Chapter 9 Motion Exam Question Pack

Name: _____

Class: _____

Date: _____

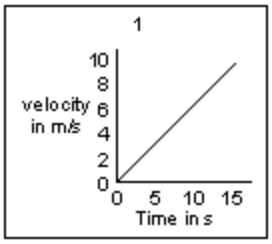
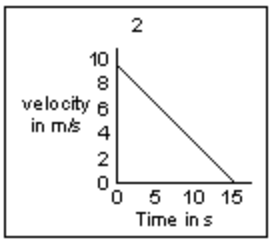
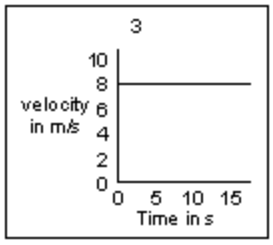
Time: **163 minutes**

Marks: **163 marks**

Comments:

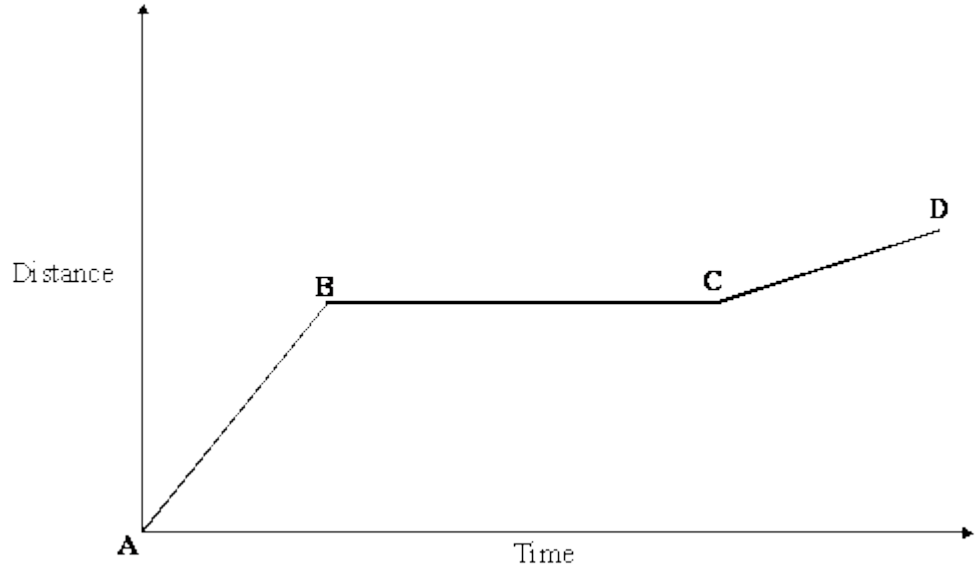
1 The graphs in **List A** show how the velocities of three vehicles change with time.
The statements in **List B** describe different motions.

Draw **one** line from each graph in **List A** to the description of the motion represented by that graph in **List B**.

List A **Velocity–time graphs**	**List B** **Descriptions of motion**
1 	**Constant velocity**
2 	**Constant acceleration**
	Not moving
3 	**Constant deceleration**

(Total 3 marks)

2 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)

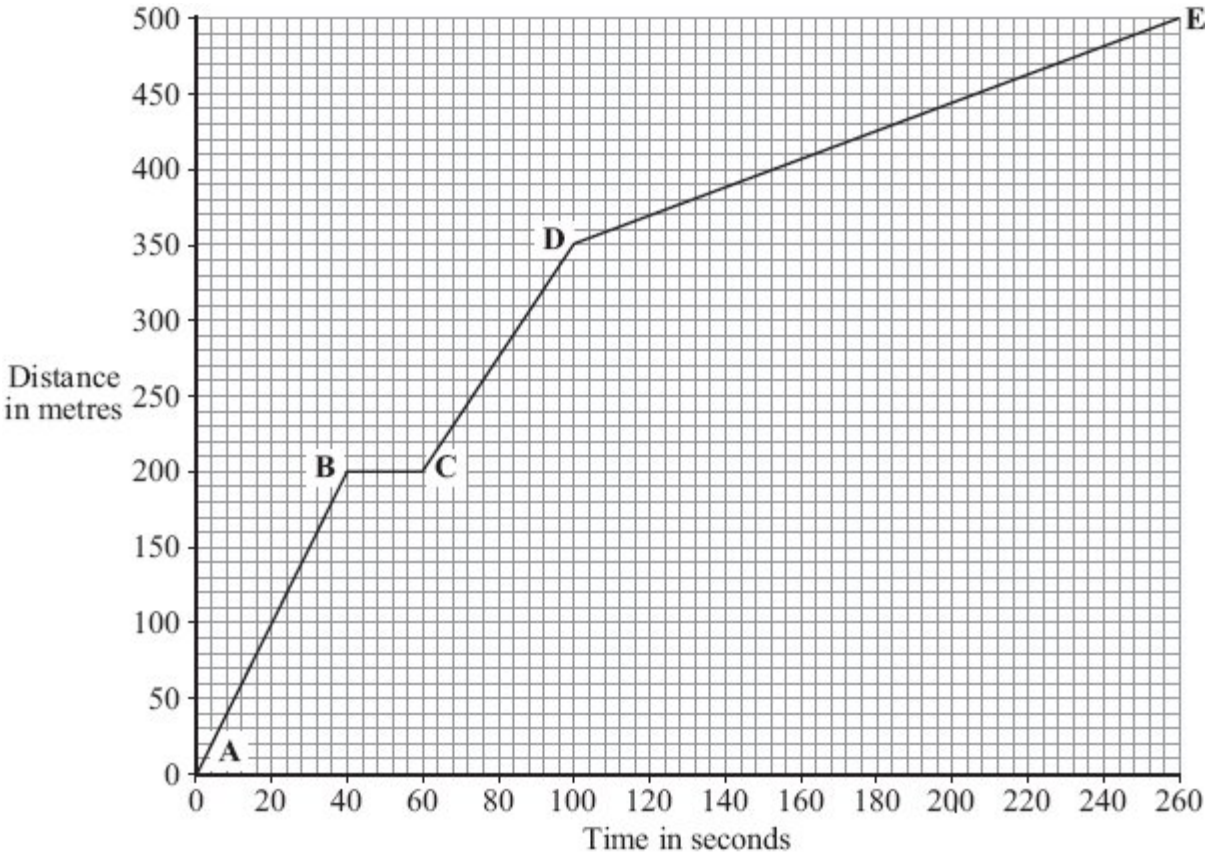
(c) Write the equation which relates distance, speed and time.

.....

(1)

(Total 5 marks)

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



(a) 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)

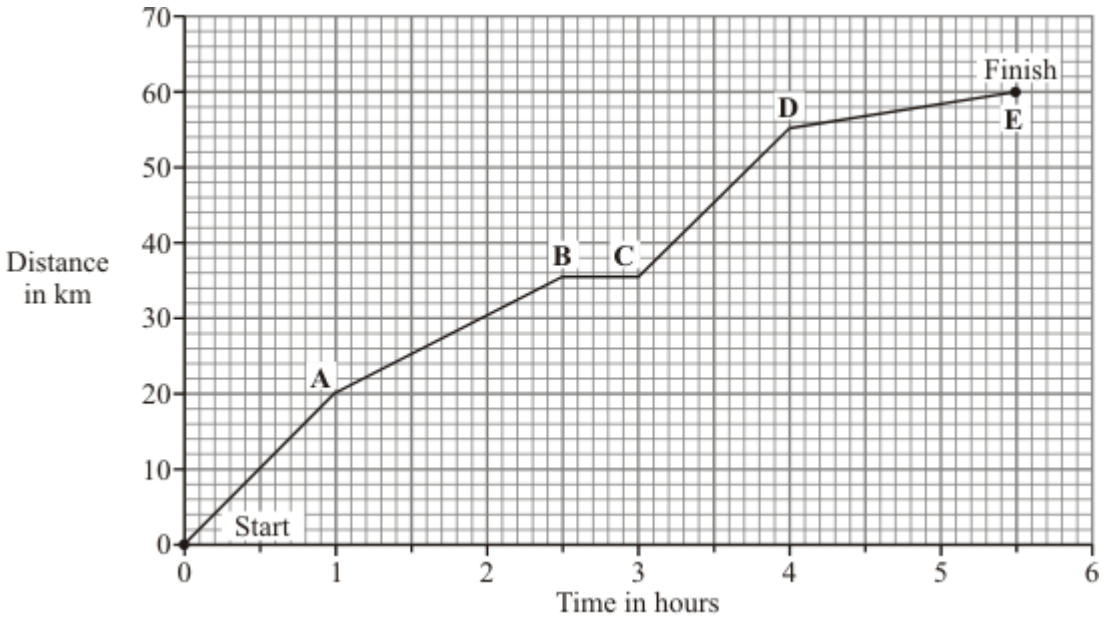
(ii) After how many seconds did the cyclist overtake the bus?

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

(1)

(Total 8 marks)

4 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.

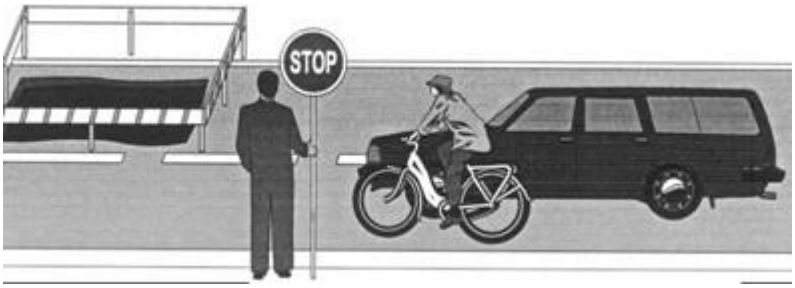
.....

.....

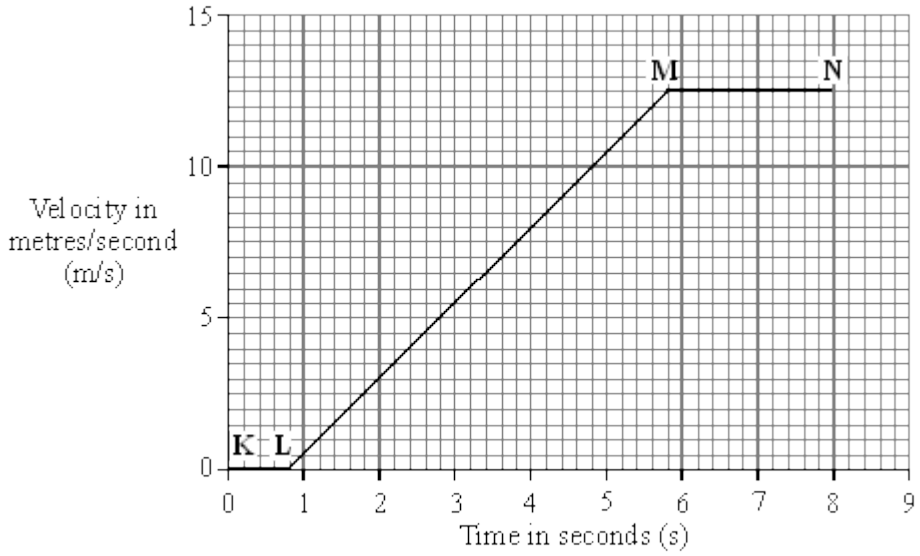
(2)

(Total 6 marks)

5 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.

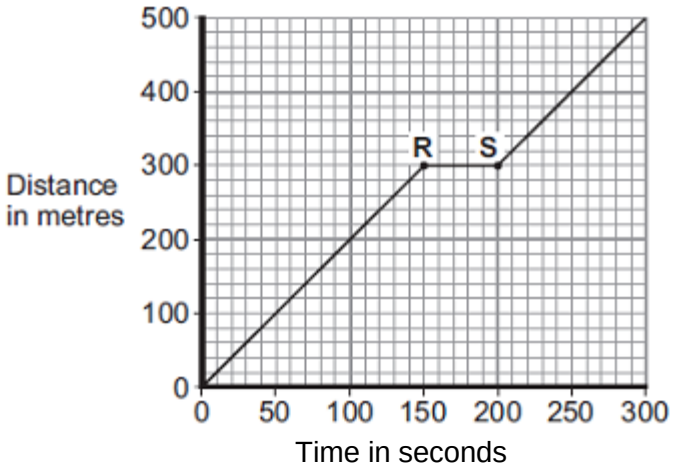
Draw a line on the graph to show how the velocity of the cyclist might change during the first 2 seconds of its motion.

(2)

(Total 6 marks)

6 (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 ☐

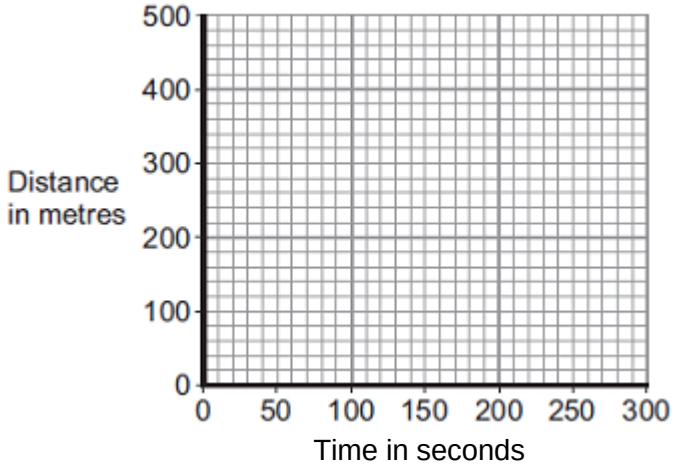
Moving with increasing speed ☐

(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.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

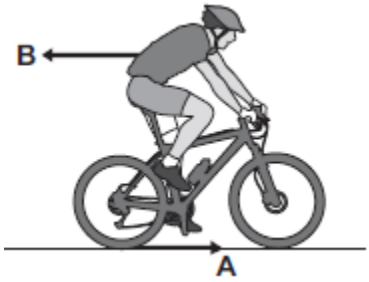
Resultant force = ... N

(2)

(Total 4 marks)

7 (a) **Figure 1** shows the horizontal forces acting on a moving bicycle and cyclist.

Figure 1



(i) What causes force **A**?

Draw a ring around the correct answer.

friction **gravity** **weight**

(1)

(ii) What causes force **B**?

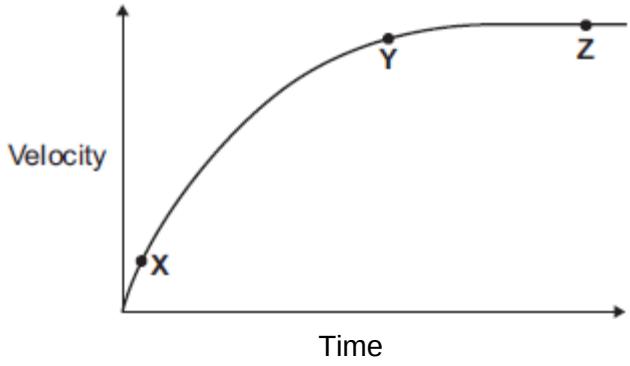
.....

(1)

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

Figure 2 shows how the velocity of the cyclist changes during the first part of a journey along a straight and level road. During this part of the journey the force applied by the cyclist to the bicycle pedals is constant.

Figure 2



Describe how **and** explain, in terms of the forces **A** and **B**, why the velocity of the cyclist changes:

- between the points **X** and **Y**
- and between the points **Y** and **Z**, marked on the graph in **Figure 2**.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Extra space .....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(6)

(b) (i) The cyclist used the brakes to slow down and stop the bicycle.

A constant braking force of 140 N stopped the bicycle in a distance of 24 m.

Calculate the work done by the braking force to stop the bicycle. Give the unit.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

Work done = ...

(3)

(ii) Complete the following sentences.

When the brakes are used, the bicycle slows down. The kinetic energy of the

bicycle ..... .

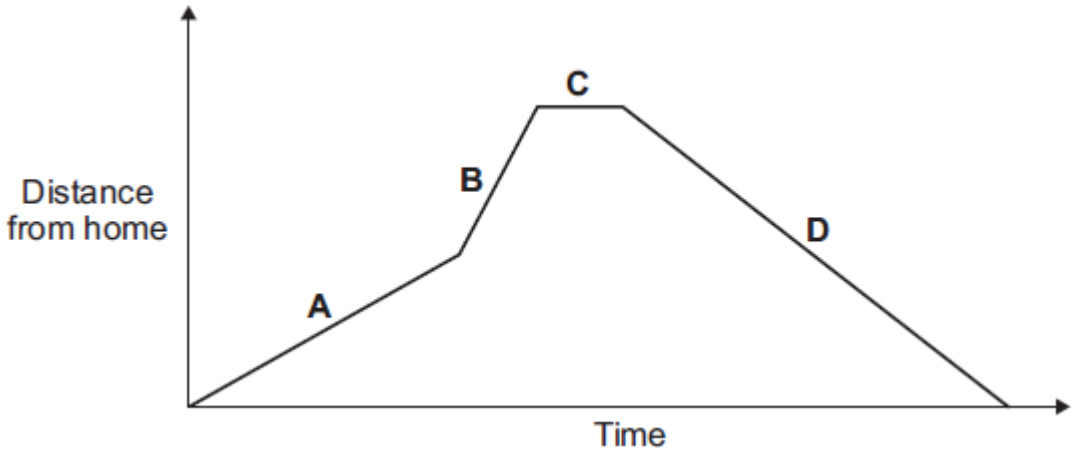
At the same time, the ..... of the brakes increases.

(2)

(Total 13 marks)

8 (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*?

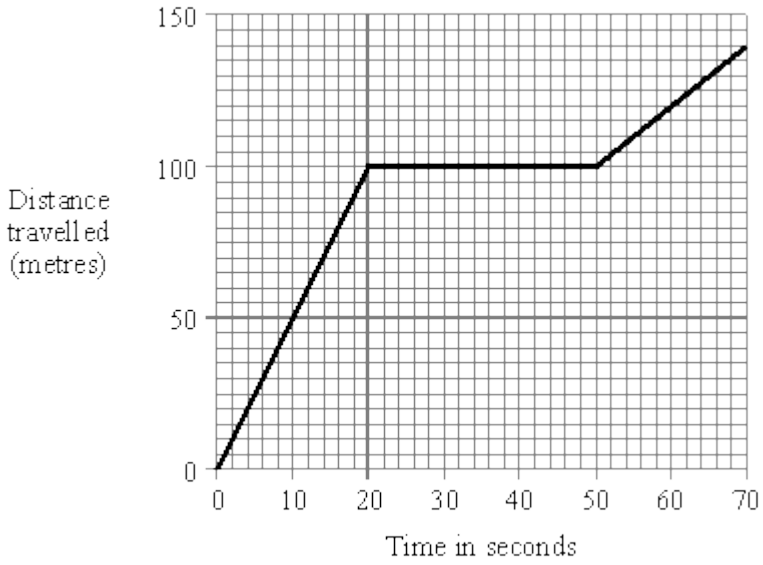
.....

.....

(1)

(Total 3 marks)

9 A child goes out to visit a friend.
The graph shows the child's journey.



(a) Calculate the child's average speed for the whole journey.
[Show your working and give the units in your answer.]

.....

.....

(3)

(b) How many times faster is the child travelling in part A of the graph than in part C?
[You should show how you obtained your answer.]

.....

.....

.....

(2)

(Total 5 marks)

10 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.

Use the correct equation from the Physics Equations Sheet.

.....

.....

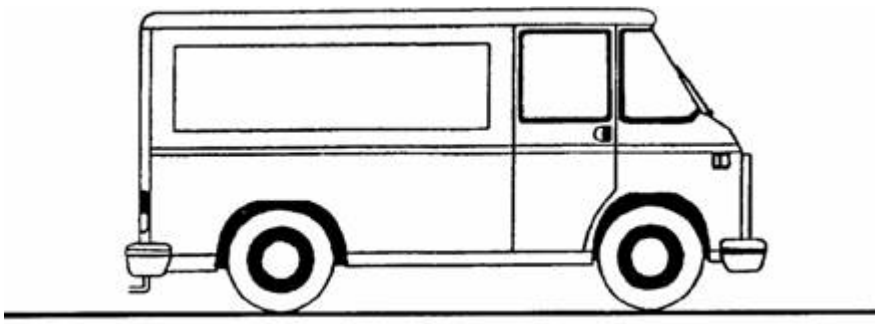
.....

Work done =.....

(3)

(Total 8 marks)

11



(a) The van shown above has a fault and leaks one drop of oil every second.

The diagram below shows the oil drops left on the road as the van moves from **W** to **Z**.

Describe the motion of the van as it moves from:

W to **X** .....

.....

X to **Y** .....

.....

Y to **Z** .....

.....

(3)

(b) The van was driven for 20 seconds at a speed of 30m/s.

Calculate the distance travelled.

.....

.....

.....

Distance ..... m

(2)

(c) The van was travelling at 30m/s. It slowed to a stop in 12 seconds.

Calculate the van's acceleration.

.....

.....

.....

Acceleration ..... m/s^2

(3)

(d) The driver and passenger wear seatbelts. Seatbelts reduce the risk of injury.

Explain how seatbelts reduce the risk of injury.

.....

.....

.....

.....

.....

.....

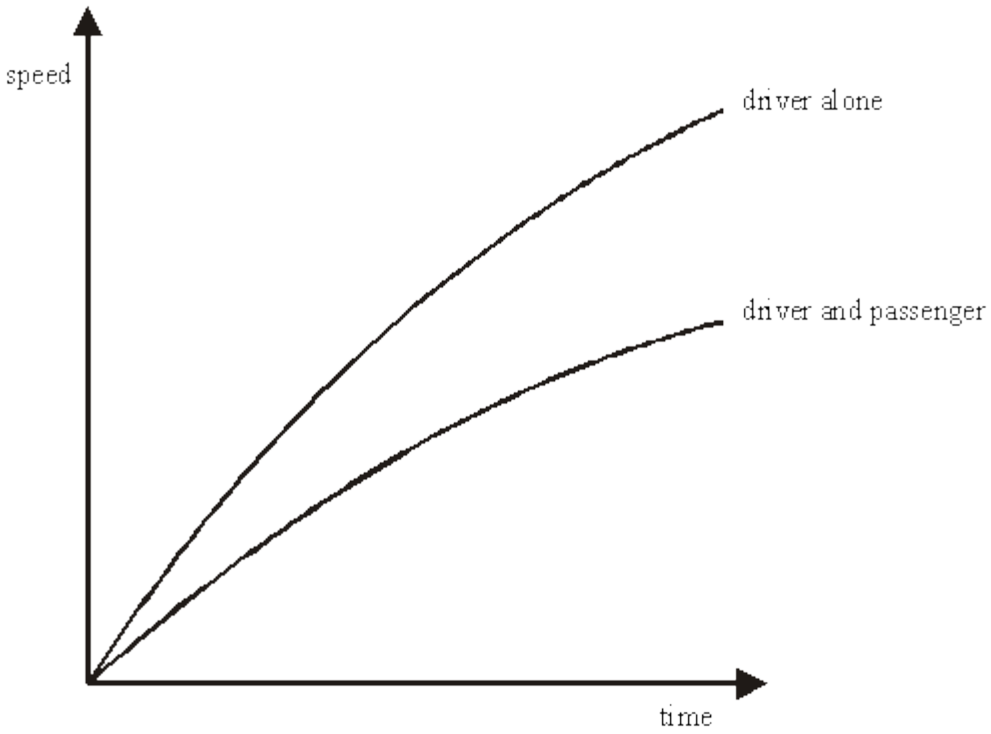
.....

.....

(4)

(Total 12 marks)

12 (a) When a car is driven efficiently the engine gives a constant forward pull on the car as the car accelerates to its maximum speed. During this time frictional forces and air resistance oppose the forward motion of the car. The sketch graphs below show how the car's speed increases when only the driver is in the car, and when the driver has a passenger in the car.



(i) How does the acceleration of the car change with time?

.....

.....

(1)

(ii) What conclusion can be made about the resultant (net) forward force on the car as its speed increases?

.....

.....

(1)

(ii) On the graph, draw a line to show how you would expect the car's speed to vary if it carried three passengers.

(1)

(b) The manufacturer of a family car gave the following information.

Mass of car 950g

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

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

.....

.....

.....

Answer .....

(2)

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

.....

.....

.....

Answer ..... N

(2)

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

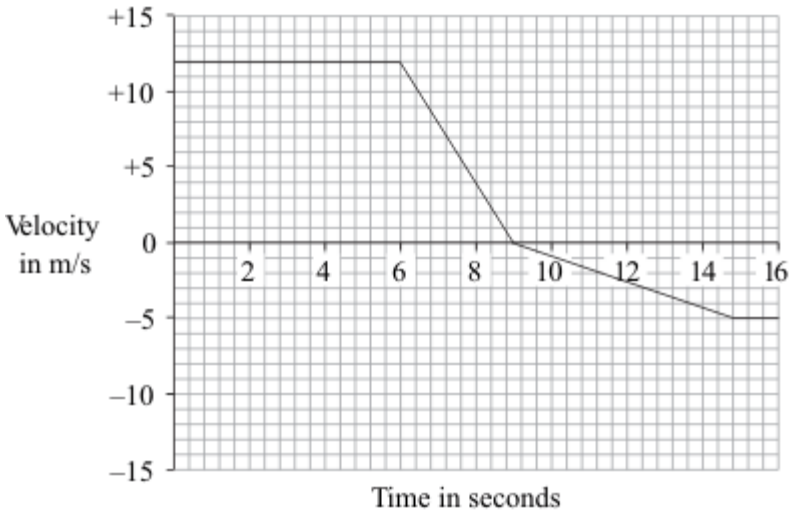
.....

.....

(2)

(Total 9 marks)

13 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?

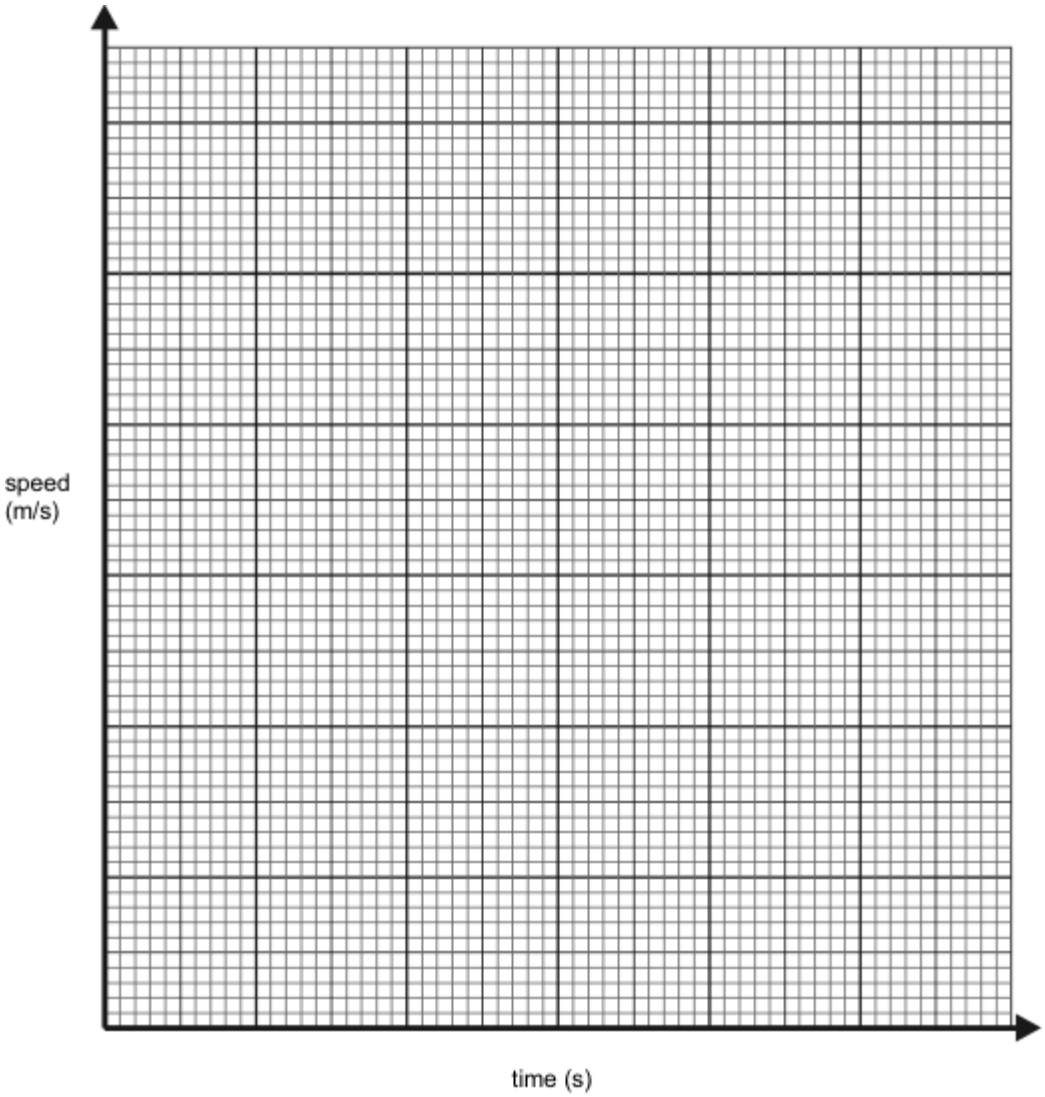
..... seconds

(1)

(Total 4 marks)

14 A driver is driving along a road at 30 m/s. The driver suddenly sees a large truck parked across the road and reacts to the situation by applying the brakes so that a constant braking force stops the car. The reaction time of the driver is 0.67 seconds, it then takes another 5 seconds for the brakes to bring the car to rest.

(a) Using the data above, draw a speed-time graph to show the speed of the car from the instant the truck was seen by the driver until the car stopped.



(5)

(b) Calculate the acceleration of the car whilst the brakes are applied.

.....

.....

.....

Answer = ... m/s^2

(3)

(c) The mass of the car is 1500 kg. Calculate the braking force applied to the car.

.....

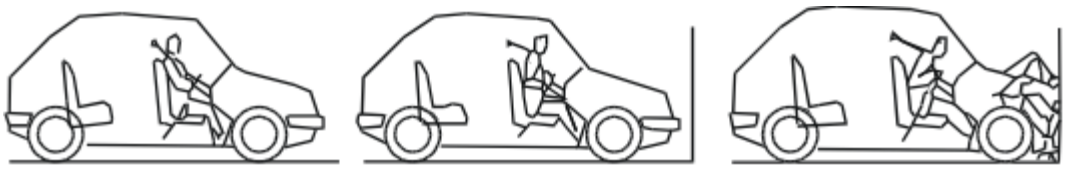
.....

.....

Answer = ... N

(3)

(d) The diagrams below show what would happen to a driver in a car crash.



(i) Explain why the driver tends to be thrown towards the windscreen.

.....

.....

.....

.....

.....

.....

(ii) During the collision the front end of the car becomes crumpled and buckled. Use this information to explain why such a collision is described as “inelastic”.

.....

.....

(iii) The car was travelling at 30 m/s immediately before the crash. Calculate the energy which has to be dissipated as the front of the car crumples.

.....

.....

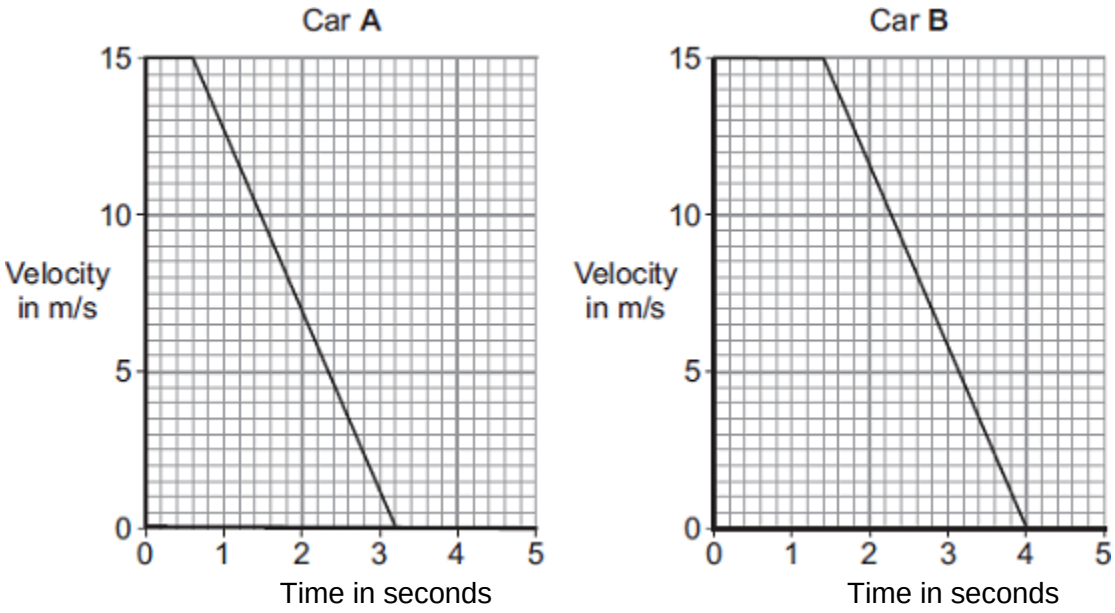
.....

.....

(8)

(Total 19 marks)

15 (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.

.....

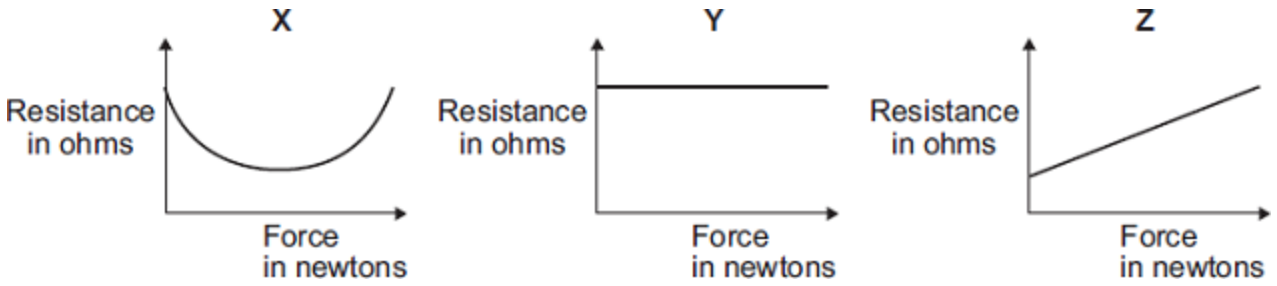
.....

.....

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.

.....

.....

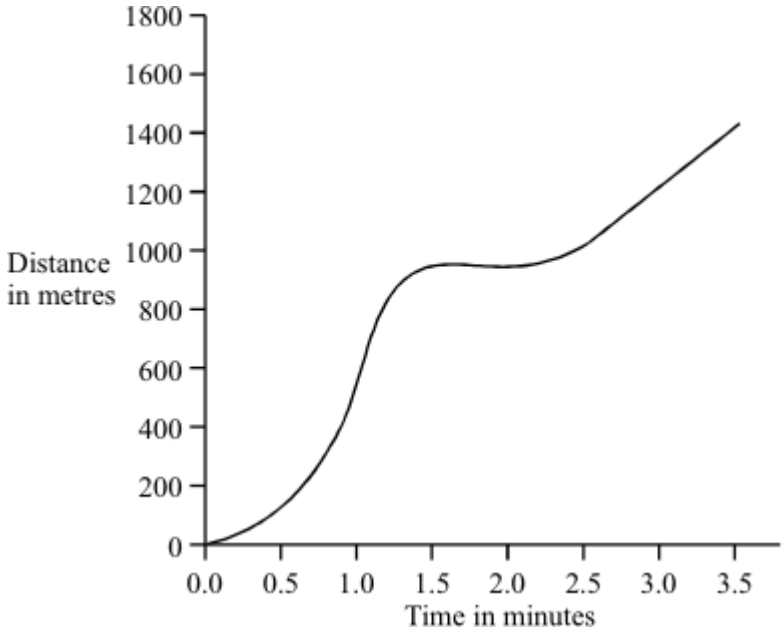
.....

.....

(2)

(Total 7 marks)

16 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?

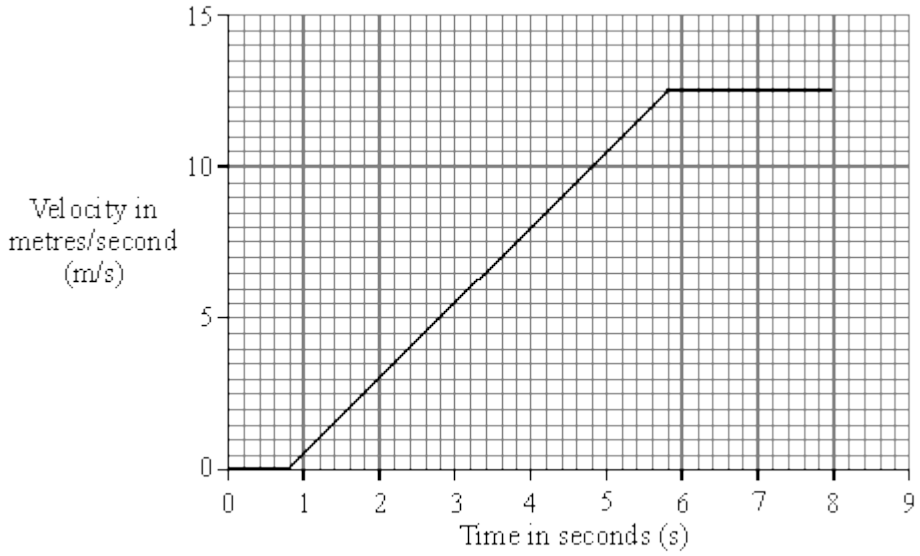
.....

.....

(1)

(Total 4 marks)

17 A car travelling along a straight road has to stop and wait at red traffic lights. The graph shows how the velocity of the car changes after the traffic lights turn green.



(a) Between the traffic lights changing to green and the car starting to move there is a time delay. This is called the reaction time. Write down **one** factor that could affect the driver's reaction time.

.....

(1)

(b) Calculate the distance the car travels while accelerating. Show clearly how you work out your answer.

.....

.....

Distance = ...metres

(3)

(c) Calculate the acceleration of the car. Show clearly how you work out your final answer and give the units.

.....

.....

.....

Acceleration = ...

(4)

(d) The mass of the car is 900 kg.

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

.....

(1)

(ii) Calculate the force used to accelerate the car. Show clearly how you work out your final answer.

.....

.....

Force = ... newtons

(2)

(Total 11 marks)

18 A number of different forces act on a moving vehicle.

(a) A car moving at a steady speed has a driving force of 3000 N.

(i) What is the value of the resistive force acting on the car?

Tick (✓) **one** box.

	Tick (✓)
2000 N	
3000 N	
4000 N	

(1)

(ii) What causes most of the resistive force?

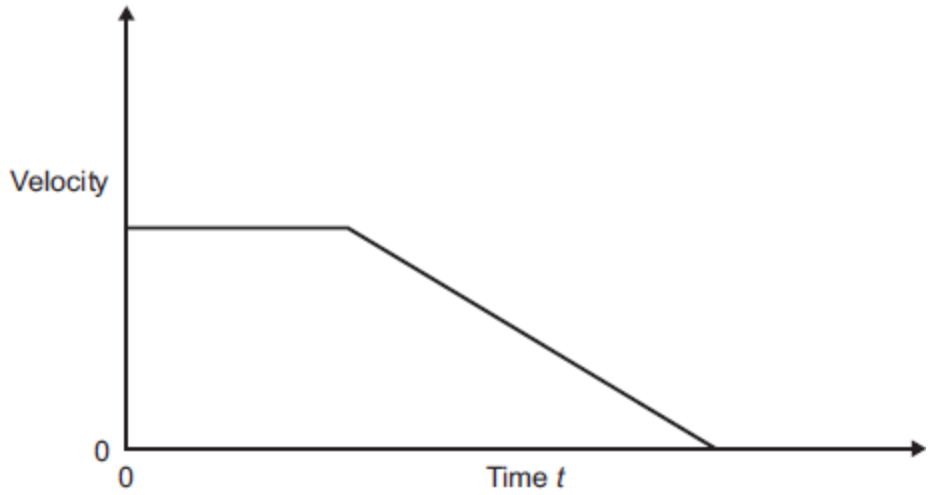
Tick (✓) **one** box.

	Tick (✓)
Air resistance	
Faulty brakes	
Poor condition of tyres	

(1)

(b) A car is moving along a road. The driver sees an obstacle in the road at time $t = 0$ and applies the brakes until the car stops.

The graph shows how the velocity of the car changes with time.



(i) Which feature of the graph represents the negative acceleration of the car?

Tick (✓) **one** box.

	Tick (✓)
The area under the graph	
The gradient of the sloping line	
The intercept on the y-axis	

(1)

(ii) Which feature of the graph represents the distance travelled by the car?

Tick (✓) **one** box.

	Tick (✓)
The area under the graph	
The gradient of the sloping line	
The intercept on the y-axis	

(1)

(iii) On a different journey, the car is moving at a **greater** steady speed.

The driver sees an obstacle in the road at time $t = 0$ and applies the brakes until the car stops.

The driver's reaction time and the braking distance are the same as shown the graph above.

On the graph above draw another graph to show the motion of the car.

(3)

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

Thinking distance and braking distance affect stopping distance.

Explain how the factors that affect thinking distance and braking distance affect stopping distance.

.....

.....

.....

.....

.....

.....

.....

.....

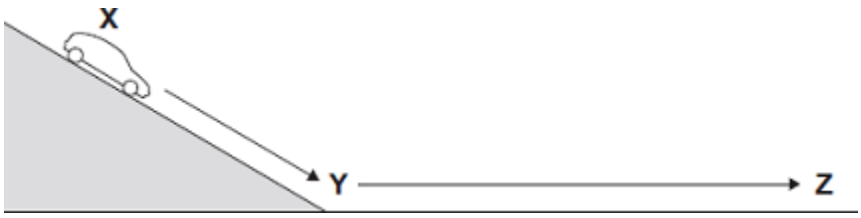
.....

.....

(6)

(Total 13 marks)

19 (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**?

.....

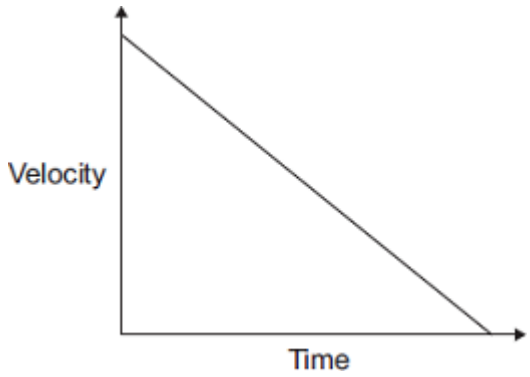
(1)

(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**?

.....

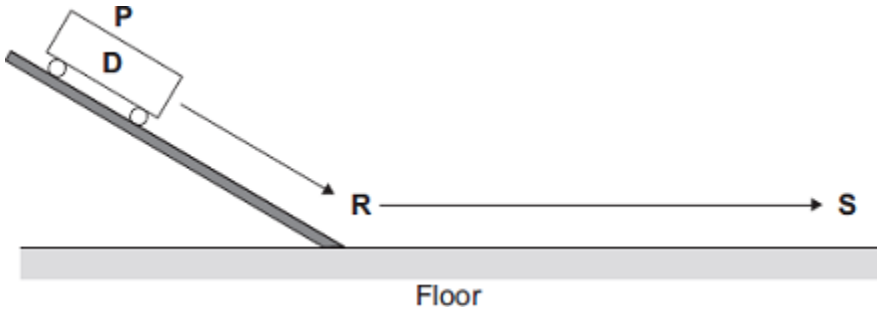
(1)

(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.

Use the correct equation from **Section A** of the Physics Equations Sheet.

.....

.....

.....

(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.

.....

.....

.....

.....

.....

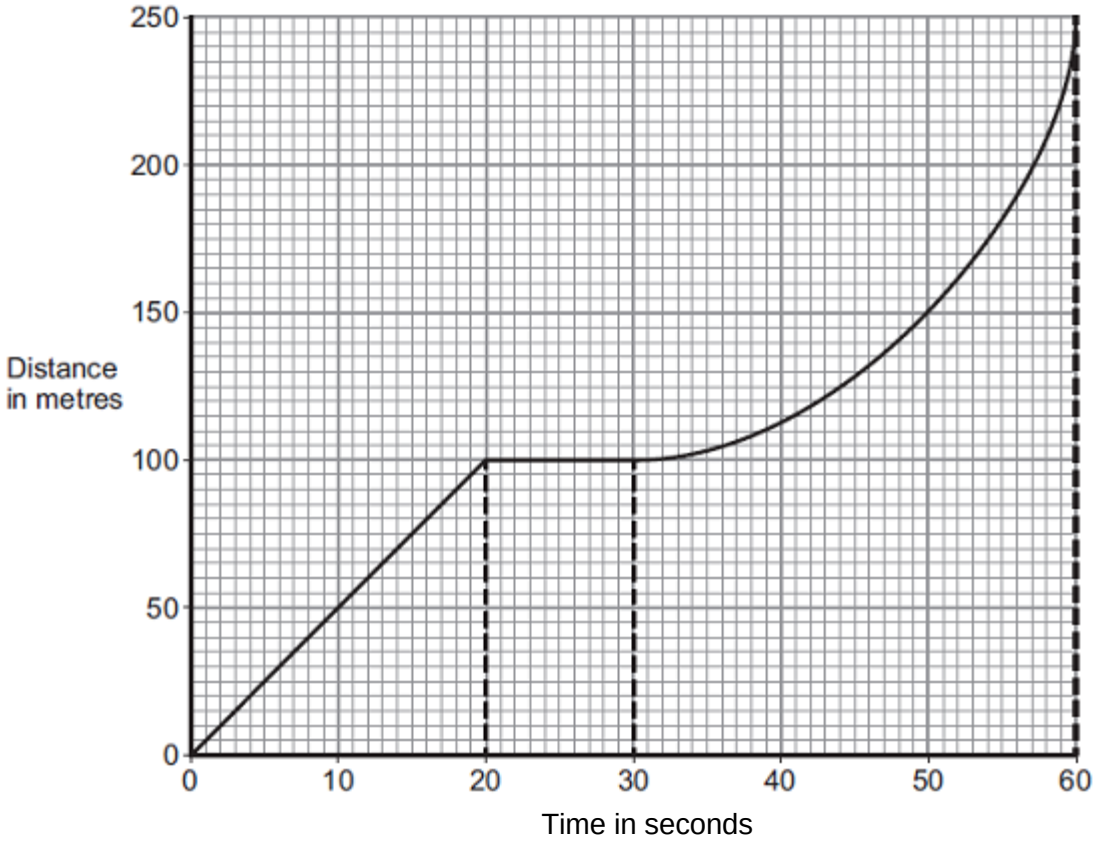
.....

(3)

(Total 12 marks)

20 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.

Use the correct equation from **Section A** of the Physics Equations Sheet.

.....

.....

Force = ... N

(2)

(iii) What happens to the kinetic energy of the bus as it is braking?

.....

.....

.....

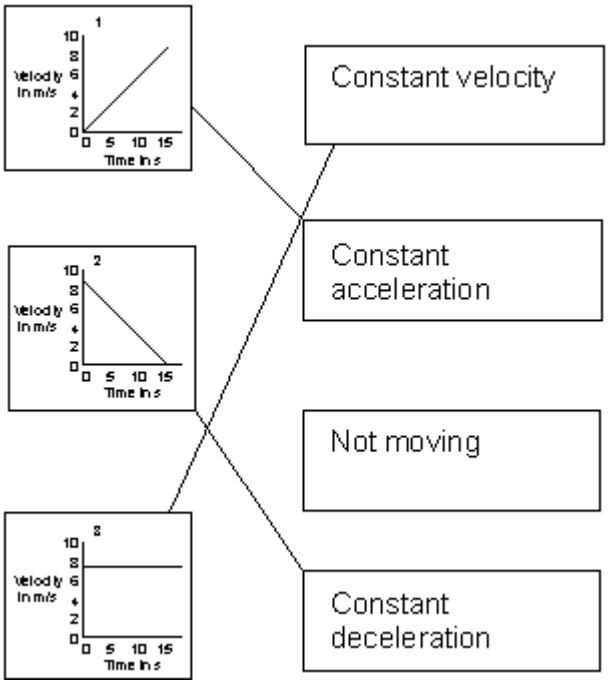
.....

(2)

(Total 11 marks)

Mark schemes

1 1 mark for each line



if more than 1 line is drawn from a graph in List A then all those lines are marked incorrect

[3]

2 (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]

3 (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) straight 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]

4 (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]

5 (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) straight (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]

6 (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]

7 (a) (i) friction

1

(ii) air resistance

accept drag

friction is insufficient

1

(iii) 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 information on page 5, and apply a 'best-fit' approach to the marking.

0 marks
No relevant content.

Level 1 (1–2 marks)
There is an attempt to explain in terms of forces A and B why the velocity of the cyclist changes between any two points
or
a description of how the velocity changes between any two points.

Level 2 (3–4 marks)
There is an explanation in terms of forces A and B of how the velocity changes between X and Y and between Y and Z
or
a complete description of how the velocity changes from X to Z.
or
an explanation and description of velocity change for either X to Y or Y to Z

Level 3 (5–6 marks)
There is a clear explanation in terms of forces A and B of how the velocity changes between X and Z
and
a description of the change in velocity between X and Z.

examples of the points made in the response

extra information

X to Y

- at X force A is greater than force B
- cyclist accelerates
- and velocity increases
- as cyclist moves toward Y, force B (air resistance) increases (with increasing velocity)
- resultant force decreases
- cyclist continues to accelerate but at a smaller value
- so velocity continues to increase but at a lower rate

Y to Z

- from Y to Z force B (air resistance) increases
- acceleration decreases
- force B becomes equal to force A
- resultant force is now zero
- acceleration becomes zero

- velocity increases until…
- cyclist travels at constant / terminal velocity

accept speed for velocity throughout

6

(b) (i) 3360

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

ie 140 × 24 provided no subsequent step

*accept 3400 for **2** marks if correct substitution is shown*

2

joule / J

*do **not** accept j*

*do **not** accept Nm*

1

(ii) decreases

accept an alternative word / description for decrease

do not accept slows down

1

temperature

accept thermal energy

accept heat

1

[13]

8 (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]

9 (a) evidence of

speed = $\frac{\text{distance}}{\text{time}}$ (travelled) or $\frac{100}{20}$ or $\frac{40}{20}$

gains 1 mark

but or any correct calculation of gradient

(except when zero) gains 2 marks

$\frac{140}{70}$ or 2

gains 1 mark

units metres per second **or** m/s **or** ms^{-1}

(not mps)

for 1 mark

3

(b) *evidence of* calculating the two speeds

($\frac{100}{20}$ and $\frac{40}{20}$ **or** 5 and 2) (evidence of this may be in (a))

or

noting distances travelled in same time (20 secs) i.e. 100m and 40m **but** 2.5

gains 2 marks

2

[5]

10 (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]

11 (a) WX deceleration / speed decreasing / slowing down / negative acceleration

XY constant speed / steady speed *not* constant motion / slow speed

YZ acceleration / speed increasing / speeding up

for 1 mark each

3

(b) distance = v × t **or** distance = 30 × 20

gains 1 mark

but
distance = 600(m)

gains 2 marks

2

(c) acceleration = v / t **or** acceleration = 30 / 12

gains 1 mark

(if –30 / 12, allow negative sign here if not in the answer)

3

but

acceleration = 2.5 (m/s²)

gains 2 marks

but

acceleration = -2.5 (m/s²)

gains 3 marks

(d) in a crash / during hard braking car body stops / slows rapidly driver / passengers continue to move forward *not* thrown forward seatbelts provide backward force / keep them in their seats / restrain them to stop them hitting the windscreen / dashboard

(an alternative argument involving momentum is acceptable)

for 1 mark each

4

[12]

12 (a) (i) decreases

for 1 mark

1

(ii) decreases

for 1 mark

1

(iii) lower speed everywhere

for 1 mark

1

(b) (i) $3\ a = \frac{s}{t}$ **or** $a = \frac{33}{11}$

gains 1 mark

1

ms^{-2}

gains 1 mark

1

(ii) 2850 ecf

gains 2 marks

else working

gains 1 mark

2

(iii) air resistance/frictional forces increase with speed;
till frictional force = max forward engine force;
when acceleration is zero

(incorrect statement – 1 mark)

or (limitation on maximum speed for safety-1 mark)

any two for 1 mark each

2

[9]

13 (a) 4

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

2

m/s^2

ignore negative sign

1

(b) 9 (s)

1

[4]

14 (a) Each scale optimum
Else both half size
Straight line joining 30,0 to 30,0.67 to 0, 5.67

any 5 for 1 mark each

5

(b) 6
Else a = 30/5

gets 2 marks

Else a = v/t

gets 1 mark

3

(c) 9000
Else F = 6 × 1500

gets 2 marks

Else F = ma

gets 1 mark

3

(d) (i) Driver has forward momentum
Which is conserved
Giving drive relative forward speed to car

for one mark each

3

(ii) If inelastic ke lost
Here ke does work crumpling car

for 1 mark each

2

(iii) Car stops in 75m

gets 1 mark

W = F.d or 9000 × 75

gets 1 mark

W = 675 000 J
OR ke = 1/2 mv^2

gets 1 mark

ke = 1/2.1500.302
ke = 675 000 J

3

[19]

15 (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]

16 (i) first statement must be accelerated

if it just accelerated then decelerates award 2 marks

1

final statement must be stationary

1

interim statement decelerates

1

(ii) direction is changing

1

[4]

17 (a) concentration / tiredness / drugs / alcohol

accept any reasonable factor that could affect a driver's reactions
*do **not** accept speed or any physical condition unrelated to the driver*

1

(b) 31.25

*credit for **1** mark correct attempt to calculate the area under the slope **or** for using the equation*
distance = <u>average</u> velocity (speed) × time
*credit for **1** mark use of correct velocity change (12.5) <u>and</u> correct time (5) **or** answer of 62.5*

3

(c) 2.5

*credit for **1** mark triangle drawn on slope **or** correct equation **or** two correct pairs of coordinates*

credit for 1 mark use of correct velocity change (12.5) and correct time (5)

accept time = between 4.8 and 5.2 if used in (b)

do not accept an attempt using one pair of coordinates taken from the slope

3

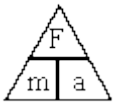
metres / second / second **or** metres / second / squared **or** m/s^2 **or** ms^{-2}

1

(d) (i) force = mass × acceleration

accept correct transformation

accept F = m × a

accept 

provided subsequent use of Δ is correct

*do **not** accept an equation in units*

1

(ii) 2250

credit their (c) × 900 for 2 marks

*credit **1** mark for correct substitution*

2

[11]

18 (a) (i) 3000 N

1

(ii) air resistance

1

(b) (i) the gradient of the sloping line

1

(ii) the area under the graph

1

(iii) horizontal line above previous one

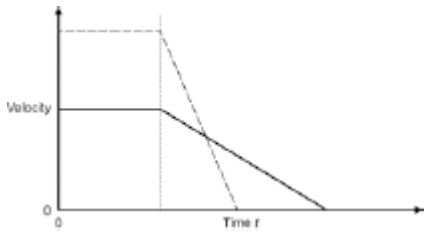
1

for the same time

1

sloping line cutting time axis before previous line

eg



1

(c) Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response. Examiners should also apply a 'best-fit' approach to the marking.

0 marks
No relevant content

Level 1 (1−2 marks)
One factor is given that affects thinking distance
or
one factor is given that affects braking distance

Level 2 (3−4 marks)
One factor and a description of its effect is given for **either** thinking distance **or** braking distance

Level 3 (5−6 marks)
One factor and a description of its effect is given for **both** thinking distance and braking distance
plus
some extra detail

Examples of the points made in the response
stopping distance = thinking distance + braking distance

the faster the car travels the greater the stopping distance

thinking distance is the distance travelled from when the driver sees an obstacle to when the brakes are applied

braking distance is the distance travelled from when the brakes are applied to when the car stops

thinking distance:
- tiredness increases thinking distance
- taking drugs increases thinking distance
- drinking alcohol increases thinking distance
- distractions in the car increase thinking distance.

braking distance:
- poor condition of brakes increases braking distance
- poor condition of tyres increases braking distance
- wet roads increase braking distance
- icy roads increase braking distance.

6

[13]

19 (a) (i) gravitational potential (energy)

1

(ii) kinetic (energy)

1

(b) (i) slope or gradient

1

(ii) area (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]

20 (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]