Q1. (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*?

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.....

(1)

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

1 .....

.....

2 .....

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(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.

Use the correct equation from the Physics Equations Sheet.

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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.

Use the correct equation from the Physics Equations Sheet.

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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.

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(1)

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

Explain why.

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(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.

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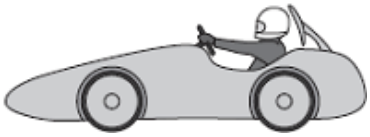
(3)

(Total 14 marks)

Q2. (a) Some students have designed and built an electric-powered go-kart. After testing, the students decided to make changes to the design of their go-kart.

First design **X**

Final design **Y**



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

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

Explain why.

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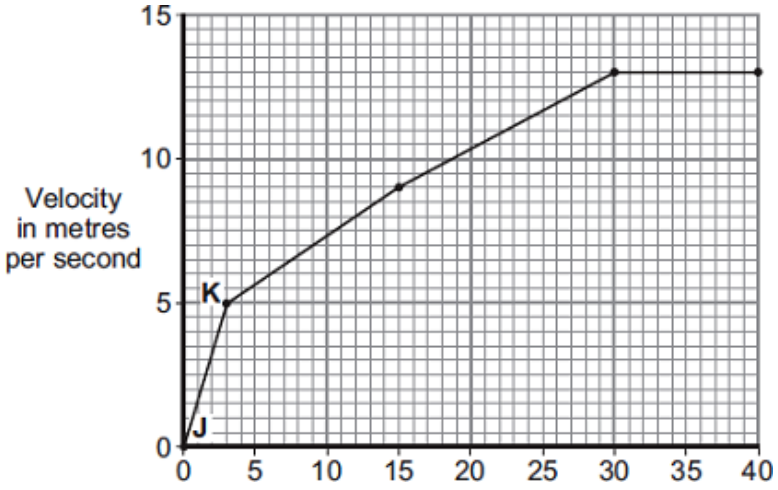
(3)

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

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



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

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

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Acceleration = ... m/s^2

(2)

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

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Distance = ... m

(2)

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

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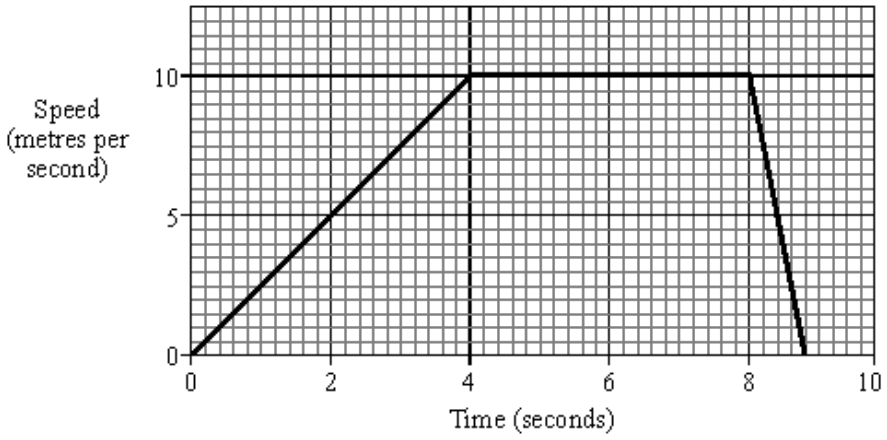
(1)

(Total 8 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.)

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(3)

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

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(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.)

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Answer ..... newtons (N)

(2)

(Total 8 marks)

Q4. When a gun is fired, a very large force acts on the bullet for a very short time.

The change in momentum of the bullet is given by the following relationship:

force (N) × time(s) = change in momentum (kg m/s)

(a) An average force of 4000 newton acts for 0.01 seconds on a bullet of mass 50g.

Calculate the speed of the bullet. (*Show your working*.)

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Answer ..... m/s

(4)

(b) The bullet is fired horizontally. In the short time it takes for the bullet to reach its target, its horizontal speed has fallen to 80% of its initial speed.

(i) Explain why the speed of the bullet decreases so quickly.

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(2)

(ii) Calculate the percentage of its original kinetic energy the bullet still has when it reaches its target.

(Show your working.)

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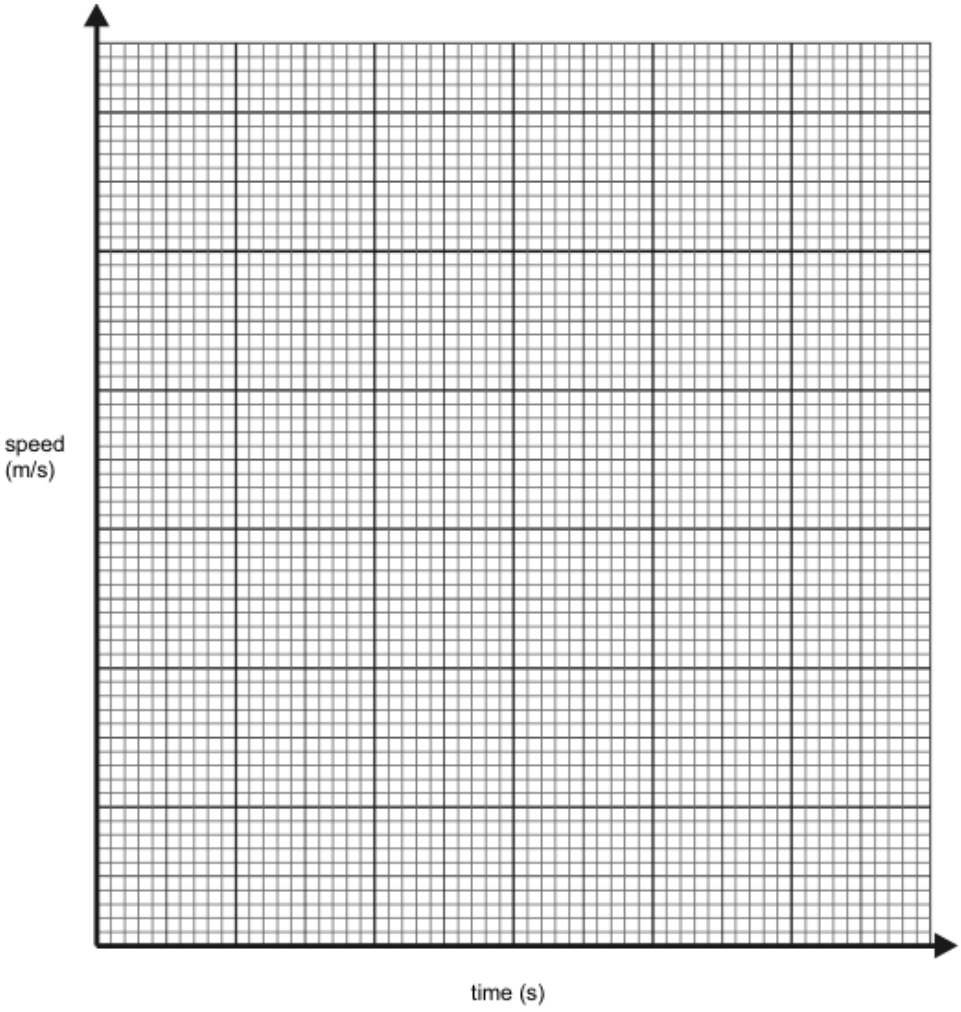
(4)

(Total 10 marks)

Q5. 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.

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Answer = ... m/s^2

(3)

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

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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.

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(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”.

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(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.

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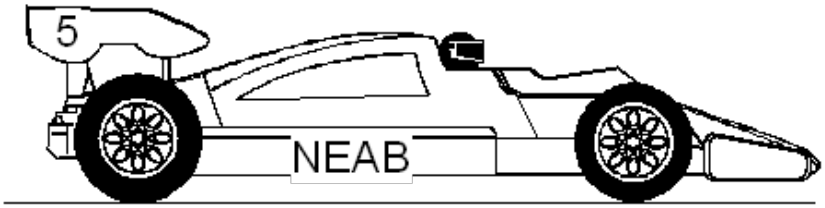
(8)

(Total 19 marks)

Q6. A racing driver is driving his car along a **straight** and **level** road as shown in the diagram below.



(a) The driver pushes the accelerator pedal as far down as possible. The car does not accelerate above a certain maximum speed. Explain the reasons for this in terms of the forces acting on the car.

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(4)

(b) The racing car has a mass of 1250 kg. When the brake pedal is pushed down a constant braking force of 10 000 N is exerted on the car.

(i) Calculate the acceleration of the car.

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(ii) Calculate the kinetic energy of the car when it is travelling at a speed of 48 m/s.

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(iii) When the brakes are applied with a constant force of 10 000 N the car travels a distance of 144 m before it stops. Calculate the work done in stopping the car.

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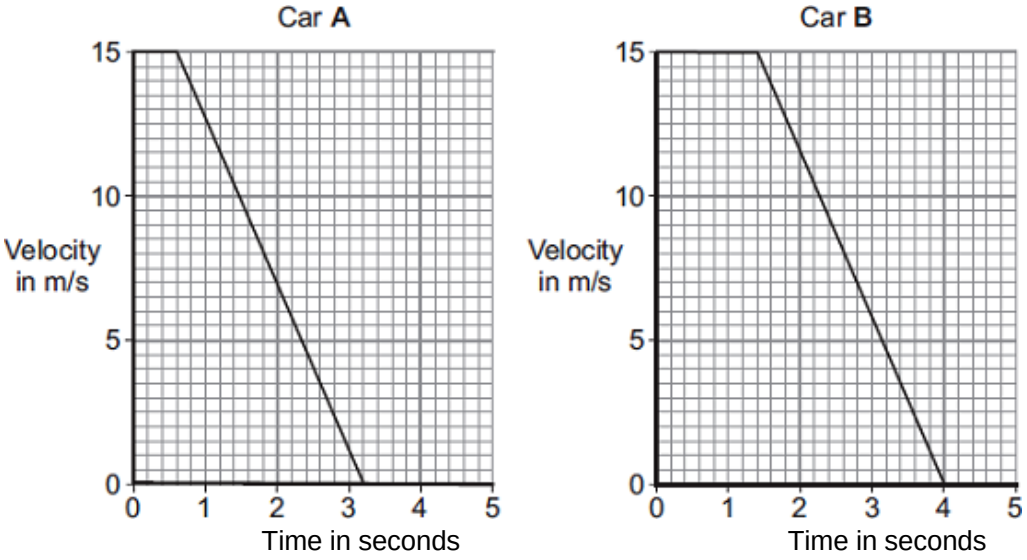
(12)
(Total 16 marks)

Q7. (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?

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(1)

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

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(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.

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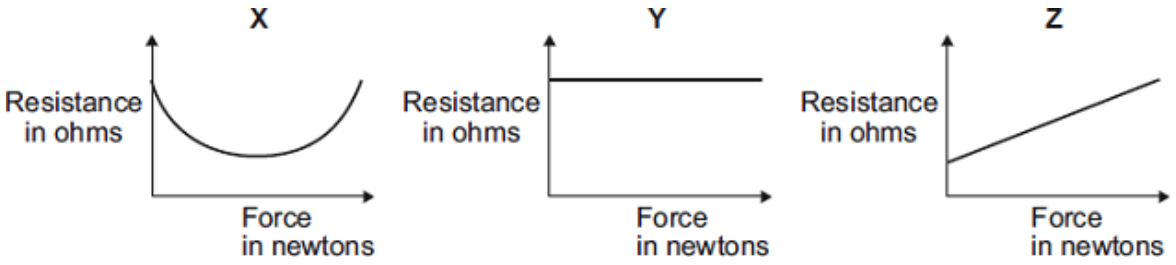
Additional stopping distance = ... m

(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?

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Give a reason for your answer.

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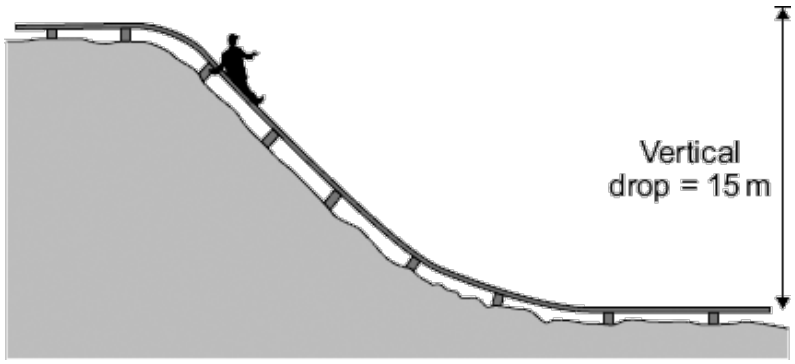
(2)

(Total 7 marks)

Q8. The miners working in a salt mine use smooth wooden slides to move quickly from one level to another.



(a) A miner of mass 90 kg travels down the slide.

Calculate the change in gravitational potential energy of the miner when he moves 15 m vertically downwards.

gravitational field strength = 10 N/kg

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

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Change in gravitational potential energy = ... J

(2)

(b) Calculate the **maximum** possible speed that the miner could reach at the bottom of the slide.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

Give your answer to an appropriate number of significant figures.

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Maximum possible speed = ... m/s

(3)

(c) The speed of the miner at the bottom of the slide is much less than the calculated maximum possible speed.

Explain why.

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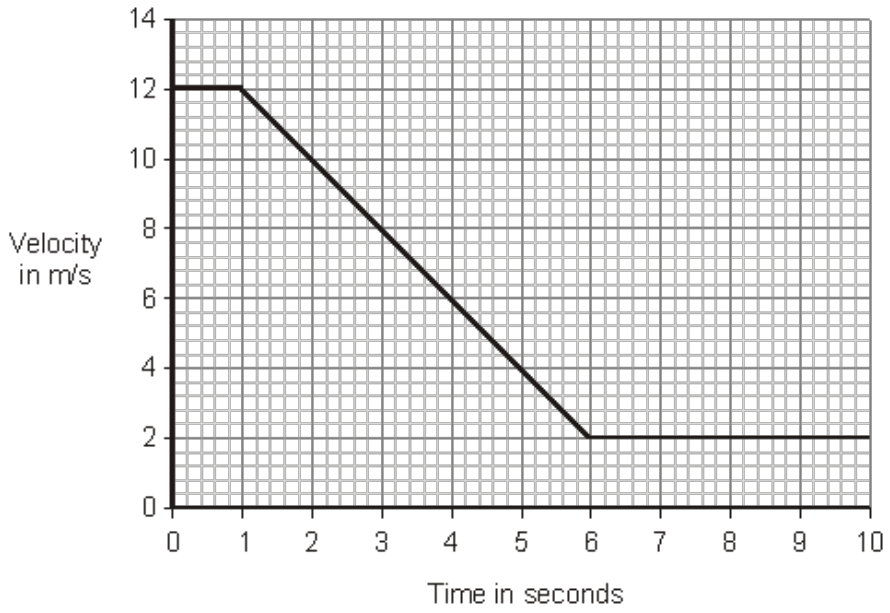
(3)
(Total 8 marks)

Q9. A car is driven along a straight, snow covered, road. The graph shows how the velocity of the car changes from the moment the driver sees a very slow moving queue of traffic ahead.



(a) Use the graph to calculate the distance the car travels while it is slowing down.

Show clearly how you work out your answer.

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Distance = ... m

(3)

(b) The car has a mass of 1200 kg.

Calculate the kinetic of the car when it travels at a speed of 12 m/s.

Write down the equation you use, and then show clearly how you work out your answer.

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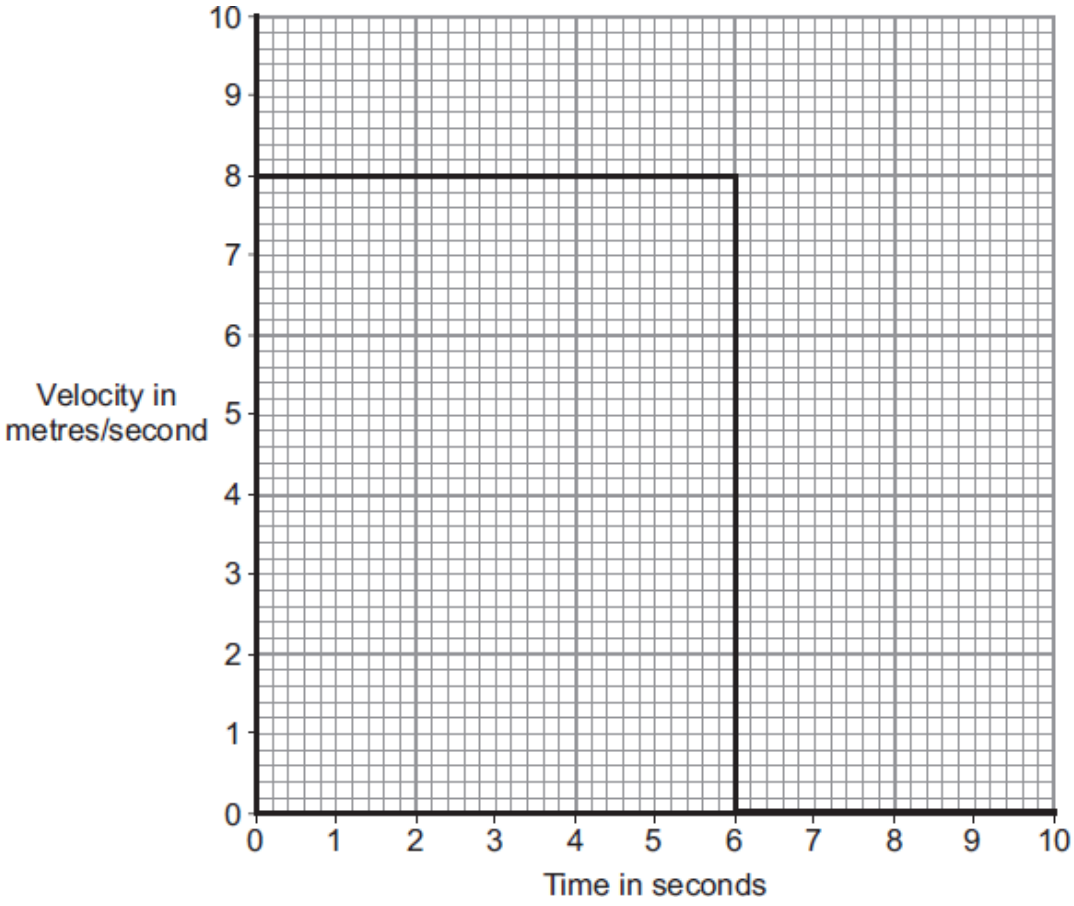
Kinetic energy = ... J

(2)

(Total 5 marks)

Q10. 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.

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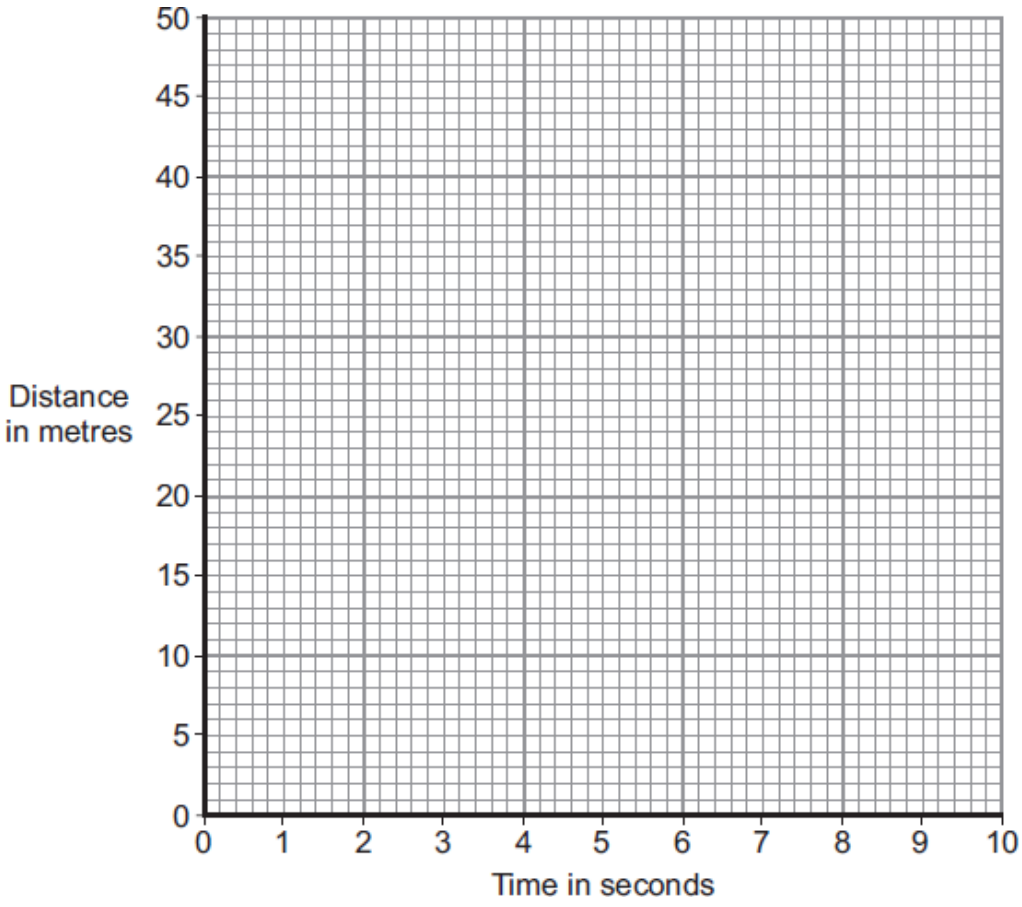
Distance = ... m

(2)

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



(2)
(Total 4 marks)

Q11. The diagram shows the horizontal forces acting on a car of mass 1200 kg.

(a) Calculate the acceleration of the car at the instant shown in the diagram.

Write down the equation you use, and then show clearly how you work out your answer and give the unit.

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Acceleration = ...

(4)

(b) Explain why the car reaches a top speed even though the thrust force remains constant at 3500 N.

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(3)

(c) The diagram shows a car and a van.

The two vehicles have the same mass and identical engines.

Explain why the top speed of the car is higher than the top speed of the van.

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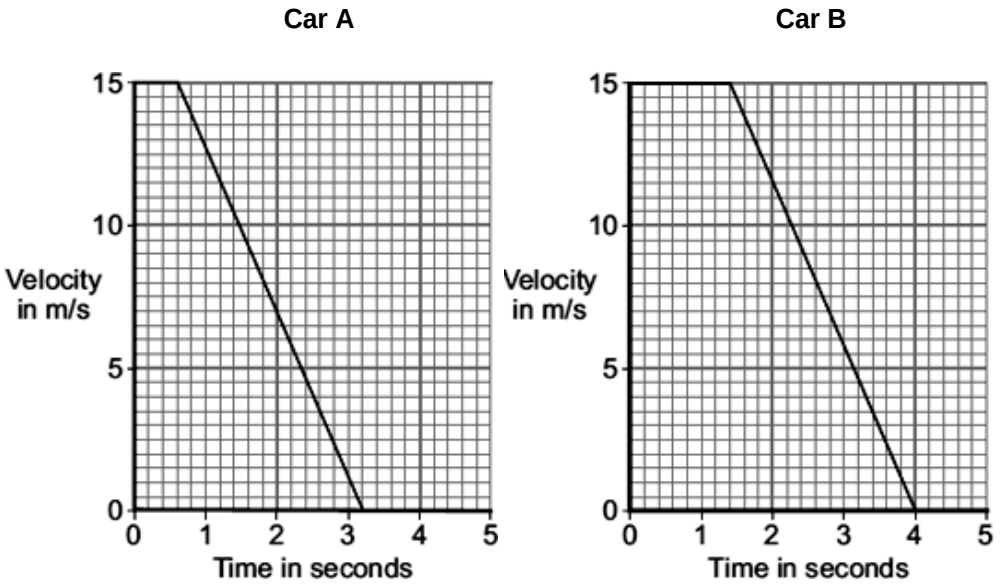
(4)
(Total 11 marks)

Q12. (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?

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(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.

.....

.....

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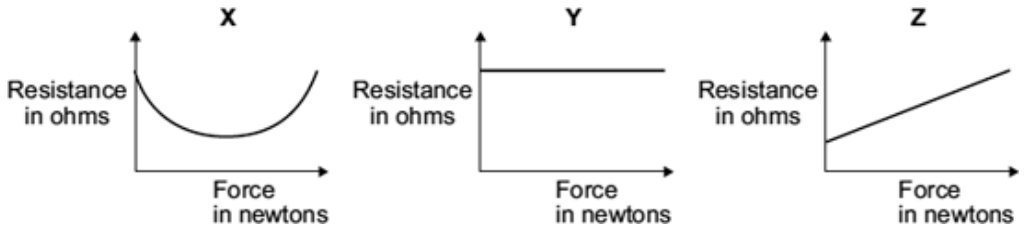
Additional stopping distance = ... m

(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?

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Give a reason for your answer.

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(2)
(Total 7 marks)