M1. (a) D 1

(b) C 1

(c) W = 300 × 45 1

W = 13 500 1

*allow 13 500 with no working shown for **2** marks*

(d) straight line drawn from 13 m / s to 0 m / s 1

finishing on x-axis at 65 s 1

[6]

M2. (a) distance travelled under the braking force

accept braking (distance)

1

(b) (directly) proportional

accept a correct description using figures

or

increase in the same ratio

eg if speed doubles then
thinking <u>distance</u> doubles
*accept for **1** mark positive correlation*
*accept for **1** mark as speed*
increases so does thinking <u>distance</u>
accept as one increases the other increases
accept as thinking <u>distance</u> increases speed increases

2

(c) (i) control variable

1

(ii) experiment done, student listens to music / ipod (etc)

1

experiment (repeated), student not listening to music

for both marks to be awarded there must be a comparison

1

(d) increase it

accept an answer which implies reactions are slower
*do **not** accept answers in terms of thinking distance only*

1

(e) **Y**

1

[8]

M3. (a) MN

accept 5.8, 8 seconds must include unit

1

(b) LM

accept 0.8, 5.8 seconds must include unit

1

(c) (i) 0.8

1

(ii) drinking alcohol

1

(d) <u>straight</u> (by eye) line starting at 0.8 seconds

1

line drawn steeper than LM starting before L

ignore lines going beyond 2 seconds but line must exceed 2.5 metres per second before terminating

1

[6]

M4. (a) terminal

1

(b) 5.4 (kg)

*correct substitution of 54 = m × 10 gains **1** mark*

2

(c) (i) $0 < a < 10$

1

some upward force

accept some drag / air resistance

1

reduced resultant force

1

(ii) 0

1

upward force = weight (gravity)

1

resultant force zero

1

[9]

M5. (a) (i) 12

1

(ii) 0.2

*allow **1** mark for their (a)(i) ÷ 60 and correctly calculated*

1

m/s^2

accept correct unit circled in list

accept ms^{-2}

*do **not** accept mps^2*

1

(b) **B**

1

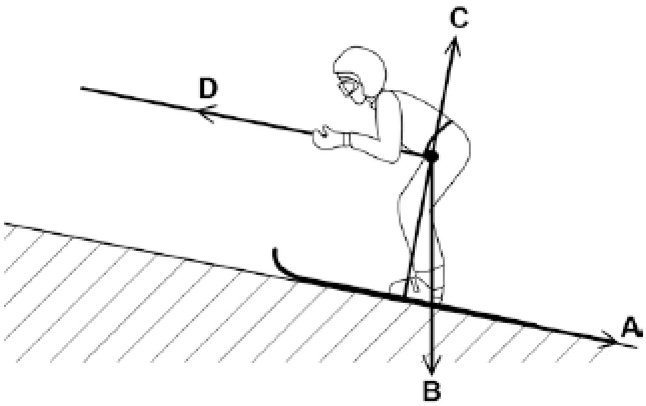
[4]

Q1.Figure 1 shows a skier using a drag lift.

The drag lift pulls the skier from the bottom to the top of a ski slope.

The arrows, **A**, **B**, **C** and **D** represent the forces acting on the skier and her skis.

Figure 1



(a) Which arrow represents the force pulling the skier up the slope?

Tick **one** box.

A ☐

B ☐

C ☐

D ☐

(1)

(b) Which arrow represents the normal contact force?

Tick **one** box.

A ☐

B ☐

C ☐

D ☐

(1)

(c) The drag lift pulls the skier with a constant resultant force of 300N for a distance of 45 m.

Use the following equation to calculate the work done to pull the skier up the slope.

work done = force × distance

....

....

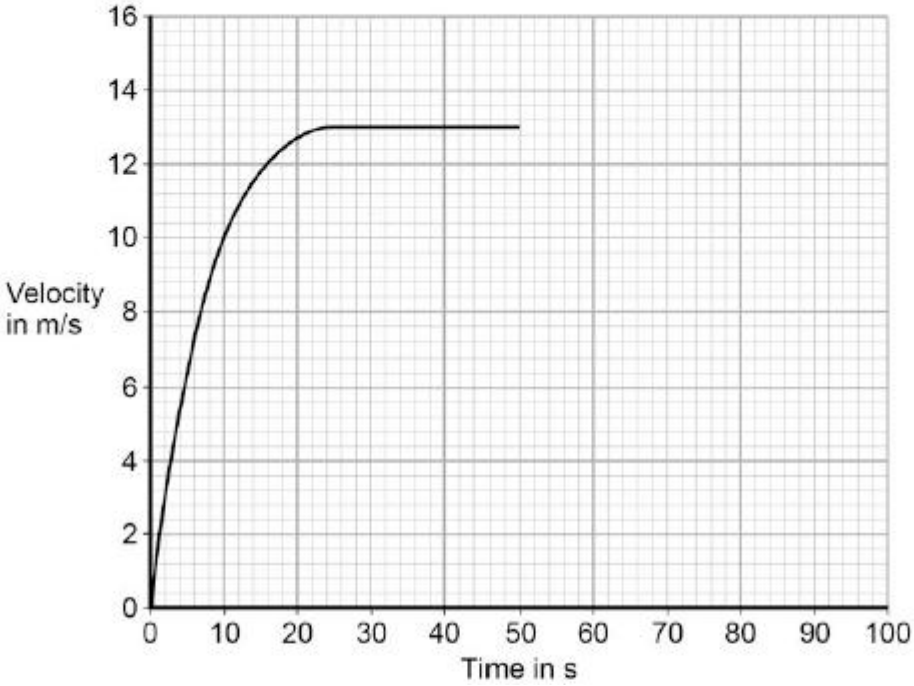
Work done = ... J

(2)

(d) At the top of the slope the skier leaves the drag lift and skis back to the bottom of the slope.

Figure 2 shows how the velocity of the skier changes with time as the skier moves down the slope.

Figure 2



After 50 seconds the skier starts to slow down.

The skier decelerates at a constant rate coming to a stop in 15 seconds.

Draw a line on **Figure 2** to show the change in velocity of the skier as she slows down and comes to a stop.

(2)
(Total 6 marks)

Q2. (a) The total stopping distance of a car has two parts. One part is the distance the car travels during the driver's reaction time. This distance is often called the 'thinking distance'.

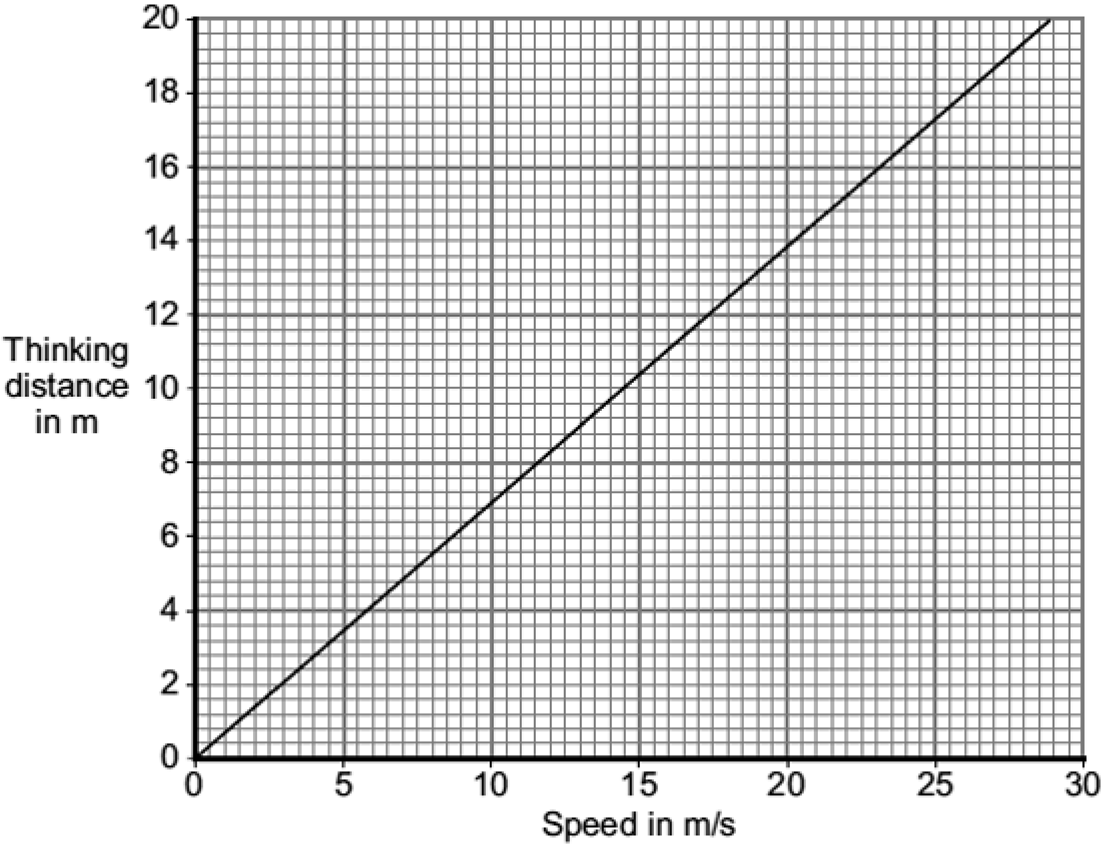
What distance is added to the 'thinking distance' to give the total stopping distance?

....

....

(1)

(b) The graph shows the relationship between the speed of a car and the thinking distance.



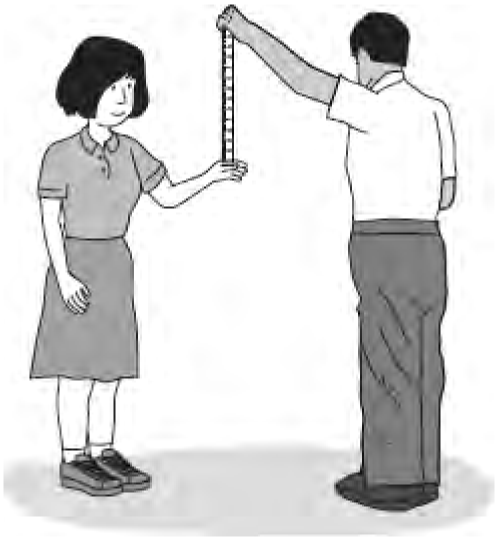
Describe the relationship between speed and thinking distance.

....

....

(2)

(c) The diagram shows two students investigating reaction time.



One student holds a 30 cm ruler, then lets go. As soon as the second student sees the ruler fall, she closes her hand, stopping the ruler. The further the ruler falls before being stopped, the slower her reaction time.

(i) One student always holds the ruler the same distance above the other student's hand.
In this experiment, what type of variable is this?

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

dependent variable_

control variable_

(1)

(ii) Describe how this experiment could be used to find out whether listening to music affects reaction time.

....

....

....

....

(2)

(d) The following information is written on the label of some cough medicine.

WARNING: Causes drowsiness.
Do not drive or operate machinery.

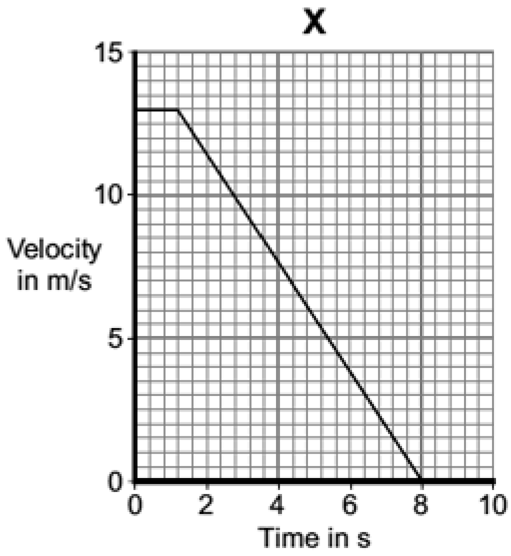
How is feeling drowsy (sleepy) likely to affect a driver's reaction time?

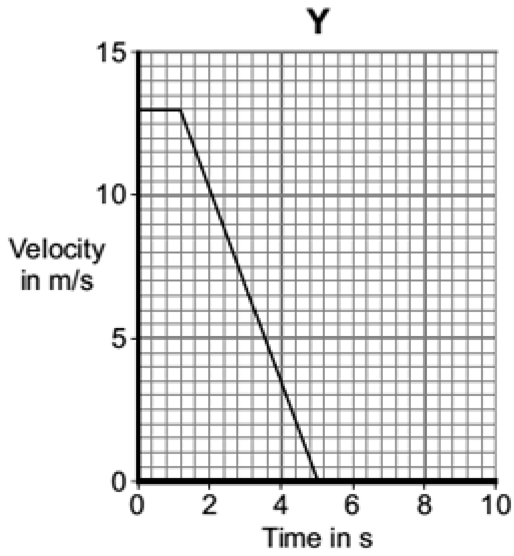
....

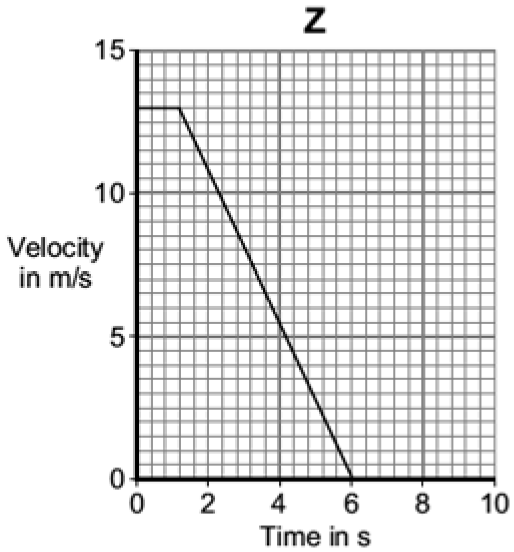
....

(1)

(e) Three cars, **X**, **Y** and **Z** , are being driven along a straight road towards a set of traffic lights.
The graphs show how the velocity of each car changes once the driver sees that the traffic light has turned to red.





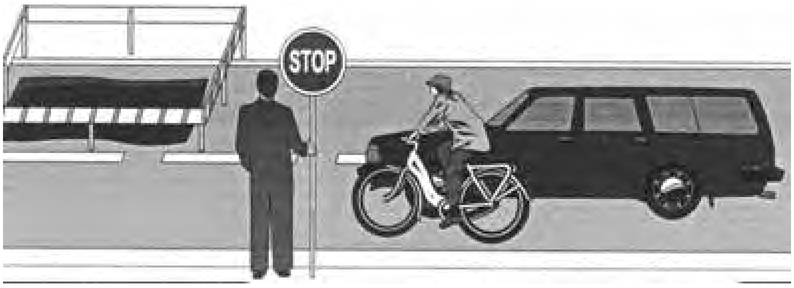


Which one of the cars, **X**, **Y** or **Z** , stops in the shortest distance?

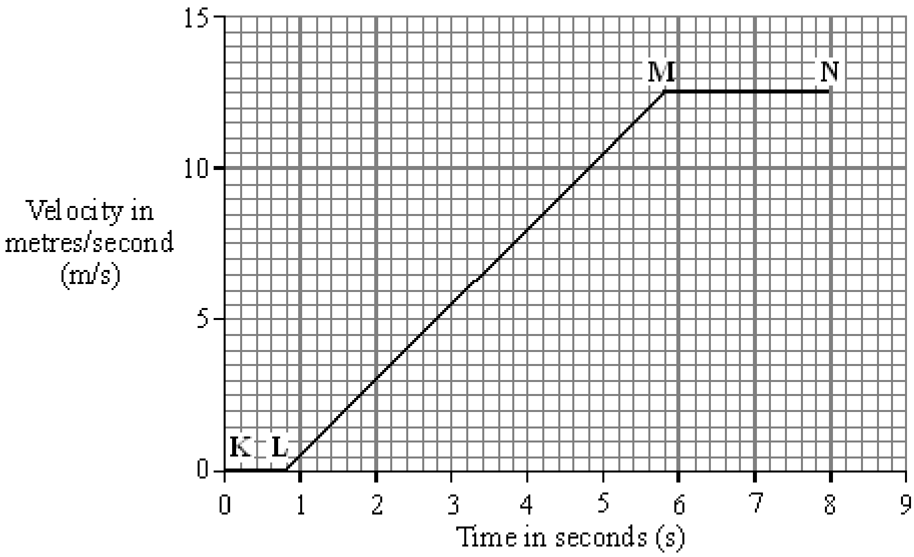
....

(1)
(Total 8 marks)

Q3. A car and a bicycle are travelling along a straight road. They have stopped at road works.



The graph shows how the velocity of the car changes after the sign is changed to GO.



(a) Between which two points on the graph is the car moving at constant velocity?

....

(1)

(b) Between which two points on the graph is the car accelerating?

....

(1)

(c) Between the sign changing to GO and the car starting to move, there is a time delay. This is called the reaction time.

(i) What is the reaction time of the car driver?

Reaction time = ... seconds

(1)

(ii) Which **one** of the following could increase the reaction time of a car driver? Tick the box next to your choice.

Drinking alcohol ☐

Wet roads ☐

Worn car brakes ☐

(1)

(d) The cyclist starts to move at the same time as the car. For the first 2 seconds the cyclist's acceleration is constant and is greater than that of the car.

Draw a line on the graph to show how the velocity of the cyclist might change during the first 2 seconds of its motion.

(2)
(Total 6 marks)

Q4. On 14 October 2012, a skydiver set a world record for the highest free fall from an aircraft.

After falling from the aircraft, he reached a maximum steady velocity of 373 m / s after 632 seconds.

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

	frictional	
This maximum steady velocity is called the	initial	velocity.
	terminal	

(1)

(b) The skydiver wore a chest pack containing monitoring and tracking equipment. The weight of the chest pack was 54 N.

The gravitational field strength is 10 N / kg.

Calculate the mass of the chest pack.

....

....

Mass of chest pack = ... kg

(2)

(c) During his fall, the skydiver's acceleration was not uniform.

Immediately after leaving the aircraft, the skydiver's acceleration was 10 m / s^2.

(i) Without any calculation, estimate his acceleration a few seconds after leaving the aircraft.

Explain your value of acceleration in terms of forces.

Estimate ....

Explanation ....

....

....

....

....

....
(3)

(ii) Without any calculation, estimate his acceleration 632 seconds after leaving the aircraft.

Explain your value of acceleration in terms of forces.

Estimate ....

Explanation ....

....

....

....

....

....
(3)
(Total 9 marks)

Q5. A high-speed train accelerates at a constant rate in a straight line.

The velocity of the train increases from 30 m/s to 42 m/s in 60 seconds.

(a) (i) Calculate the change in the velocity of the train.

....

Change in velocity = ... m/s

(1)

(ii) Use the equation in the box to calculate the acceleration of the train.

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

Show clearly how you work out your answer and give the unit.
Choose the unit from the list below.

m/s **m/s²** **N/kg** **Nm**

....

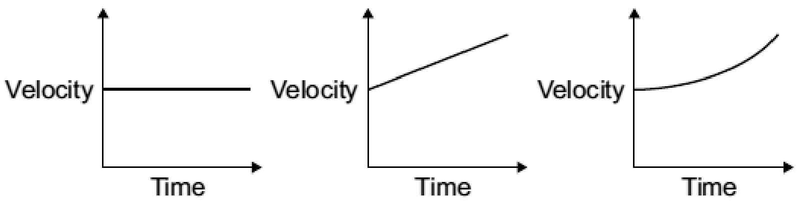
....

Acceleration = ...

(2)

(b) Which **one** of the graphs, **A**, **B** or **C**, shows how the velocity of the train changes as it accelerates?

Write your answer, **A**, **B** or **C**, in the box.



A **B** **C**

Graph

(1)
(Total 4 marks)

M1. (a) It will have a constant speed.

1

(b) distance travelled = speed × time

1

(c) $a = \frac{18 - 9}{6}$

1

a = 1.5

*allow 1.5 with no working shown for **2** marks*

1

(d) resultant force = mass × acceleration

1

(e) F = (1120+80) × 1.5

1

F = 1800 (N)

*allow 1800 with no working shown for **2** marks*

1

*accept their 10.3 × 1200 correctly calculated for **2** marks*

(f) $18^2 - 9^2 = 2 \times 1.5 \times s$

1

$s = 18^2 - 9^2 / 2 \times 1.5$

1

s = 81 (m)

1

*allow 81 (m) with no working shown for **3** marks*

*accept answer using their 10.3 (if not 1.5) correctly calculated for **3** marks*

(g) **Level 2 (3–4 marks):**

A detailed and coherent explanation is provided. The response makes logical links between clearly identified, relevant points that include references to the numerical factor.

Level 1 (1–2 marks):

Simple statements are made. The response may fail to make logical links between the points raised.

0 marks:

No relevant content.

Indicative content

- doubling speed increase the kinetic energy
- kinetic energy increases by a factor of 4
- work done (by brakes) to stop the car increases
- work done increases by a factor of 4
- work done is force × distance and braking force is constant
- so if work done increases by 4 then the braking distance must increase by 4

4

[14]

M2. (a) gravity

accept weight
*do **not** accept mass*
accept gravitational pull

1

(b) (i) Initially force L greater than force M

accept there is a resultant force downwards

1

(as speed increases) force M increases

accept the resultant force decreases

1

when M = L, (speed is constant)

accept resultant force is 0
accept gravity/weighty for L
accept drag/ upthrust/resistance/friction for M
*do **not** accept air resistance for M but penalise only once*

1

(ii) terminal <u>velocity</u>

1

(iii) 0.15

accept an answer between 0.14 – 0.16
an answer of 0.1 gains no credit
*allow **1** mark for showing correct use of the graph*

2

[7]

M3. (a) (i) 4.5

*allow **1** mark for correct substitution i.e. 9 ÷ 2*

2

(ii) m/s^2

accept answer given in (a)(i) if not contradicted here

1

(iii) speed

1

(iv) straight line from the origin passing through (2s, 9m/s)

*allow **1** mark for straight line from the origin passing through to t = 2 seconds*

*allow **1** mark for an attempt to draw a straight line from the origin passing through (2,9)*

*allow **1** mark for a minimum of 3 points plotted with no line provided if joined up would give correct answer. Points must include(0,0) and (2,9)*

2

(b) (i) **B**

*if **A** or **C** given scores **0** marks in total*

1

smallest (impact) force

1

on all/ every/ any surfaces

these marks are awarded for comparative answers

1

(ii) (conditions) can be repeated

or

difficult to measure forces with human athletes

accept answers in terms of variations in human athletes e.g.

athletes may have different weights area / size of feet may be different difficult to measure forces athletes run at different speeds

accept any answer that states or implies that with humans the conditions needed to repeat tests may not be constant

e.g.
athletes unable to maintain constant speed during tests (or during repeat tests)

*do **not** accept the robots are more accurate*

removes human error is insufficient

fair test is insufficient

1

[10]

M4. (a) 750

*allow **1** mark for correct substitution, ie 75 × 10 provided no subsequent step shown*

2

newton(s) / N

*do **not** accept n*

1

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the Marking Guidance, and apply a 'best-fit' approach to the marking.

0 marks
No relevant content.

Level 1 (1-2 marks)
There is a brief attempt to explain why the velocity / speed of the parachutist changes.
or
the effect of opening the parachute on velocity/speed is given.

Level 2 (3-4 marks)
The change in velocity / speed is clearly explained in terms of force(s)
or
a reasoned argument for the open parachute producing a lower speed.

Level 3 (5-6 marks)
There is a clear and detailed explanation as to why the parachutist reaches terminal velocity **and** a reasoned argument for the open parachute producing a lower speed

examples of the physics points made in the response to explain first terminal velocity

- on leaving the plane the only force acting is weight (downwards)
  accept gravity for weight throughout
- as parachutist falls air resistance acts (upwards)
  accept drag / friction for air resistance
- weight greater than air resistance
  orresultant force downwards
- (resultant force downwards) so parachutist accelerates
- as velocity / speed increases so does air resistance
- terminal velocity reached when air resistance = weight

accept terminal velocity reached when forces are balanced

to explain second lower terminal velocity

- opening parachute increases surface area
- opening parachute increases air resistance
- air resistance is greater than weight
- resultant force acts upwards / opposite direction to motion
- parachutist decelerates / slows down
- the lower velocity means a reduced air resistance

air resistance and weight become equal but at a lower (terminal) velocity

6

(c) (i) any **one** from:

- mass of the (modelling) clay
  accept size/shape of clay size/amount/volume/shape of clay
  accept plasticine for (modelling)clay
- material parachute made from
  accept same (plastic) bag
- number / length of strings

1

(ii) **C**

*reason only scores if **C** is chosen*

1

smallest (area) so falls fastest (so taking least time)

accept quickest/quicker for fastest

*if **A** is chosen with the reason given as 'the largest area so falls slowest' this gains **1** mark*

1

[12]

M5. (a) 96

*allow **1** mark for correct substitution*

ie 80 × 1.2

2

newton or N

allow Newton

*do **not** allow n*

1

(b) (i) direction

1

(ii) velocity <u>and</u> time are continuous (variables)

answers must refer to both variables

accept the variables are continuous / not categoric

accept the data / 'it' is continuous

accept the data / 'it' is not categoric

1

(iii) **C**

1

velocity is not changing

*the **2** marks for reason may be scored even if **A** or **B** are chosen*

accept speed for velocity

accept speed is constant (9 m/s)

*accept **not** decelerating*

*accept **not** accelerating*

accept reached terminal velocity

1

forces must be balanced

accept forces are equal

accept arrows are the same length / size

or

resultant force is zero

*do **not** accept the arrows are equal*

1

[8]

M6. (a) 2.75

*allow **1** mark for correct substitution, ie* $\frac{11}{4}$

or $\frac{23-12}{4}$

provided no subsequent step shown

2

m/s²

1

(b) driving force increases

1

frictional force increases

accept air resistance / drag for frictional force

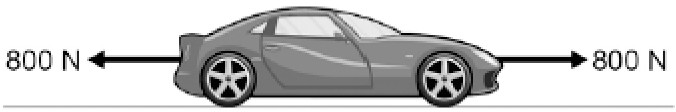
1

driving force > frictional force

1

[6]

Q1. 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 9m / s to 18m / 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.

....

....

....

....

....

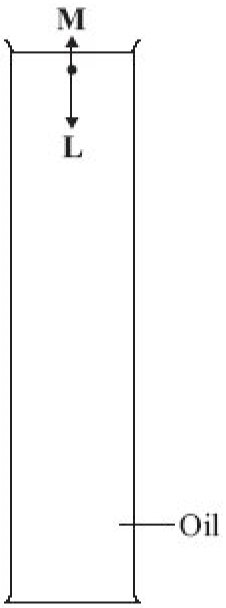
....

....

....

(4)
(Total 14 marks)

Q2. (a) The diagram shows a steel ball-bearing falling through a tube of oil. The forces, **L** and **M**, act on the ball-bearing.

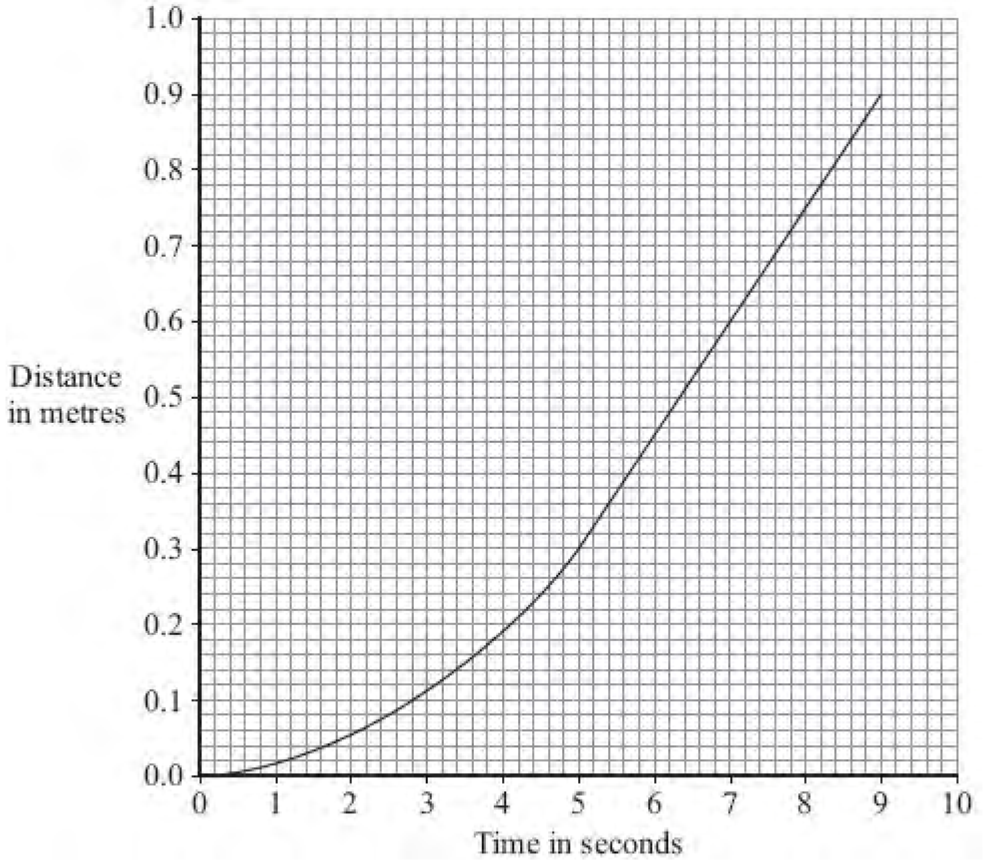


What causes force **L**?

....

(1)

(b) The distance – time graph represents the motion of the ball-bearing as it falls through the oil.



(i) Explain, in terms of the forces, **L** and **M**, why the ball-bearing accelerates at first but then falls at constant speed.

....

....

....

....

....

....

(3)

(ii) What name is given to the constant speed reached by the falling ball-bearing?

....

(1)

(iii) Calculate the constant speed reached by the ball-bearing.

Show clearly how you use the graph to work out your answer.

....

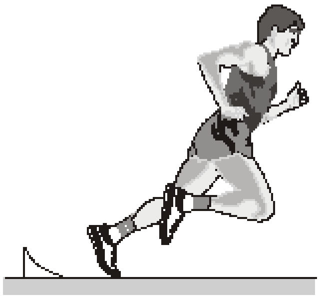
....

....

Speed = ... m/s

(2)
(Total 7 marks)

Q3. (a) The diagram shows an athlete at the start of a race. The race is along a straight track.



In the first 2 seconds, the athlete accelerates constantly and reaches a speed of 9 m/s.

(i) Calculate the acceleration of the athlete.

Show clearly how you work out your answer.

....

....

....

Acceleration = ...

(2)

(ii) Which **one** of the following is the unit for acceleration?

Draw a ring around your answer.

J/s **m/s** **m/s²** **Nm**

(1)

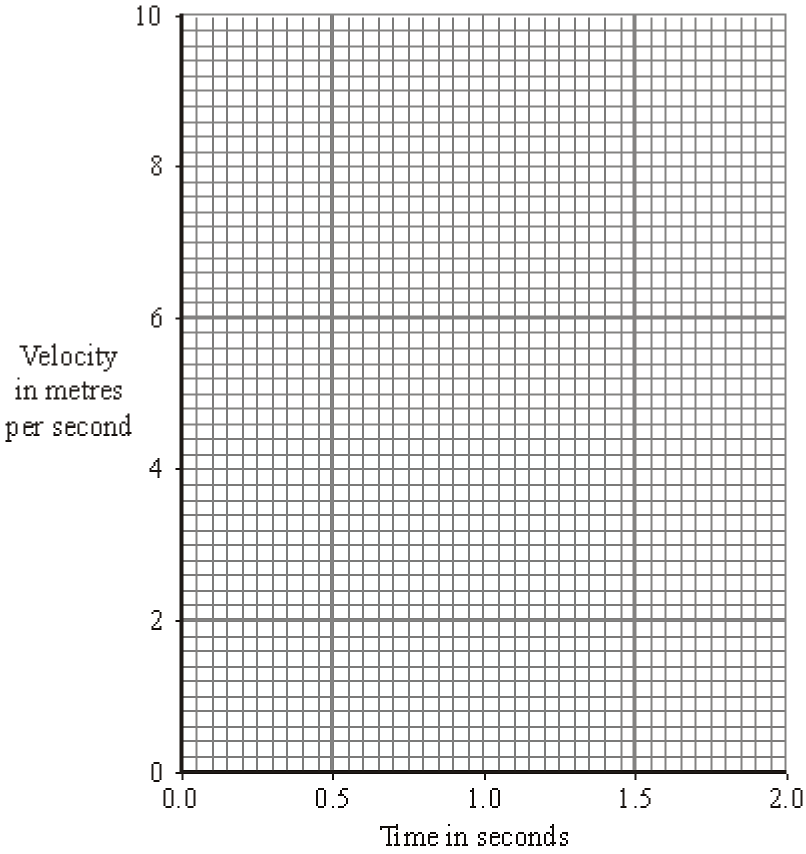
(iii) Complete the following sentence.

The velocity of the athlete is the .... of the

athlete in a given direction.

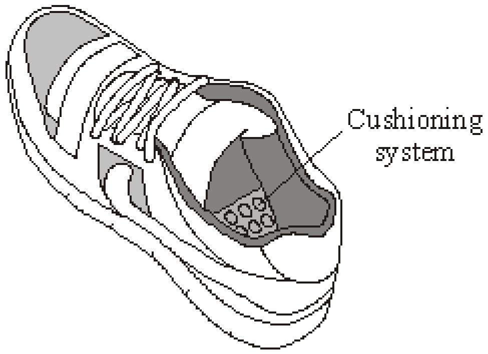
(1)

(iv) Complete the graph to show how the velocity of the athlete changes during the first 2 seconds of the race.

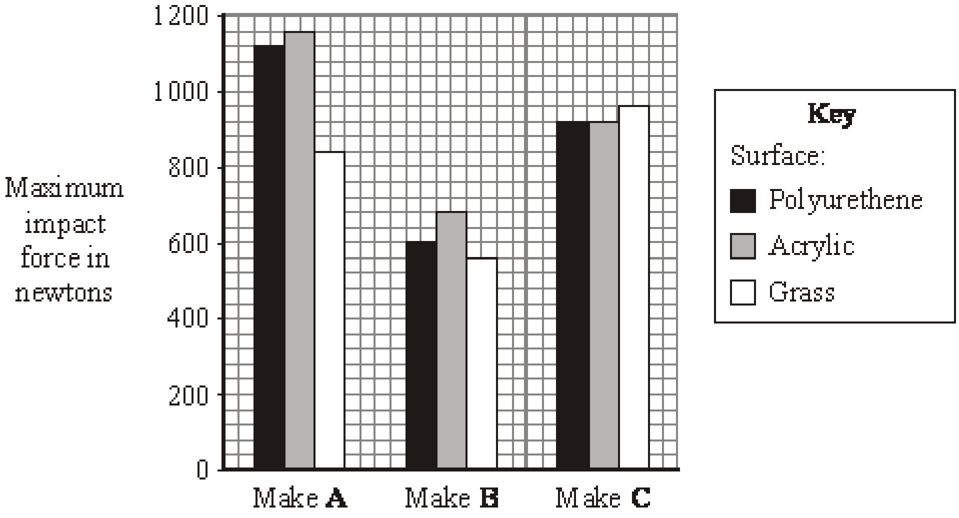


(2)

(b) Many running shoes have a cushioning system. This reduces the impact force on the athlete as the heel of the running shoe hits the ground.



The bar chart shows the maximum impact force for three different makes of running shoe used on three different types of surface.



(i) Which **one** of the three makes of running shoe, **A**, **B** or **C**, has the best cushioning system?

....

Explain the reason for your answer.

....

....

....

....

(3)

(ii) The data needed to draw the bar chart was obtained using a robotic athlete fitted with electronic sensors.

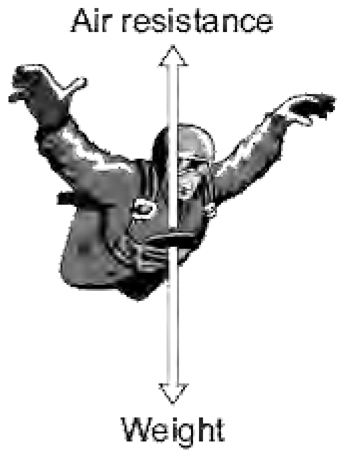
Why is this data likely to be more reliable than data obtained using human athletes?

....

....

(1)
(Total 10 marks)

Q4. (a) The diagram shows the forces acting on a parachutist in free fall.



The parachutist has a mass of 75 kg.

Calculate the weight of the parachutist.

gravitational field strength = 10 N/kg

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

....

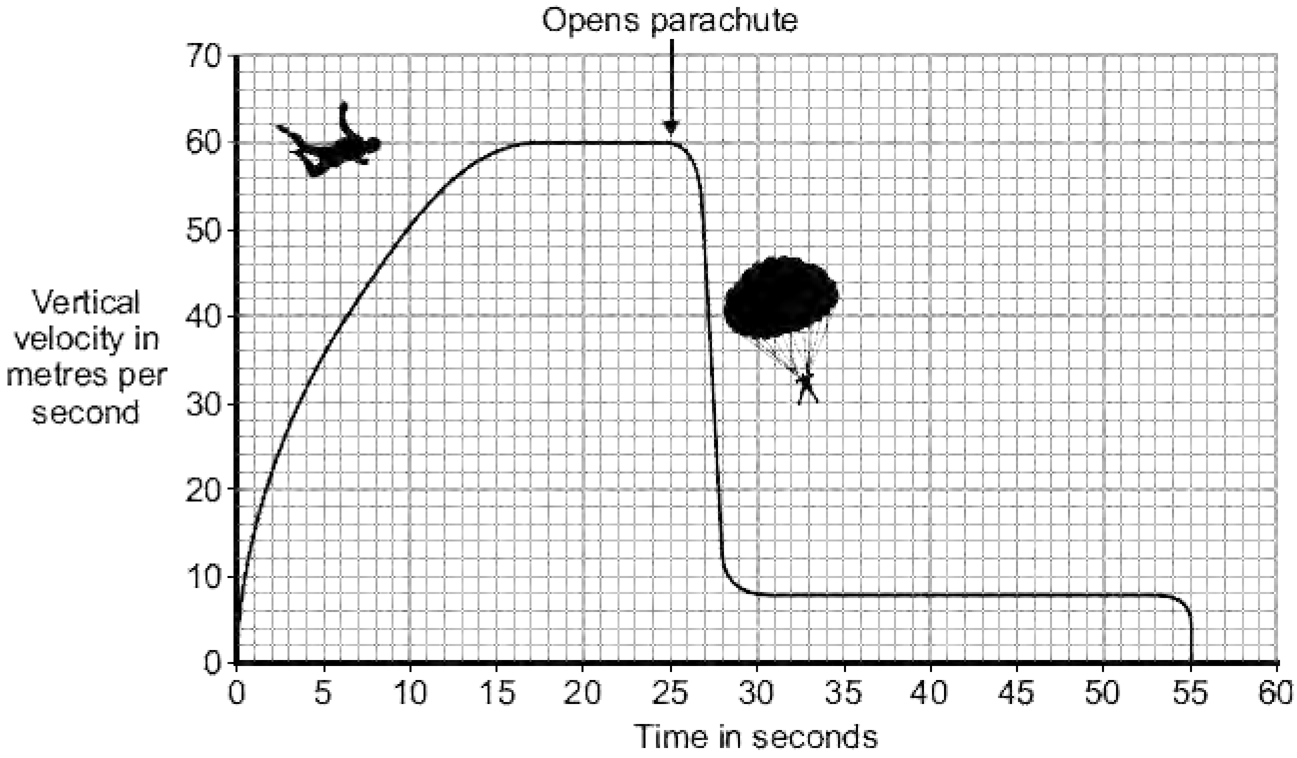
....

Weight = ...

(3)

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

The graph shows how the vertical velocity of a parachutist changes from the moment the parachutist jumps from the aircraft until landing on the ground.



Using the idea of forces, explain why the parachutist reaches a terminal velocity and why opening the parachute reduces the terminal velocity.

....

....

....

....

....

....

....

....

....

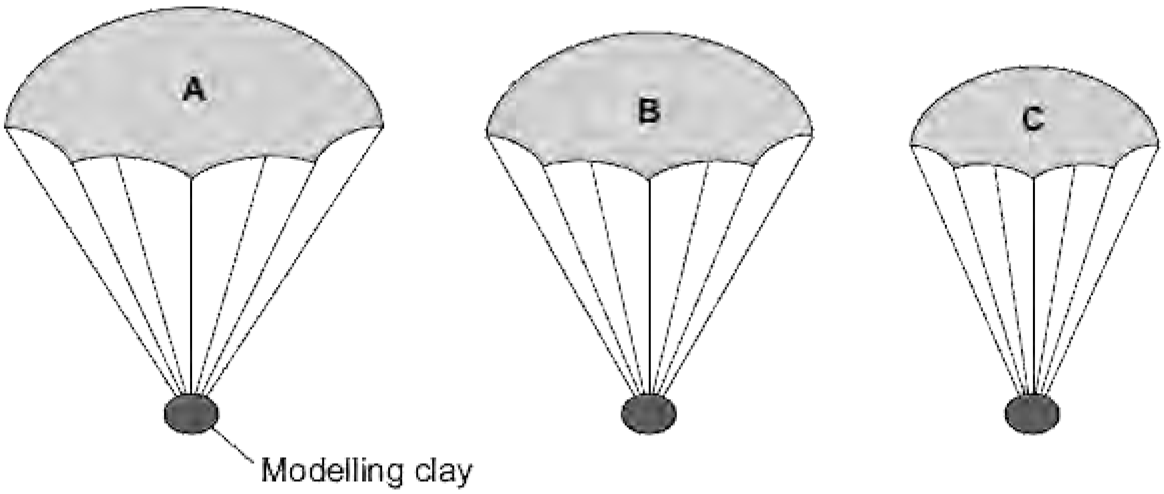
....

(6)

(c) A student wrote the following hypothesis.

'*The larger the area of a parachute, the slower a parachutist falls.*'

To test this hypothesis the student made three model parachutes, **A**, **B** and **C**, from one large plastic bag. The student dropped each parachute from the same height and timed how long each parachute took to fall to the ground.



(i) The height that the student dropped the parachute from was a control variable.

Name **one** other control variable in this experiment.

....

(1)

(ii) Use the student's hypothesis to predict which parachute, **A**, **B** or **C**, will hit the ground first.

Write your answer in the box.

Give a reason for your answer.

....

....

....

(2)
(Total 12 marks)

Q5. A cyclist travelling along a straight level road accelerates at 1.2 m/s² for 5 seconds. The mass of the cyclist and the bicycle is 80 kg.

(a) Calculate the resultant force needed to produce this acceleration.

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

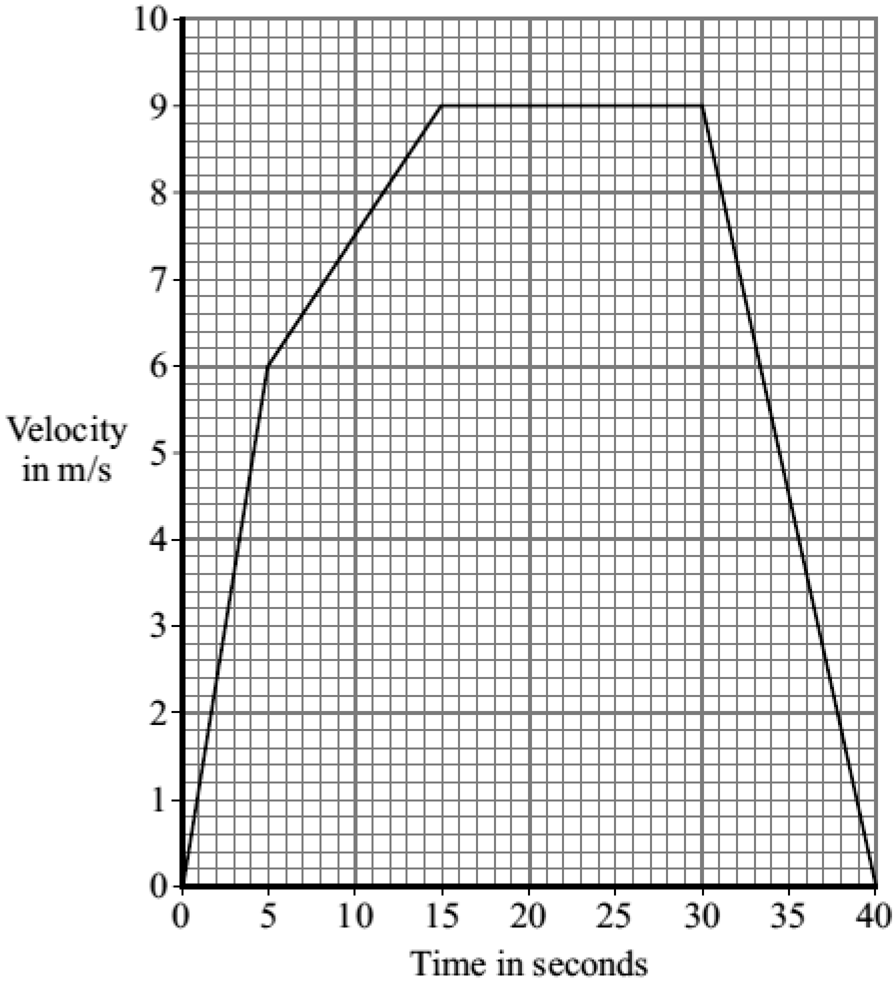
....

....

Resultant force = ...

(3)

(b) The graph shows how the velocity of the cyclist changes with time.



(i) Complete the following sentence.

The velocity includes both the speed and the ....of the cyclist.

(1)

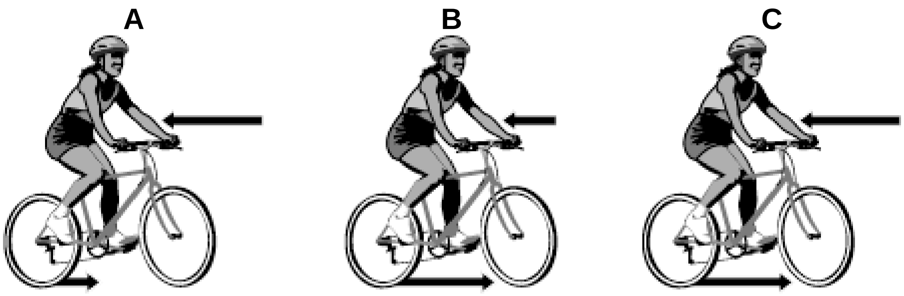
(ii) Why has the data for the cyclist been shown as a line graph instead of a bar chart?

....

....

(1)

(iii) The diagrams show the horizontal forces acting on the cyclist at three different speeds. The length of an arrow represents the size of the force.



Which **one** of the diagrams, **A**, **B** or **C**, represents the forces acting when the cyclist is travelling at a constant 9 m/s?

....

Explain the reason for your choice.

....

....

....

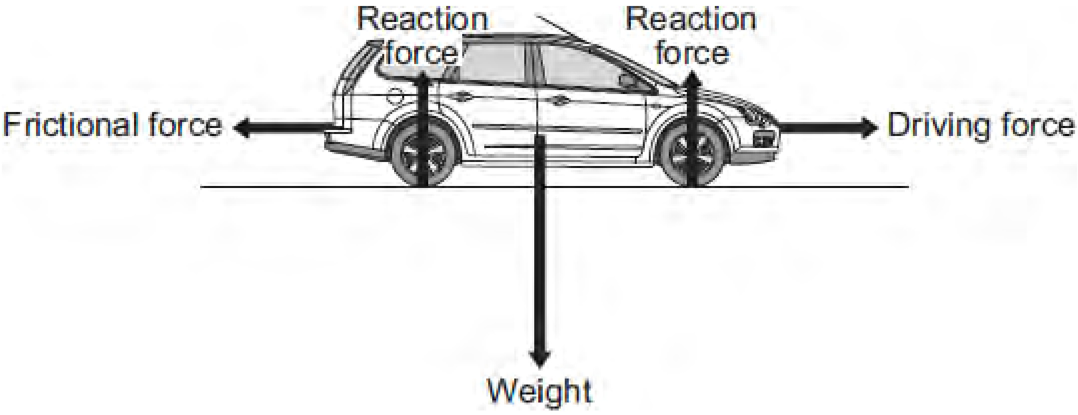
....

....

....

(3)
(Total 8 marks)

Q6. 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.

....

....

Acceleration = ...

(3)

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

....

....

....

....

....

....

(3)
(Total 6 marks)

M1. (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]

M2. (a) 4

*allow **1** mark for extracting correct information 12*

2

m/s^2

ignore negative sign

1

(b) 9 (s)

1

[4]

M3. (a) (i) velocity includes direction

accept velocity is a vector

1

(ii) 64

*allow **1** mark for obtaining values of 16 and 4 from the graph*

***or** marking correct area or correct attempt to calculate an area*

2

(iii) any **two** from:

- velocity zero from 0 to 4 seconds
- increasing in 0.2 s (or very rapidly) to 8 m/s
- decreasing to zero over the <u>next 8 seconds</u>

2

(iv) momentum before does not equal momentum after

ignore reference to energy

or total momentum changes

or an external force was applied

1

(b) to reduce the <u>momentum</u> of the driver

1

a <u>smaller</u> (constant) force would be needed

*do **not** accept reduces the impact / impulse on the driver*

1

[8]

M4. (a) (i) a single force that has the same effect as all the forces combined

accept all the forces added / the sum of the forces / overall force

1

(ii) constant speed (in a straight line)

*do **not** accept stationary*

or constant velocity

1

(b) 3

*allow **1** mark for correct substitution into transformed equation*
*accept answer 0.003 gains **1** mark*
*answer = 0.75 gains **1** mark*

2

m/s^2

1

(c) as speed increases air resistance increases

accept drag / friction for air resistance

1

reducing the resultant force

1

[7]

M5. (a) (i) longer reaction time

accept slower reactions

*do **not** accept slower reaction time unless qualified*

or

greater thinking distance

accept greater thinking time

or

greater stopping distance

accept greater stopping time

greater braking distance negates answer

1

(ii) lines / slopes have the same gradient

accept slopes are the same

or

velocity decreases to zero in same time / in 2.6 seconds

accept any time between 2.3 and 2.8

accept braking distances are the same

1

(iii) 12

*accept extracting both reaction times correctly for **1** mark*

*(0.6 and 1.4) **or** time = 0.8(s) for **1** mark*

*accept 0.8 × 15 for **2** marks*

accept calculating the distance

*travelled by car **A** as 28.5 m **or** the distance travelled by car **B** as 40.5 m for **2** marks*

3

(b) **Z**

1

different force values give a unique / different resistance

*only scores if **Z** chosen*

*do **not** accept force andresistance are (directly) proportional*

accept answers in terms of why

*either **X or Y** would not be the best eg*

***X** – same resistance value is obtained for 2 different force values*

***Y** – all force values give the same resistance*

1

[7]

M6. (a) 48

*allow for **1** mark correct method shown, ie 6 × 8*
***or** correct area indicated on the graph*

2

(b) diagonal line from (0,0) to (6,48) / (6, their (a))

if answer to (a) is greater than 50, scale must be changed to gain this mark

1

horizontal line at 48m between 6 and 10 seconds

accept horizontal line drawn at their (a) between 6 and 10 seconds

1

[4]

M7. (a) any **two** from:

- (acceleration occurs when) the direction (of each capsule) changes
- velocity has direction
- acceleration is (rate of) change of velocity

2

(b) to(wards) the centre (of the wheel)

1

(c) the greater the radius / diameter / circumference (of the wheel) the smaller the (resultant) force (required)

accept 'the size' for radiusboth parts required for the mark

1

[4]

M8. (a) more streamlined

accept decrease surface area

1

air resistance is smaller (for same speed)

accept drag for air resistance

friction is insufficient

1

so reaches a higher speed (before resultant force is 0)

ignore reference to mass

1

(b) (i) 1.7

*allow **1** mark for correct method, ie* $\frac{5}{3}$

***or** allow **1** mark for an answer with more than 2 sig figs that rounds to 1.7*

***or** allow **1** mark for an answer of 17*

2

(ii) 7.5

*allow **1** mark for correct use of graph, eg* $\frac{1}{2} \times 5 \times 3$

2

(iii) air (resistance)

accept wind (resistance)

drag is insufficient

friction is insufficient

1

[8]

M9. (a) (i) longer reaction time

accept slower reactions

*do **not** accept slower reaction time unless qualified*

or greater thinking distance

accept greater thinking time

or greater stopping distance

accept greater stopping time

greater braking distance negates answer

1

(ii) lines / slopes have the same gradient

accept slopes are the same

or velocity decreases to zero in same time / in 2.6 seconds

accept any time between 2.4 and 2.8

accept braking distances are the same

1

(iii) 12

*accept extracting both reaction times correctly for **1** mark(0.6 and 1.4)*
or
*time = 0.8 (s) for **1** mark*

*accept 0.8 × 15 for **2** marks*

*accept calculating the distance travelled by car **A** as 28.5 m*
or
*the distance travelled by car **B** as 40.5 m for **2** marks*

3

(b) **Z**

1

different force values give a unique / different resistance

*only scores if **Z** chosen*

*do **not** accept force and resistance are (directly) proportional*

*accept answers in terms of why either **X** or **Y** would not be best eg*

***X** – same resistance value is obtained for 2 different force values*

Y *– all force values give the same resistance*

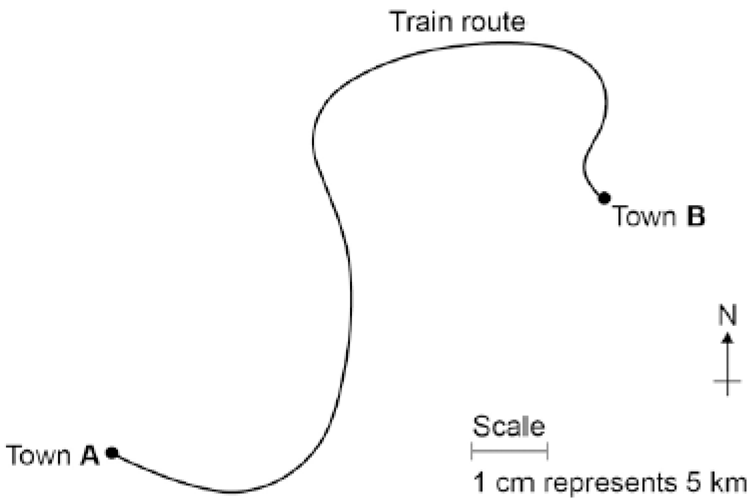
1

[7]

Q1. 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.

....

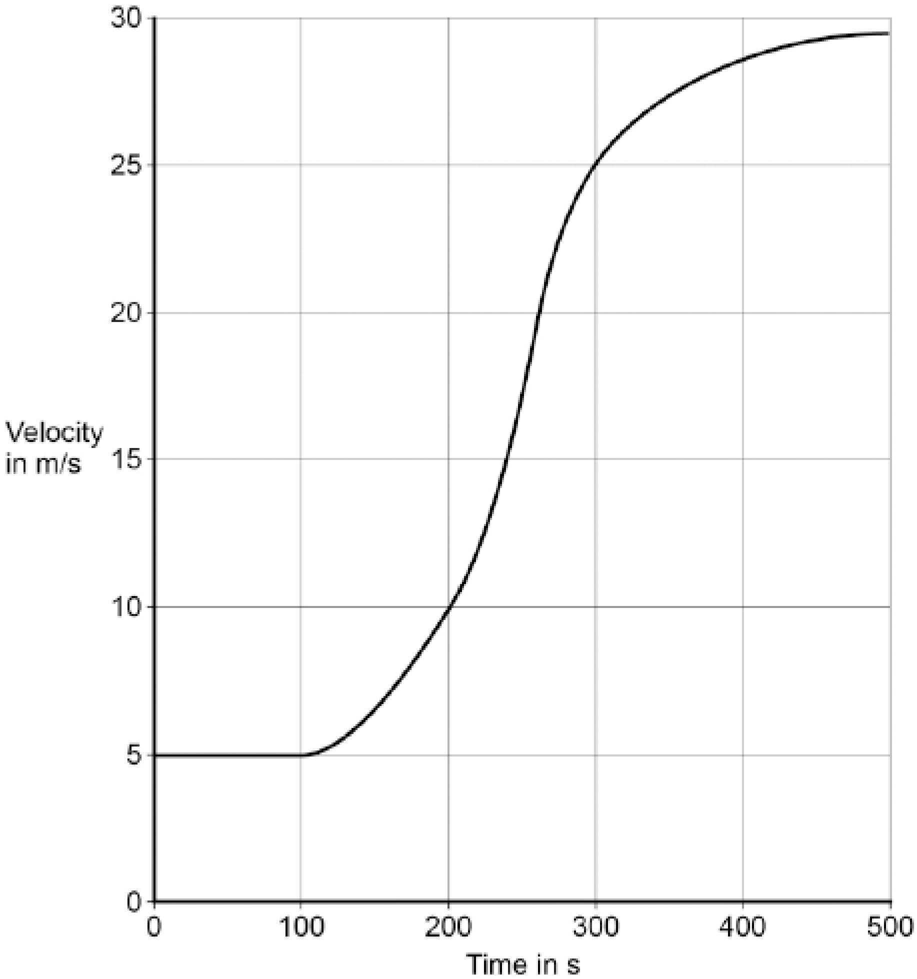
....

....

.... **(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.

....

....

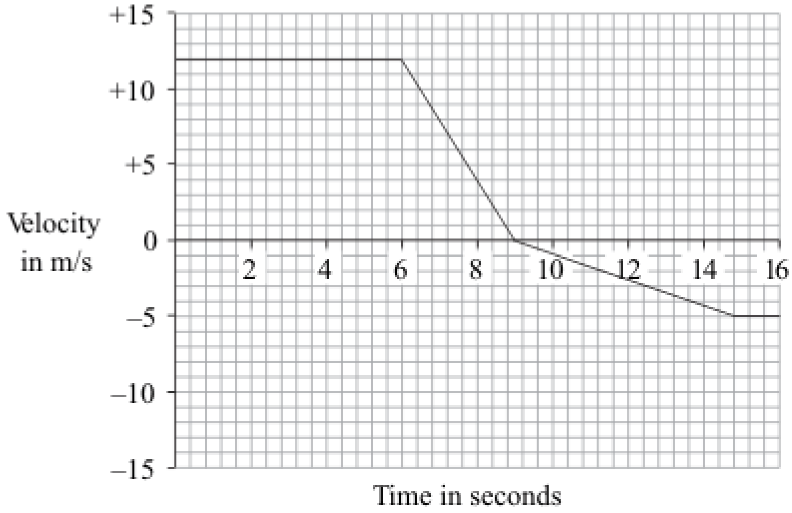
....

....

Distance = ... m

(3)
(Total 8 marks)

Q2. A car is driven along a straight road. The graph shows how the velocity of the car changes during part of the journey.



(a) Use the graph to calculate the deceleration of the car between 6 and 9 seconds.

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

....

....

....

Deceleration = ...

(3)

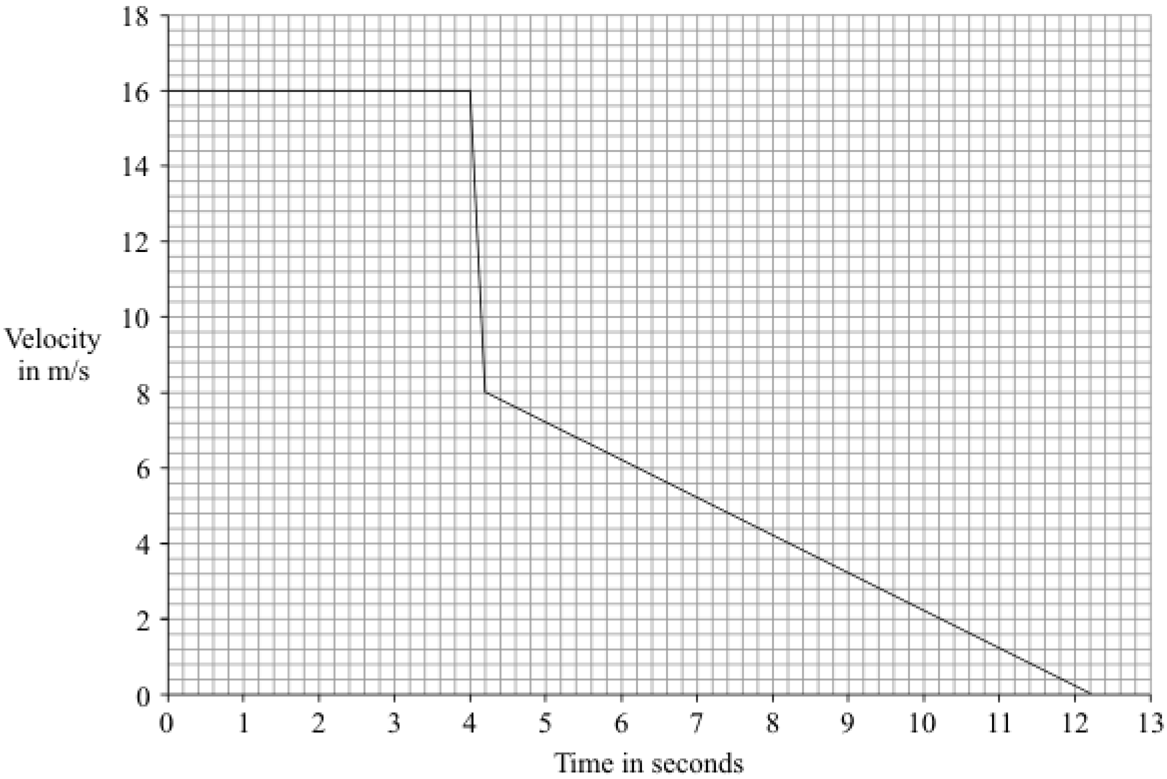
(b) At what time did the car change direction?

.... seconds

(1)
(Total 4 marks)

Q3. In an experiment at an accident research laboratory, a car driven by remote control was crashed into the back of an identical stationary car. On impact the two cars joined together and moved in a straight line.

(a) The graph shows how the velocity of the remote-controlled car changed during the experiment.



(i) How is the *velocity* of a car different from the speed of a car?

....

(1)

(ii) Use the graph to calculate the distance travelled by the remote-controlled car before the collision.

Show clearly how you work out your answer.

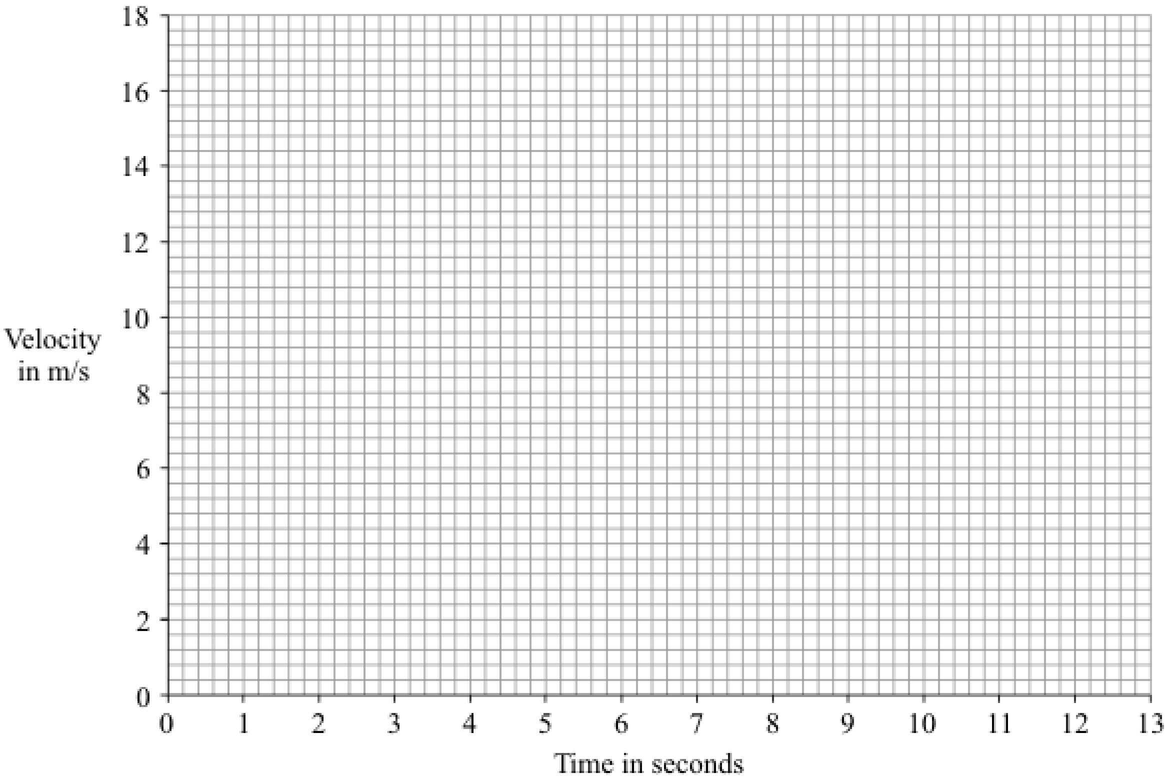
....

....

Distance = ... m

(2)

(iii) Draw, on the grid below, a graph to show how the velocity of the second car changed during the experiment.



(2)

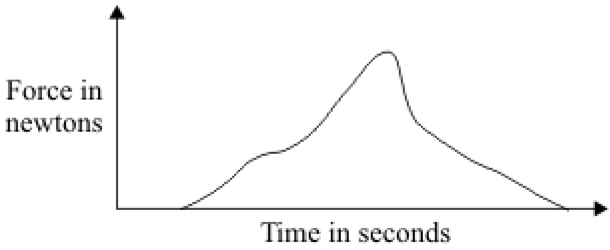
(iv) The total momentum of the two cars was not conserved.

What does this statement mean?

....

.... **(1)**

(b) The graph line shows how the force from a seat belt on a car driver changes during a collision.



Scientists at the accident research laboratory want to develop a seat belt that produces a constant force throughout a collision.

Use the idea of momentum to explain why this type of seat belt would be better for a car driver.

....

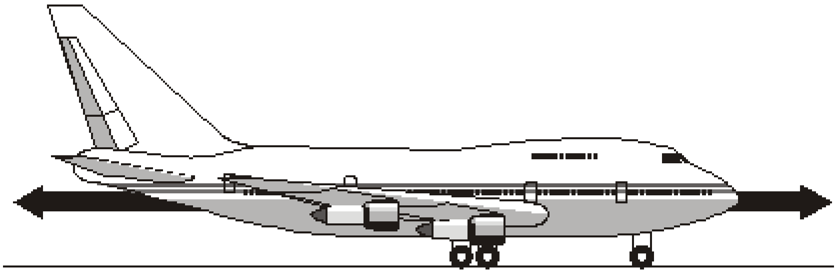
....

....

....

(2)
(Total 8 marks)

Q4. (a) The diagram shows an aircraft and the horizontal forces acting on it as it moves along a runway. The *resultant force* on the aircraft is zero.



(i) What is meant by the term *resultant force*?

....

....

(1)

(ii) Describe the movement of the aircraft when the resultant force is zero.

....

....

(1)

(b) The aircraft has a take-off mass of 320 000 kg. Each of the 4 engines can produce a maximum force of 240 kN.

Calculate the maximum acceleration of the aircraft.

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

....

....

....

Acceleration = ...

(3)

(c) As the aircraft moves along the runway to take off, its acceleration decreases even though the force from the engines is constant.

Explain why.

....

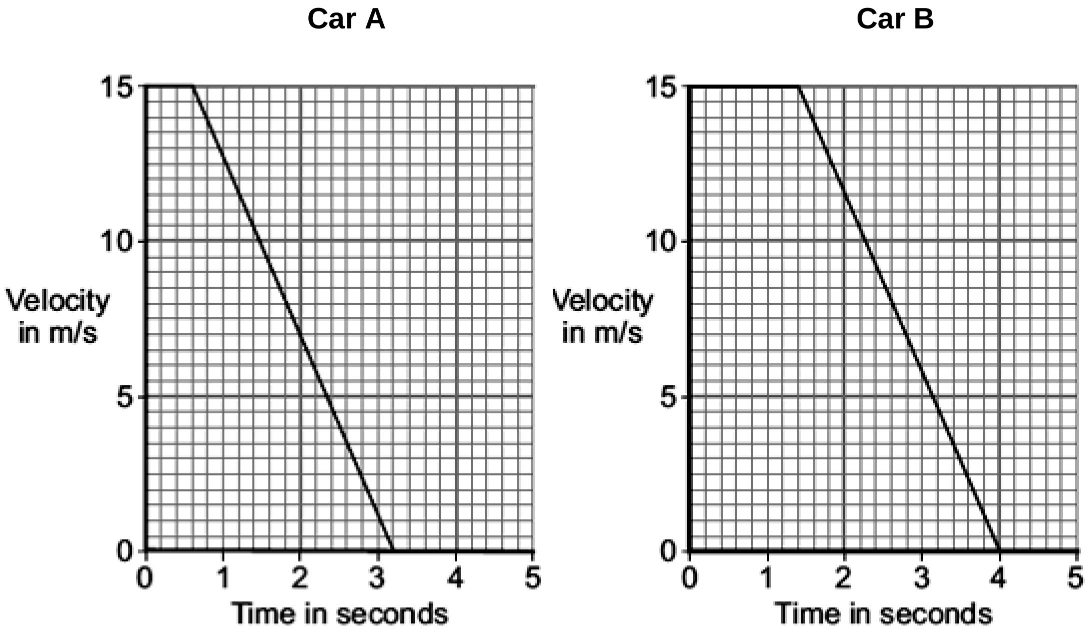
....

....

....

(2)
(Total 7 marks)

Q5. (a) The graphs show how the velocity of two cars, **A** and **B**, change from the moment the car drivers see an obstacle blocking the road.



One of the car drivers has been drinking alcohol. The other driver is wide awake and alert.

(i) How does a comparison of the two graphs suggest that the driver of car **B** is the one who has been drinking alcohol?

....

....

(1)

(ii) How do the graphs show that the two cars have the same deceleration?

....

....

(1)

(iii) Use the graphs to calculate how much further car **B** travels before stopping compared to car **A**.

Show clearly how you work out your answer.

....

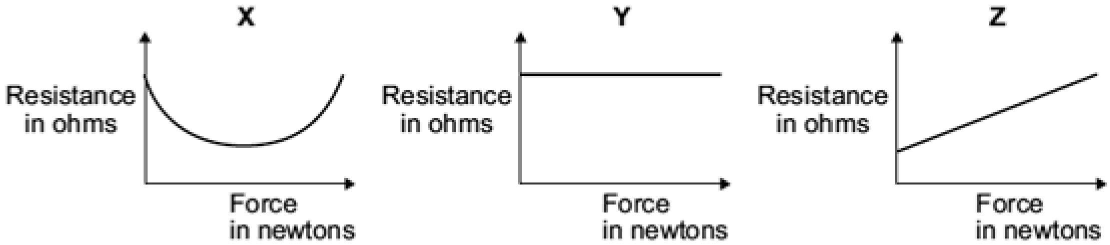
....

....

Additional stopping distance = ... m

(3)

(b) In a crash test laboratory, scientists use sensors to measure the forces exerted in collisions. The graphs show how the electrical resistance of 3 experimental types of sensor, **X**, **Y** and **Z**, change with the force applied to the sensor.



Which of the sensors, **X**, **Y** or **Z**, would be the best one to use as a force sensor?

....

Give a reason for your answer.

....

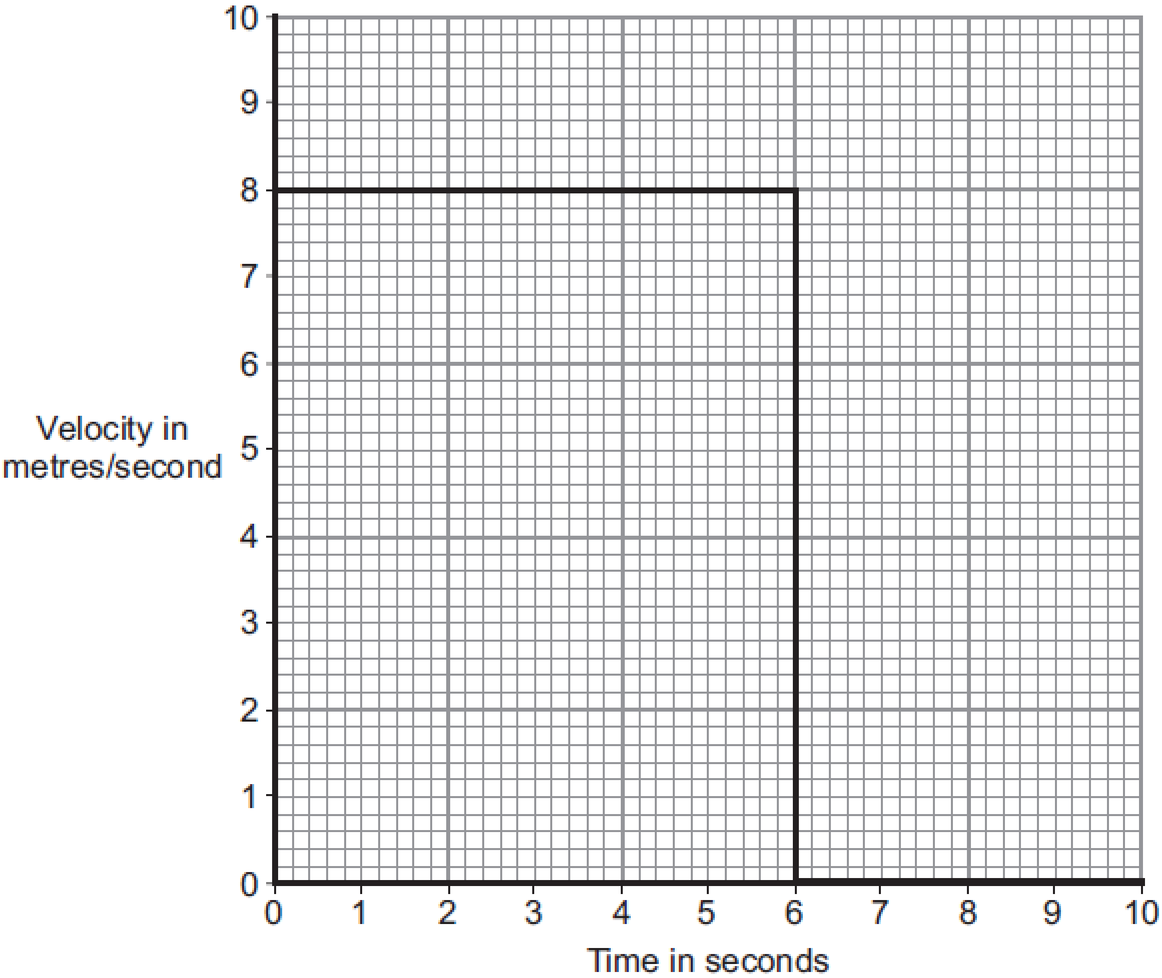
....

....

....

(2)
(Total 7 marks)

Q6. 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.

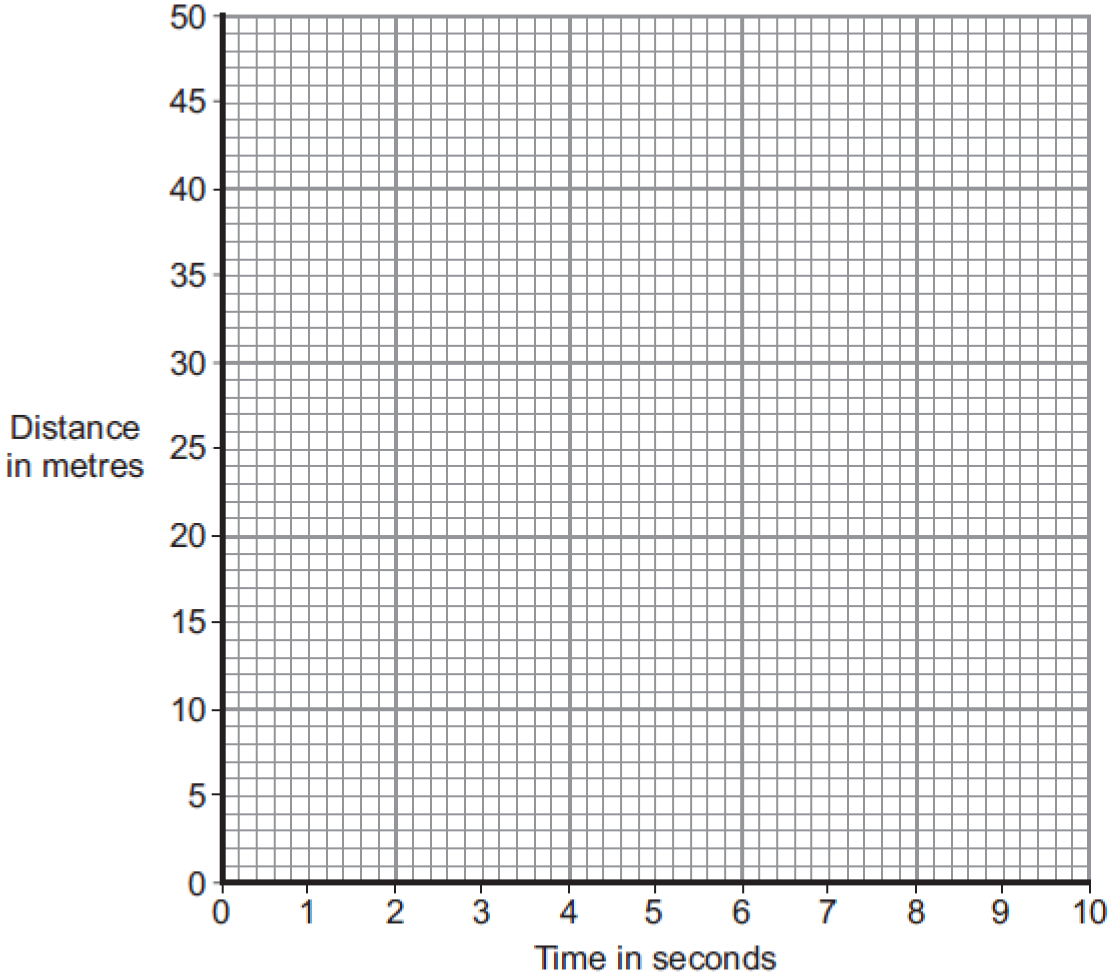
....

....

Distance = ... m

(2)

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



(2)
(Total 4 marks)

Q7. 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.

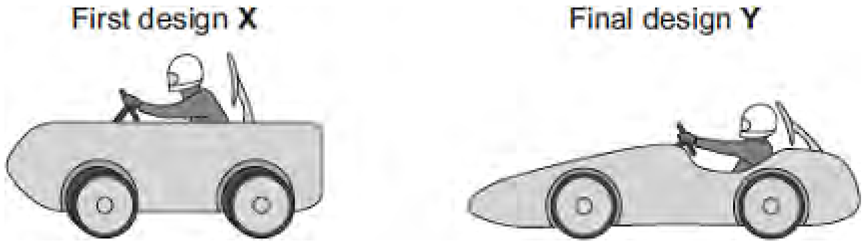
Name the other factor that affects the resultant force and state what effect it has on the resultant force.

....

....

(1)
(Total 4 marks)

Q8.(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.



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.

....

....

....

....

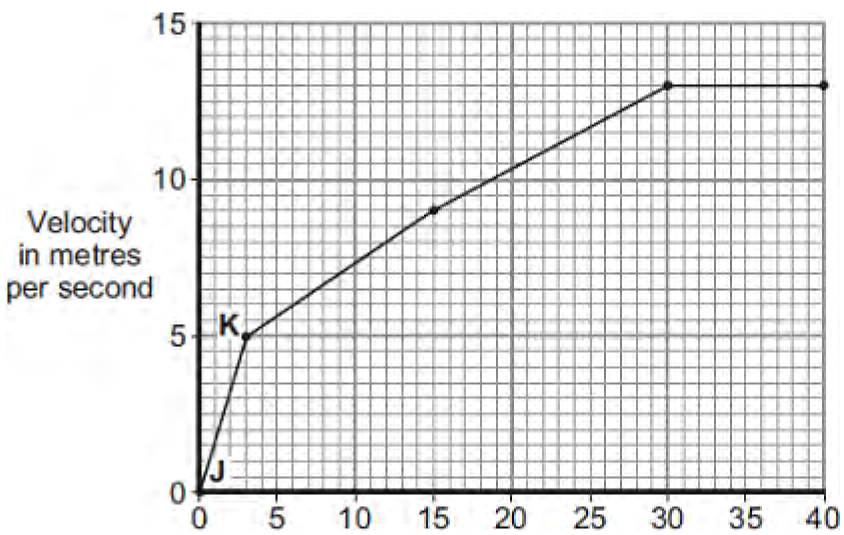
....

....

(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.



Time in seconds

(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

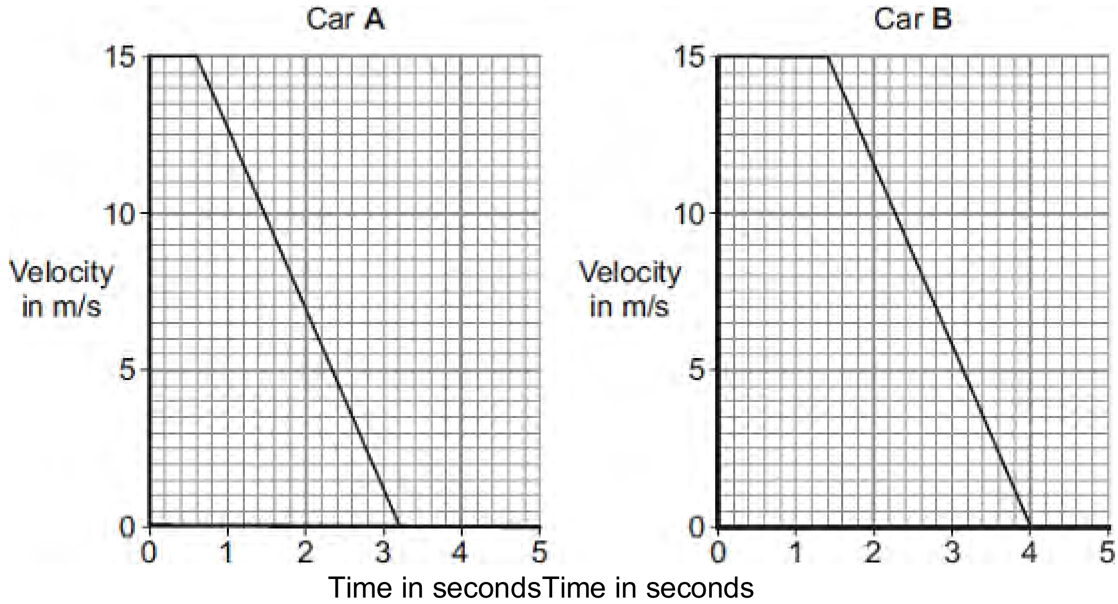
(2)

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

....

(1)
(Total 8 marks)

Q9.(a) The graphs show how the velocity of two cars, **A** and **B**, change from the moment the car drivers see an obstacle blocking the road.



One of the car drivers has been drinking alcohol. The other driver is wide awake and alert.

(i) How does a comparison of the two graphs suggest that the driver of car **B** is the one who has been drinking alcohol?

....

.... **(1)**

(ii) How do the graphs show that the two cars have the same deceleration?

....

.... **(1)**

(iii) Use the graphs to calculate how much further car **B** travels before stopping compared to car **A**.

Show clearly how you work out your answer.

....

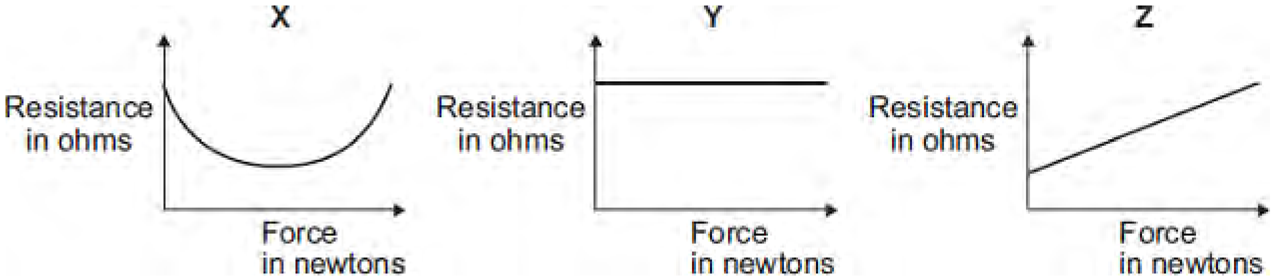
....

....

Additional stopping distance = ... m

(3)

(b) In a crash-test laboratory, scientists use sensors to measure the forces exerted in collisions. The graphs show how the electrical resistance of 3 experimental types of sensor, **X**, **Y**, and **Z**, change with the force applied to the sensor.



Which of the sensors, **X**, **Y** or **Z**, would be the best one to use as a force sensor?

....

Give a reason for your answer.

....

....

....

....

(2)
(Total 7 marks)

M1. (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]

M2.(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]

M3. (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^{-2}*

for 1 mark

3

(b) *evidence* of using area under graph or distance average 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.*

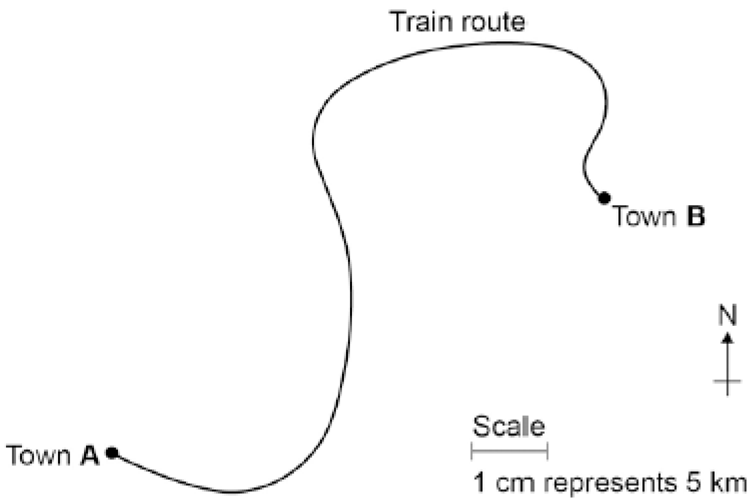
2

[8]

Q1. 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.

....

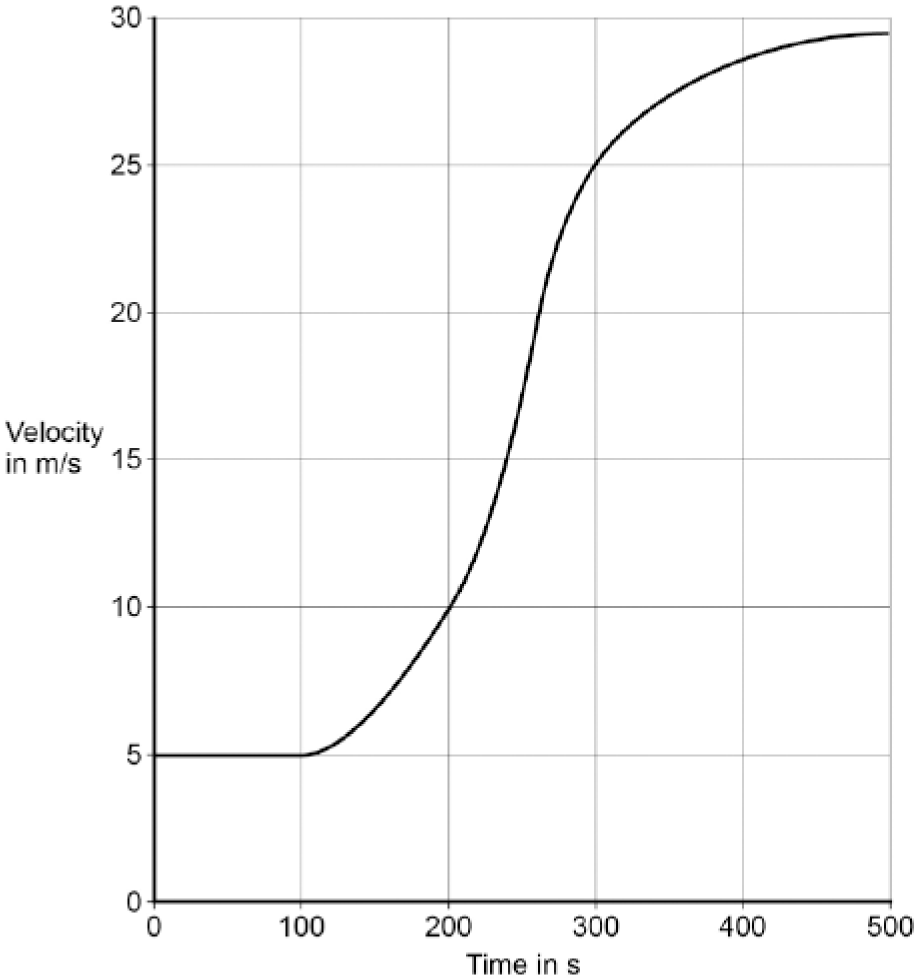
....

....

....
(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.

....

....

....

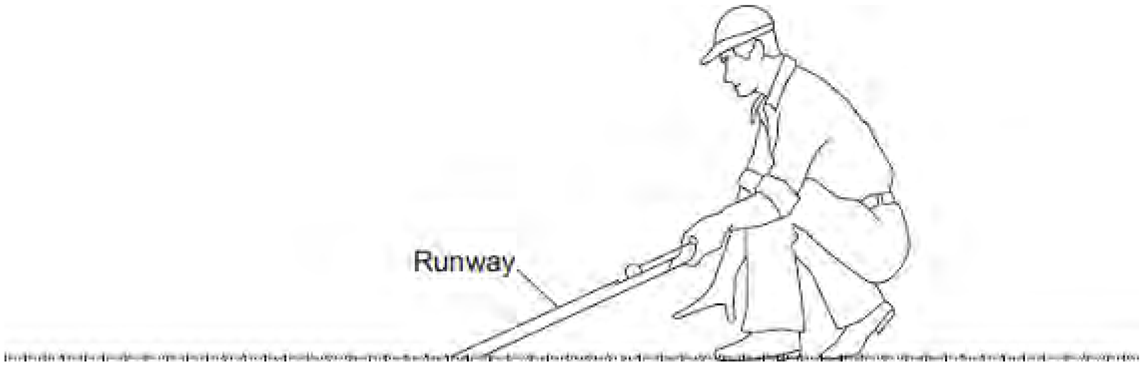
....

Distance = ... m

(3)
(Total 8 marks)

Q2.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.

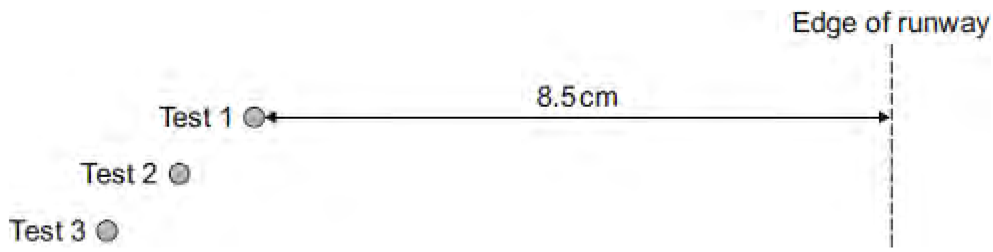
Figure 1



(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.

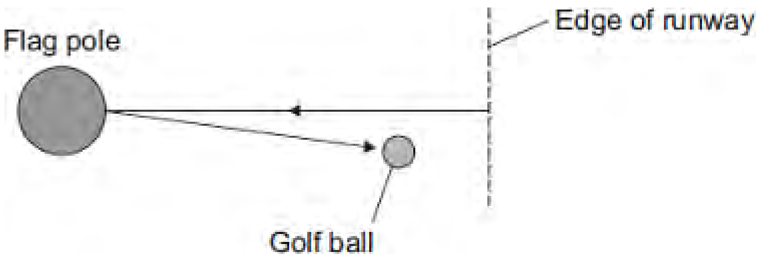
Give a reason why.

....

.... **(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?

....

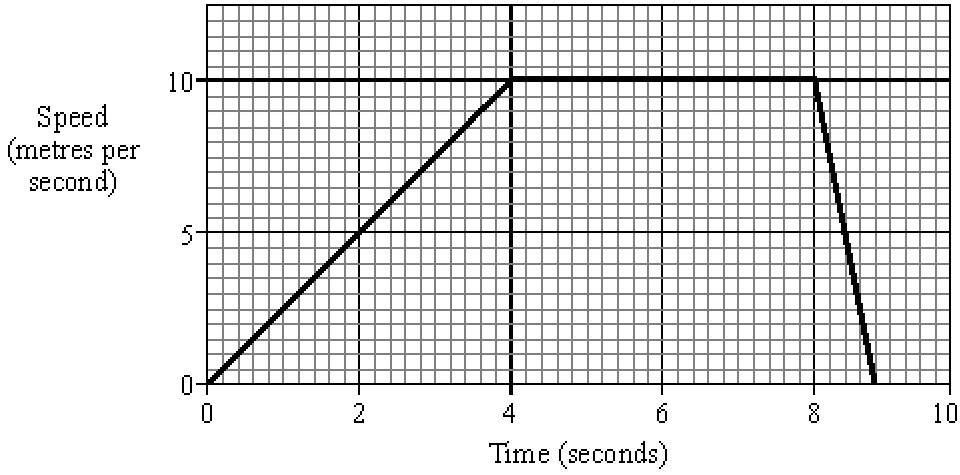
....

....

....

(2)
(Total 15 marks)

Q3. 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)

M1. (a) (i) not moving

1

(ii) straight line from origin to (200,500)

ignore a horizontal line after (200,500)

1

(b) 35 000

*allow **1** mark for correct substitution, ie 14 000 × 2.5 provided no subsequent step*

an answer of 87 500 indicates acceleration (2.5) has been squared and so scores zero

2

[4]

M2. (a) (i) **E-F** (ticked)

1

(ii) **B-C or D-E**

accept both answers

1

(b) fast(er)

accept downhill

1

slow(er)

1

force

*do **not** accept distance*

1

[5]

M3. (a) (i) walking at constant speed

1

(ii) standing still

1

(b) is higher **or** faster

accept less time to walk more distance (both time and distance must be mentioned)

1

the slope of graph is steeper

accept slope is more

1

(c) speed = $\frac{\text{distance}}{\text{time}}$

accept suitable symbols used in correct formula

do not accept a triangle

1

[5]

M4. (a) 60

1

(b) $5\frac{1}{2}$ hours

must include unit

1

(c) 30

1

(d) 30 minutes or

$\frac{1}{2}$ hour

must include unit

1

(e) D **and** E

accept finish for E
accept correct numbers from axes with units

1

least steep part of the graph

accept covers smallest distance in a set time
accept only moves 5 km in 1 ½ hours (accept anything between 5 and 6)
ignore horse is tired

1

[6]

M5. (a) (i) 12

1

(ii) 0.2

*allow **1** mark for their (a)(i) ÷ 60 and correctly calculated* 1

m/s^2

accept correct unit circled in list

accept ms^{-2}

*do **not** accept mps^2* 1

(b) **B** 1

[4]

M6. (a) shallowest slope/ gradient

accept smallest distance in biggest time
accept longest time to travel the same distance
accept the line is not as steep
accept it is a less steep line
*do **not** accept the line is not steep*

1

(b) **A – B**

If 2 or 3 boxes are ticked no mark

1

(c) (i) 200 m

1

(ii) 20 s

*allow **1** mark for correctly identifying 60 s or 40 s from the graph*

2

(d) (i) <u>straight</u> line starting at origin

accept within one small square of the origin

1

passing through t = 200 and d = 500

1

(ii) 166

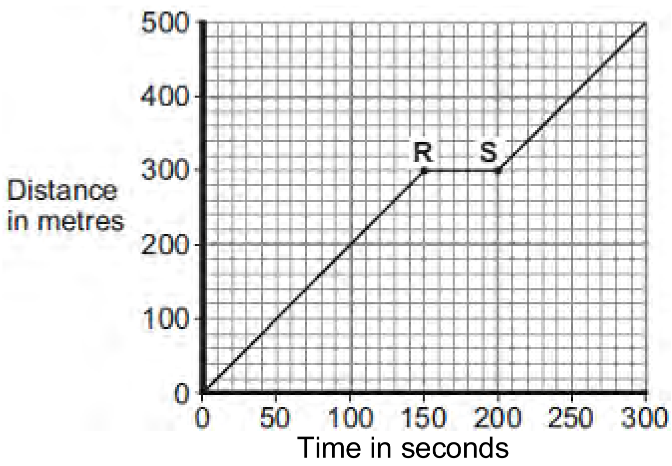
accept any value between 162 and 168
accept where their line intersects
given graph line correctly read ± 3 s

1

[8]

Q1.(a) **Figure 1** shows the distance–time graph for a person walking to a bus stop.

Figure 1



(i) Which **one** of the following statements describes the motion of the person between points **R** and **S** on the graph?

Tick (✓) **one** box.

Not moving ☐

Moving at constant speed ☐

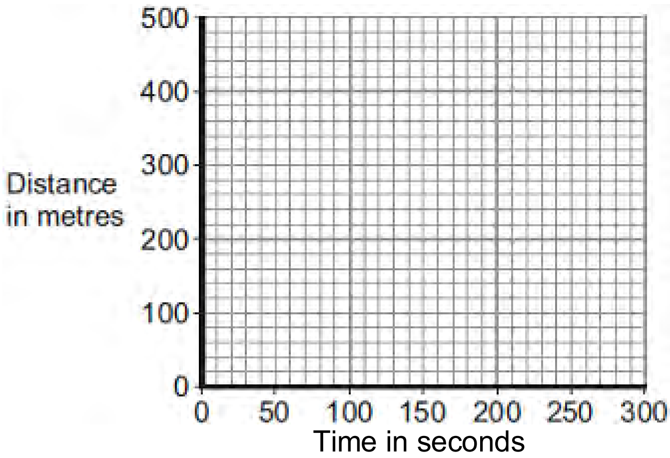
Moving with increasing speed ☐

(1)

(ii) Another person, walking at constant speed, travels the same distance to the bus stop in 200 seconds.

Complete **Figure 2** to show a distance–time graph for this person.

Figure 2



(1)

(b) A bus accelerates away from the bus stop at 2.5 m/s^2.

The total mass of the bus and passengers is 14 000 kg.

Calculate the resultant force needed to accelerate the bus and passengers.

....

....

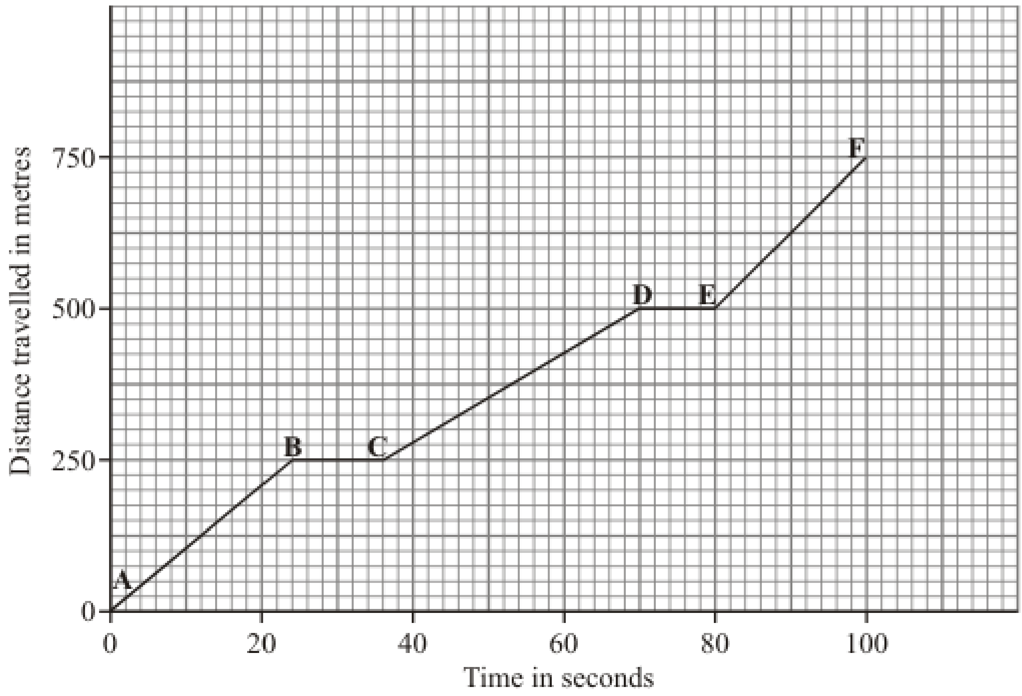
....

Resultant force = ... N

(2)
(Total 4 marks)

Q2. This question is about a car travelling through a town.

(a) The graph shows how far the car travelled and how long it took.



(i) Between which points was the car travelling fastest? Tick (✓) your answer.

Points	Tick (✓)
A – B	
B – C	
C – D	
D – E	
E – F	

(1)

(ii) Between which points was the car stationary?

....

....

(1)

(b) Complete the sentences by writing the correct words in the spaces.

When a car has to stop, the **overall** stopping distance is greater if:

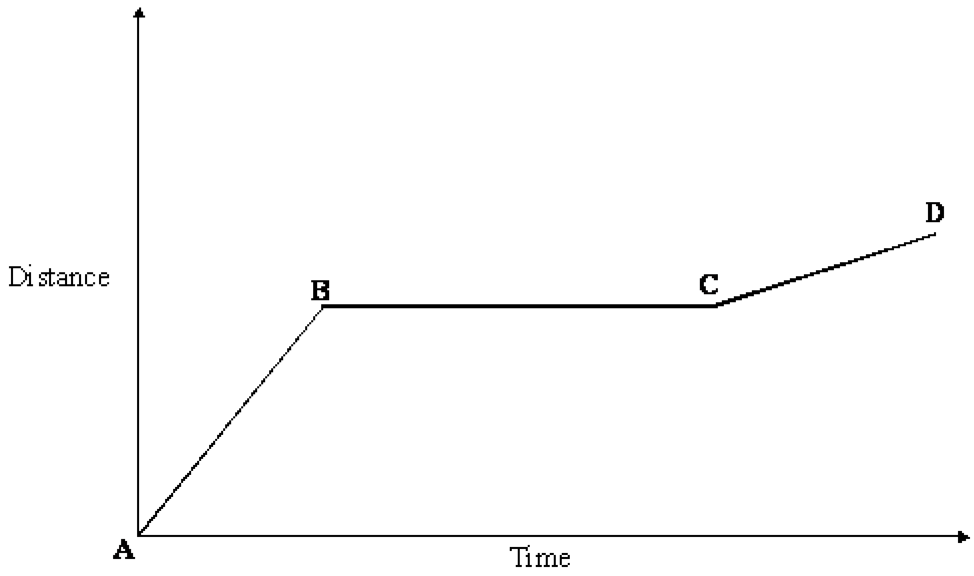
- the car is poorly maintained;
- there are adverse weather conditions;
- the car is travelling .... ;
- the driver's reactions are ....

Also, the greater the speed of the car, then the greater the braking ....

needed to stop in a certain time.

(3)
(Total 5 marks)

Q3. The graph shows the distance a person walked on a short journey.



(a) Choose from the phrases listed to complete the statements which follow. You may use each statement once, more than once or not at all.

standing still

walking at constant speed

walking with an increasing speed

walking with a decreasing speed

(i) Between points **A** and **B** the person is

....

(1)

(ii) Between points **B** and **C** the person is

....

(1)

(b) Complete the sentence.

You can tell that the speed of the person between points **A** and **B** is ....

than the speed between points **C** and **D** because ....

....

(2)

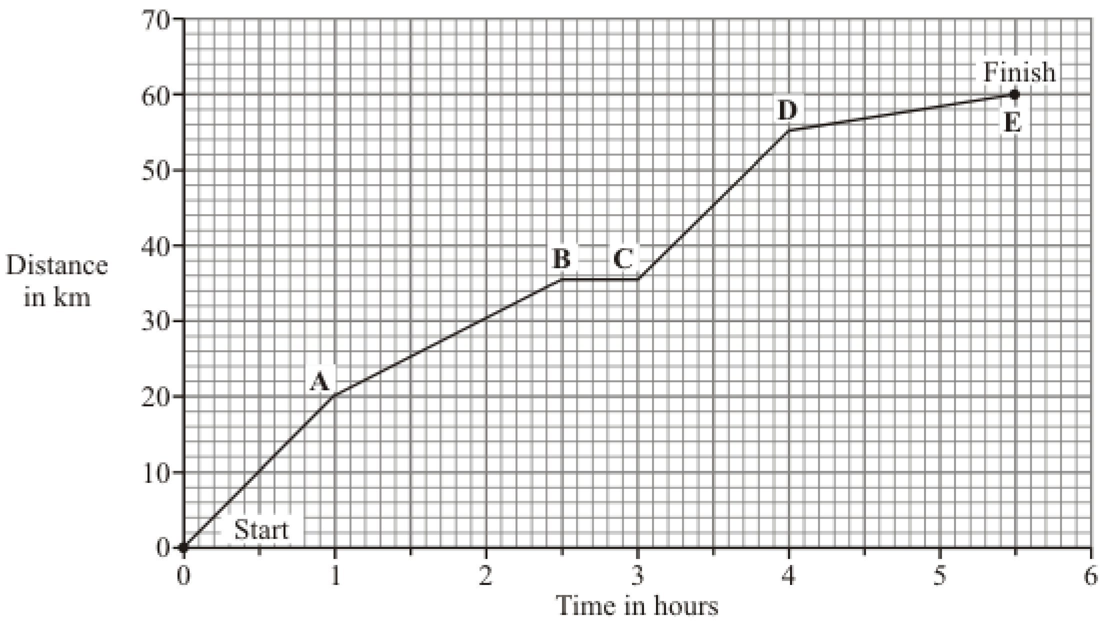
(c) Write the equation which relates distance, speed and time.

....

(1)

(Total 5 marks)

Q4. A horse and rider take part in a long distance race. The graph shows how far the horse and rider travel during the race.



(a) What was the distance of the race?

distance = ... km

(1)

(b) How long did it take the horse and rider to complete the race?

....

(1)

(c) What distance did the horse and rider travel in the first 2 hours of the race?

distance = ... km

(1)

(d) How long did the horse and rider stop and rest during the race?

....

(1)

(e) Not counting the time it was resting, between which two points was the horse moving the slowest?

.... and ....

Give a reason for your answer.

....

....

(2)
(Total 6 marks)

Q5. A high-speed train accelerates at a constant rate in a straight line.

The velocity of the train increases from 30 m/s to 42 m/s in 60 seconds.

(a) (i) Calculate the change in the velocity of the train.

....

Change in velocity = ... m/s

(1)

(ii) Use the equation in the box to calculate the acceleration of the train.

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

Show clearly how you work out your answer and give the unit.
Choose the unit from the list below.

m/s **m/s²** **N/kg** **Nm**

....

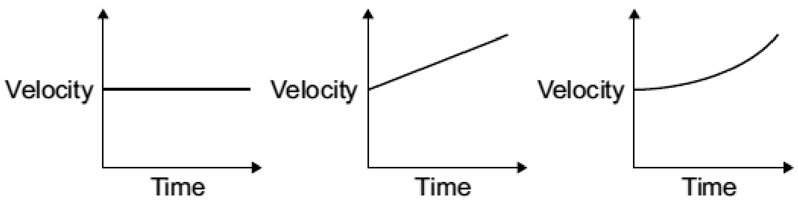
....

Acceleration = ...

(2)

(b) Which **one** of the graphs, **A**, **B** or **C**, shows how the velocity of the train changes as it accelerates?

Write your answer, **A**, **B** or **C**, in the box.

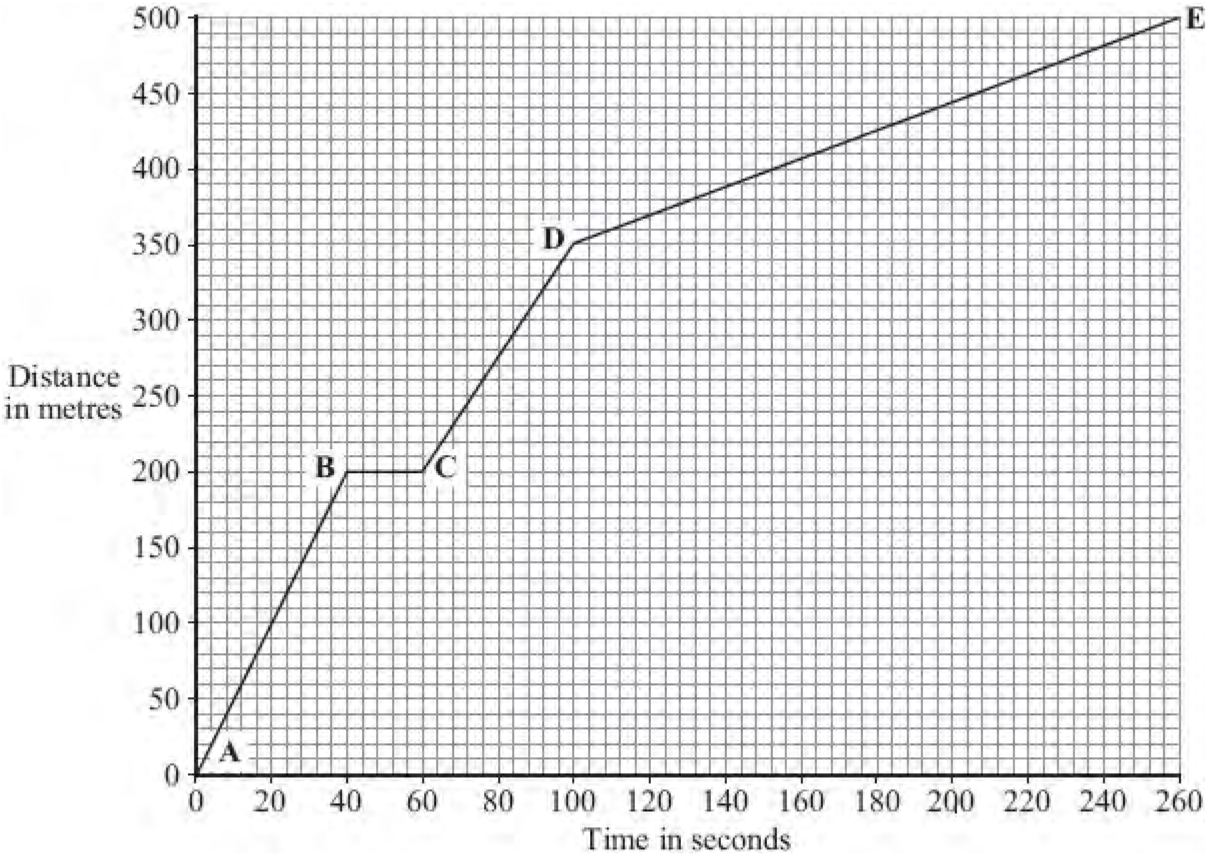


A **B** **C**

Graph ☐

(1)
(Total 4 marks)

Q6. 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) The bus travels the **slowest** between points **D** and **E**.

How can you tell this from the graph?

....

....

(1)

(b) Between which two points was the bus travelling the **fastest**?

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

Points	
A – B	

B – C	
C – D	

(1)

(c) There is a bus stop in the high street.
This is marked as point **B** on the graph.

(i) What is the distance between point **A** on the graph and the bus stop?

Distance .... metres

(1)

(ii) How long did the bus stop at the bus stop?
Show clearly how you work out your answer.

....

Time = ... seconds

(2)

(d) 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 200 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 8 marks)

M1. (a) (sound waves) which have a frequency higher than the upper limit of hearing for humans

or

a (sound) wave (of frequency) above 20 000 Hz

sound waves that cannot be heard is insufficient

a wave of frequency 20 000 Hz is insufficient

1

(b) 640

*an answer of 1280 gains **2** marks*

*allow **2** marks for the correct substitution*

ie 1600 × 0.40 provided no subsequent step

*allow **2** marks for the substitution* $\frac{1600 \times 0.80}{2}$

provided no subsequent step

*allow **1** mark for the substitution 1600 × 0.80 provided no subsequent step*

*allow **1** mark for the identification that time (boat to bed) is 0.4*

3

(c) any **one** from:

- pre-natal scanning / imaging
- imaging of a named organ (that is not surrounded by bone), eg stomach, bladder, testicles

  accept heart

  *do **not** allow brain **or** lungs (either of these negates a correct answer)*
- Doppler scanning blood flow

1

(d) advantage

any **one** from:

- (images are) high quality or detailed or high resolution

  clearer / better image is sufficient
- (scan) produces a slice through the body
- image can be viewed from any direction

  allow images are (always) 3D / 360°
- an image can be made of <u>any</u> part (inside the body)

  allow whole body can be scanned
- easier to diagnose **or** see a problem (on the image)

1

disadvantage

any **one** from:

- (the X-rays used **or** scans) are <u>ionising</u>

  allow a description of what ionising is

- mutate cells **or** cause mutations **or** increase chances of mutations

  allow for cells:

  DNA / genes / chromosomes / nucleus / tissue
- turn cells cancerous **or** produce abnormal growths **or** produce rapidly growing cells
- kill cells

  damage cells is insufficient
- shielding is needed

  can be dangerous (to human health) unqualified, is insufficient

1

[7]

M2. (a) (i) air resistance/drag/friction (or upthrust)
weight/gravitational pull/gravity

for 1 mark each

1

(ii) air resistance/friction acts in opposite direction to motion

1

(iii) Y

1

(iv) the sky-diver accelerates/his speed increases
in downward direction/towards the Earth/falls

for 1 mark each

2

(b) force X has increased force Y has stayed the same the speed of the sky-diver will stay the same

for 1 mark each

3

(c) (i) CD

1

(ii) 500 } (but apply e.c.f. from (i))
(iii) 50

3

(iv) 10 (but apply e.c.f. from (ii) and (iii))

gets 2 marks

or 500/50 or d/t

gets 1 mark

2

[14]

M3. (a) (i) 3km [allow 2.9 to 3.1]

for 1 mark

1

(ii) 6.6 min [allow 6.5 to 6.8]

for 1 mark

1

(b) can be in any units, 1.5 km/min, 1500 m/min, 25 m/s, 90 km/h

Sp = d/t

=12/8

=1.5

km/min

for 1 mark each (see marking of calculations)

4

[6]

M4. (a) (i) Constant speed
2

(ii) Accelerates to higher constant speed
1

(b) (i) Points correct (allow one major or two minor mistakes)
Line correct (for their points)
2

(ii) 5 m/s
or 5
gets 2 marks

or correct unit
gets 1 mark mark
3

(c) (i) 50 s or 50
gets 2 marks

or t = d/v
gets 1 mark
3

(ii) Line correct (of gradient 4 and spans 30 consecutive seconds)
1

(d) (i) 0.04 or 6/15
gets 2 marks

or a = v/t
gets 1 mark
3

[15]

M5. (i) C and D **or** D and C

accept CD
accept DC
accept answers in terms of time

1

(ii) any **one** from:

streamline position streamline clothes

accept crouched position
accept tight clothes
accept design of cycle
accept cycle slower

1

(iii) 0.5 hours **or** 30 minutes **or** 1800 seconds

***must** have unit*

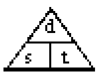
1

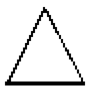
(iv) speed = $\frac{\text{distance}}{\text{time (taken)}}$

accept any correct rearrangement

accept s = d/t ***or*** *v s/t*

accept velocity for speed

accept 

if subsequent use of  *correct*

1

(v) 16

allow for mark for each of time = 3.5 hours
distance = 56km
allow e.c.f. from part (a)(iii) if correctly used

an answer of 14 gains ***2*** *marks*

allow ***1*** *mark for correct attempt to average the three sections*

3

[7]

M6. (a) 96

*allow **1** mark for correct substitution*
ie 80 × 1.2

2

newton or N

allow Newton
*do **not** allow n*

1

(b) (i) direction

1

(ii) velocity <u>and</u> time are continuous (variables)

answers must refer to both variables
accept the variables are continuous / not categoric
accept the data / 'it' is continuous
accept the data / 'it' is not categoric

1

(iii) **C**

1

velocity is not changing

*the **2** marks for reason may be scored even if **A** or **B** are chosen*
accept speed for velocity
accept speed is constant (9 m/s)
*accept **not** decelerating*
*accept **not** accelerating*
accept reached terminal velocity

1

forces must be balanced

accept forces are equal

accept arrows are the same length / size

or

resultant force is zero

*do **not** accept the arrows are equal*

1

[8]

M7. (a) **B**

reason only scores if B is chosen

1

gradient / slope is the steepest / steeper

answers must be comparative

accept steepest line

ignore greatest speed

1

(b) (velocity includes) direction

'it' refers to velocity

1

[3]

Q1.(a) What is ultrasound?

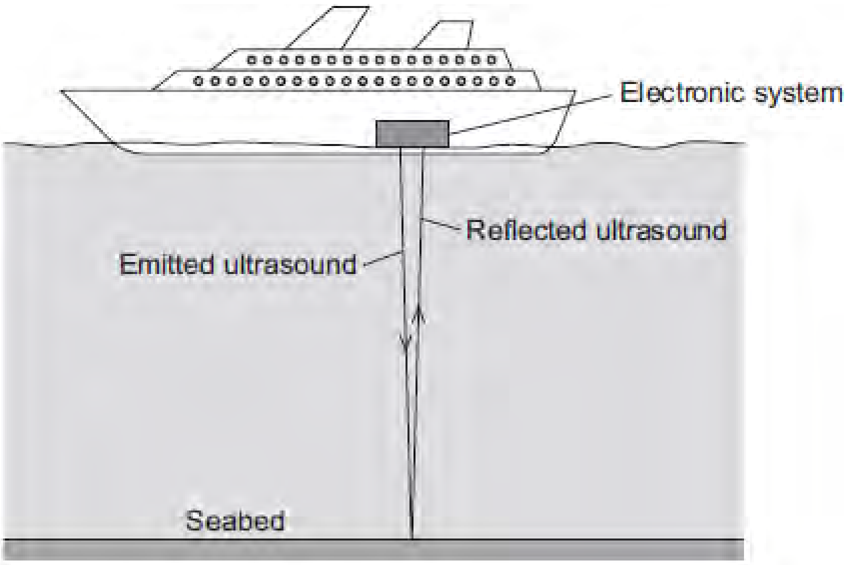
....

....

(1)

(b) **Figure 1** shows how ultrasound is used to measure the depth of water below a ship.

Figure 1



A pulse of ultrasound is sent out from an electronic system on-board the ship.

It takes 0.80 seconds for the emitted ultrasound to be received back at the ship.

Calculate the depth of the water.

Speed of ultrasound in water = 1600 m / s

....

....

....

....

Depth of water = ... metres

(3)

(c) Ultrasound can be used in medicine for scanning.

State **one** medical use of ultrasound scanning.

....

(1)

(d) Images of the inside of the human body can be made using a Computerised Tomography (CT) scanner. The CT scanner in **Figure 2** uses X-rays to produce these images.

Figure 2

monkeybusinessimages/iStock/Thinkstock

State **one** advantage and **one** disadvantage of using a CT scanner, compared with ultrasound scanning, for forming images of the inside of the human body.

Advantage of CT scanning ....

....

....

Disadvantage of CT scanning ....

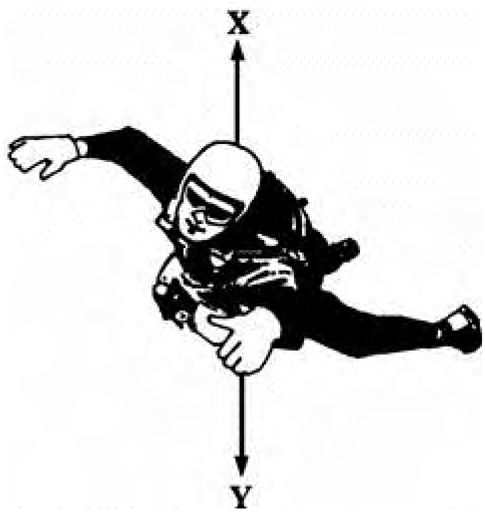
....

....

(2)
(Total 7 marks)

Q2. A sky-diver jumps from a plane.

The sky-diver is shown in the diagram below.



(a) Arrows **X** and **Y** show two forces acting on the sky-diver as he falls.

(i) Name the forces **X** and **Y**.

X ....

Y ....

(2)

(ii) Explain why force **X** acts in an upward direction.

....

....

(1)

(iii) At first forces **X** and **Y** are unbalanced.

Which of the forces will be bigger? ....

(1)

(iv) How does this unbalanced force affect the sky-diver?

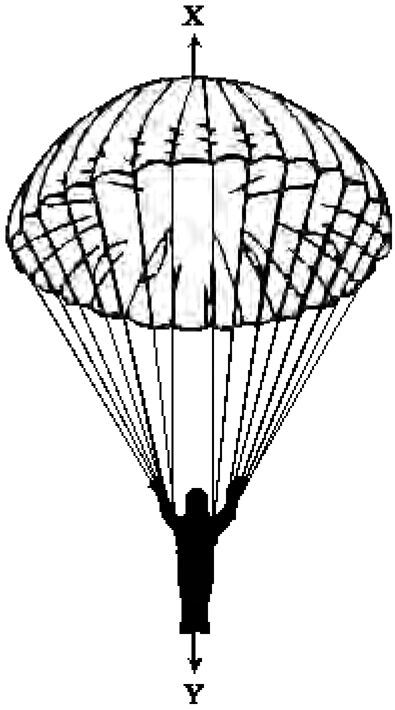
....

....

(2)

(b) After some time the sky-diver pulls the rip cord and the parachute opens.

The sky-diver and parachute are shown in the diagram below.



After a while forces **X** and **Y** are balanced.

Underline the correct answer in each line below.

Force **X** has

increased / stayed the same / decreased.

Force **Y** has

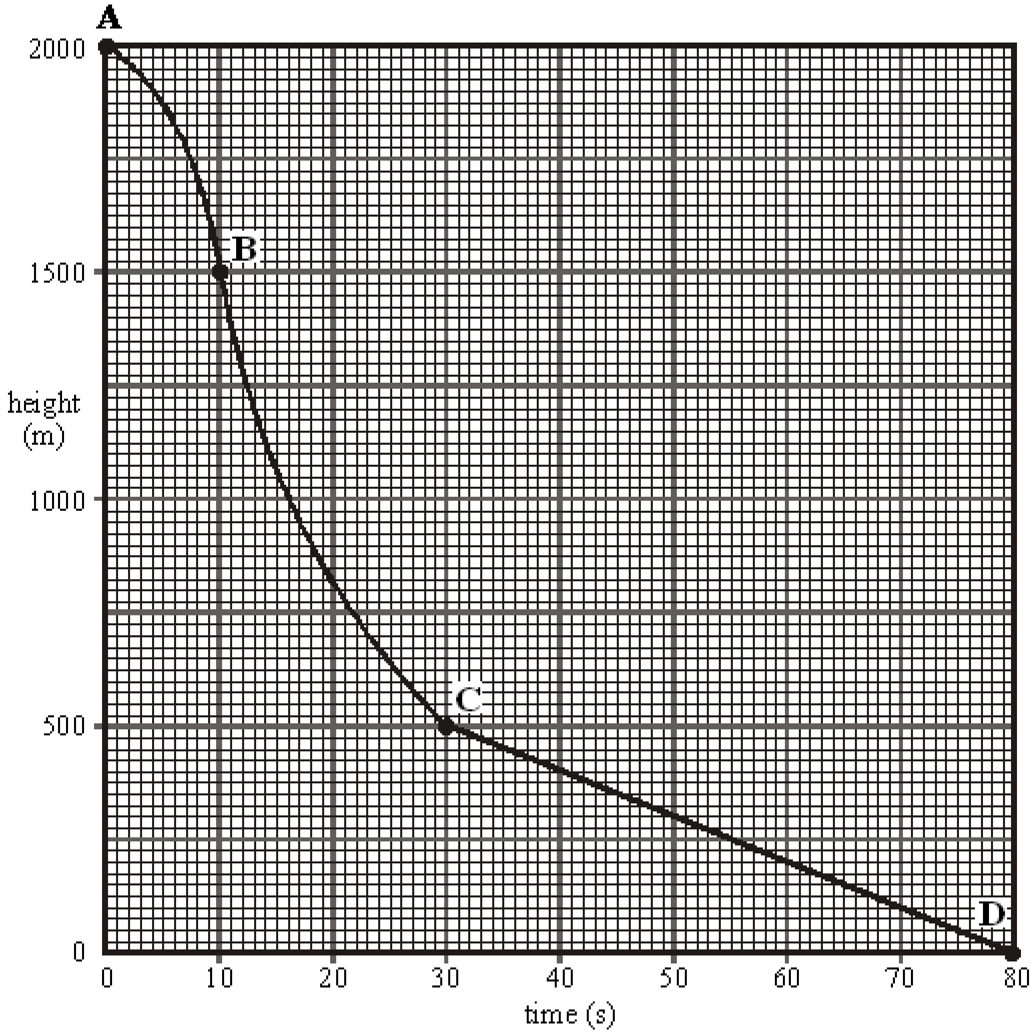
increased / stayed the same / decreased.

The speed of the sky-diver will

increase / stay the same / decrease.

(3)

(c) The graph below shows how the height of the sky-diver changes with time.



(i) Which part of the graph, **AB**, **BC** or **CD** shows the sky-diver falling at a constant speed?

.... **(1)**

(ii) What distance does the sky-diver fall at a constant speed?

Distance .... m **(1)**

(iii) How long does he fall at this speed?

Time .... s

(1)

(iv) Calculate this speed.

....

....

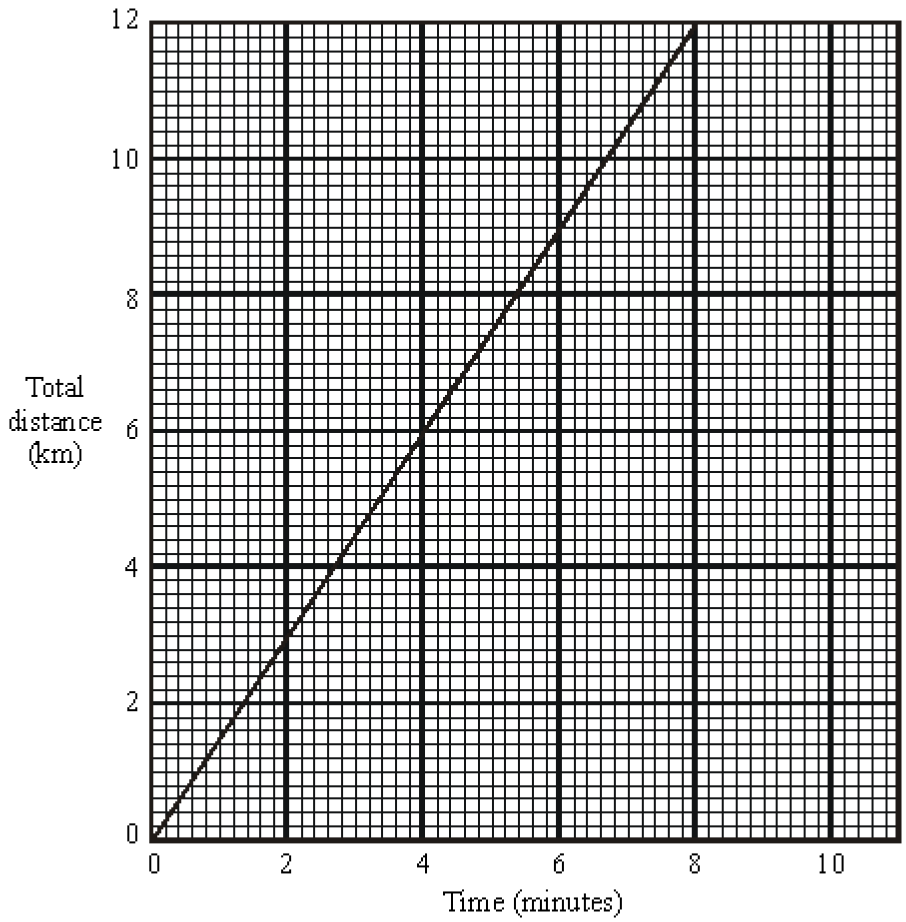
....

Speed .... m/s

(2)

(Total 14 marks)

Q3. Below is a distance-time graph for part of a train journey.
The train is travelling at a constant speed.



(a) Use the graph to find

(i) how far the train travels in 2 minutes .... km.

(ii) how long it takes the train to travel a distance of 10 kilometres .... minutes.

(2)

(b) Calculate the speed of the train.

....

....

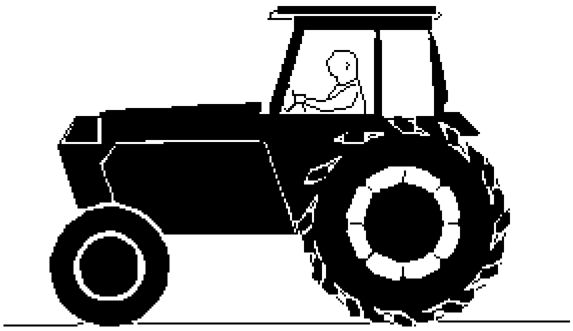
....

....

....

(4)
(Total 6 marks)

Q4. (a) The diagram below shows a moving tractor. The forward force from the engine exactly balances the resisting forces on the tractor.



(i) Describe the motion of the tractor.

....

(ii) The tractor comes to a drier part of the field where the resisting forces are less. If the forward force from the engine is unchanged how, if at all, will the motion of the tractor be affected?

....

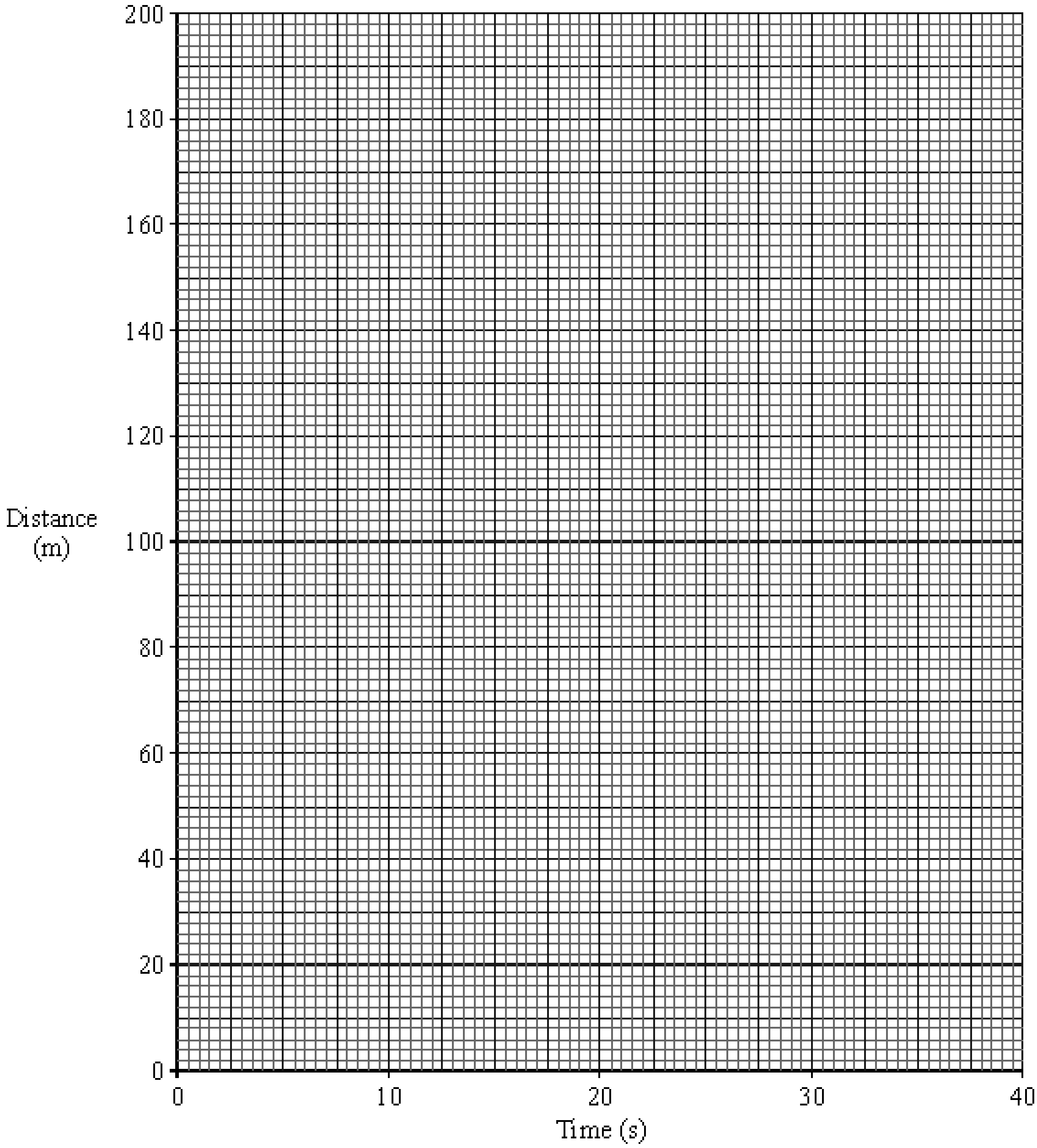
....

(3)

(b) Two pupils are given the task of finding out how fast a tractor moves across a field. As the tractor starts a straight run across the field the pupils time how long it takes to pass a series of posts which are forty metres apart. The results obtained are shown in the table below.

Distancetravelled (m)	0	40	80	120	160	200
Timetaken (s)	0	8	16	24	32	40

(i) Draw a graph of distance travelled against time taken using the axes on the graph below. Label your graph line A.



(2)

(ii) Calculate the speed of the tractor.

....

....

(3)

(c) In another, wetter field there is more resistance to the movement of the tractor. It now travels at 4 m/s.

(i) Calculate the time needed to travel 200m.

....

....

....

(ii) On the graph in part (b) draw a line to represent the motion of the tractor across the second field. Label this line B.

(4)

(d) On a road the tractor accelerates from rest up to a speed of 6 m/s in 15 seconds.

Calculate the acceleration of the tractor.

....

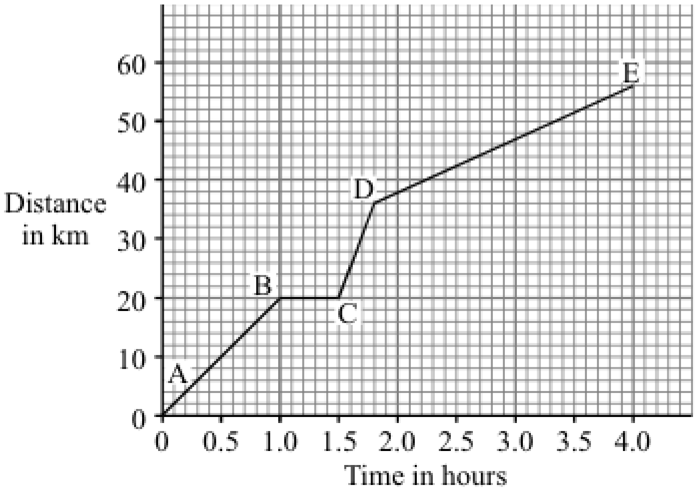
....

....

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

(3)
(Total 15 marks)

Q5. A cyclist goes on a long ride. The graph shows how the distance travelled changes with time during the ride.



(i) Between which **two** points on the graph was the cyclist moving at the fastest speed?

.... **(1)**

(ii) State **one** way cyclists can reduce the air resistance acting on them.

....

.... **(1)**

(iii) How long did the cyclist stop and rest?

.... **(1)**

(iv) Write down the equation which links distance, speed and time.

.... **(1)**

(v) Calculate, in km/hr, the average speed of the cyclist while moving.

....

....

....

....

Average speed = ... km/hr

(3)
(Total 7 marks)

Q6. A cyclist travelling along a straight level road accelerates at 1.2 m/s^2 for 5 seconds. The mass of the cyclist and the bicycle is 80 kg.

(a) Calculate the resultant force needed to produce this acceleration.

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

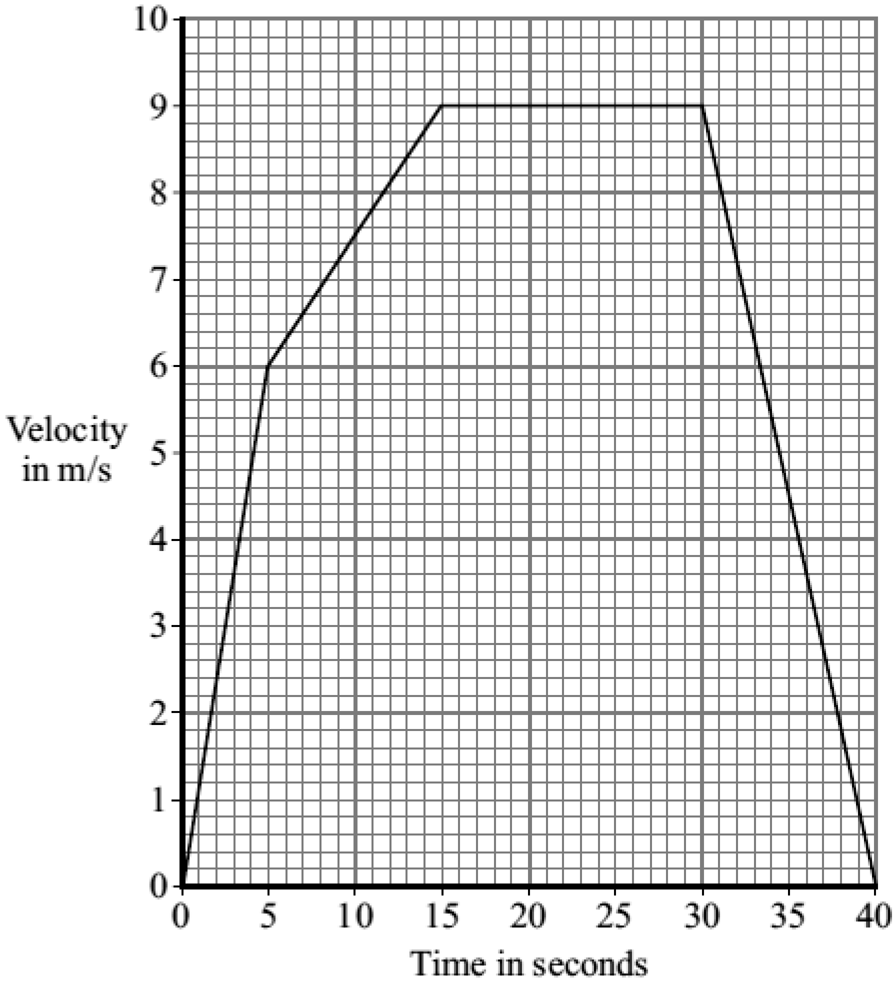
....

....

Resultant force = ...

(3)

(b) The graph shows how the velocity of the cyclist changes with time.



(i) Complete the following sentence.

The velocity includes both the speed and the ....of the cyclist.

(1)

(ii) Why has the data for the cyclist been shown as a line graph instead of a bar chart?

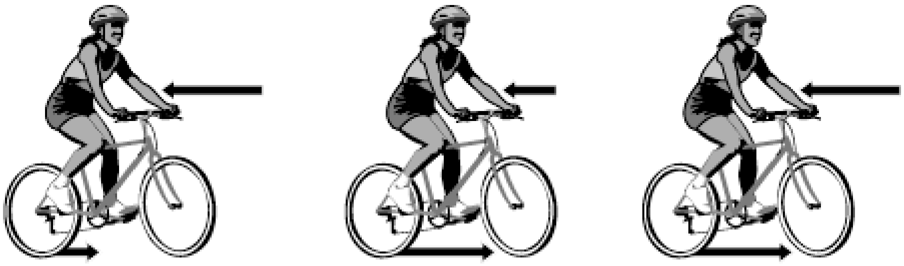
....

....

(1)

(iii) The diagrams show the horizontal forces acting on the cyclist at three different speeds. The length of an arrow represents the size of the force.

A **B** **C**



Which **one** of the diagrams, **A**, **B** or **C**, represents the forces acting when the cyclist is travelling at a constant 9 m/s?

....

Explain the reason for your choice.

....

....

....

....

....

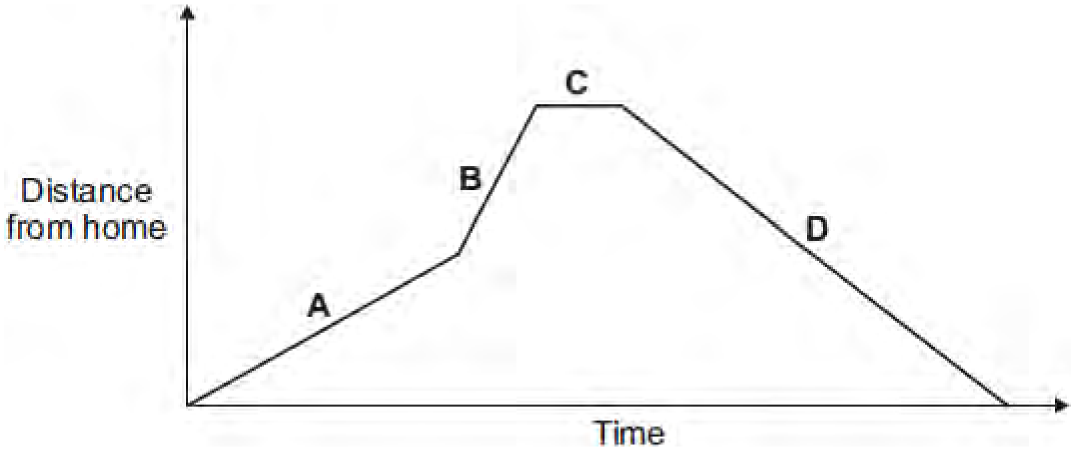
....

(3)

(Total 8 marks)

Q7. (a) A person takes their dog for a walk.

The graph shows how the distance from their home changes with time.



Which part of the graph, **A**, **B**, **C** or **D**, shows them walking the fastest?

Write your answer in the box.

Give the reason for your answer.

....

....

(2)

(b) During the walk, both the speed and the velocity of the person and the dog change.

How is *velocity* different from *speed*?

....

....

(1)
(Total 3 marks)

M1. (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]

M2.(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]

M3. (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.*

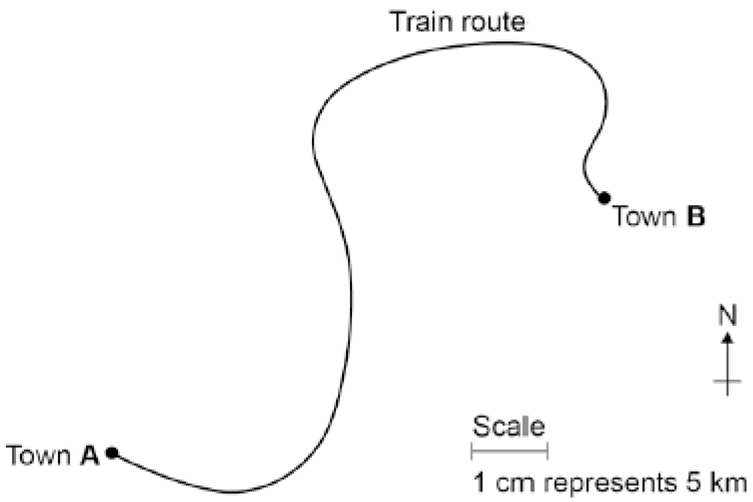
2

[8]

Q1. 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.

....

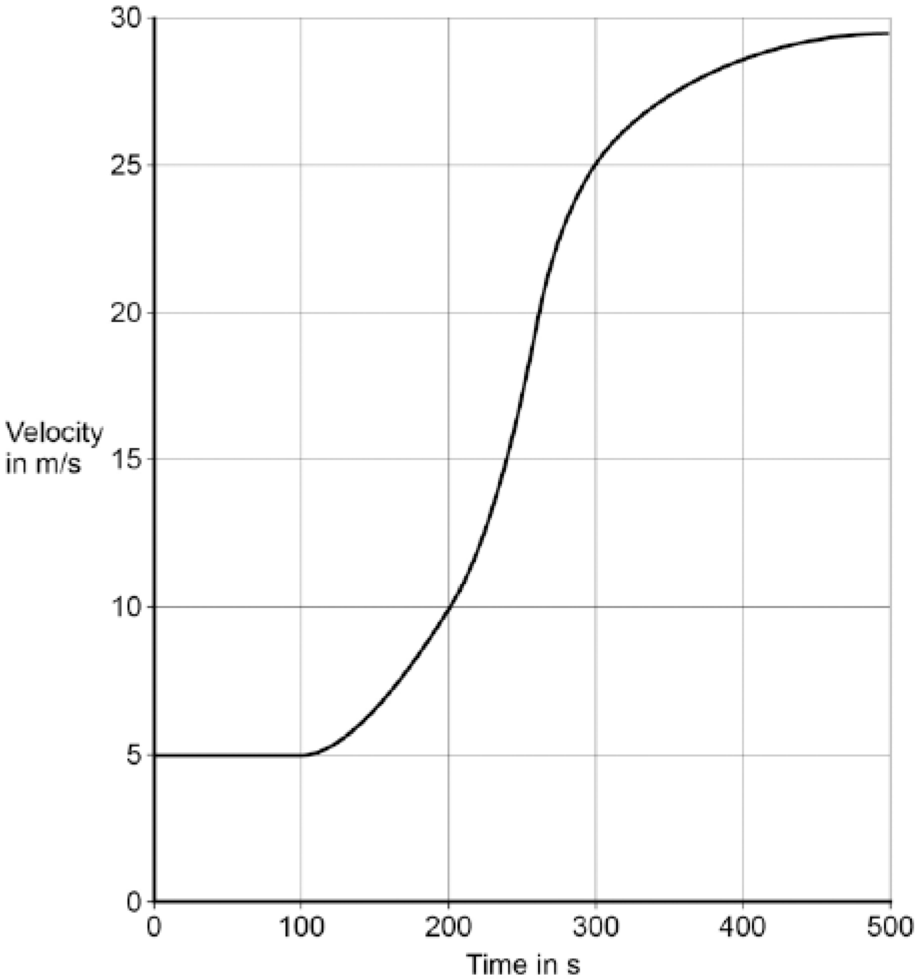
....

....

.... **(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.

....

....

....

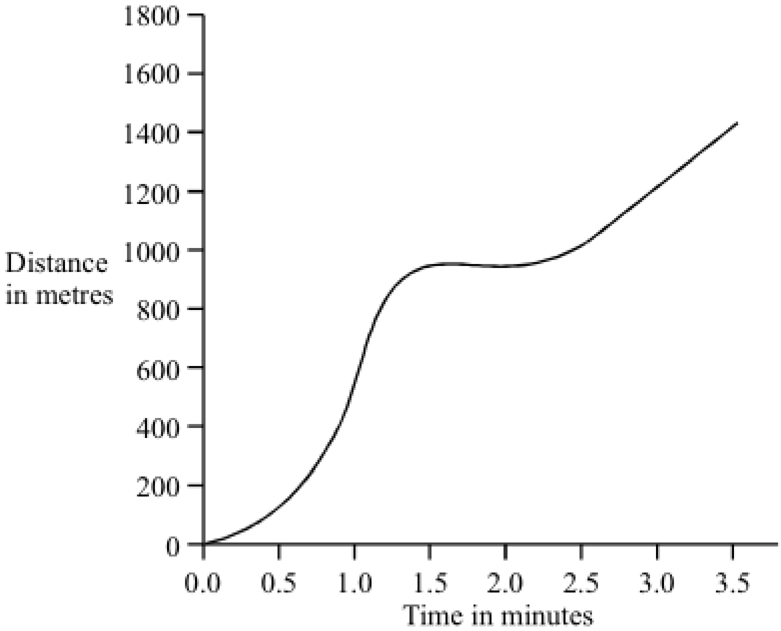
....

Distance = ... m

(3)

(Total 8 marks)

Q2. The graph shows how the distance travelled by a car changes with time during a short journey.



(i) Describe fully the motion of the car during the first **two** minutes of the journey.

....

....

....

....

.... **(3)**

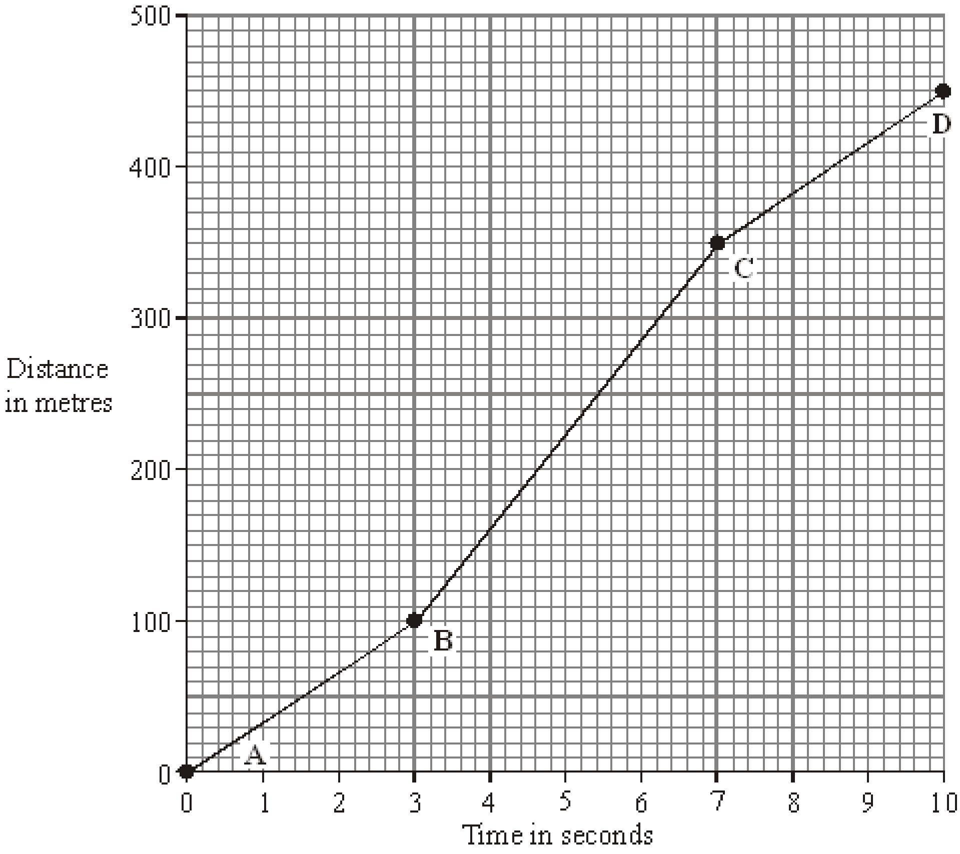
(ii) During the last minute of the journey the velocity of the car changes although the speed remains constant. How is this possible?

....

.... **(1)**

(Total 4 marks)

Q3. The distance-time graph represents the motion of a car during a race.



(a) Describe the motion of the car between point **A** and point **D**. You should not carry out any calculations.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

....

....

....

....

....

(3)

(b) Calculate the gradient of the graph between point **B** and point **C**. Show clearly how you get your answer.

....

....

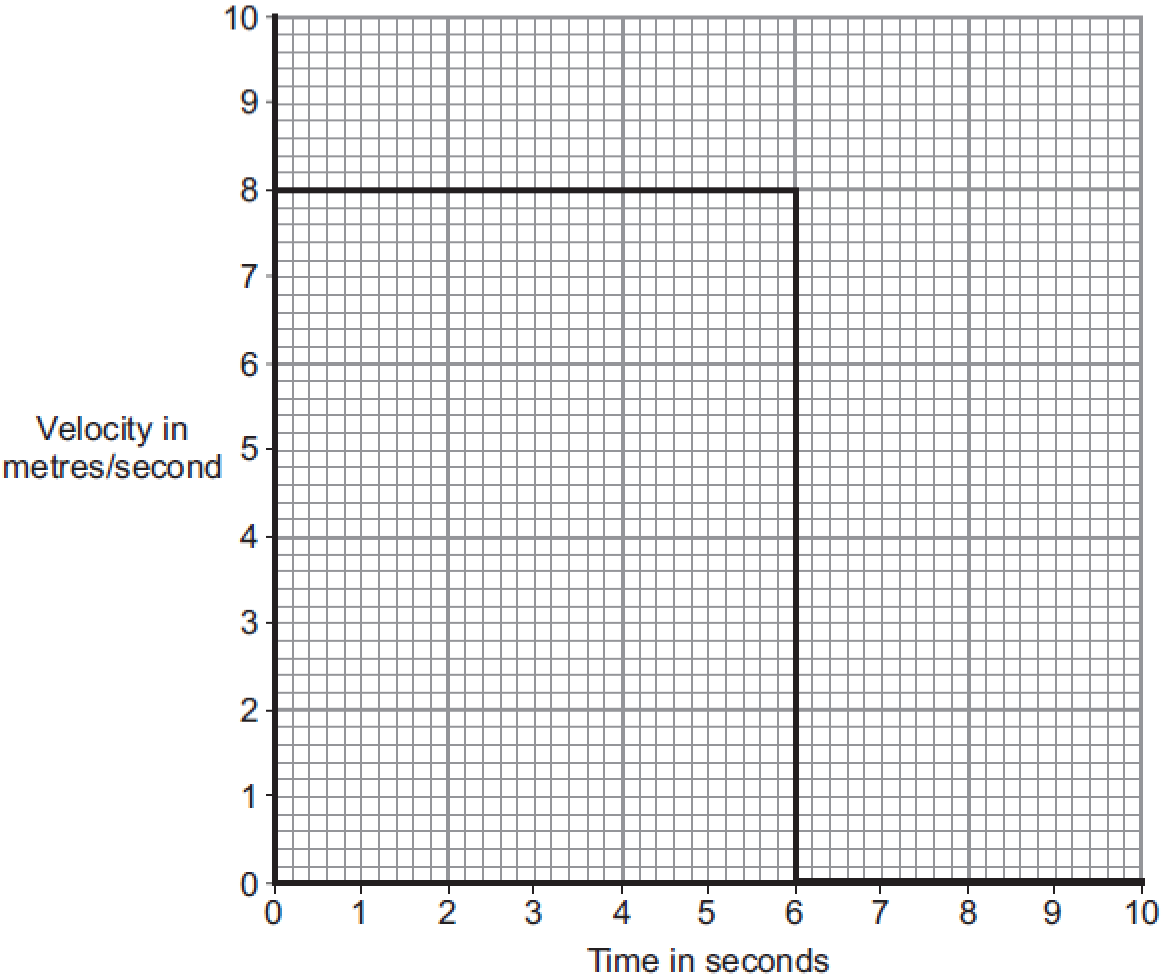
....

gradient = ...

(3)

(Total 6 marks)

Q4. 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.

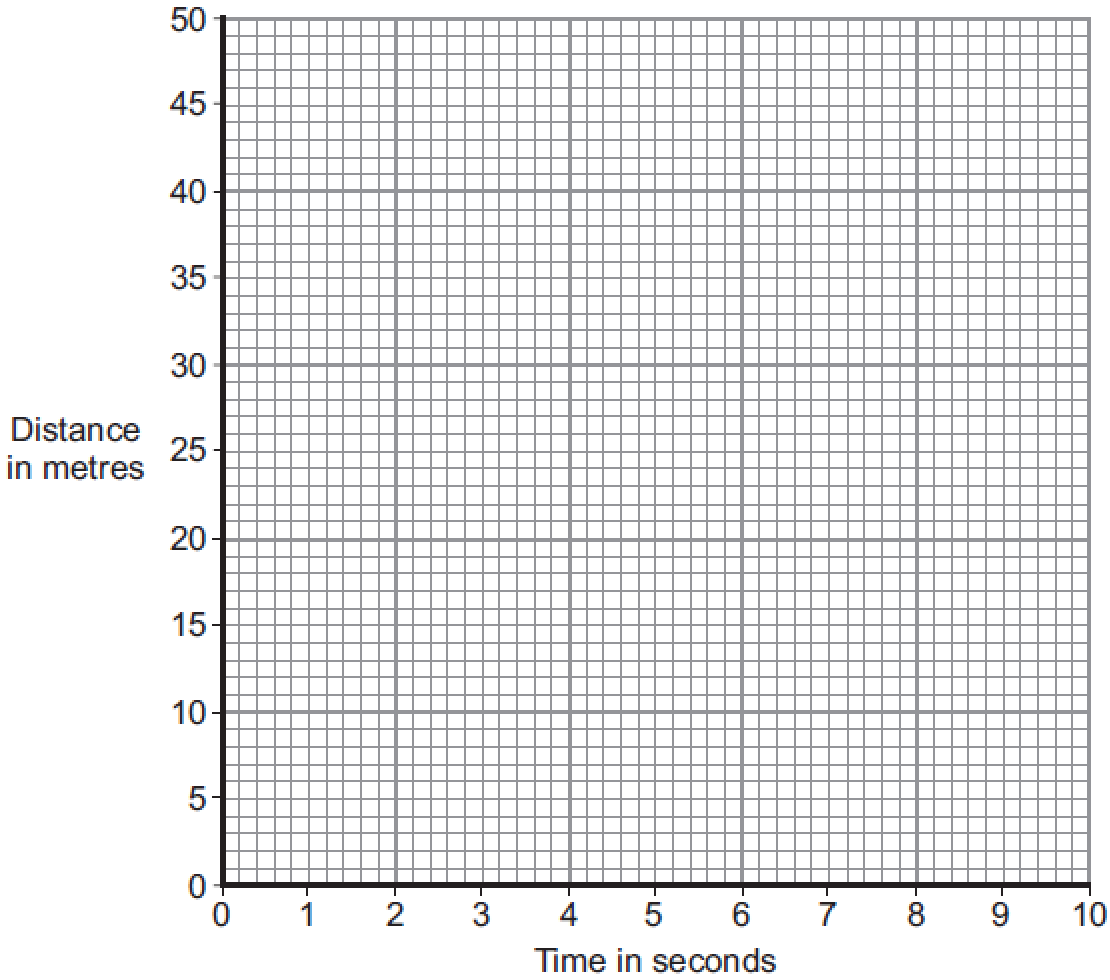
....

....

Distance = ... m

(2)

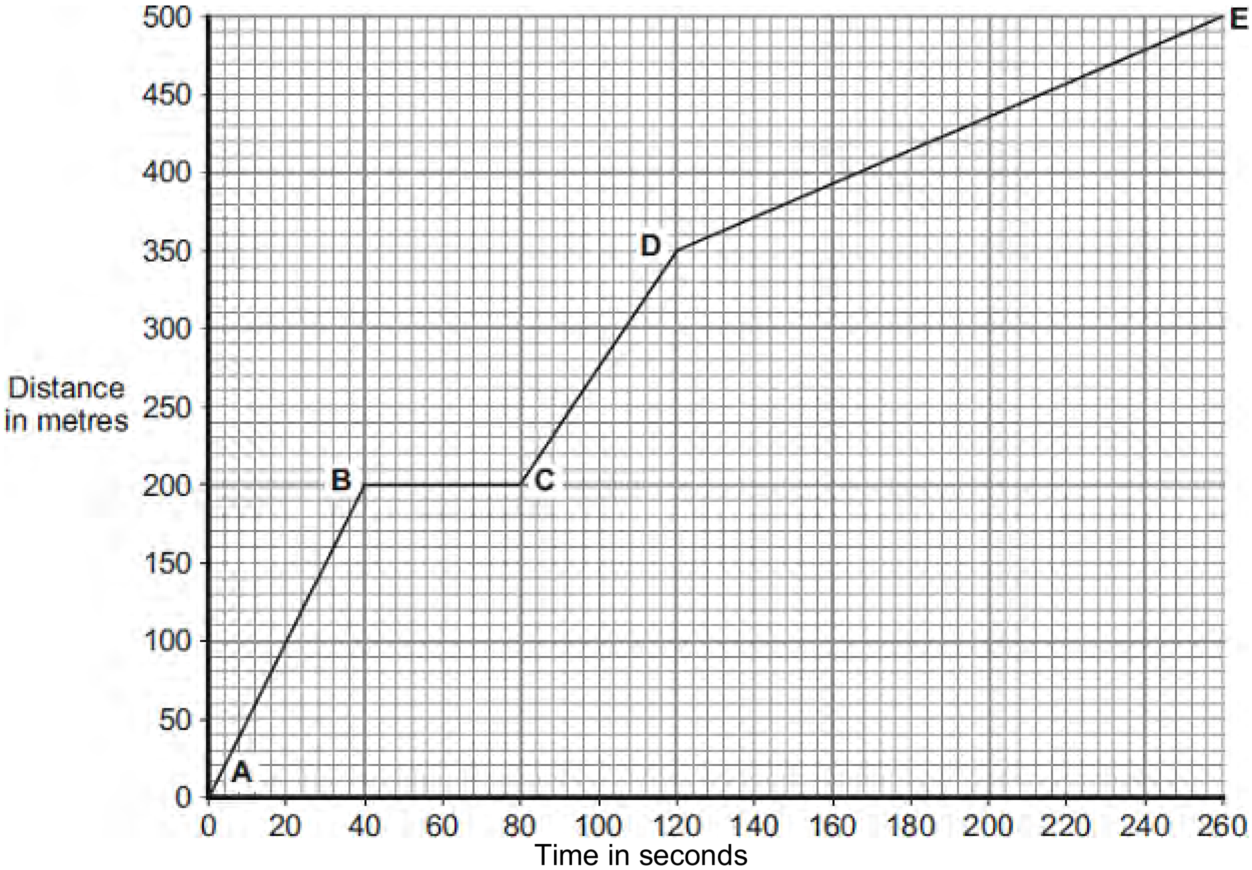
(b) Complete the distance-time graph for the object over the same 10 seconds.



(2)
(Total 4 marks)

Q5. 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)

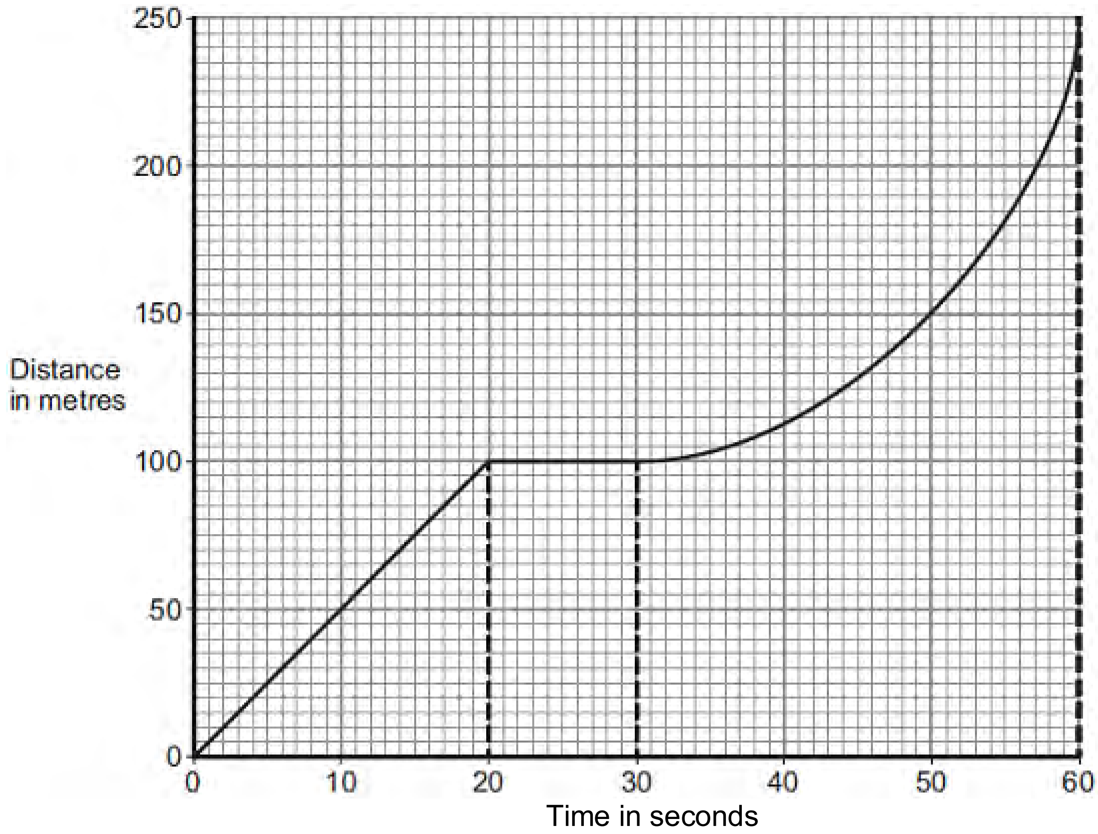
(ii) After how many seconds did the cyclist overtake the bus?

The cyclist overtook the bus after .... seconds.

(1)
(Total 7 marks)

Q6. 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)

M1. (a) (i) **E-F** (ticked)

1

(ii) **B-C or D-E**

accept both answers

1

(b) fast(er)

accept downhill

1

slow(er)

1

force

*do **not** accept distance*

1

[5]

M2. (a) 53 (m)

1

(b) (i) Similar shape curve drawn <u>above</u> existing line going <u>through (0, 0)</u>

*allow **1** mark for any upward smooth curve or straight upward line above existing line going through (0, 0)*

2

(ii) rain on road

1

car brakes in bad condition

1

(c) (i) all three lines correctly labelled

*allow **1** mark for one correctly labelled*

top line – C

accept 1.2

middle line – B

accept 0.9

bottom line – A

accept 0.7

2

(ii) any **two** from:

- (table has) both variables are together
  accept tired and music as named variables
- both (variables) could/ would affect the reaction time
- cannot tell original contribution
  accept cannot tell which variable is affecting the drive (the most)
- need to measure one (variable) on its own
  accept need to test each separately
- need to control one of the variables

2

[9]

M3. (a) MN

accept 5.8, 8 seconds must include unit

1

(b) LM

accept 0.8, 5.8 seconds must include unit

1

(c) (i) 0.8

1

(ii) drinking alcohol

1

(d) <u>straight</u> (by eye) line starting at 0.8 seconds

1

line drawn steeper than LM starting before L

ignore lines going beyond 2 seconds but line must exceed 2.5 metres per second before terminating

1

[6]

M4. (a) time 1

force 1

(b) any **three** from

- driver's reactions are slow(er)

  *accept driver could have taken drugs **or** alcohol **or** due to tiredness **or** distractions*

- poor weather conditions

  *accept raining **or** snowing **or** fog / mist (poor visibility)*

- greater mass **or** weight
- poor road conditions

  oil / gravel / mud / leaves / wet / icy going downhill

- poorly maintained brakes

  *do **not** accept driver's weak foot force*

- worn tyres

3

[5]

M5. (a) 96 (m)

1

(b) (i) similar shape curve drawn <u>above</u> existing line going <u>through (0,0)</u>

*allow **1** mark for any upward smooth curve or straight upward line <u>above</u> existing line going through (0,0)*

2

(ii) Rain on the road

1

(c) (i) all three lines correctly labelled

*allow **1** mark for one correctly labelled*

top line – **C**

accept 1.2

middle line – **B**

accept 0.9

bottom line – **A**

accept 0.7

2

(ii) any **two** from:

- (table has) <u>both</u> variables are together
  accept tired and music as named variables
- both (variables) could / would affect the reaction time
  accept cannot tell which variable is affecting the drive (the most)
- cannot tell original contribution
- need to measure one (variable) on its own
  accept need to test each separately
- need to control one of the variables
  fair test is insufficient

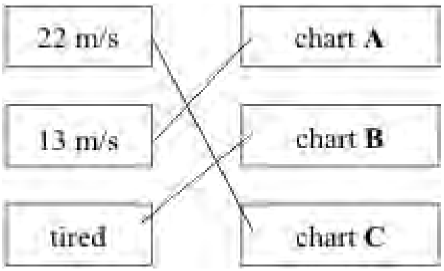
2

[8]

M6. (a) (i) constant 1

(ii) heat 1

(b) (i) 3 links correct



*allow **1** mark for 1 correct link*

if more than one line is drawn from a condition mark all lines from that condition incorrect

2

(ii) increased 1

[5]

M7. (a) distance travelled under the braking force

accept braking (distance)

1

(b) (directly) proportional

accept a correct description using figures

or

increase in the same ratio

eg if speed doubles then
thinking distance doubles
accept for ***1*** *mark positive correlation*
accept for ***1*** *mark as speed*
increases so does thinking distance
accept as one increases the other increases
accept as thinking distance increases speed increases

2

(c) (i) control variable

1

(ii) experiment done, student listens to music / ipod (etc)

1

experiment (repeated), student not listening to music

for both marks to be awarded there must be a comparison

1

(d) increase it

accept an answer which implies reactions are slower
do ***not*** *accept answers in terms of thinking distance only*

1

(e) **Y**

1

[8]

M8. (a) The driver has been drinking alcohol.

reason only scores if this box is ticked

1

driver's reaction time increases

accept slower reactions

accept slower reaction time

or thinking distance / stopping distance increases

do not accept braking distance increases

or driver less alert

accept driver may fall asleep / be tired

1

(b) they are all variables that could affect outcome / results

accept specific effect of changing one of the variables

accept to make the test valid

ignore reliable

1

so data / barriers can be compared

accept to see which is / works best / safest

do ***not*** *accept fair test on its own*

1

(c) ticks in both the top <u>and</u> middle boxes

1

[5]

M9. (a) time

correct order only

1

force

1

(b) The car tyres being badly worn

1

(c) (i) braking distance increases with speed

accept positive correlation

*do **not** accept stopping distance for braking distance*

1

relevant further details, eg

- but not in direct proportion
- and increases more rapidly after 15 m/s

  accept any speed between 10 and 20

  accept numerical example
- double the speed, braking distance increases × 4

1

(ii) line drawn above existing line starting at the origin

as speed increases braking distance must increase
each speed must have a single braking distance

1

(d) (i) reaction time / reaction (of driver) does not depend on speed (of car)

1

(ii) (on the reduced speed limit roads) over the same period of time

accept a specific time, eg 1 year

1

monitor number of accidents before and after (speed limit reduced)

*allow **1** mark only for record number of vehicles / cars using the (20 mph) roads **or** collect data on accidents on the (20 mph) roads*

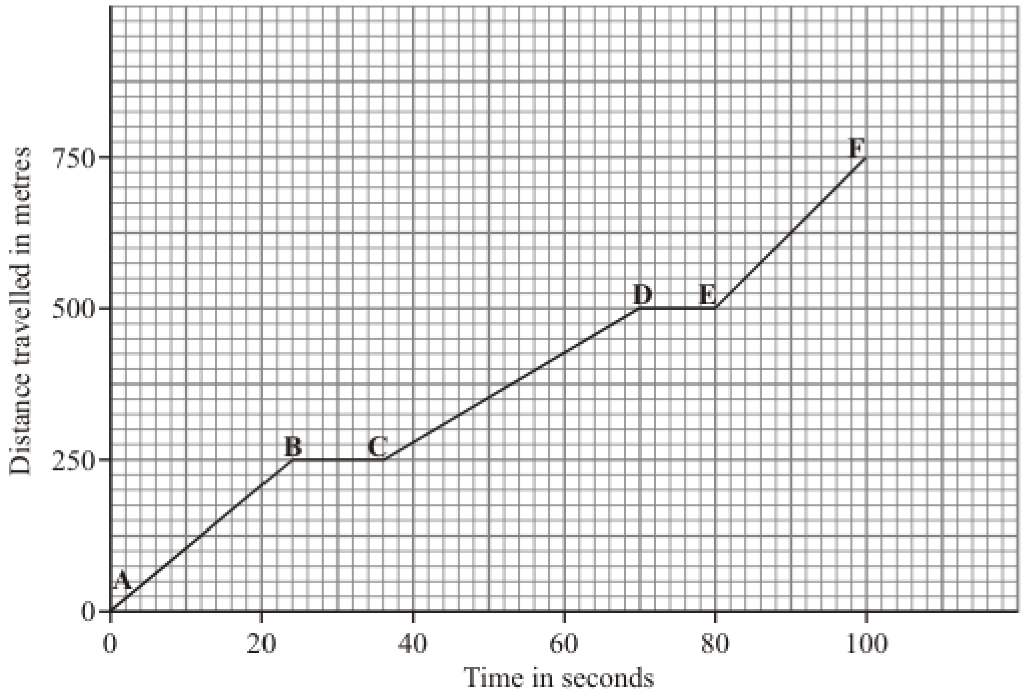
to score both marks the answer must refer to the roads with the reduced speed limit

1

[9]

Q1. This question is about a car travelling through a town.

(a) The graph shows how far the car travelled and how long it took.



(i) Between which points was the car travelling fastest? Tick (✓) your answer.

Points	Tick (✓)
A – B	
B – C	
C – D	
D – E	
E – F	

(1)

(ii) Between which points was the car stationary?

....

....

(1)

(b) Complete the sentences by writing the correct words in the spaces.

When a car has to stop, the **overall** stopping distance is greater if:

- the car is poorly maintained;
- there are adverse weather conditions;
- the car is travelling .... ;
- the driver's reactions are ....

Also, the greater the speed of the car, then the greater the braking ....

needed to stop in a certain time.

(3)
(Total 5 marks)

Q2. (a) A car driver makes an emergency stop.

The chart shows the 'thinking distance' and the 'braking distance' needed to stop the car.

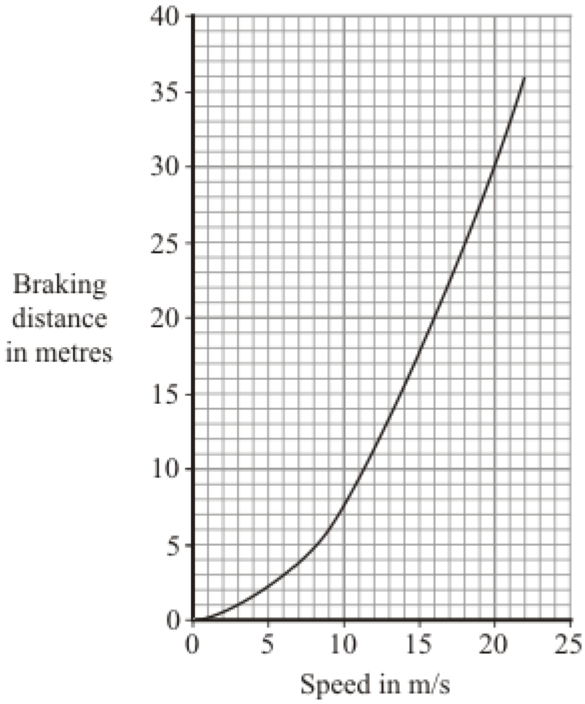
Calculate the total stopping distance of the car.

....

Stopping distance = ... m

(1)

(b) The graph shows how the braking distance of a car driven on a dry road changes with the car's speed.



The braking distance of the car on an icy road is longer than the braking distance of the car on a dry road.

(i) Draw a new line on the graph to show how the braking distance of the car on an icy road changes with speed.

(2)

(ii) Which **two** of the following would also increase the braking distance of the car?

Put a tick (✓) next to each of your answers.

rain on the road ☐

the driver having drunk alcohol ☐

car brakes in bad condition ☐

the driver having taken drugs ☐

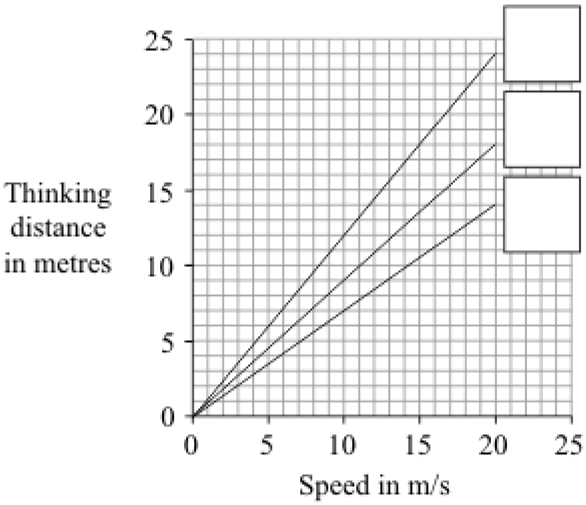
(2)

(c) The thinking distance depends on the driver's reaction time.

The table shows the reaction times of three people driving under different conditions.

Car driver	**Condition**	**Reaction time in seconds**
A	Wide awake with no distractions	0.7
B	Using a hands-free mobile phone	0.9
C	Very tired and listening to music	1.2

The graph lines show how the thinking distance for the three drivers, **A**, **B** and **C**, depends on how fast they are driving the car.



(i) Match each graph line to the correct driver by writing **A**, **B** or **C** in the box next to the correct line.

(2)

(ii) The information in the table cannot be used to tell if driver **C**'s reaction time is increased by being tired or by listening to music.

Explain why.

....

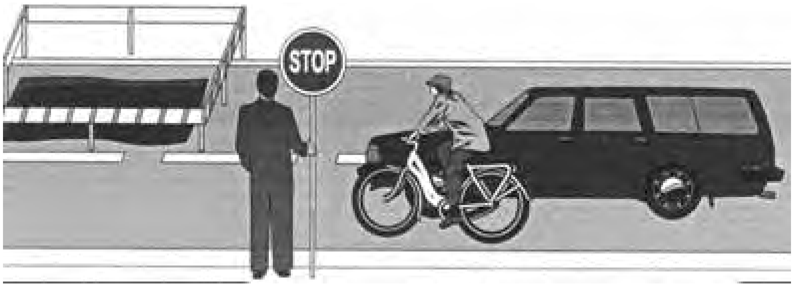
....

....

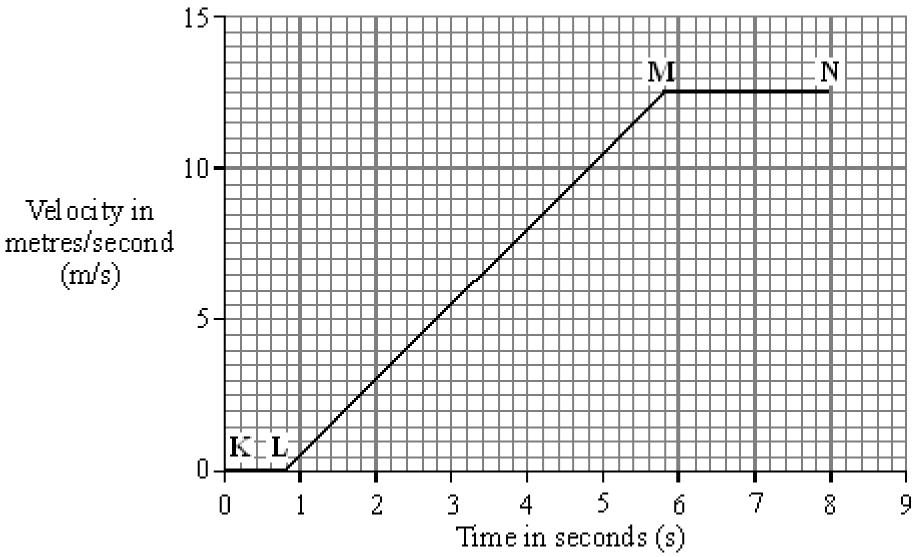
....

(2)
(Total 9 marks)

Q3. A car and a bicycle are travelling along a straight road. They have stopped at road works.



The graph shows how the velocity of the car changes after the sign is changed to GO.



(a) Between which two points on the graph is the car moving at constant velocity?

....

(1)

(b) Between which two points on the graph is the car accelerating?

....

(1)

(c) Between the sign changing to GO and the car starting to move, there is a time delay. This is called the reaction time.

(i) What is the reaction time of the car driver?

Reaction time = ... seconds

(1)

(ii) Which **one** of the following could increase the reaction time of a car driver? Tick the box next to your choice.

Drinking alcohol ☐

Wet roads ☐

Worn car brakes ☐

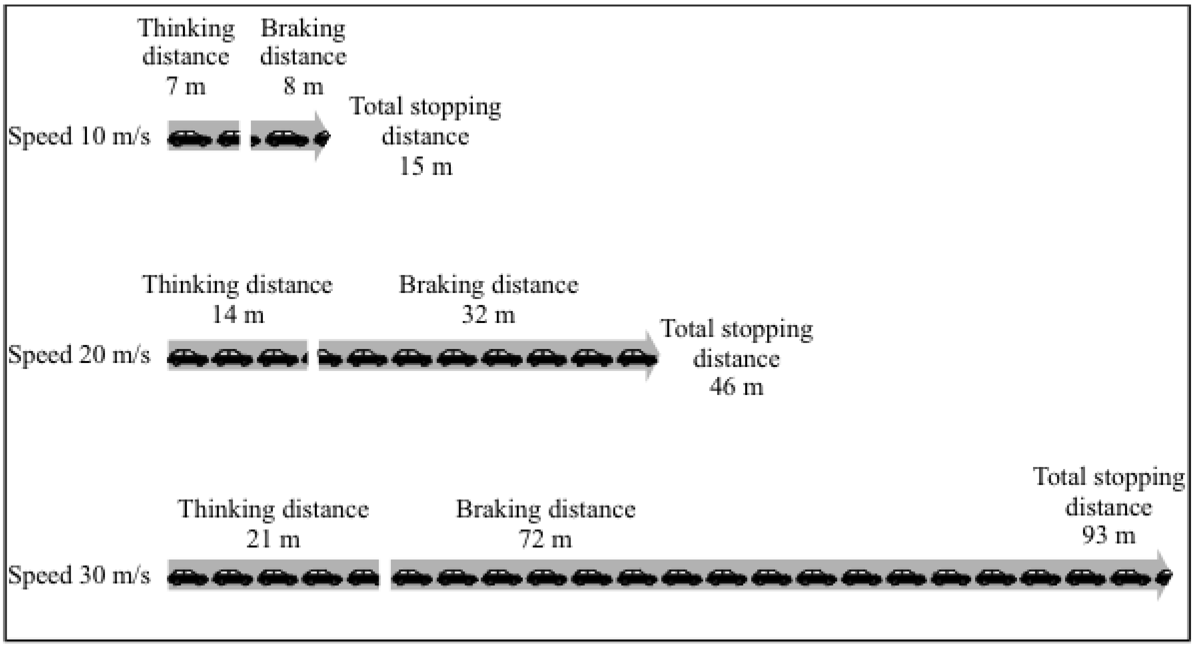
(1)

(d) The cyclist starts to move at the same time as the car. For the first 2 seconds the cyclist's acceleration is constant and is greater than that of the car.

Draw a line on the graph to show how the velocity of the cyclist might change during the first 2 seconds of its motion.

(2)
(Total 6 marks)

Q4. The diagram below shows the thinking distances, braking distances and total stopping distances at different speeds.



(a) Look at the total stopping distances at each speed.

Complete the sentence by choosing the correct words from the box.

distance	**force**	**mass**	**time**

The total stopping distance depends on the distance the car travels during the driver's reaction .... and under the braking ....

(2)

(b) Give **three** other factors that could cause the total stopping distance of a car to be greater. Do **not** give the factors in **Figure 1.**

1 ....

....

2 ....

....

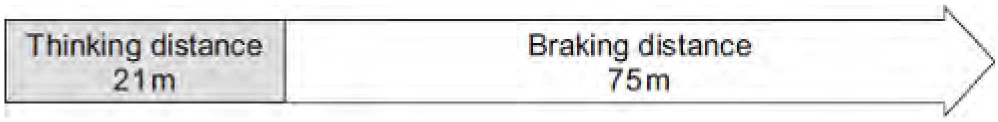
3 ....

....

(3)
(Total 5 marks)

Q5.(a) A car driver makes an emergency stop.

The chart shows the 'thinking distance' and the 'braking distance' needed to stop the car.



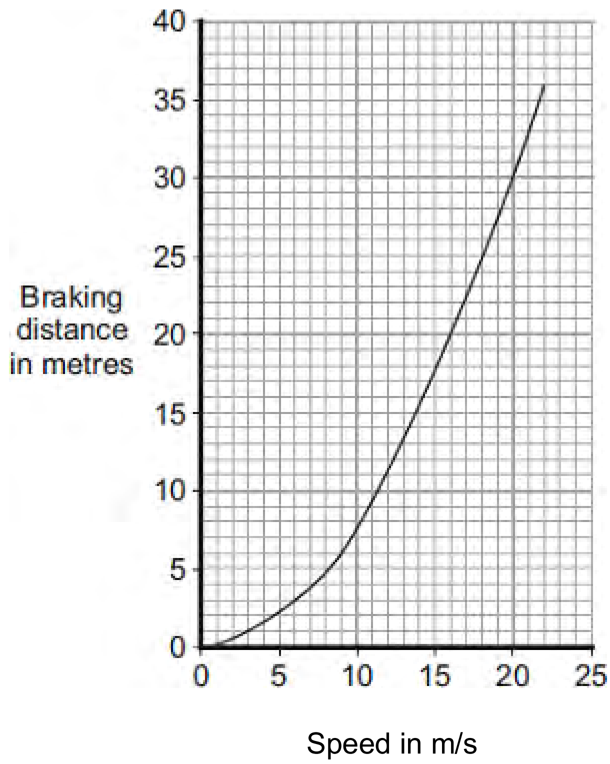
Calculate the total stopping distance of the car.

....

Stopping distance = ... m

(1)

(b) The graph shows how the braking distance of a car driven on a dry road changes with the car's speed.



The braking distance of the car on an icy road is longer than the braking distance of the car on a dry road.

(i) Draw a new line on the graph to show how the braking distance of the car on an icy road changes with speed.

(2)

(ii) Which **one** of the following would also increase the braking distance of the car?

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

Rain on the road	☐
The driver having drunk alcohol	☐
The driver having taken drugs	☐

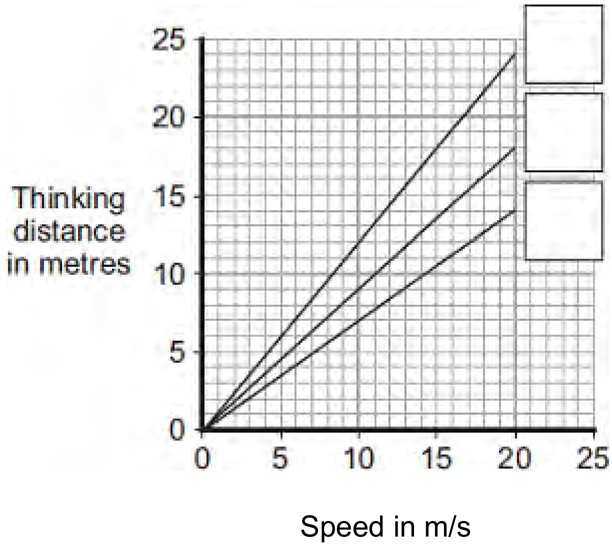
(1)

(c) The thinking distance depends on the driver's reaction time.

The table shows the reaction times of three people driving under different conditions.

Car driver	**Condition**	**Reaction time in second**
A	Wide awake with no distractions	0.7
B	Using a hands-free mobile phone	0.9
C	Very tired and listening to music	1.2

The graph lines show how the thinking distance for the three drivers, **A**, **B**, and **C**, depends on how fast they are driving the car.



(i) Match each graph line to the correct driver by writing **A**, **B**, or **C** in the box next to the correct line.

(2)

(ii) The information in the table cannot be used to tell if driver **C**'s reaction time is increased by being tired **or** by listening to music.
Explain why.

....

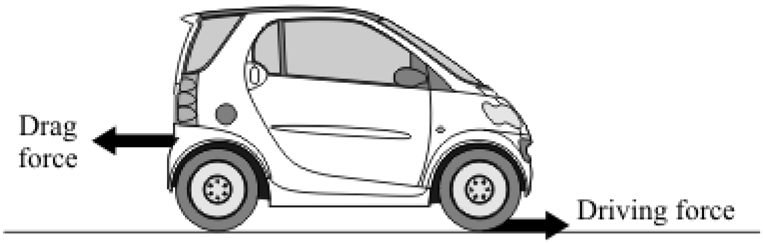
....

....

....

(2)
(Total 8 marks)

Q6. The diagram shows the horizontal forces acting on a car travelling along a straight road.



(a) Complete the following sentences by drawing a ring around the correct word in each box.

(i) When the driving force equals the drag force, the speed ofthe car is

decreasing
constant
increasing

(1)

(ii) Putting the brakes on transforms the car's kinetic energy mainly into

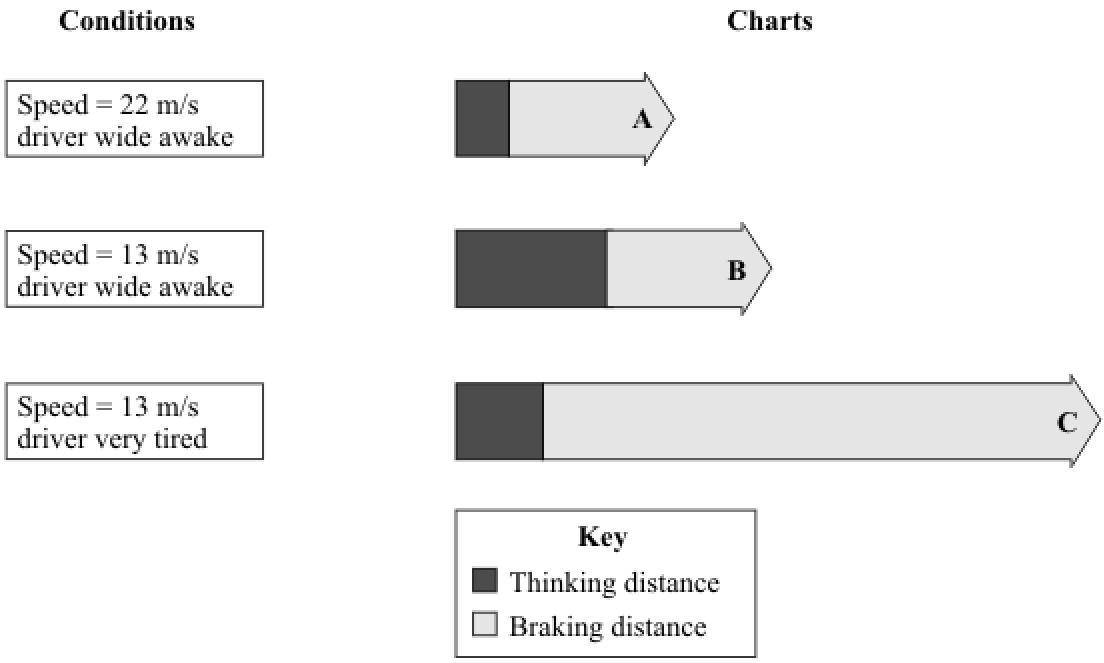
heat
light
sound

(1)

(b) The charts, **A**, **B** and **C** give the thinking distance and the braking distance for a car driven under different conditions.

(i) Draw straight lines to match each chart to the correct conditions.

Draw only **three** lines.



(2)

(ii) The three charts above all apply to dry road conditions.

How would the braking distances be different if the road were wet?

....

....

(1)
(Total 5 marks)

Q7. (a) The total stopping distance of a car has two parts. One part is the distance the car travels during the driver's reaction time. This distance is often called the 'thinking distance'.

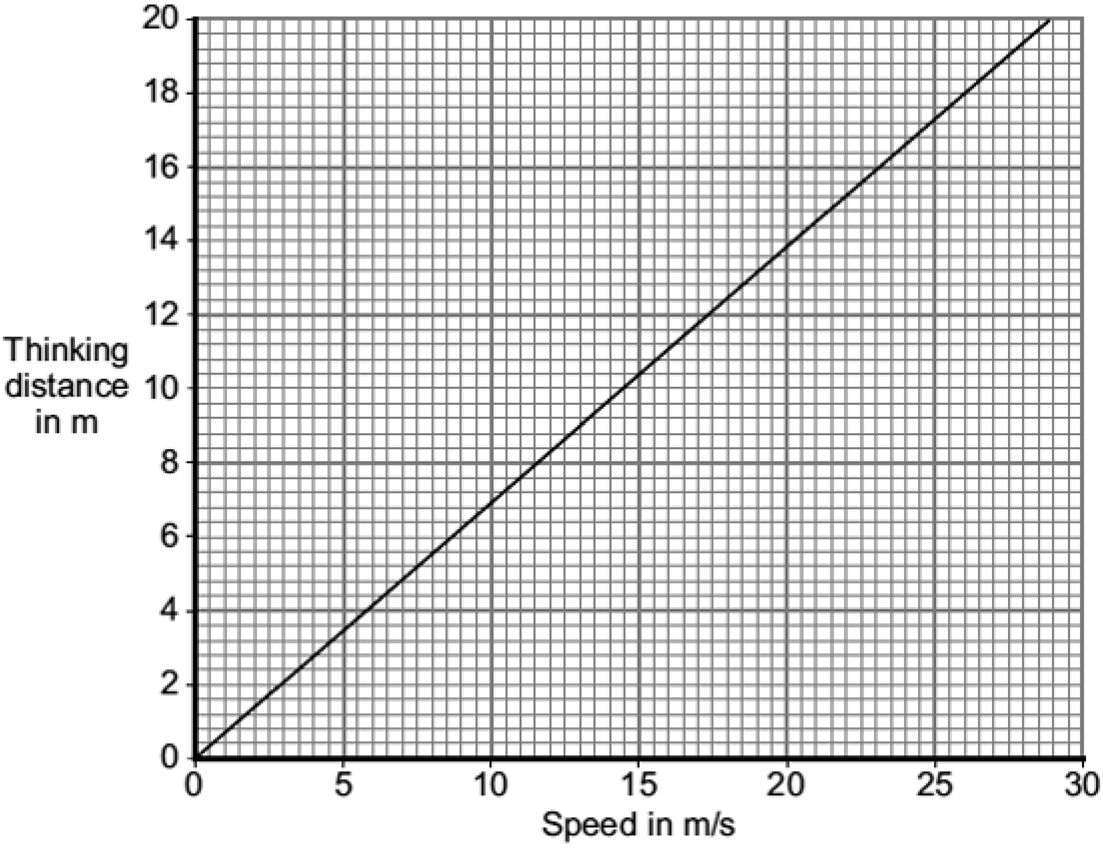
What distance is added to the 'thinking distance' to give the total stopping distance?

....

....

(1)

(b) The graph shows the relationship between the speed of a car and the thinking distance.



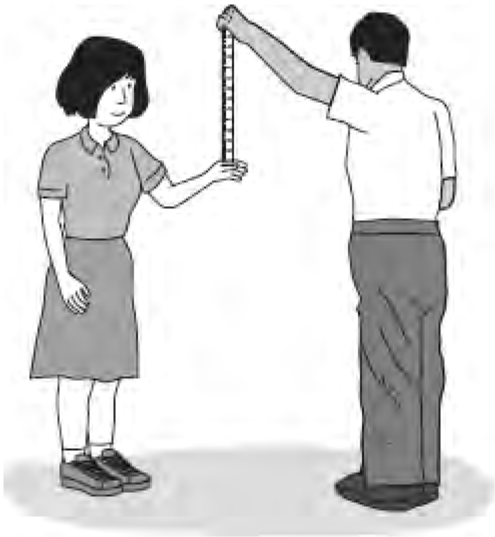
Describe the relationship between speed and thinking distance.

....

....

(2)

(c) The diagram shows two students investigating reaction time.



One student holds a 30 cm ruler, then lets go. As soon as the second student sees the ruler fall, she closes her hand, stopping the ruler. The further the ruler falls before being stopped, the slower her reaction time.

(i) One student always holds the ruler the same distance above the other student's hand.
In this experiment, what type of variable is this?

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

☐

dependent variable_☐

control variable_☐

(1)

(ii) Describe how this experiment could be used to find out whether listening to music affects reaction time.

....

....

....

....

(2)

(d) The following information is written on the label of some cough medicine.

WARNING: Causes drowsiness. Do not drive or operate machinery.

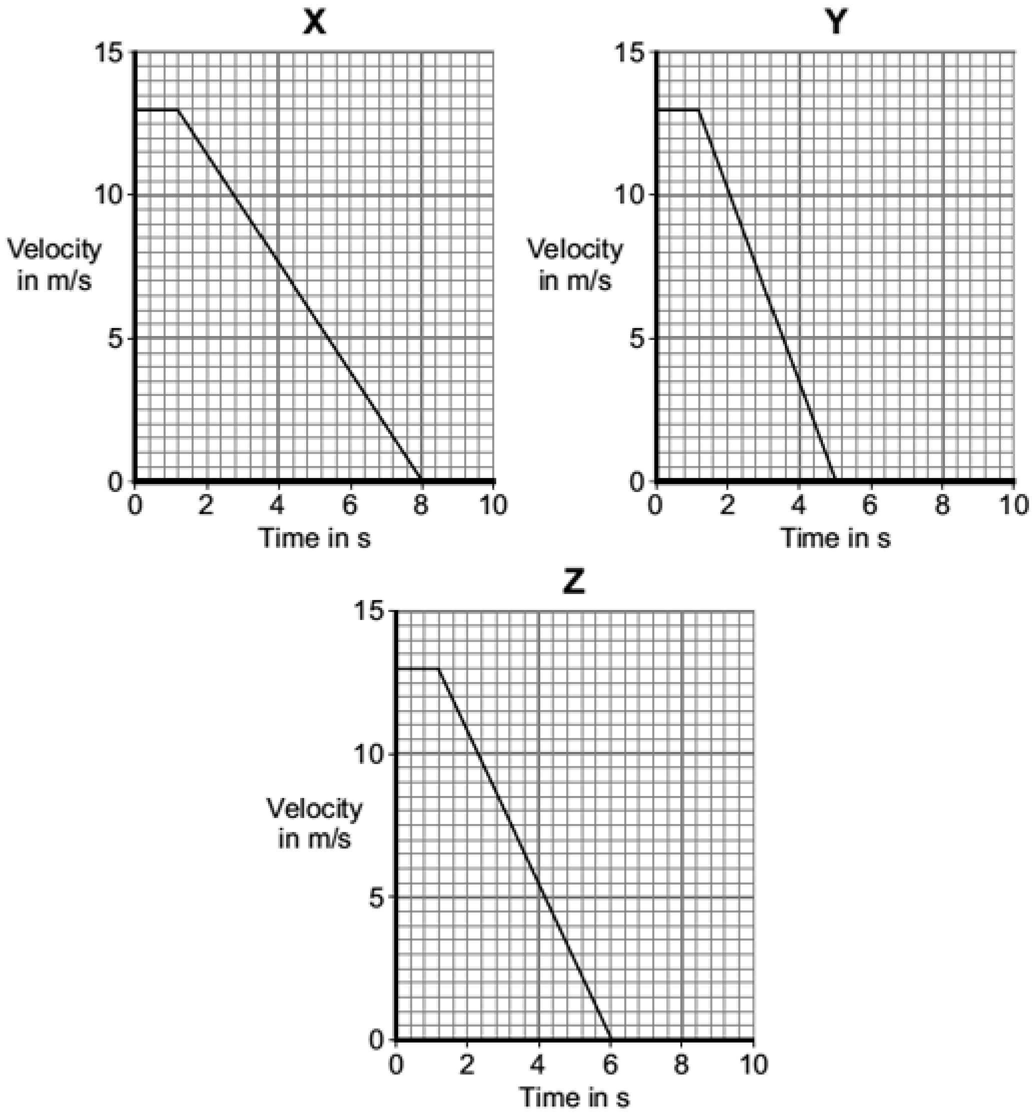
How is feeling drowsy (sleepy) likely to affect a driver's reaction time?

....

....

(1)

(e) Three cars, **X**, **Y** and **Z** , are being driven along a straight road towards a set of traffic lights.
The graphs show how the velocity of each car changes once the driver sees that the traffic light has turned to red.



Which one of the cars, **X**, **Y** or **Z** , stops in the shortest distance?

....

(1)
(Total 8 marks)

Q8. Motorway accidents have many causes.

(a) Which **one** of the following is most likely to increase the chance of a car being in an accident?

Tick (✓) the box next to your answer.

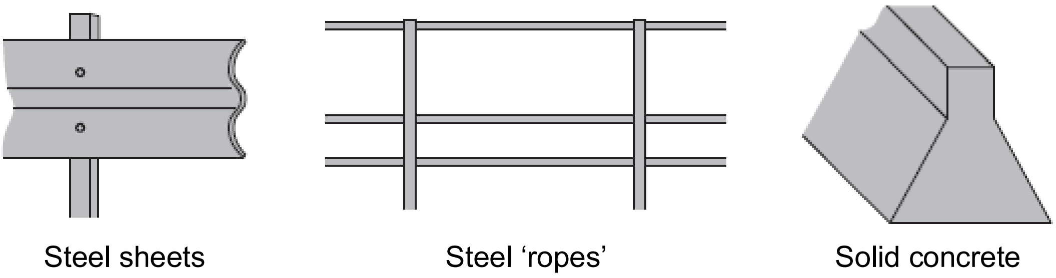
The car has just had new tyres fitted.	☐
The driver has been drinking alcohol.	☐
A road surface in dry conditions	☐

Give a reason for your answer.

....

.... **(2)**

(b) The diagram shows three designs of motorway crash barriers.



Before a new design of barrier is used, it must be tested.
A car of mass 1500 kg is driven at 30 m/s to hit the barrier at an angle of 20 degrees.
This barrier must slow the car down and must not break.

Explain why the mass of the car, the speed of the car and the angle at which the car hits the barrier must be the same in every test.

....

....

....

....

....

(2)

(c) A group of scientists has suggested that new designs of crash barriers should be first tested using computer simulations.

Which **two** statements give sensible reasons for testing new barrier designs using a computer simulation?

Put a tick (✓) in the box next to each of your answers.

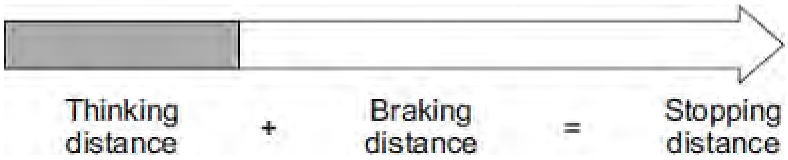
The design of the barrier can be changed easily. ☐

Data for different conditions can be obtained quickly. ☐

Simulations are more realistic than using cars and barriers. ☐

(1)
(Total 5 marks)

Q9. The diagram shows how the thinking distance and braking distance of a car add together to give the stopping distance of the car.



(a) Use words from the box to complete the sentence.

distance	**energy**	**force**	**time**

The stopping distance is found by adding the distance the car travels during the driver's reaction .... and the distance the car travels under the braking ....

(2)

(b) Which **one** of the following would **not** increase the thinking distance?

Tick (✓) **one** box.

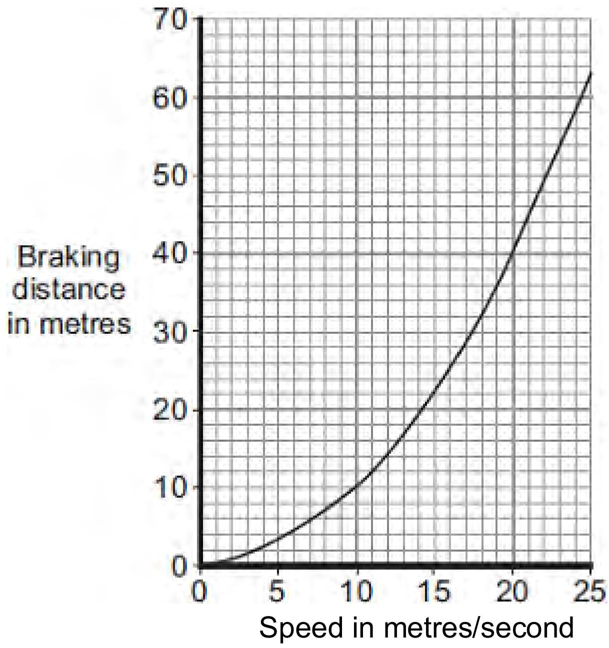
The car driver being tired. ☐

The car tyres being badly worn. ☐

The car being driven faster. ☐

(1)

(c) The graph shows how the braking distance of a car changes with the speed of the car.
The force applied to the car brakes does not change.



(i) What conclusion about braking distance can be made from the graph?

....

....

....

....

(2)

(ii) The graph is for a car driven on a dry road.

Draw a line on the graph to show what is likely to happen to the braking distance at different speeds if the same car was driven on an icy road.

(1)

(d) A local council has reduced the speed limit from 30 miles per hour to 20 miles per hour on a few roads. The reason for reducing the speed limit was to reduce the number of accidents.

(i) A local newspaper reported that a councillor said:

"It will be much safer because drivers can react much faster when driving at 20 miles per hour than when driving at 30 miles per hour."

This statement is wrong. Why?

....

....

(1)

(ii) The local council must decide whether to introduce the lower speed limit on a lot more roads.

What evidence should the local council collect to help make this decision?

....

....

....

....

(2)
(Total 9 marks)

M1. (a) increases

1

increases

1

(b) 23 (m)

*accept 43 circled for **1** mark*
*accept 9 + 14 for **1** mark*

2

(c) (i) all points correctly plotted

all to ± ½ small square
*one error = **1** mark*
*two or more errors = **0** marks*

2

line of best fit

1

(ii) correct value from their graph (± ½ small square)

1

(d) (i) 70

*½ × 35 × 4 gains **2** marks*
*attempt to estimate area under the graph for **1** mark*

3

(ii) line from (0.6,35)

1

sloping downwards with a less steep line than the first line

1

cutting time axis at time > 4.6 s

accept cutting x-axis at 6

1

(e) (i) 42 000

*1200 × 35 gains **1** mark*

2

kgm / s

Ns

1

(ii) 10 500 (N)

*42 000 / 4 gains **1** mark*

alternatively:

$a = 35 / 4 = 8.75\ m / s^2$

$F = 1200 \times 8.75$

2

[19]

M2. (a) (i) as one goes up so does the other

or (directly) proportional

accept change by the same ratio

1

(ii) steeper straight line through the origin

judge by eye

1

(iii) Yes with reason

eg data would have been checked / repeated

accept produced by a reliable/ official/ government source

*do **not** accept it needs to be reliable*

or No with reason

eg does not apply to all conditions / cars / drivers

or are only average values

or Maybe with a suitable reason

eg cannot tell due to insufficient information

1

(b) (i) stopping distance = thinking distance + braking distance

1

(ii) any **two** from:

factors must be to do with increasing braking distance

- smooth road / loose surface
- rain / snow / ice

  accept wet road/ petrol spills

  *do **not** accept condition of road unless suitably qualified*
- badly maintained brakes

  accept worn brakes

  accept bad/ worn/ rusty brakes

  *do **not** accept old brakes*

- worn tyres

  accept bald tyres
  accept lack of grip on tyres
  *do **not** accept old tyres*

- downhill slope/gradient

- heavily loaded car

2

[6]

M3. (a) **A** constant speed / velocity

accept steady pace

*do **not** accept terminal velocity*

*do **not** accept stationary*

1

B acceleration

accept speeding up

1

C deceleration

accept slowing down

accept accelerating backwards

accept accelerating in reverse

*do **not** accept decelerating backwards*

1

(b) (i) the distance the car travels under the braking force

accept braking <u>distance</u>

1

(ii) speed/velocity/momentum

1

(c) (i) 5000 (N) to the left

***both** required*

accept 5000(N) with the direction indicated by an arrow drawn pointing to the left

accept 5000(N) in the opposite direction to the force of the car (on the barrier)

accept 5000(N) towards the car

1

(ii) to measure/detect forces exerted (on dummy / driver during the collision)

1

(iii) 4

*allow **1** mark for showing a triangle drawn on the straight part of the graph*

***or** correct use of two pairs of coordinates*

2

m/s^2

*do **not** accept mps^2*

1

[10]

M4. (a) (i) *<u>gravitational potential</u> (energy)* **1**

(ii) *<u>kinetic</u> (energy)* **1**

(b) (i) *slope or gradient* **1**

(ii) *<u>area</u> (under graph)*

*do **not** accept region* **1**

(iii) *starts at same y−intercept* **1**

steeper slope than original and cuts time axis before original

the entire line must be below the given line

allow curve **1**

(c) (i) *31*

and

31

*correct answers to 2 significant figures gains **3** marks even if no working shown*

*both values to more than 2 significant figures gains **2** marks:*

30.952…...

30.769….

65 / 2.1 and / or

*80 / 2.6 gains **1** mark*

*if incorrect answers given but if both are to 2 significant figures allow **1** mark* **3**

(ii) *student 1 incorrect because 80 ≠ 65* **1** *student 2 correct because average velocities similar*

*ecf from **(c)(i)*** 1

student 3 incorrect because times are different 1

[12]

M5. (a) *gravitational / gravity / weight*

*do **not** accept gravitational potential*

1

(b) *accelerating*

accept speed / velocity increases

1

the distance between the drops increases

1

but the time between the drops is the same

accept the time between drops is (always) 5 seconds
accept the drops fall at the same rate

1

(c) (i) *any **one** from:*

- *speed / velocity*
- *(condition of) brakes / road surface / tyres*
- *weather (conditions)*

accept specific examples, eg wet / icy roads

accept mass / weight of car friction is insufficient

reference to any factor affecting thinking distance negates this answer

1

(ii) *75 000*

*allow **1** mark for correct substitution, ie 3000 × 25 provided no subsequent step shown*

***or** allow **1** mark for an answer 75**or** allow **2** marks for 75 k(+ incorrect unit), eg 75 kN*

2

joules / J

*do **not** accept j*

*an answer 75 kJ gains **3** marks*

for full marks the unit and numerical answer must be consistent

1

[8]

Q1. An investigation was carried out to show how thinking distance, braking distance and stopping distance are affected by the speed of a car.

The results are shown in the table.

Speed in metres per second	**Thinking distance in metres**	**Braking distance in metres**	**Stopping distance in metres**
10	6	6	12
15	9	14	43
20	12	24	36
25	15	38	53
30	18	55	73

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

As speed increases, thinking distance

decreases.
increases.
stays the same.

As speed increases, braking distance

decreases.
increases.
stays the same.

(2)

(b) One of the values of stopping distance is incorrect.

Draw a ring around the incorrect value in the table.

Calculate the correct value of this stopping distance.

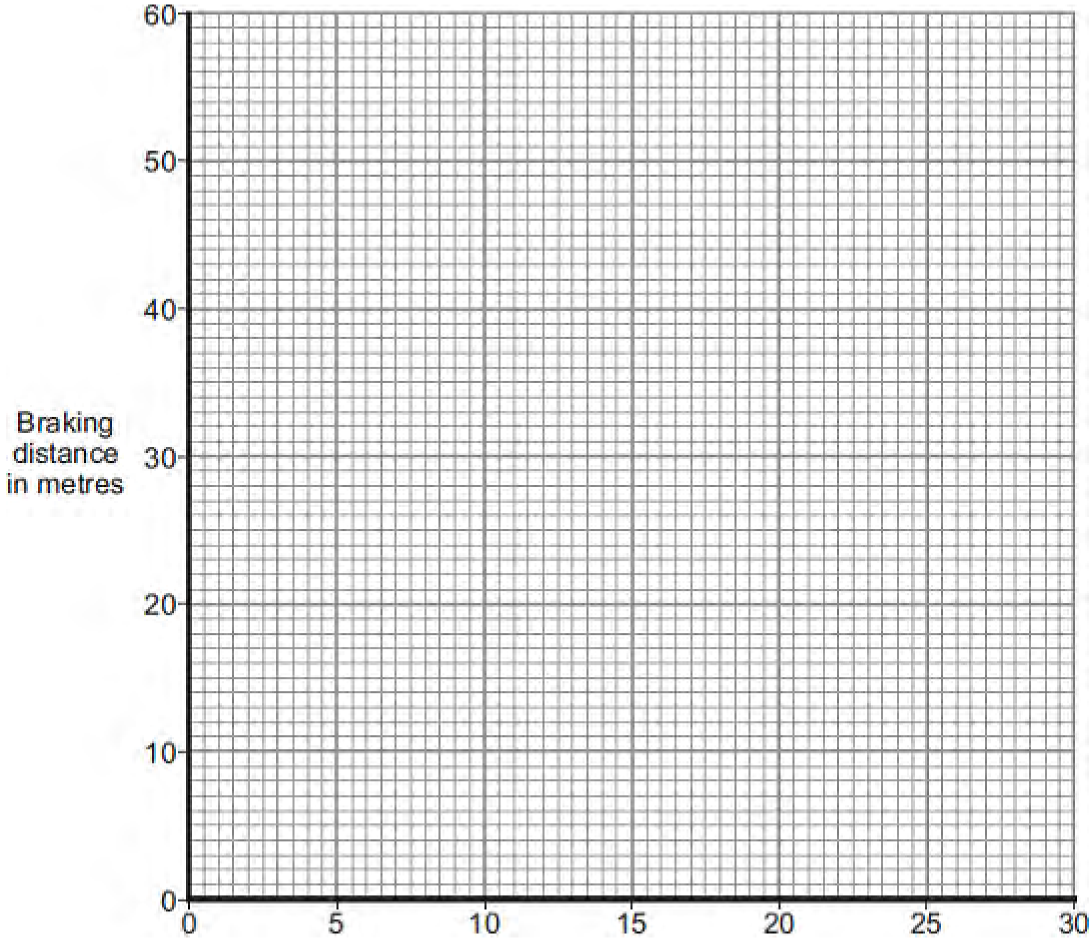
....

Stopping distance = ... m

(2)

(c) (i) Using the results from the table, plot a graph of braking distance against speed.

Draw a line of best fit through your points.



Speed in metres per second

(3)

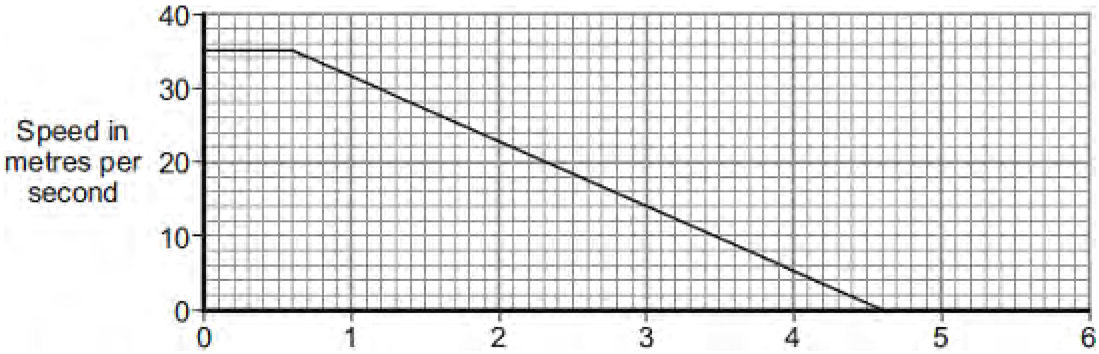
(ii) Use your graph to determine the braking distance, in metres, at a speed of 22 m / s.

Braking distance = ... m

(1)

(d) The speed–time graph for a car is shown below.

While travelling at a speed of 35 m / s, the driver sees an obstacle in the road at time t = 0. The driver reacts and brakes to a stop.



Time in seconds

(i) Determine the braking distance.

....

....

....

....

Braking distance = ... m

(3)

(ii) If the driver was driving at 35 m / s on an icy road, the speed–time graph would be different.

Add another line to the speed–time graph above to show the effect of travelling at 35 m / s on an icy road and reacting to an obstacle in the road at time t = 0.

(3)

(e) A car of mass 1200 kg is travelling with a velocity of 35 m / s.

(i) Calculate the momentum of the car.

Give the unit.

....

....

....

Momentum = ...

(3)

(ii) The car stops in 4 seconds.

Calculate the average braking force acting on the car during the 4 seconds.

....

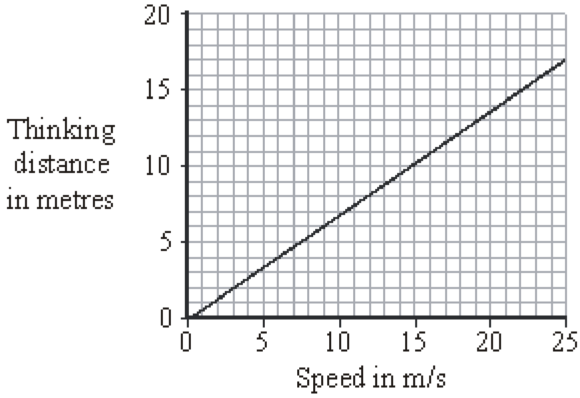
....

Force = ... N

(2)
(Total 19 marks)

Q2. (a) A car driver takes a short time to react to an emergency before applying the brakes. The distance the car will travel during this time is called the ‘thinking distance’.

The graph shows how the thinking distance of a driver depends on the speed of the car.



(i) What is the connection between thinking distance and speed?

....

(1)

(ii) Many people drive while they are tired.

Draw a new line on the graph to show how thinking distance changes with speed for a tired driver.

(1)

(iii) The graph was drawn using data given in the Highway Code.

Do you think that the data given in the Highway Code is likely to be reliable?

Draw a ring around your answer.

Yes **No** **Maybe**

Give a reason for your answer.

....

....

(1)

(b) The distance a car travels once the brakes are applied is called the 'braking distance'.

(i) What is the relationship between thinking distance, braking distance and stopping distance?

....

(1)

(ii) State **two** factors that could increase the braking distance of a car at a speed of
15 m/s.

1 ....

2 ....

(2)
(Total 6 marks)

Q3. (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**.

....

....

....

....

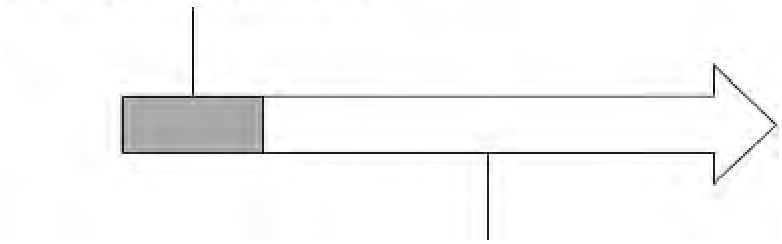
....

....

(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.



....

....

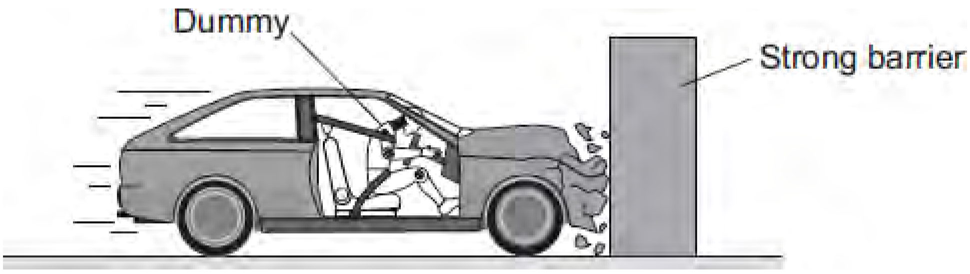
(1)

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

....

(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.

....

....

(1)

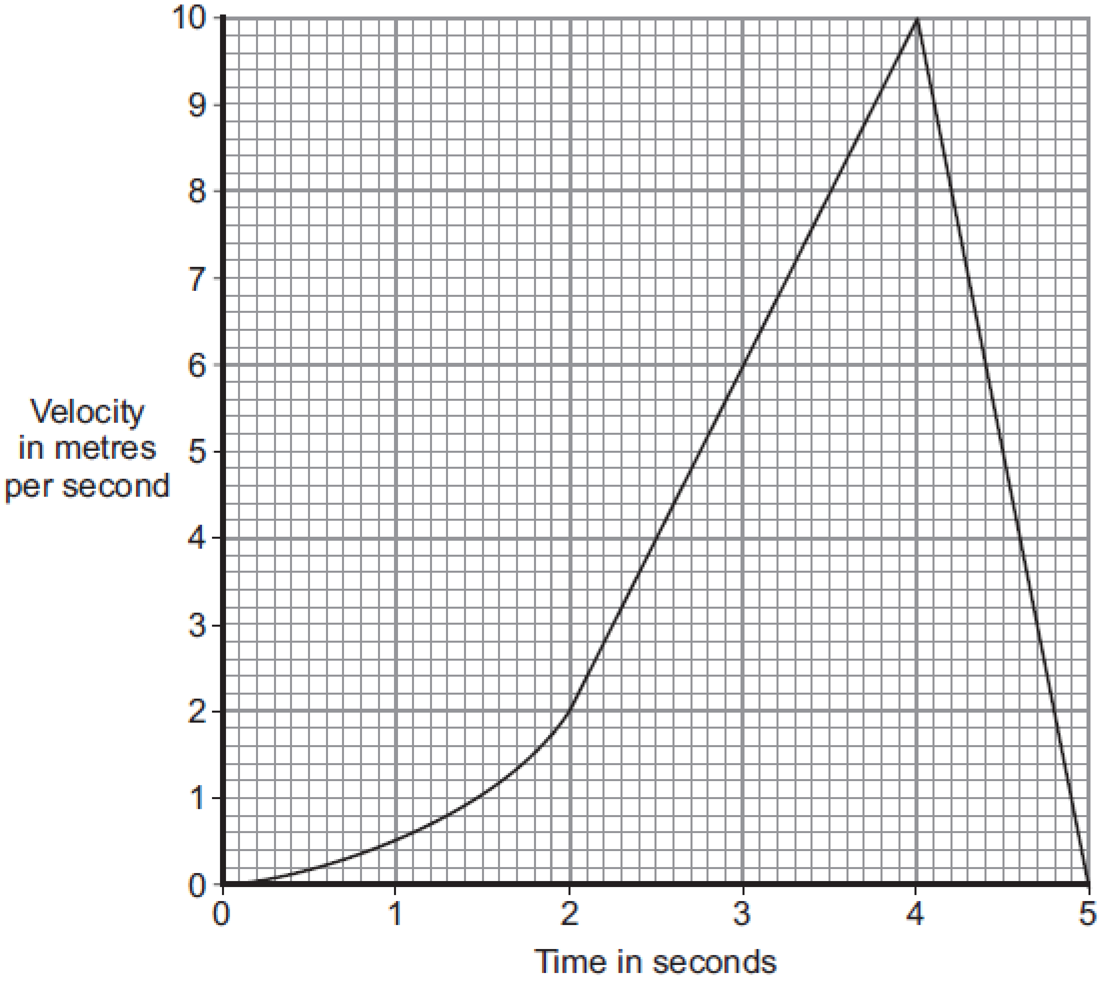
(ii) Suggest why the dummy is fitted with electronic sensors.

....

....

(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.

....

....

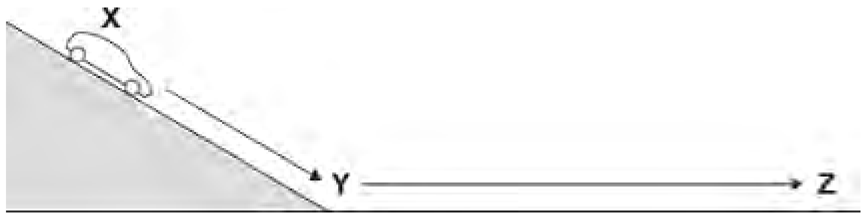
....

....

Acceleration = ...

(3)
(Total 10 marks)

Q4.(a) The diagram shows a car at position **X**.



The handbrake is released and the car rolls down the slope to **Y**.
The car continues to roll along a horizontal surface before stopping at **Z**.
The brakes have **not** been used during this time.

(i) What type of energy does the car have at **X**?

....

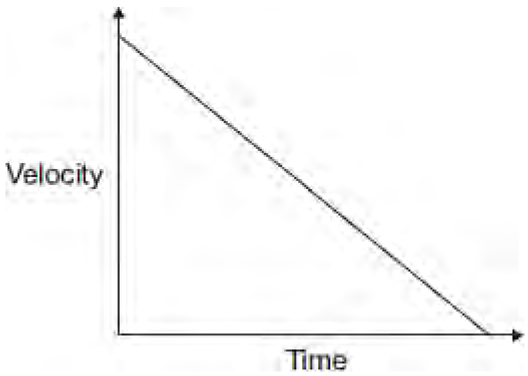
(1)

(ii) What type of energy does the car have at **Y**?

....

(1)

(b) The graph shows how the velocity of the car changes with time between **Y** and **Z**.



(i) Which feature of the graph represents the negative acceleration between **Y** and **Z**?

....

(1)

(ii) Which feature of the graph represents the distance travelled between **Y** and **Z**?

....

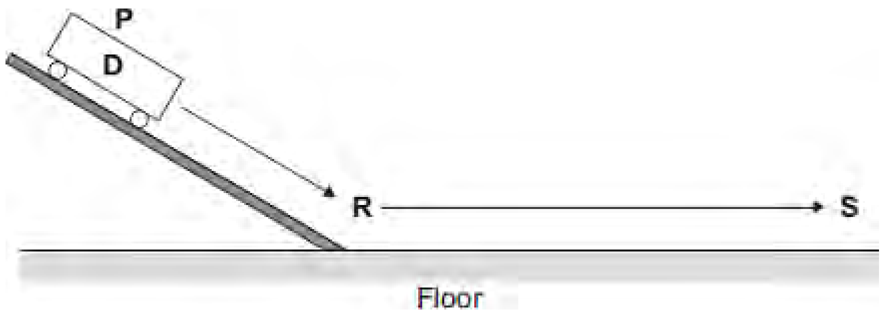
(1)

(iii) The car starts again at position **X** and rolls down the slope as before. This time the brakes are applied lightly at **Y** until the car stops.

Draw on the graph another straight line to show the motion of the car between **Y** and **Z**.

(2)

(c) Three students carry out an investigation. The students put trolley **D** at position **P** on a slope. They release the trolley. The trolley rolls down the slope and along the floor as shown in the diagram.



The students measure the distance from **R** at the bottom of the slope to **S** where the trolley stops. They also measure the time taken for the trolley to travel the distance **RS**.
They repeat the investigation with another trolley, **E**.

Their results are shown in the table.

Trolley	Distance RS in centimetres	Time taken in seconds	Average velocity in centimetres per second
D	65	2.1	

E	80	2.6	

(i) Calculate the average velocity, in centimetres per second, between **R** and **S** for trolleys **D** and **E**. Write your answers in the table.

....

....

....

(3)

(ii) Before the investigation, each student made a prediction.

- Student **1** predicted that the two trolleys would travel the same distance.
- Student **2** predicted that the average velocity of the two trolleys would be the same.
- Student **3** predicted that the negative acceleration of the two trolleys would be the same.

Is each prediction correct?

Justify your answers.

....

....

....

....

....

....

(3)
(Total 12 marks)

Q5. A car has an oil leak. Every 5 seconds an oil drop falls from the bottom of the car onto the road.

(a) What force causes the oil drop to fall towards the road?

.... **(1)**

(b) The diagram shows the spacing of the oil drops left on the road during part of a journey

Describe the motion of the car as it moves from **A** to **B**.

....

Explain the reason for your answer.

....

....

....

.... **(3)**

(c) When the brakes are applied, a braking force slows down and stops the car.

(i) The size of the braking force affects the braking distance of the car.

State **one** other factor that affects the braking distance of the car.

.... **(1)**

(ii) A braking force of 3 kN is used to slow down and stop the car in a distance of 25 m.

Calculate the work done by the brakes to stop the car and give the unit.

....

....

....

Work done =... **(3)**

(Total 8 marks)

M1. (a) more streamlined

accept decrease surface area

1

air resistance is smaller (for same speed)

accept drag for air resistance

friction is insufficient

1

so reaches a higher speed (before resultant force is 0)

ignore reference to mass

1

(b) (i) 1.7

*allow **1** mark for correct method, ie* $\frac{5}{3}$

***or** allow **1** mark for an answer with more than 2 sig figs that rounds to 1.7*

***or** allow **1** mark for an answer of 17*

2

(ii) 7.5

*allow **1** mark for correct use of graph, eg* $\frac{1}{2} \times 5 \times 3$

2

(iii) air (resistance)

accept wind (resistance)

drag is insufficient

friction is insufficient

1

[8]

M2. (a) the distance travelled under the braking force

1

(b) the reaction time will increase

1

increasing the thinking distance (and so increasing stopping distance)

(increases stopping distance is insufficient)

1

(c) No, because although when the speed increases the thinking distance increases by the same factor the braking distance does not.

1

eg

increasing from 10 m / s to 20 m / s increases thinking distance from 6 m to 12 m but the braking distance increases from 6 m to 24 m

1

(d) If the sled accelerates the value for the constant of friction will be wrong.

1

(e) only a (the horizontal) component of the force would be pulling the sled forward

1

the vertical component of the force (effectively) lifts the sled reducing the force of the surface on the sled

1

(f) $-u^2 = 2 \times -7.2 \times 22$

award this mark even with 0^2 and / or the negative sign missing

1

u = 17.7(99)

1

18

1

*allow 18 with no working shown for **3** marks*
*allow 17.7(99) then incorrectly rounded to 17 for **2** marks*

[11]

M3. (a) any **two** from:

- (acceleration occurs when) the direction (of each capsule) changes
- velocity has direction
- acceleration is (rate of) change of velocity

2

(b) to(wards) the centre (of the wheel)

1

(c) the greater the radius / diameter / circumference (of the wheel) the smaller the (resultant) force (required)

accept 'the size' for radiusboth parts required for the mark

1

[4]

M4. (a) (i) longer reaction time

accept slower reactions

*do **not** accept slower reaction time unless qualified*

or greater thinking distance

accept greater thinking time

or greater stopping distance

accept greater stopping time

greater braking distance negates answer

1

(ii) lines / slopes have the same gradient

accept slopes are the same

or velocity decreases to zero in same time / in 2.6 seconds

accept any time between 2.4 and 2.8

accept braking distances are the same

1

(iii) 12

*accept extracting both reaction times correctly for **1** mark(0.6 and 1.4)*
or
*time = 0.8 (s) for **1** mark*

*accept 0.8 × 15 for **2** marks*

*accept calculating the distance travelled by car **A** as 28.5 m*
or
*the distance travelled by car **B** as 40.5 m for **2** marks*

3

(b) **Z**

1

different force values give a unique / different resistance

*only scores if **Z** chosen*

*do **not** accept force and resistance are (directly) proportional*

*accept answers in terms of why either **X** or **Y** would not be best eg*

***X** – same resistance value is obtained for 2 different force values*

***Y** – all force values give the same resistance*

1

[7]

M5. (a) (i) 100 (m)

1

(ii) stationary

1

(iii) accelerating

1

(iv) tangent drawn at t = 45 s

1

attempt to determine slope

1

speed in the range 3.2 – 4.2 (m / s)

dependent on 1st marking point

1

(b) (i) 500 000 (J)

ignore negative sign

1

(ii) 20 000 (N)

ignore negative sign

*allow **1** mark for correct substitution, ie*

500 000 = F × 25

***or** their part (b)(i) = F × 25*

provided no subsequent step

2

(iii) *(kinetic) energy* transferred by heating

1

to the brakes

ignore references to sound energy

*if no other marks scored allow k.e. decreases for **1** mark*

1

[11]

M6. (a) (i) distance vehicle travels during driver's reaction time

accept distance vehicle travels while driver reacts

1

(ii) any **two** from:

- tiredness
- (drinking) alcohol
- (taking) drugs
- speed
- age

accept as an alternative factor distractions, eg using a mobile phone

2

(b) (i) 320 000

*allow **1** mark for correct substitution, ie* $\frac{1}{2} \times 1600 \times 20^2$ *provided no subsequent step shown*

2

(ii) 320000 **or** their (b)(i)

1

(iii) 40

or

$\frac{\text{their (b)(ii)}}{8000}$ correctly calculated

*allow **1** mark for statement work done = KE lost*

or

*allow **1** mark for correct substitution, ie*
*8000 × distance = 320 000 **or** their (b)(ii)*

2

(iv) any **one** from:

- icy / wet roads
  accept weather conditions
- (worn) tyres
- road surface
- mass (of car and passengers)
  accept number of passengers
- (efficiency / condition of the) brakes

1

(v) (work done by) friction
(between brakes and wheel)
*do **not** accept friction between road and tyres / wheels*

1

(causes) decrease in KE and increase in thermal energy
accept heat for thermal energy accept
KE transferred to thermal energy

1

(c) the battery needs recharging less often
accept car for battery

1

orincreases the range of the car
*accept less demand for other fuels **or** lower emissions **or** lower fuel costs*
environmentally friendly is insufficient

as the efficiency of the car is increased
accept it is energy efficient

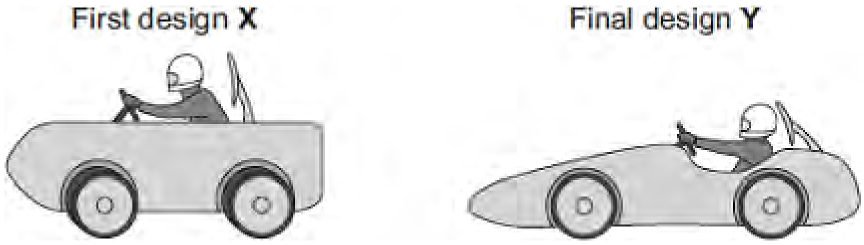
1

the decrease in (kinetic) energy / work done charges the battery (up) *accept because not all work done / (kinetic) energy is wasted*

1

[14]

Q1.(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.



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.

....

....

....

....

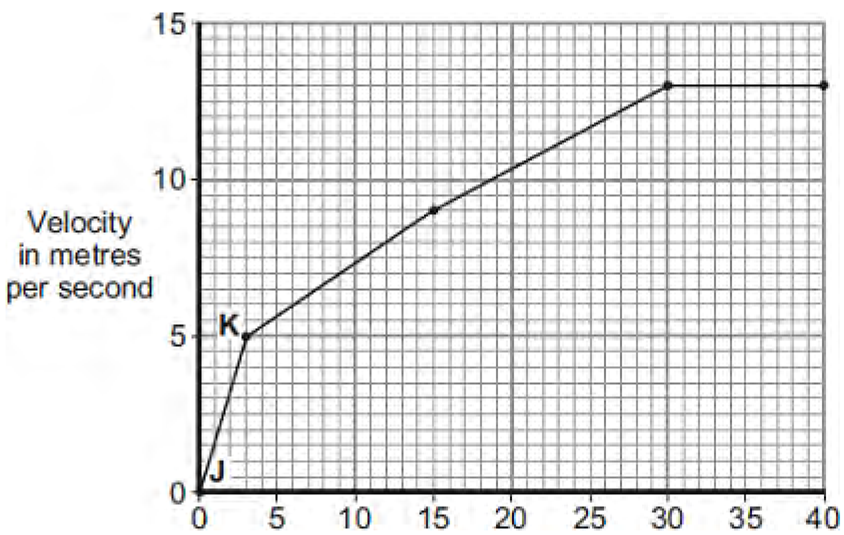
....

....

(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.



Time in seconds

(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)

Q2. The stopping distance of a car is the sum of the thinking distance and the braking distance.

The table below shows how the thinking distance and braking distance vary with speed.

Speed in m / s	**Thinking distance in m**	**Braking distance in m**
10	6	6.0
15	9	13.5

20	12	24.0
25	15	37.5
30	18	54.0

(a) What is meant by the braking distance of a vehicle?

....

....

(1)

(b) The data in the table above refers to a car in good mechanical condition driven by an alert driver.

Explain why the stopping distance of the car increases if the driver is very tired.

....

....

....

....

(2)

(c) A student looks at the data in the table above and writes the following:

thinking distance $\propto$ speed

thinking distance $\propto$ speed

Explain whether the student is correct.

....

....

....

....

(2)

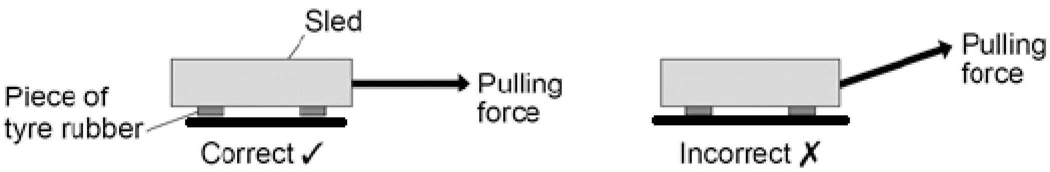
(d) Applying the brakes with too much force can cause a car to skid.

The distance a car skids before stopping depends on the friction between the road surface and the car tyres and also the speed of the car.

Friction can be investigated by pulling a device called a 'sled' across a surface at constant speed.

The figure below shows a sled being pulled correctly and incorrectly across a surface.

The constant of friction for the surface is calculated from the value of the force pulling the sled and the weight of the sled.



Why is it important that the sled is pulled at a constant speed?

Tick **one** box.

If the sled accelerates it will be difficult to control.	☐
If the sled accelerates the value for the constant of friction will be wrong.	☐
If the sled accelerates the normal contact force will change.	☐

(1)

(e) If the sled is pulled at an angle to the surface the value calculated for the constant of friction would not be appropriate.

Explain why.

....

....

....

....

(2)

(f) By measuring the length of the skid marks, an accident investigator determines that the distance a car travelled between the brakes being applied and stopping was 22 m.

The investigator used a sled to determine the friction. The investigator then calculated that the car decelerated at 7.2 m / s^2.

Calculate the speed of the car just before the brakes were applied.

Give your answer to two significant figures.

Use the correct equation from the Physics Equation Sheet.

....

....

....

....

Speed = ... m / s

(3)
(Total 11 marks)

Q3. 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.

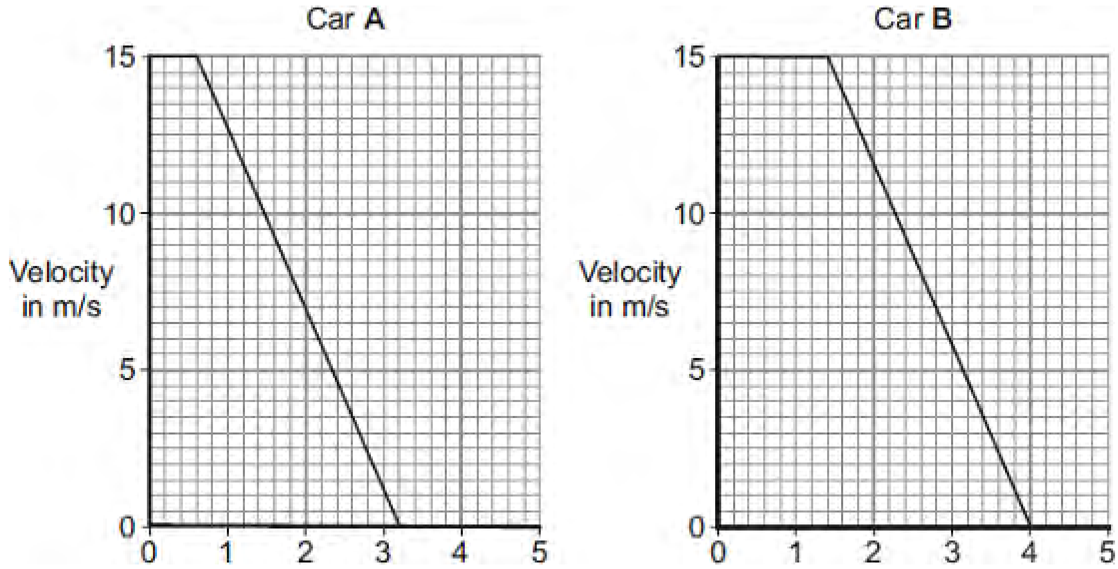
Name the other factor that affects the resultant force and state what effect it has on the resultant force.

....

....

(1)
(Total 4 marks)

Q4.(a) The graphs show how the velocity of two cars, **A** and **B**, change from the moment the car drivers see an obstacle blocking the road.



One of the car drivers has been drinking alcohol. The other driver is wide awake and alert.

(i) How does a comparison of the two graphs suggest that the driver of car **B** is the one who has been drinking alcohol?

....

....

(1)

(ii) How do the graphs show that the two cars have the same deceleration?

....

....

(1)

(iii) Use the graphs to calculate how much further car **B** travels before stopping compared to car **A**.

Show clearly how you work out your answer.

....

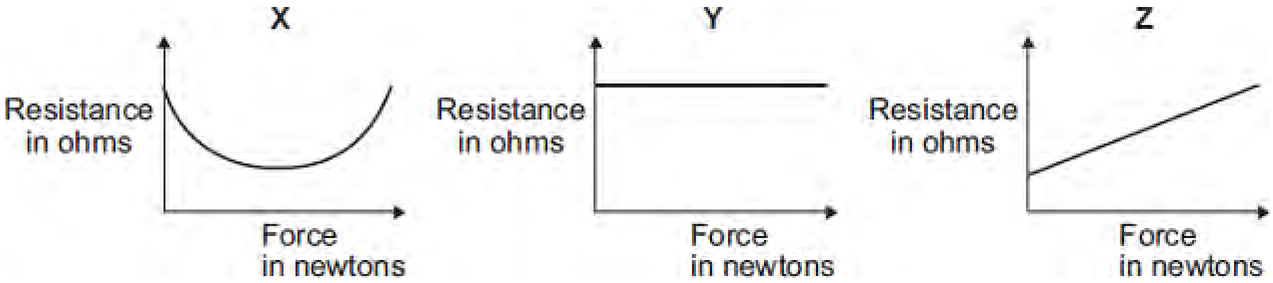
....

....

Additional stopping distance = ... m

(3)

(b) In a crash-test laboratory, scientists use sensors to measure the forces exerted in collisions. The graphs show how the electrical resistance of 3 experimental types of sensor, **X**, **Y**, and **Z**, change with the force applied to the sensor.



Which of the sensors, **X**, **Y** or **Z**, would be the best one to use as a force sensor?

....

Give a reason for your answer.

....

....

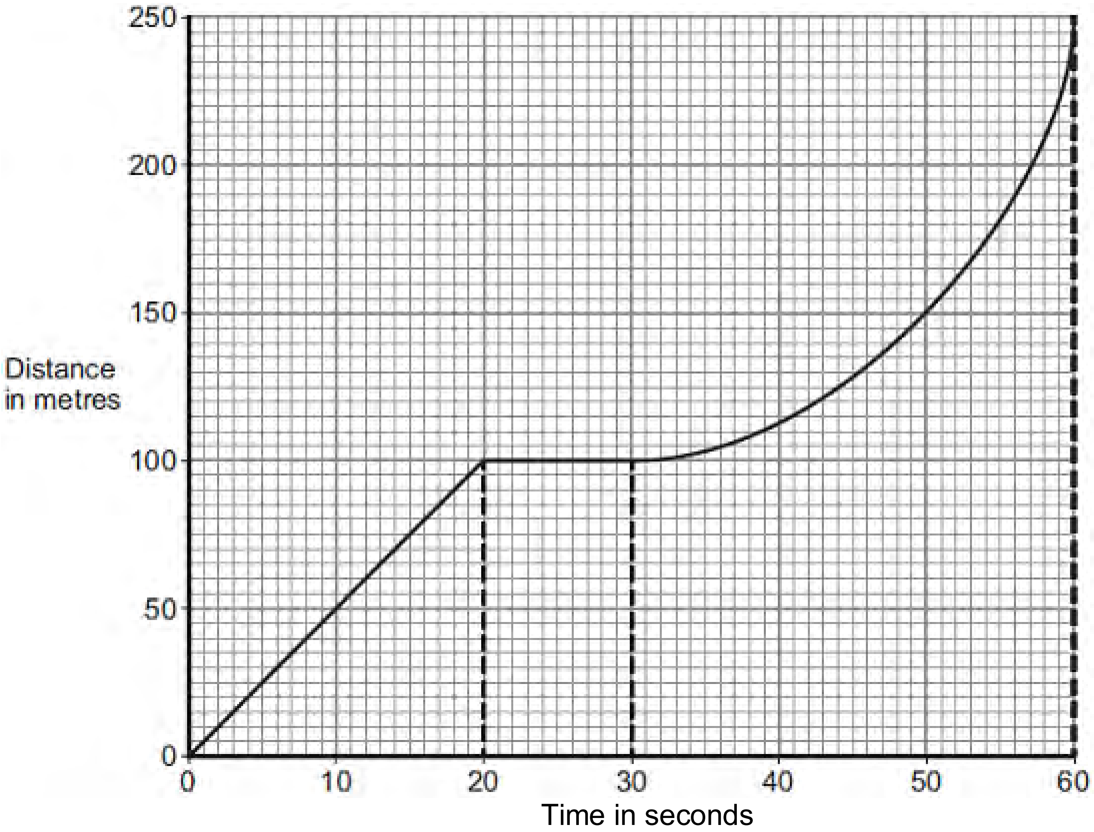
....

....

(2)
(Total 7 marks)

Q5. 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)

Q6.(a) The stopping distance of a vehicle is made up of two parts, the thinking distance and the braking distance.

(i) What is meant by *thinking distance*?

....

.... **(1)**

(ii) State **two** factors that affect thinking distance.

1 ....

....

2 ....

.... **(2)**

(b) A car is travelling at a speed of 20 m/s when the driver applies the brakes. The car decelerates at a constant rate and stops.

(i) The mass of the car and driver is 1600 kg.

Calculate the kinetic energy of the car and driver before the brakes are applied.

....

....

....

Kinetic energy = ... J **(2)**

(ii) How much work is done by the braking force to stop the car and driver?

Work done = ... J **(1)**

(iii) The braking force used to stop the car and driver was 8000 N.

Calculate the braking distance of the car.

....

....

....

....

Braking distance = ... m

(2)

(iv) The braking distance of a car depends on the speed of the car and the braking force applied.

State **one** other factor that affects braking distance.

....

....

(1)

(v) Applying the brakes of the car causes the temperature of the brakes to increase.

Explain why.

....

....

....

....

(2)

(c) Hybrid cars have an electric engine and a petrol engine. This type of car is often fitted with a regenerative braking system. A regenerative braking system not only slows a car down but at the same time causes a generator to charge the car's battery.

State and explain the benefit of a hybrid car being fitted with a regenerative braking system.

....

....

....

....

....

....

(3)
(Total 14 marks)

1

moment = 252

1

*allow 252 with no working shown for **2** marks*
*allow 25200 with no working shown for **1** mark*

(b) the clockwise moment (of child B) decreases

1

making it is less than the anticlockwise moment (of child A)
accept so moments are no longer balanced

1

so child A moves downwards

or

so child B moves upwards

1

[5]

M2. (a) centre of **X** at the centre of the concentric circles
judge by eye that the intention is correct

1

(b) drawn from any corner to the diagonally opposite corner

judge by eye that the intention is correct

or from the mid-point of any side to the mid-point of the opposite side

if more than one axis of symmetry has been drawn,
accept only if both / all are correct

1

(c) a turning

accept any unambiguous indication

1

[3]

M3. lever

turning effect

pivot

for 1 mark each

[3]

M4. (a) (i) moment

1

(ii) rotation

1

(iii) the girl moves nearer to point **P**

1

(b) (i) **X** drawn in the centre of the space enclosed by the tyre

judge by eye

1

(ii) below

1

[5]

M5. (a) 1250

*allow **1** mark for correct substitution*

ie 500 × 2.5 provided there is no subsequent calculation

2

(b) (i) smaller than

1

(ii) force (exerted) further from axis of rotation (than the weight)

accept pivot for axis of rotation

1

(c) increase the force (exerted)

*do **not** accept increase distance of force from axis of rotation*

1

[5]

M6. (a) **C**

1

(b) moment

accept any unambiguous correct indication

1

(c) bigger than

accept any unambiguous correct indication

1

(d) 120 (Ncm)

*allow **1** mark for correct substitution*
ie 12 × 10

2

[5]

M7. (a) (i) 75

*allow **1** mark for correct substitution ie 250 × 0.3*
*do **not** credit if subsequent step shown*
*allow **1** mark for an answer 7500*

2

(ii) Nm

1

(b) force is (applied) further from the nut / pivot / axis of rotation

handle is longer is insufficient
*do **not** accept less force needed*

1

moment (on wrench) is larger

1

[5]

M8. (a) 360

*allow **1** mark for correct substitution ie 300 × 1.2 provided no subsequent step shown*

2

(b) the force is applied further from the axis of rotation

accept pivot / (tree) stump for 'axis of rotation'

1

or

this increases the moment of the force

increases the force on the (tree) stump

1

[4]

M9. (a) centre of X drawn at centre of pendulum bob

judged by eye

accept dot drawn at centre of circle

1

(b) (i) 2

*allow **1** mark for correct substitution, ie $\frac{1}{0.5}$ provided no subsequent step shown*

2

(ii) 30 **or** 60 ÷ their (b)(i) correctly calculated

allow 1 mark for $\frac{60}{2}$

or $\frac{60}{\text{their (b)(i)}}$

or *0.5 × 60*

provided no subsequent step shown

2

(c) 51.2

*allow **1** mark for correct substitution, ie 64 × 0.8 provided no subsequent step shown*

2

(d) it increases (the moment)

must be comparative

*accept **1** mark for calculation of the moment = 64 (Nm)*

1

[8]

M10. (a) 3000

*allow **1** mark for correct substitution, ie 600 × 5 provided no subsequent step*

2

(b) anticlockwise moment

must be both words

1

(c) (i) 3400

allow 3.4 kilo (newtons)

1

(ii) as the distance (of the girl from point A) increases, force F increases

allow gets bigger for increases

force is (directly) proportional to distance will negate any correct response

1

[5]

M11. (a) make the rod longer

1

push down on the rod with a greater force 1

(b) particles are close together 1

so no room for more movement
dependent on 1st marking point 1

(c) (i) downward force produces pressure in liquid
reference to compression of liquid negates this mark 1

this pressure is the same at all points in a liquid
or
this pressure is transmitted equally through the liquid

and $P = F / A$ ***or*** $F = P \times A$ 1

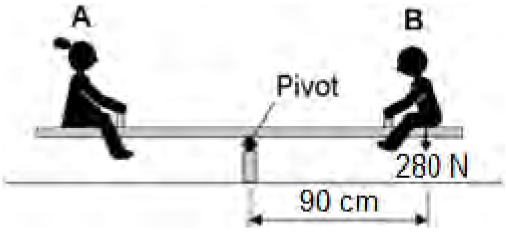
area (at load) bigger *(so force bigger)* 1

(ii) the force acting on the car moves less distance than the effort force 1

[9]

Q1. Two children, **A** and **B**, are sitting on a see-saw, as shown in the figure below.

The see-saw is balanced.



(a) Use the following equation to calculate the moment of child **B** about the pivot of the see-saw.

moment of a force = force × distance

Give your answer in newton-metres

....

....

....

Moment = ... Nm

(2)

(b) Use the idea of moments to explain what happens when child **B** moves closer to the pivot.

....

....

....

....

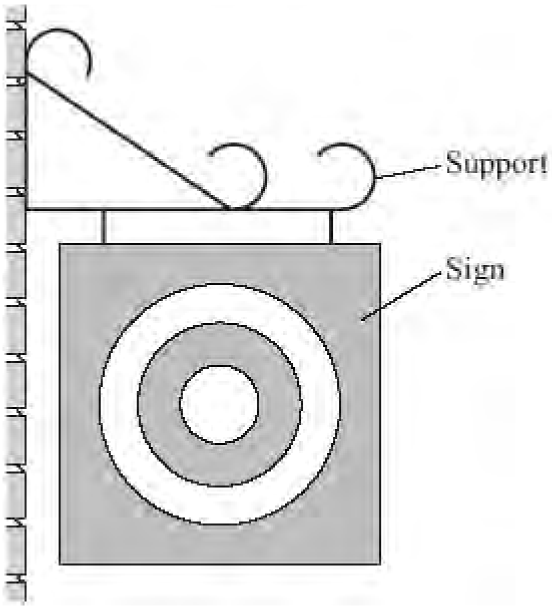
....

....

(3)

(Total 5 marks)

Q2. The drawing shows a sign which hangs outside a shop.



(a) Draw an **X** on the sign so that the centre of your **X** is at the centre of mass of the sign.

(1)

(b) Use a ruler to draw **one** axis of symmetry on the sign.

(1)

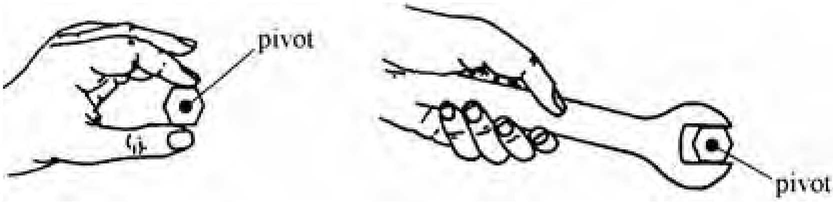
(c) One force which acts on the sign is its weight.

Complete the following sentence by drawing a ring around the correct line in the box.

The moment of the weight produces	an accelerating a balancing a turning	effect.

(1)
(Total 3 marks)

Q3. A spanner makes it a lot easier to loosen a bolt.



You cannot usually loosen a bolt with your fingers.

It is easier with a spanner.

Choose words from this list to complete the sentences below.

lever **piston** **pivot** **pulley** **turning effect**

The spanner is a simple ....

You use it to produce a bigger .... on the bolt.

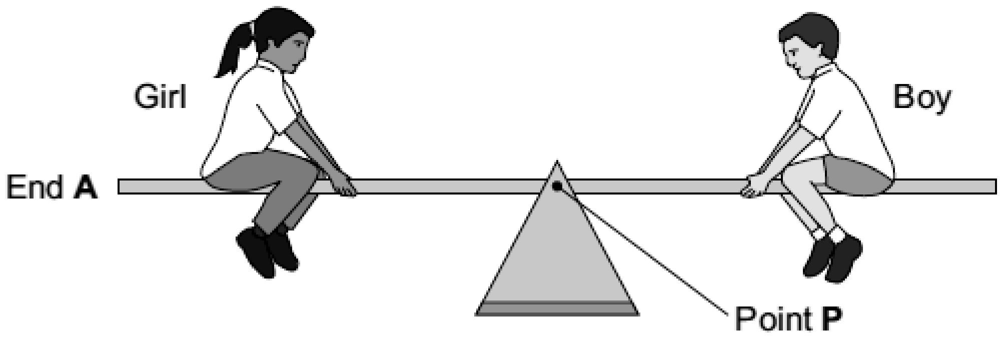
A longer spanner works better.

This is because there is a bigger distance between your force and the ....

(Total 3 marks)

Q4. Two children visit a playground.

(a) The diagram shows them on a see-saw. The see-saw is balanced.



Complete the following sentences by drawing a ring around the correct word or line in the box.

(i) The turning effect of the girl's weight is called her

force.
oad.
moment.

(1)

(ii) Point **P** is the axis of

balance
rotation
turning

of the see-saw.

(1)

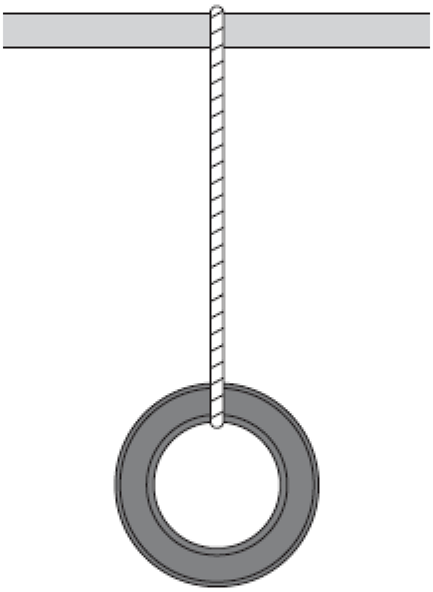
(iii) To make end **A** of the see-saw go up,

the boy moves nearer to point **P**.
the girl moves nearer to point **P**.
the girl moves nearer to end **A**.

(1)

(b) In another part of the playground, a tyre has been suspended from a bar.

(i) Draw an **X** on the diagram so that the centre of the **X** marks the centre of mass of the tyre.



(1)

(ii) Complete the sentence by using the correct word or phrase from the box.

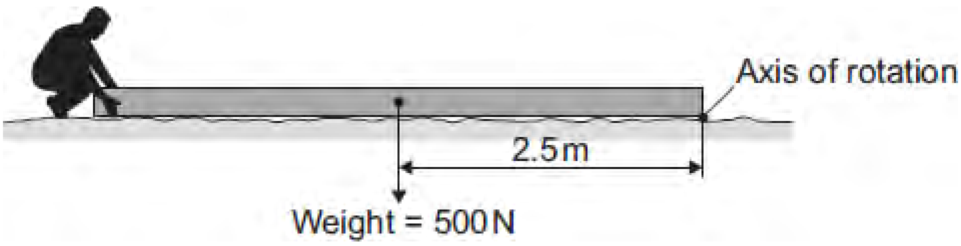
above	**below**	**to the left of**	**to the right of**

If the suspended tyre is pushed, it will come to rest with its centre of mass

directly .... the point of suspension.

(1)
(Total 5 marks)

Q5. The diagram shows someone starting to lift the end of a heavy wooden pole.



(a) Use the equation in the box to calculate the moment produced by the weight of the pole.

moment = for ce ×		perpendicular distance from the line of action of the force to the axis of rotation

....

....

Moment = ... Nm

(2)

(b) (i) Complete the following sentence by drawing a ring around the correct line in the box.

The smallest force needed to lift the end of the pole will be

bigger than
the same as
smaller than

the weight of the pole.

(1)

(ii) Give a reason for your answer to part (b)(i).

....

....

(1)

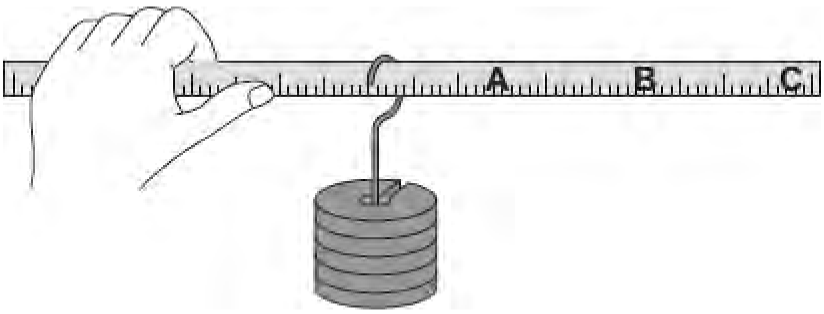
(c) How could the person lifting the end of the pole increase the moment?

....

....

(1)
(Total 5 marks)

Q6. (a) A student holds a ruler at one end and slides a weight along the ruler.



At which point, **A**, **B** or **C**, will the turning effect of the weight feel greatest?

Write your answer, **A**, **B** or **C**, in the box. Point ☐

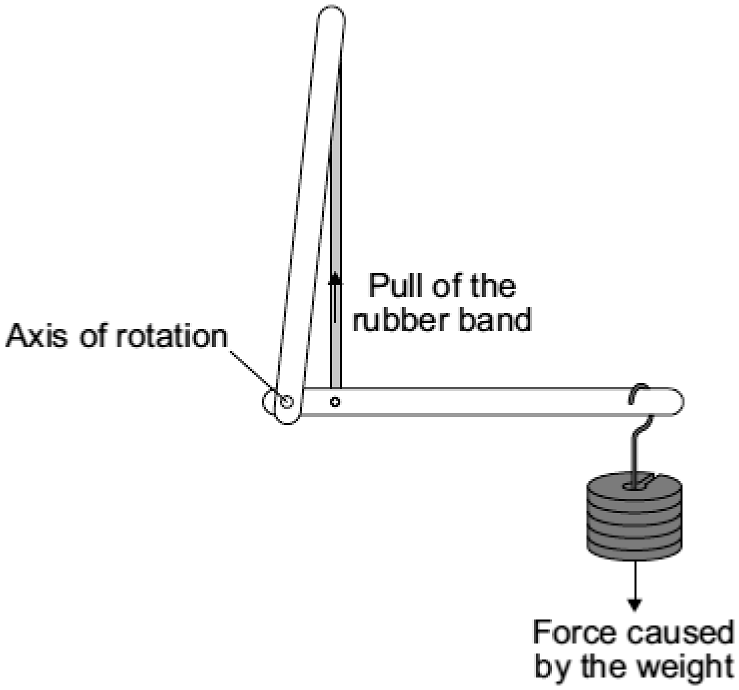
(1)

(b) Complete the following sentence by drawing a ring around the correct word in the box.

	axis	
The turning effect of a force is called the	equilibrium	of the force.
	moment	

(1)

(c) In a human arm, the biceps muscle provides the force needed to hold the arm horizontal.
A student uses a model in which a rubber band represents the biceps muscle.



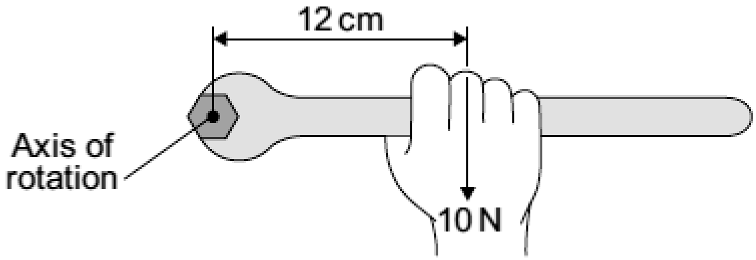
Complete the following sentence by drawing a ring around the correct line in the box.

To hold the model arm horizontal, the pull from the rubber band will be

bigger than smaller than the same as	the force caused by the weight.

(1)

(d) The diagram shows a long spanner.



Use the equation in the box to calculate the moment, in N cm, being produced.

moment	=	force	× perpendicular distance from the line of action of the force to the axis of rotation

Show clearly how you work out your answer.

....

....

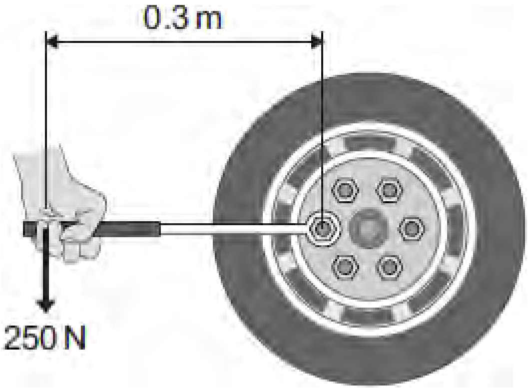
Moment = ... N cm

(2)

(Total 5 marks)

Q7. A company makes a wheel wrench with an extending handle. The company claims that the extending handle makes it easier to loosen the wheel nuts on a car.

The diagram shows the wheel wrench being used without the handle extended.



(a) (i) Use the equation in the box to calculate the moment produced by the force on the wrench.

moment	=	force	× perpendicular distance from the line of action of the force to the axis of rotation

Show clearly how you work out your answer.

....

....

Moment = ... newton metres

(2)

(ii) Units can be written in words or symbols.

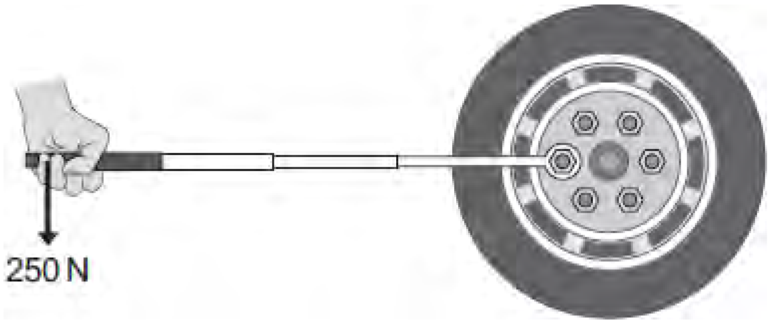
Which of the following is the unit for a moment written using symbols?

Draw a ring around your answer.

nm **Nm** **nM** **NM**

(1)

(b) The wheel nut will not move and so the handle of the wrench is extended.



It is now easy to loosen the wheel nut using the same force as before.

Explain why.

....

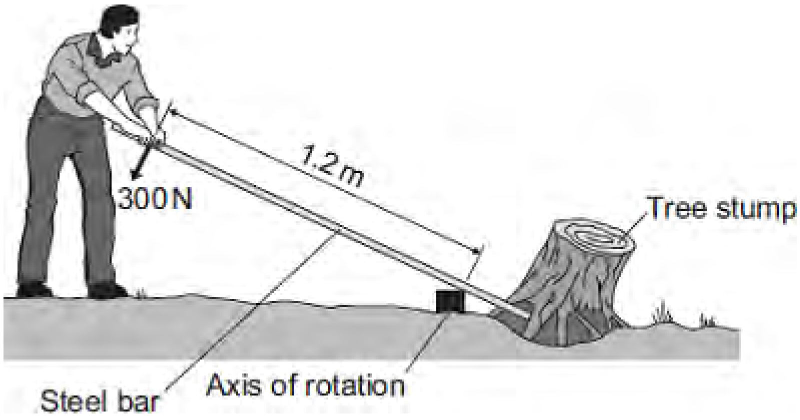
....

....

....

(2)
(Total 5 marks)

Q8. The diagram shows a gardener using a steel bar to lift a tree stump out of the ground.



When the gardener pushes with a force of 300 **N**, the tree stump just begins to move.

(a) Use the equation in the box to calculate the moment produced by the 300 N force.

moment = force x perpendicular distance from the line of action of the force to the axis of rotation

Show clearly how you work out your answer.

....

....

Moment = ... newton metres

(2)

(b) Using a longer steel bar would have made it easier for the gardener to lift the tree stump out of the ground.

Explain why.

....

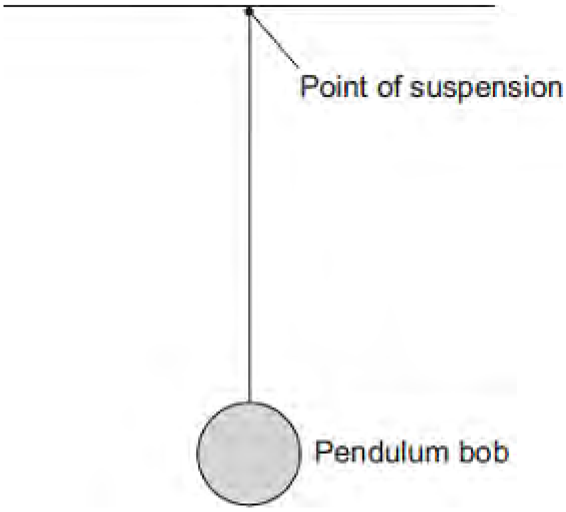
....

....

....

(2)
(Total 4 marks)

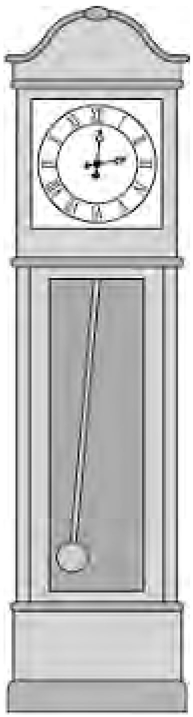
Q9.(a) The diagram shows a pendulum.



Draw an X on the diagram above, so that the centre of the **X** marks the centre of mass of the pendulum bob.

(1)

(b) A large clock keeps time using the swing of a pendulum.



(i) The frequency of the swinging pendulum is 0.5 hertz.

Calculate the periodic time of the pendulum.

....

....

....

Periodic time = ... seconds

(2)

(ii) Calculate the number of complete swings the pendulum would make in 60 seconds.

Use your answer from part (b)(i) in your calculation.

....

....

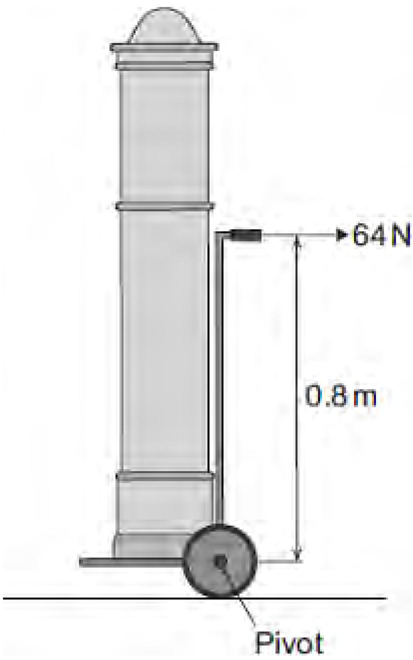
....

Number of swings in 60 seconds = ...

(2)

(c) The diagram shows a clock on a trolley.

The trolley is being used to move the clock.



Calculate the moment of the 64 N force about the pivot.

....

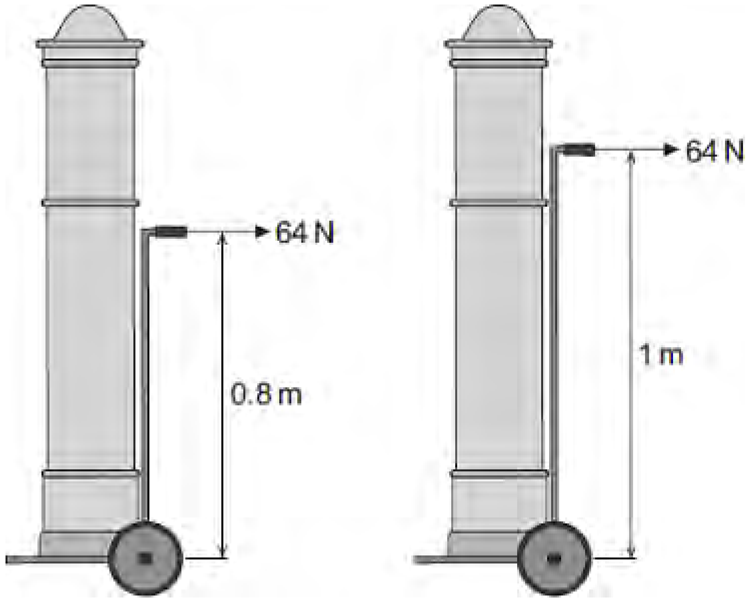
....

....

Moment of the force = ... Nm

(2)

(d) The design of the trolley is now changed to make it taller.



How does making the trolley taller affect the moment produced by the 64 N force about the pivot?

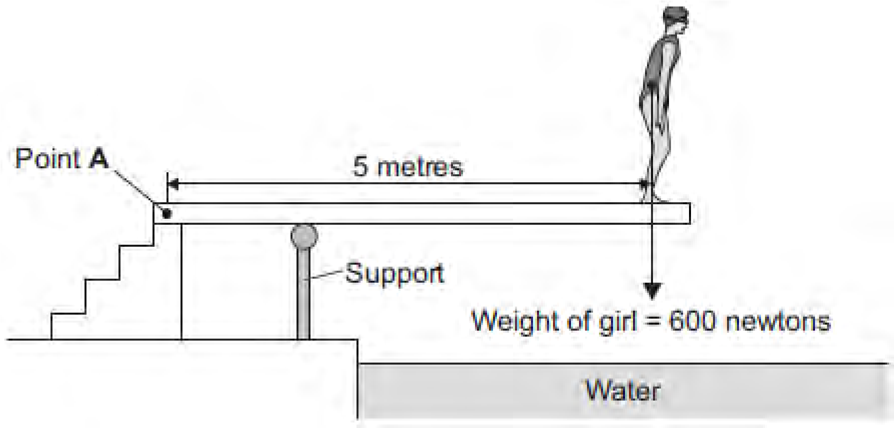
....

....

(1)
(Total 8 marks)

Q10.Figure 1 shows a girl standing on a diving board.

Figure 1



(a) Calculate the moment of the girl's weight about Point **A**.

....

....

....

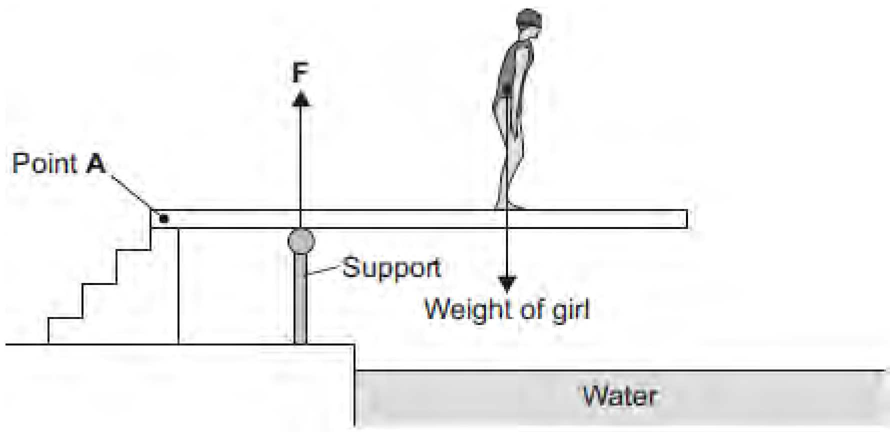
Moment = ... newton metres

(2)

(b) **Figure 2** shows the girl standing at a different place on the diving board.

The support provides an upward force **F** to keep the diving board balanced.

Figure 2



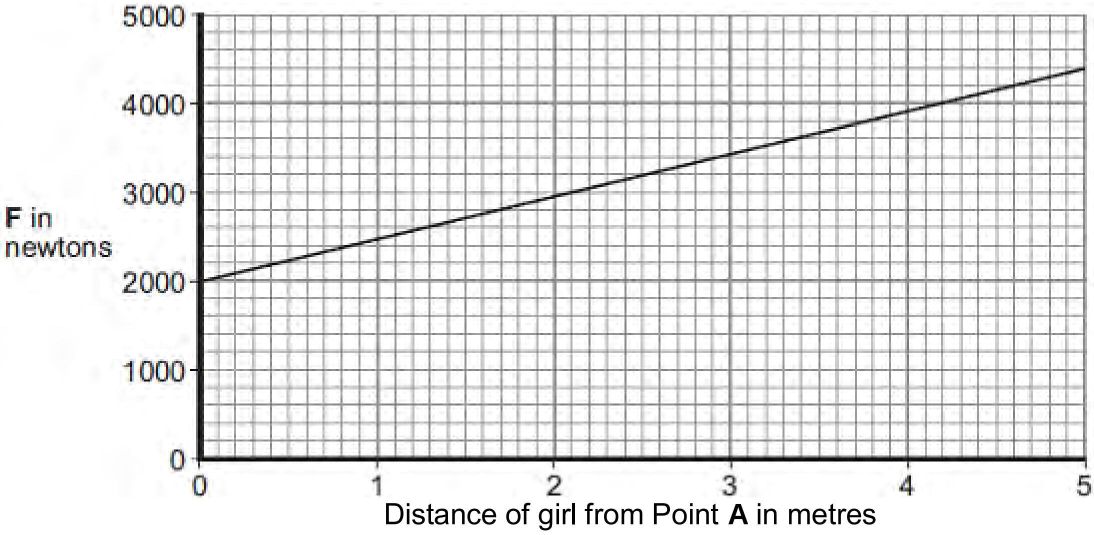
Complete the following sentence.

The diving board is not turning. The total clockwise moment is balanced by the total ....

(1)

(c) **Figure 3** shows how the upward force **F** varies with the distance of the girl from Point **A**.

Figure 3



(i) Use **Figure 3** to determine the upward force **F** when the girl is standing at a distance of 3 metres from point **A**.

Upward force **F** = ... newtons

(1)

(ii) What conclusion should be made from **Figure 3**?

....

....

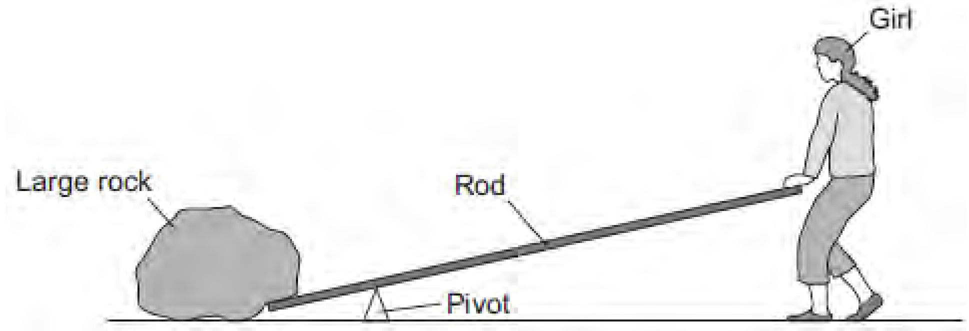
....

(1)
(Total 5 marks)

Q11. Levers and hydraulic systems can act as force multipliers.

(a) **Figure 1** shows a girl trying to lift a large rock using a long rod as a lever.

Figure 1



The girl is pushing down on the rod but is just unable to lift the rock.

Which of the following changes would allow her to lift the rock?

Tick (✓) **two** boxes.

Change	**Tick (✓)**
Move the pivot away from the rock	
Make the rod longer	
Push the rod upwards	
Push down on the rod with a greater force	

(2)

(b) Liquids are used in hydraulic systems because they are virtually incompressible.

Explain how the spacing of particles in a liquid cause it to be virtually incompressible.

....

....

....

....

(2)

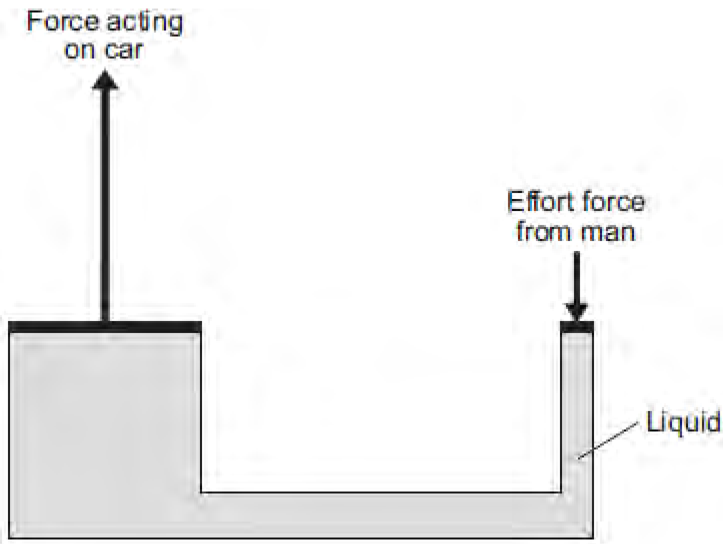
(c) **Figure 2** shows a man using a car jack to lift his car.

Figure 2

© lisafx/iStock/Thinkstock

Figure 3 shows a simple diagram of a car jack.

Figure 3



(i) The man pushes down with an effort force. This results in a much larger force acting upwards on the car.

Use information from **Figure 3** to explain how.

....

....

....

....

....

....

....

....

(4)

(ii) Which of the following statements about the forces in **Figure 3** is correct?

Tick (✓) **one** box.

	Tick (✓)
The force acting on the car moves a greater distance than the effort force.	
The force acting on the car moves less distance than the effort force.	
The force acting on the car moves the same distance as the effort force.	

(1)
(Total 9 marks)

M1. (a) 3800

*allow **1** mark for 2000*

*allow **1** mark for 1800*

*if neither of above scored, allow correct substitution for **1** mark (800 × 2.5) + (600 × 3)*

if moments have been calculated incorrectly, allow 1 mark for adding their two moment values correctly

3

newton metres **or** Nm

*do **not** allow nm **or** NM*

1

(b) as the girl increases her distance (from the pivot) the clockwise moment increases

1

(F must increase) as the anticlockwise moment must increase

1

so (the anticlockwise moment) is equalled / balanced by the clockwise moment
or
so resultant / overall moment (on the board) is zero

accept to balance / equal the moments

to balance the board is insufficient

1

[7]

M2. (a) (i) **X** at the centre of the lifebelt

measuring from the centre of ***X****, allow 2 mm tolerance in any direction*

1

(ii) any **two** from:

if X is on vertical line below the hanger (but not at centre) can gain the first point only

below the point of suspension

accept '(vertically) below ***Y****'*

at the centre (of the lifebelt)

accept 'in the middle'

(because) the lifebelt / it is symmetrical

or *(because) the mass / weight is evenly distributed*

2

(b) Nm **or** newton metre(s)

accept Newton metre(s)
do ***not*** *accept any ambiguity in the symbol ie NM, nM or nm*

1

750

(moment) = force × (perpendicular) distance (between line of action and pivot)
or *(moment) = 500 × 1.5 gains* ***1*** *mark*

2

(c) Quality of written communication:

for ***2*** *of the underlined terms used in the correct context*

1

any **three** connected points from:

low(er) centre of mass / gravity

or *<u>centre of mass / gravity</u> will be close(r) to the wheels / axle / ground*

(more) <u>stable</u>

or *less <u>unstable</u>*

less likely to fall over

accept 'less likely to overturn'

*do **not** accept 'will not fall over'*

the turning effect / moment (of the weight of case) is less

***or** so less effort is needed to hold the case*
ignore references to pulling the case

so the pull on her arm is less

3

[10]

M3. (a) 810 000

*allow 45 000 × 18 for **1** mark*

2

newton-metres / Nm

1

(b) any **three** from:

ignore references to force throughout

- their weight / mass can be altered / adjusted
- so that the crane remains stable

  allow does not topple
- so that the (total) clockwise moment equals the (total) anticlockwise moment

  *do **not** allow just 'moments are equal'*
- because not all containers are the same weight / mass

  *do **not** allow 'not all containers are the same size / volume'*
- because not all containers will be / need to move the same distance (from the crane)
- to keep the centre of mass (of the upper crane and container) in/ above the base of the tower
- so that the crane remains in equilibrium/balanced

3

[6]

M4. (a) point at which its mass (seems to) act **or** point at which gravity (seems to) act

accept ... its weight acts

accept correct statements if the intent is clear e.g.. .. if suspended, the centre of gravity will be directly under the point of suspension

e.g.... (if the object is symmetrical), the centre of gravity is on the ***or*** *an axis (of symmetry)*

do ***not*** *credit just 'it is a point'*

1

(b) *The answer to this question requires good English in a sensible order with correct use of scientific terms. Quality of written communication should be considered in crediting points in the mark scheme*

maximum of ***4*** *marks if ideas not well expressed*

any **five** from:

clamp (steel) rod (horizontally)

no *marks if method quite unworkable*

hang plastic / sheet by rod through (one) hole

hang plumb line from rod

mark ends of plumb line on the sheet and use the ruler to draw a straight line

repeat with other hole

centre of mass is where the lines cross

check by balancing at this point

maximum of ***3*** *marks if no 'repeat with other hole'*

5

(c) (i) (turning) effect **or** moment
force
distance

all three correct

accept weight
accept length

1

(ii) 17.6

allow 44 x 0.4 ***or*** *0.4 x 44 for* ***1*** *mark*

2

Nm **or** newton metre(s)

do ***not*** *accept N/m* ***or*** *N/cm*
1760 Ncm gains all ***3*** *marks*

1

[10]

M5. (a) (i) turning effect

accept turning force

accept force x distance

(accept symbols only if correctly defined)

*do **not** accept newtons x metres*

1

(ii) stop apparatus falling over

accept holds the stand in place

accept make it safer / stable

references to balanced / equilibrium are insufficient

1

(iii) as *x* increases *y* increases

1

in same proportion / ratios

allow both marks for they are <u>*directly*</u> *proportional*

or

a specific example eg doubling y, doubles x

allow both marks for a correct answer giving figures

eg they increase in the ratio of 1 to 7

*allow for **1** mark positive correlation*

1

(iv) the centre of mass of the ruler is at the axis of rotation

1

(b) 108

*allow **1** mark for correct substitution ie 240 x 0.45*

2

newton metres / Nm

symbols must be correct

for full credit the unit must be consistent with the numerical answer

1

[8]

M6. (a) moment

__or__ torque do __not__ credit 'leverage'

1

(b) 4 (2)

__either__ 0.20 × 20 (1) __or__ allow '400' (1)

2

(c) use a longer spanner

__or__ increases the perpendicular distance / length

or 'fit a pipe over the (end of the) spanner (to lengthen it)'

note 'lever' refers to 'spanner'
note <u>change</u> the . . . (0)
ignore references to wider / larger nut

1

use a greater force / pull

either order

1

[5]

M7. (a) any **two** from:

- inversely proportional
- as the load gets biggerthe (maximum safe) distance gets less

  allow 'as the mass increases the distance decreases'
  accept an unspecified response e.g. 'big load at a short distance' for (1)
- load × distance = 60 (kNm)

2

(b) yes, because 30 × 2 = 60 (2)

accept for (1) a correct but insufficiently explained response e.g. 'yes because it's safe'

accept for (2) a correct response which is sufficiently explained

e.g. 'yes, because 60 (kNm) at 1 metre is safe and 30 (kNm) is half the load at twice the distance

*do **not** accept 'no' and do not accept just 'yes'*

*do **not** accept 'yes, because 30 is between 24 and 40 and 2 is between 2.5 and 1.5'*

*do **not** accept 'the crane/ cable may break' or other dangers*

2

(c) the crane may/will topple over/fall <u>over/forward</u>

1

(d) results of experiments on this mobile crane

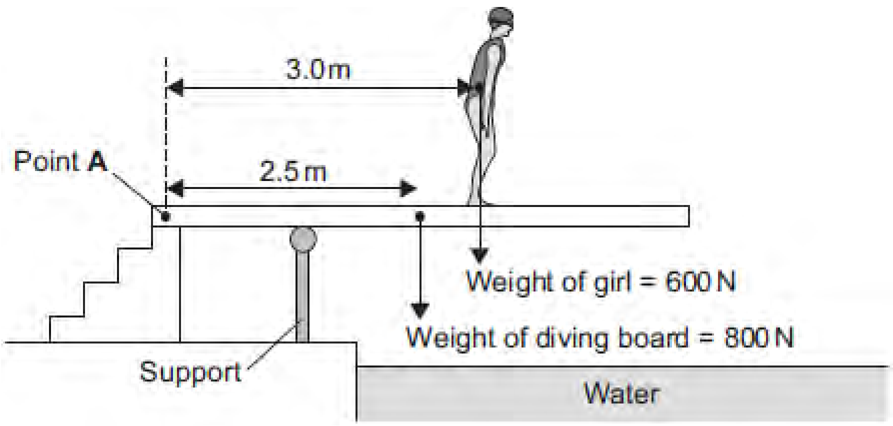
accept any unambiguous indication

1

[6]

Q1.(a) **Figure 1** shows a girl standing on a diving board.

Figure 1



Calculate the total clockwise moment of the weight of the diving board and the weight of the girl about Point **A**. Give the unit.

....

....

....

....

....

....

....

Total clockwise moment about Point **A** = ...

(4)

(b) **Figure 2** shows the girl standing at a different place on the diving board.

The support provides an upward force **F** to keep the diving board balanced.

Figure 2

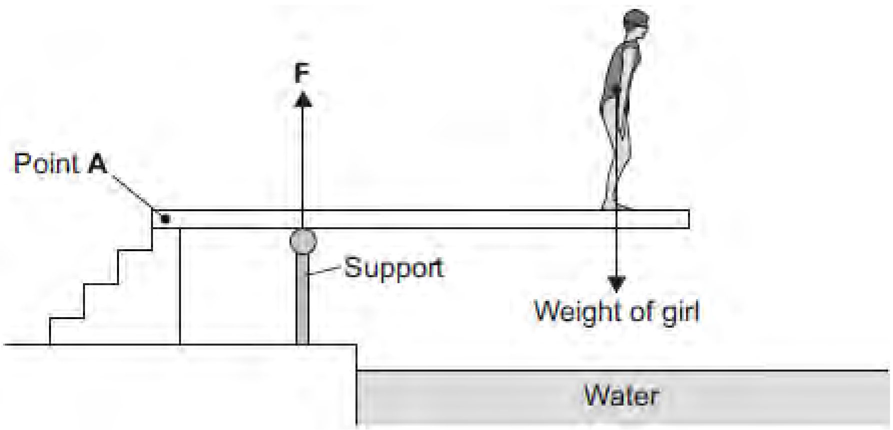
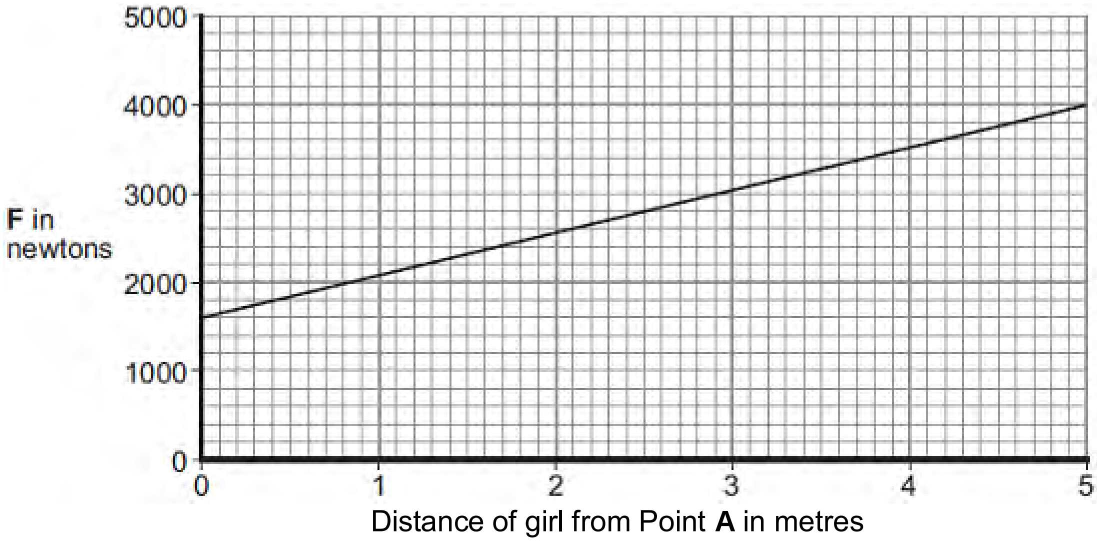


Figure 3 shows how the upward force **F** varies with the distance of the girl from Point **A**.

Figure 3



Explain, in terms of clockwise and anticlockwise moments, why the upward force **F** increases as shown in **Figure 3**.

....

....

....

....

....

....

....

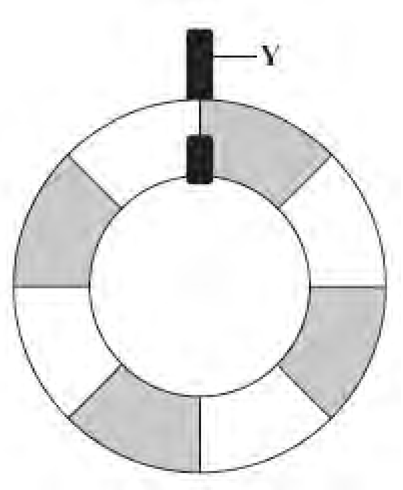
....

(3)

(Total 7 marks)

Q2. (a) The diagram shows a lifebelt. It is hanging freely from hook **Y**.

(i) On the diagram, mark with an **X** the point where you think the centre of mass of the lifebelt will be.



(1)

(ii) Explain why you have chosen this point.

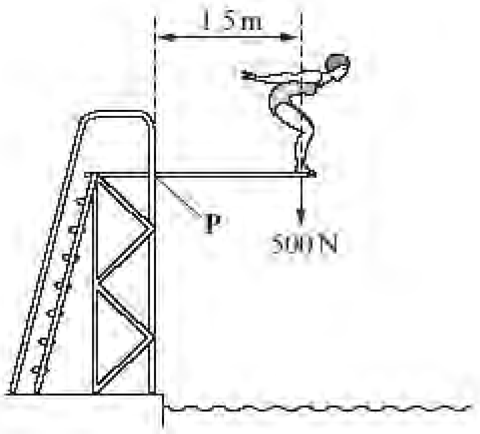
....

....

....

(2)

(b) The drawing shows Susan on a diving board. She is 1.5 metres from point **P** and she weighs 500 N.



Calculate her moment (turning effect) about point **P**.
Show clearly how you work out your answer and give the unit.

....

....

Moment about **P** = ...

(3)

(c) Susan has a case with wheels.

When she packs this case, she puts the heaviest items at the end where the wheels are.
This means that the heaviest items are less likely to crush the other contents and it helps her to find things when she opens the case.

Explain another advantage of packing her case in this way.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

....

....

....

....

....

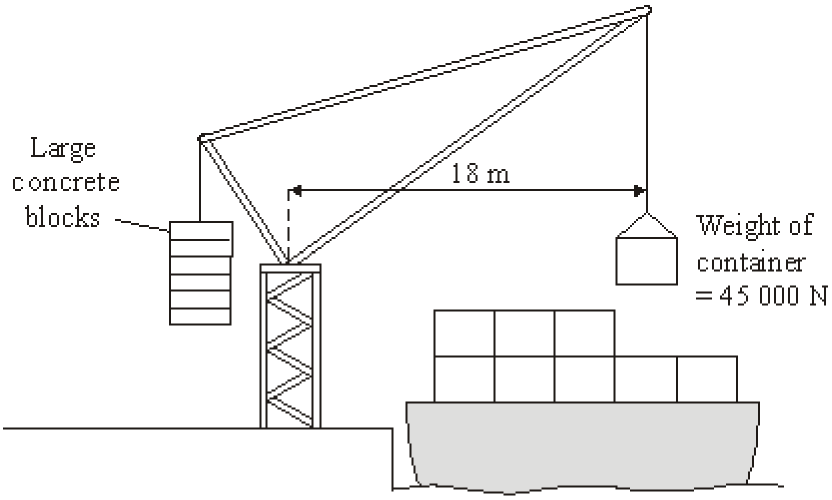
....

....

....

(4)
(Total 10 marks)

Q3. The diagram shows a crane which is loading containers onto a ship.



(a) Calculate the moment of the container which is being loaded.

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

....

....

Moment of the container = ...

(3)

(b) Suggest and explain the purpose of the large concrete blocks.

....

....

....

....

....

(3)
(Total 6 marks)

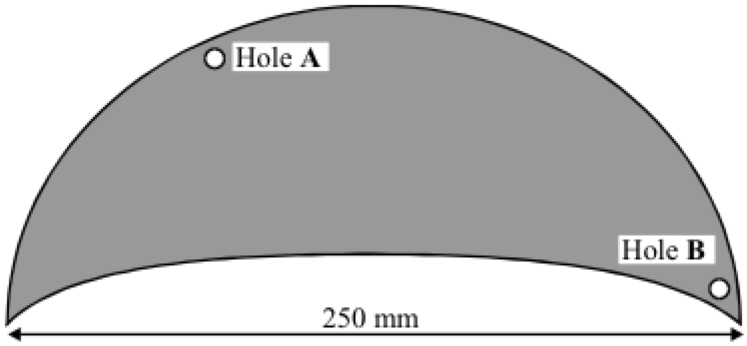
Q4. (a) Every object has a *centre of mass*. What is meant by the *centre of mass*?

....

....

(1)

(b) The drawing shows a thin sheet of plastic. The sheet is 250 mm wide. Two holes, each with a radius of 2 mm, have been drilled through the sheet.



Describe how you could use:

- a clamp and stand
- a steel rod 100 mm long and with a radius of l mm
- a weight on a thin piece of string (= a plumb line)
- a ruler
- a pen which will write on the plastic sheet

to find the centre of mass of the plastic sheet.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

....

....

....

....

....

....

....

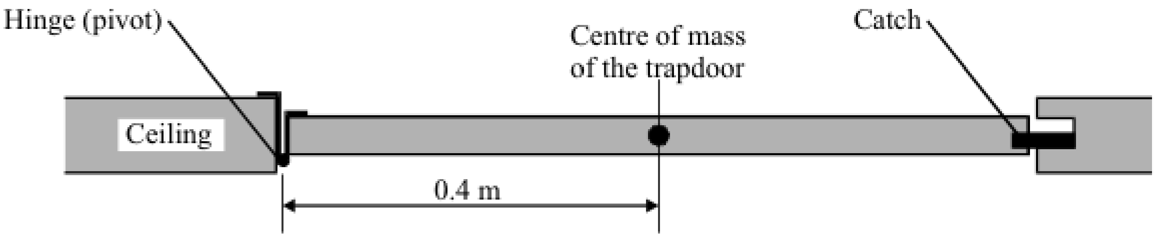
....

....

....

(5)

(c) There is a trapdoor in the ceiling of a house.
The trapdoor weighs 44 N.
The drawing shows a side view of the trapdoor.



(i) Complete the **three** spaces to give the equation which is used to calculate the turning effect of a force.

.... = ... × perpendicular between .... line of action and pivot

(1)

(ii) Calculate the turning effect, about the hinge, due to the weight of the trapdoor.

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

....

....

Turning effect = ...

(3)
(Total 10 marks)

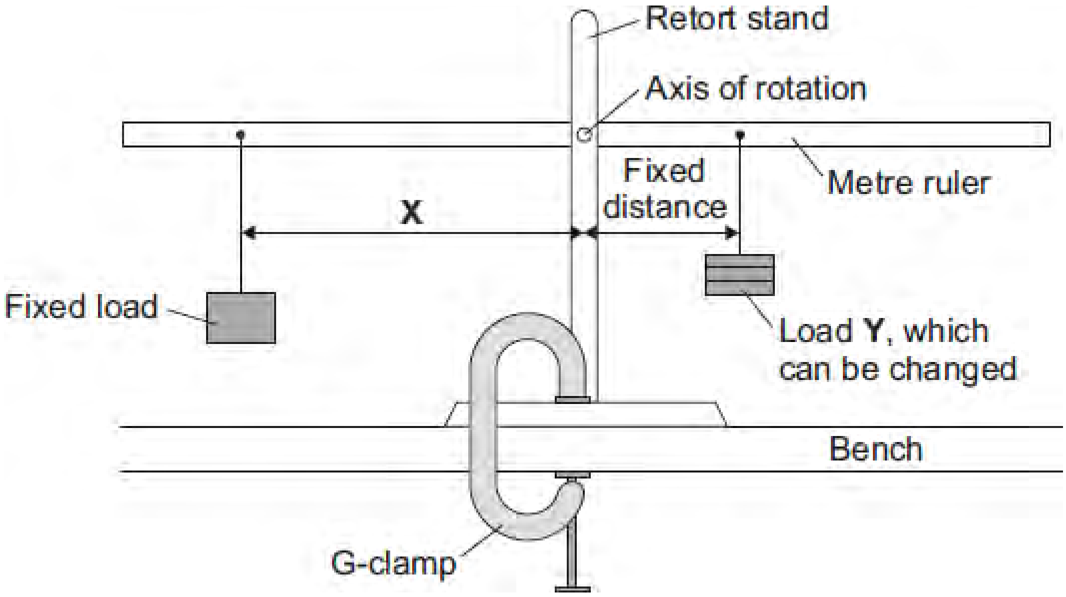
Q5. (a) A student investigates the moment of a force.

(i) What does the word *moment* mean in this sentence?

....

.... **(1)**

(ii) The diagram shows how she sets up her apparatus.



Suggest the purpose of the G-clamp.

....

.... **(1)**

(iii) A horizontal rod fits into a hole at the centre of the metre ruler. This is the axis of rotation. The student changes the load **Y** and adjusts the distance **X** until the metre ruler is horizontal. She takes six pairs of measurements which are shown in the table.

Load Y in newtons	Distance X in centimetres
1	7
2	14

3	21
4	28
5	35
6	42

Explain fully how distance **X** varies with load **Y**.

....

....

....

....

....

(2)

(iv) The weight of the ruler can be ignored in this experiment.

Which statement gives the reason why?

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

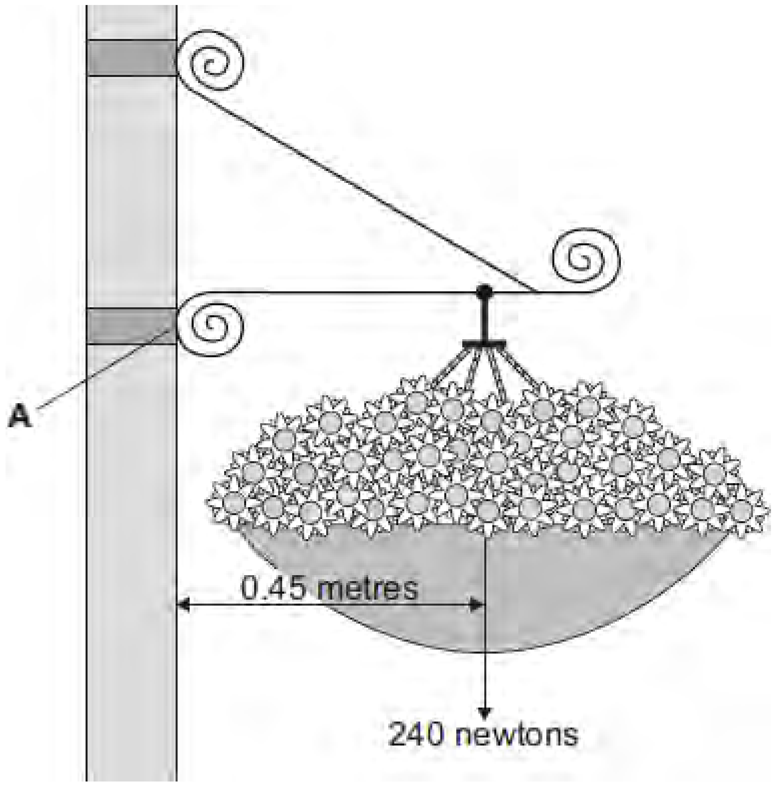
The weight of the ruler is so small it is negligible. ☐

The centre of mass of the ruler is at the axis of rotation. ☐

The ruler is a symmetrical object. ☐

(1)

(b) In the summer, a town council fits hanging baskets to some of its lamp posts.



Use the information in the diagram and the equation in the box to calculate the moment produced by the weight of the hanging basket about an axis through point **A**.

moment	=	force	×	perpendicular distance from the line of action of the force to the axis of rotation

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

....

....

....

....

Moment =...

(3)
(Total 8 marks)

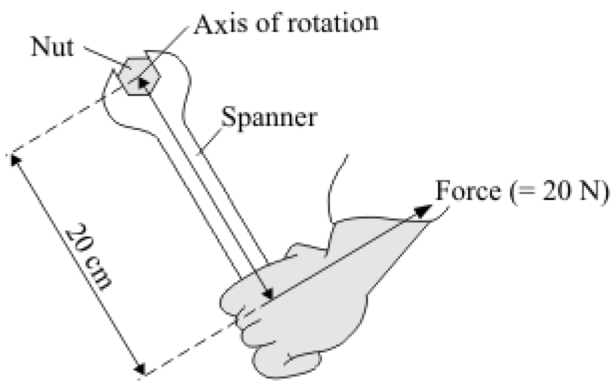
Q6. A spanner gives a turning effect to undo a nut.

(a) Complete the sentence.

The turning effect of a force is called the .... of the force.

(1)

(b) The diagram shows a spanner being used.



Calculate the spanner's turning effect in newton metres.

Show clearly how you work out your answer.

....

....

Turning effect = ... Nm

(2)

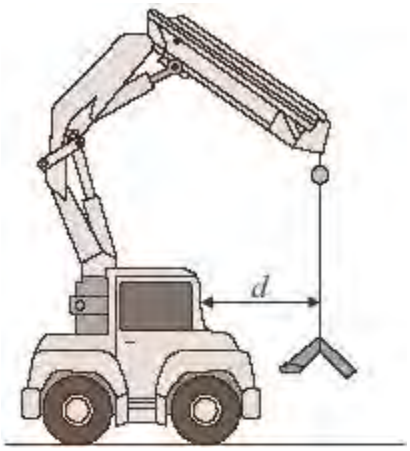
(c) Give **two** ways in which you can increase the spanner's turning effect.

1 ....

2 ....

(2)
(Total 5 marks)

Q7. The diagram shows a small mobile crane. It is used on a building site.



The distance, *d*, is measured to the front of the cab.

The table shows information from the crane driver's handbook.

Load in kilonewtons (kN)	**Maximum safe distance, *d*, in metres (m)**
10	6.0
15	4.0
24	2.5
40	1.5
60	1.0

(a) What is the relationship between the load and the maximum safe distance?

....

....

....

(2)

(b) The crane driver studies the handbook and comes to the conclusion that a load of

30 kN would be safe at a distance, d, of 2.0 metres.

Is the driver correct?

Explain your answer.

....

....

....

....

(2)

(c) What is the danger if the driver does not follow the safety instructions?

....

....

(1)

(d) How should the data in the table have been obtained?

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

average results from an opinion poll of mobile crane drivers	☐
copied from a handbook for a similar crane	☐
results of experiments on a model mobile crane	☐
results of experiments on this mobile crane	☐

(1)
(Total 6 marks)

M1. (a) motor effect

1

(b) increase the strength of the magnet

or

increase the current

1

(c) $4.8 \times 10^{-4} = F \times 8 \times 10^{-2}$

1

$F = 6 \times 10^{-3}$ (N)

1

$6 \times 10^{-3} = B \times 1.5 \times 5 \times 10^{-2}$

1

$B = \frac{6 \times 10^{-3}}{7.5 \times 10^{-2}}$

1

$B = 8 \times 10^{-2}$ or 0.08

1

*allow 8×10^{-2} **or** 0.08 with no working shown for **5** marks*
*a correct method with correct calculation using an incorrect value of F gains **3** marks*

Tesla

accept T

1

do not accept t

[8]

M2. (a) the point at which the (total) mass seems to act / appears to be concentrated

accept 'weight' for 'mass'

accept the point at which gravity seems to act

*do **not** accept a definitive statement eg where (all) the mass is*

1

(b) wid<u>er</u> / larg<u>er</u> base

marks are for a correct comparison

1

low<u>er</u> centre of mass

accept lower centre of gravity / c of g

1

(c) <u>line of action</u> (of the weight) lies / falls inside the base

in each case the underlined term must be used correctly to gain the mark

1

the <u>resultant moment</u> returns mixer to its original position

accept there is no <u>resultant moment / resultant moment</u> is zero

accept resulting moment for resultant moment

*do **not** accept converse argument*

1

[5]

M3. (a) (i) will not fall over (1)

accept will not easily fall over (2)

orcentre of mass will remain above the base (1)

(line of action of the) weight will remain above within the base

accept centre of gravity / c of g / c of m / c m

if the monitor is given a small push (1)

depends on mark above

2

(ii) (total) clockwise moment = (total) anticlockwise moment

or *they are equal / balanced*

1

(b) the position of the centre of mass has changed (1)the line of action of the weight is outside the base (1)producing a (resultant) moment (1)

points may be expressed in any order

3

[6]

M4. (a) 1.2

*allow **1** mark for conversion of 2.4 kN to 2400 N*
or for correct transformation without conversion
ie d = 2880 ÷ 2.4

2

metre(s)/m

1

(b) any **two** from:

- as the load increases the (total) clockwise moment increases
- danger is that the fork lift truck / the load will topple / tip forward
- (this will happen) when the total clockwise moment is equal to (or greater than) the anticlockwise moment
  accept moments will not be balanced
- (load above 10.0 kN) moves line of action (from C of M) outside base (area)

2

[5]

M5. (a) 960 (Nm)

1

see-saw is in equilibrium

accept see-saw is balanced

see-saw is stationary is insufficient

1

(total) clockwise moments = anticlockwise moment

accept no resultant moment

forces are balanced is insufficient

*an answer clockwise moments balance the anticlockwise moments gains **2** marks*

1

(b) (i) 600 (Nm)

1

(ii) 375 (N) **or** their (b)(i) ÷ 1.6 correctly calculated

*do **not** credit if (b)(i) is larger than 960*

*allow **1** mark for correct substitution **and** transformation ie*

$\frac{600}{1.6}$ *or* $\frac{\text{their (b)(i)}}{1.6}$

2

[6]

M6. (a) (i) current produces a magnetic field (around XY)

accept current (in XY) is perpendicular to the (permanent) magnetic field

1

(creating) a force (acting) on XY / wire / upwards

reference to Fleming's left hand rule is insufficient

1

(ii) motor (effect)

1

(iii) vibrate / move up and down

1

5 times a second

only scores if first mark point scores

*allow for **1** mark only an answer 'changes direction 5 times a second'*

1

(b) 0.005

*allow **1** mark for calculating moment of the weight as 0.04 (Ncm)andallow **1** mark for correctly stating principle of moments**or**allow **2** marks for correct substitution*

*ie F × 8 = 2 × 0.02 **or** F × 8 = 0.04*

3

[8]

M7. (a) 38 400

*allow 6.4 × 6000 for **1** mark*

2

Nm **or** newton metres

*do **not** credit 'nm', 'mN' or 'metre newtons'*

1

(b) 16 000 (N) **or** 16 kN

*allow **1** mark for 38 400 ÷ 2.4*

*accept their (a) ÷ 2.4 correctly calculated for **2** marks*

*accept their (a) ÷ 2.4 for **1** mark*

2

[5]

M8. (a) (i) turning

accept turning ringed in the box

1

(ii) point at which mass (or weight) may be thought to be concentrated

accept the point from which the weight appears to act

allow focused for concentrated

*do **not** accept most / some of the mass*

*do **not** accept region / area for point*

1

(b) 600 (Nm)

*400 × 1.5 gains **1** mark provided no subsequent steps shown*

2

(c) (i) plank rotates clockwise

accept girl moves downwards

*do **not** accept rotates to the right*

1

(total) CM > (total) ACM

accept moment is larger on the girl's side

1

weight of see-saw provides CM

answer must be in terms of moment

*maximum of **2** marks if there is no reference to the weight of the see-saw*

1

(ii) W = 445 (N)

*W × 1.5 = (270 × 0.25) + (300 × 2.0) gains **2** marks*

*allow for **1** mark:*

total CM = total ACM either stated or implied

or

(270 × 0.25) + (300 × 2.0)

if no other marks given

3

[10]

M9. (a) 60

*allow **1** mark for correct substitution (with d in metres),ie 36 = F × 0.6*

*an answer of 0.6 **or** 6 gains **1** mark*

2

(b) the line of action of the weight lies outside the base / bottom (of the bag)

accept line of action of the weight acts through the side

accept the weight (of the bag) acts outside the base / bottom(of the bag)

1

a resultant / overall / unbalanced moment acts (on the bag)

accept the bag is not in equilibrium

*do **not** accept the bag is unbalanced*

1

[4]