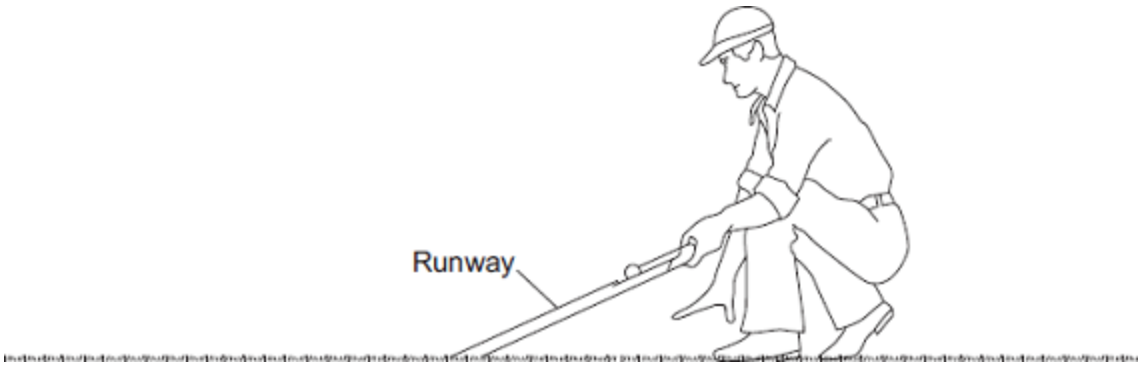
Distance = ... m

(3)

(Total 8 marks)

2 **Figure 1** shows a golfer using a runway for testing how far a golf ball travels on grass.
One end of the runway is placed on the grass surface.
The other end of the runway is lifted up and a golf ball is put at the top.
The golf ball goes down the runway and along the grass surface.

Figure 1



(a) A test was done three times with the same golf ball.

The results are shown in **Figure 2**.

Figure 2

(i) Make measurements on **Figure 2** to complete **Table 1**.

Table 1

Test	Distance measured in centimetres
1	8.5
2	
3	

(2)

(ii) Calculate the mean distance, in centimetres, between the ball and the edge of the runway in **Figure 2**.

.....

Mean distance = ... cm

(1)

(iii) **Figure 2** is drawn to scale.
Scale: 1 cm = 20 cm on the grass.

Calculate the mean distance, in centimetres, the golf ball travels on the grass surface.

.....

Mean distance on the grass surface = ... cm

(1)

(iv) The distance the ball travels along the grass surface is used to estimate the 'speed' of the grass surface.

The words used to describe the 'speed' of a grass surface are given in **Table 2**.

Table 2

'Speed' of grass surface	**Mean distance the golf ball travels in centimetres**
Fast	250
Medium fast	220
Medium	190
Medium Slow	160
Slow	130

Use **Table 2** and your answer in part **(iii)** to describe the 'speed' of the grass surface.

.....

(1)

(b) The shorter the grass, the greater the distance the golf ball will travel.
A student uses the runway on the grass in her local park to measure the distance the golf ball travels.

(i) Suggest **two** variables the student should control.

.....

.....

.....

(2)

(ii) She carried out the test five times.
Her measurements, in centimetres, are shown below.

75 **95** **84** **74** **79**

What can she conclude about the length of the grass in the park?

.....

.....

(1)

(c) Another student suggests that the 'speed' of a grass surface depends on factors other than grass length.

She wants to test the hypothesis that 'speed' depends on relative humidity.

Relative humidity is the percentage of water in the air compared to the maximum amount of water the air can hold. Relative humidity can have values between 1% and 100%.

The student obtains the data in **Table 3** from the Internet.

Table 3

Relative humidity expressed as a percentage	Mean distance the golf ball travels in centimetres
71	180
79	162
87	147

(i) Describe the pattern shown in **Table 3**.

.....

.....

(1)

(ii) The student writes the following hypothesis:
'The mean distance the golf ball travels is inversely proportional to relative humidity.'

Use calculations to test this hypothesis and state your conclusion.

.....

.....

.....

.....

.....

.....

(3)

(iii) The data in **Table 3** does **not** allow a conclusion to be made with confidence.

Give a reason why.

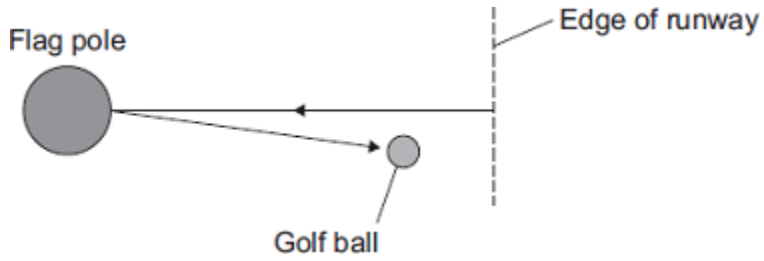
.....

.....

(1)

(d) In a test, a golf ball hits a flag pole on the golf course and travels back towards the edge of the runway as shown in **Figure 3**.

Figure 3



The distance the ball travels and the displacement of the ball are **not** the same.

What is the difference between distance and displacement?

.....

.....

.....

.....

(2)
(Total 15 marks)

3 The manufacturer of a family car gave the following information.

Mass of car 950 kg

The car will accelerate from 0 to 33 m/s in 11 seconds.

(a) Calculate the acceleration of the car during the 11 seconds.

.....

.....

.....

(2)

(b) Calculate the force needed to produce this acceleration.

.....

.....

.....

(2)

(c) The manufacturer of the car claims a top speed of 110 miles per hour. Explain why there must be a top speed for any car.

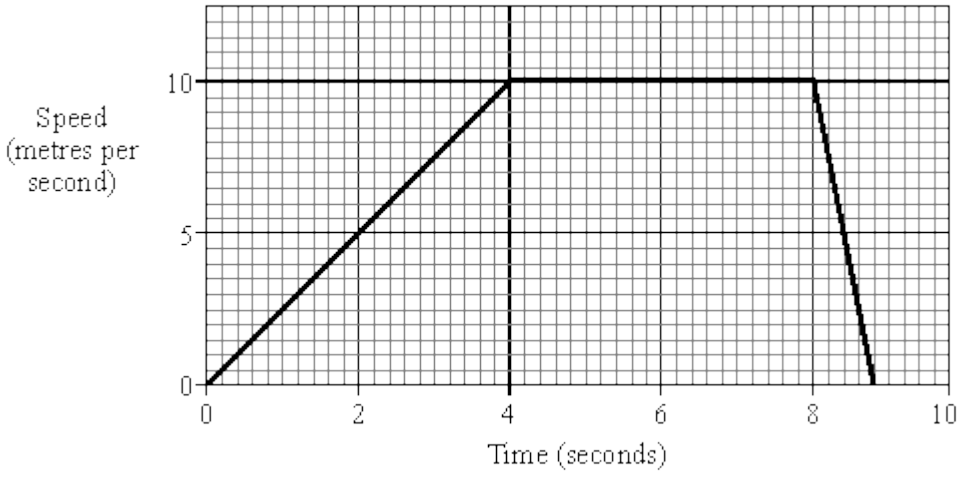
.....

.....

.....

(3)
(Total 7 marks)

4 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)

1

(a) distance is a scalar and displacement is a vector

or

distance has magnitude only, displacement has magnitude and direction

1

(b) 37.5 km

accept any value between 37.0 and 38.0 inclusive

1

062° or N62°E

accept 62° to the right of the vertical

1

accept an angle in the range 60° −64°

accept the angle correctly measured and marked on the diagram

(c) train changes direction so velocity changes

1

acceleration is the rate of change of velocity

1

(d) number of squares below line = 17

accept any number between 16 and 18 inclusive

1

each square represents 500 m

1

distance = number of squares × value of each square correctly calculated − 8500 m

1

[8]

2

(a) (i) 9.5

accept ±1 mm

1

10.5

1

(ii) 9.5

*ecf from **(a)(i)***

1

(iii) 190

*20 × **(a)(ii)** ecf*

1

(iv) medium

*ecf from **(a)(iii)***

1

(b) (i) any **two** from:

- position of ball before release
- same angle **or** height of runway
- same ball
- same strip of grass

2

(ii) long
or
longer than in part **(a)**
or
uneven

*do **not** allow reference to speed*

1

(c) (i) as humidity increases mean distance decreases

accept speed for distance

1

(ii) 71 × 180 = 12780
79 × 162 = 12798
87 × 147 = 12789

*all three calculations correct with a valid conclusion gains **3** marks*

or
find k from R = k / d

*all three calculations correct gains **2** marks*

or
87 / 71 × 147 = 180.1 ~ 180
87 / 79 × 147 = 161.9 ~ 162

*two calculations correct with a valid conclusion gains **2** marks*

conclusion based on calculation

*one correct calculation of k gains **1** mark*

3

(iii) only three readings **or** small range for humidity

accept not enough readings
accept data from Internet could be unreliable
ignore reference to repeats

1

(d) distance is a scalar **or** has no direction **or** has magnitude only

allow measurements from diagram of distance and displacement

1

displacement is a vector **or** has direction

1

[15]

3 (a) 3

gains 1 mark

m/s^2

gains 1 mark

else working *gains 1 mark*

2

(b) 2850 ecf

gains 1 mark

N

gains 1 mark

else working

gains 1 mark

2

(c) friction/air resistance increases with speed;
till frictional = max forward force;
then force/acceleration is zero

for 1 mark each

alternative limitation for safety

gains 1 mark only

3

[7]

4

(a) acceleration = $\frac{\text{change in speed/velocity}}{\text{time taken}}$

or $\frac{10}{4}$

gains 1 mark
do not penalise if <u>both</u> of these present
but 'change in' omitted from formula

but
2.5

gains 2 marks

unit m/s^2 **or** metres per second squared

or metres per second per second

or ms^{-}*

for 1 mark

3

(b) *evidence* of using area under graph or distance <u>average</u> speed × time
or

$10 \times 4 \times \frac{1}{2}$

gains 1 mark

but
20

gains 2 marks

units metres / m^{-2}*

for 1 mark

3

(c) force = mass × acceleration **or** 75 × 25

gains 1 mark

but
1875

gains 2 marks

**NB Correct unit to be credited even if numerical answer wrong or absent.*

2

[8]