AQA GCSE PHYSICS (HIGHER) · 8463

PHYSICS



EXAM QUESTION PACK

4.5.6.2.2 NEWTON'S SECOND LAW (PACK 2)

SCORE	PERCENTAGE
/247	%

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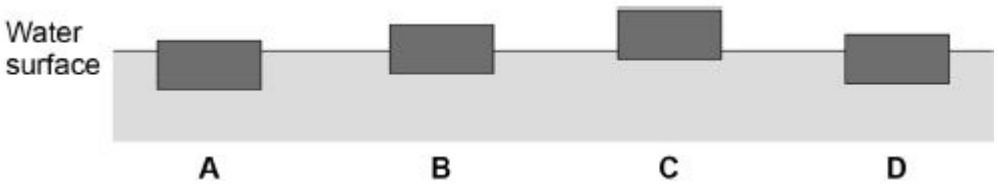
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Q1.

Figure 1 shows four blocks of different materials floating on water.

The four blocks are the same volume.

Figure 1



(a) Which of the blocks has the smallest weight?

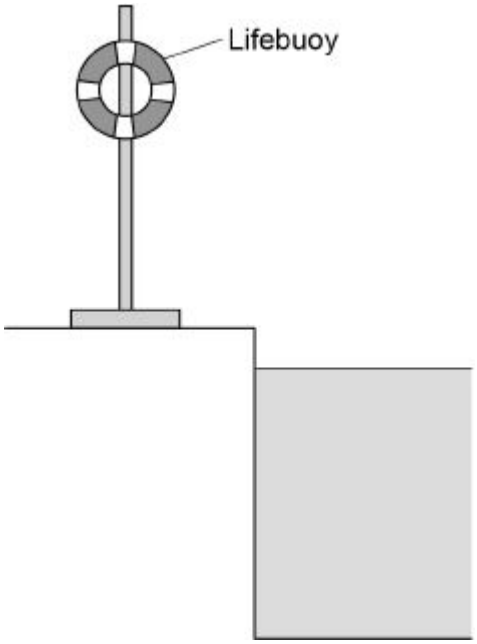
Tick **one** box.

A ☐ B ☐ C ☐ D ☐

(1)

Figure 2 shows a lifebuoy next to a deep swimming pool.

Figure 2



(b) The lifebuoy has a mass of 2.5 kg.

gravitational field strength = 9.8 N/kg

Calculate the weight of the lifebuoy.

Use the equation:

weight = mass × gravitational field strength

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_____

_____

_____

_____

Weight = _____ N

(2)

(c) When thrown into the water the lifebuoy floats. The two forces acting on the lifebuoy are the weight of the lifebuoy downwards and upthrust upwards.

How big is the upthrust on the lifebuoy compared to the weight of the lifebuoy?

Tick **one** box.

The upthrust is greater than the weight. ☐

The upthrust is less than the weight. ☐

The upthrust is the same as the weight. ☐

(1)

(d) Write down the equation which links acceleration, mass and resultant force.

_____

(1)

(e) A rope is used to pull the lifebuoy to the side of the swimming pool.

A resultant force of 4.0 N acts on the lifebuoy.

The mass of the lifebuoy is 2.5 kg.

Calculate the acceleration of the lifebuoy.

_____

_____

_____

_____

Acceleration = _____ m/s^2

(3)

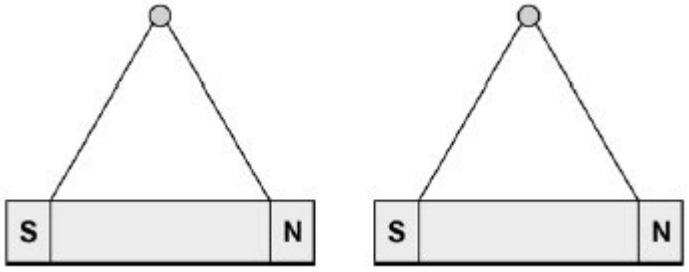
(Total 8 marks)

Q2.

Figure 1 shows two bar magnets suspended close to each other.

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Figure 1



(a) Explain what is meant by the following statement.

'A non-contact force acts on each magnet'.

_____

_____

_____

_____

(2)

(b) Describe how to plot the magnetic field pattern of a bar magnet.

_____

_____

_____

_____

_____

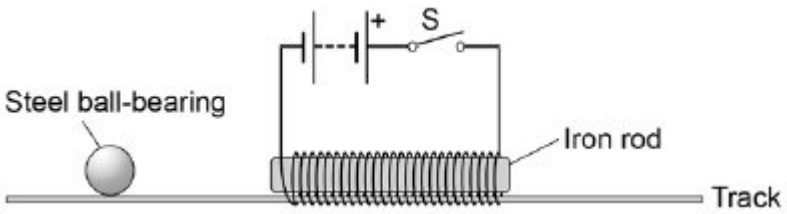
_____

(3)

A student has set up the apparatus shown in **Figure 2**.

The iron rod is fixed to the track and cannot move.

Figure 2



(c) The student gives the steel ball bearing a gentle push in the direction of the iron rod.

At the same time the student closes the switch **S**.

Explain the effect on the motion of the ball bearing when the switch **S** is closed.

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_____

_____

_____

_____

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_____

(4)

(Total 9 marks)

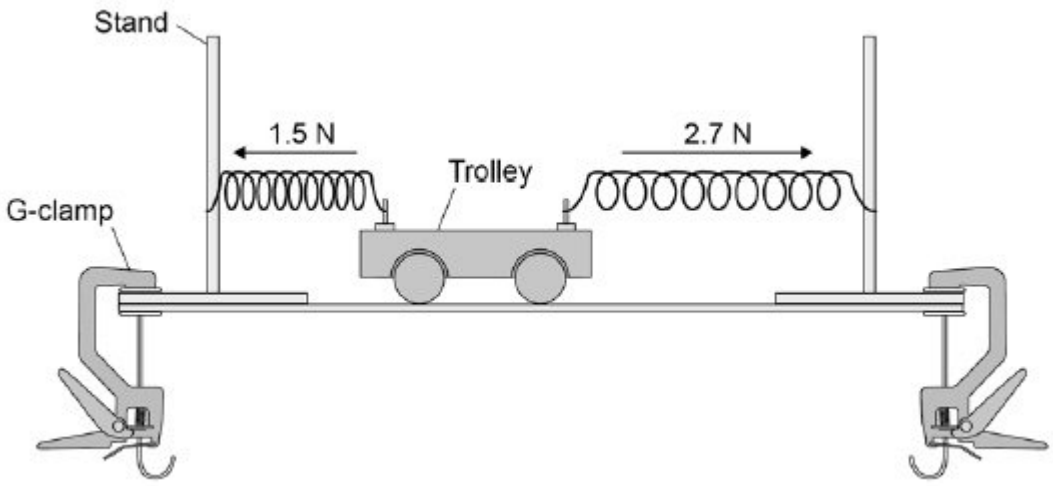
Q3.

A trolley is attached to two identical springs.

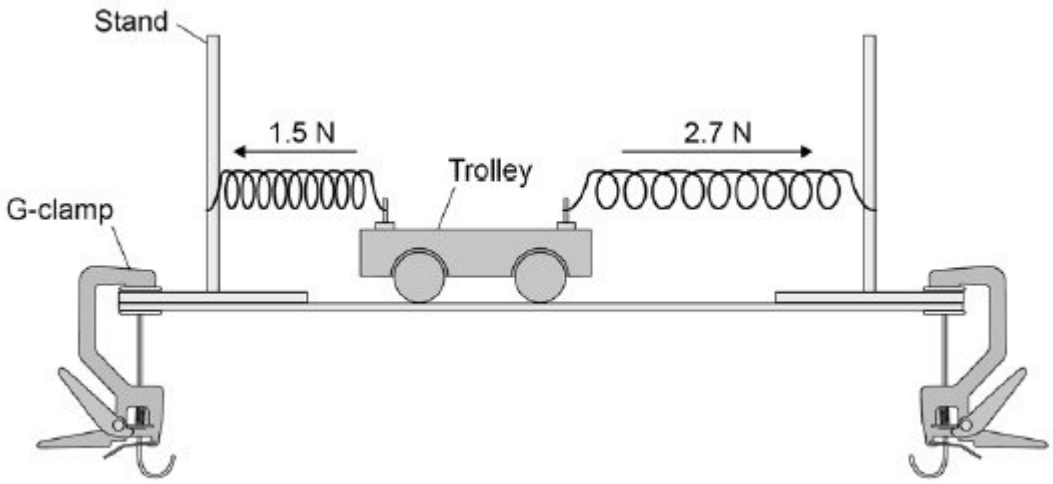
The trolley is pushed to the left and then released.

Figure 1 shows the horizontal forces acting on the trolley just after it is released.

Figure 1



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(a) Write the equation which links acceleration, mass and resultant force.

_____

(1)

(b) The trolley has a mass of 0.75 kg

Calculate the acceleration of the trolley just after it is released.

Give the unit.

_____

_____

_____

_____

_____

Acceleration = _____ Unit _____

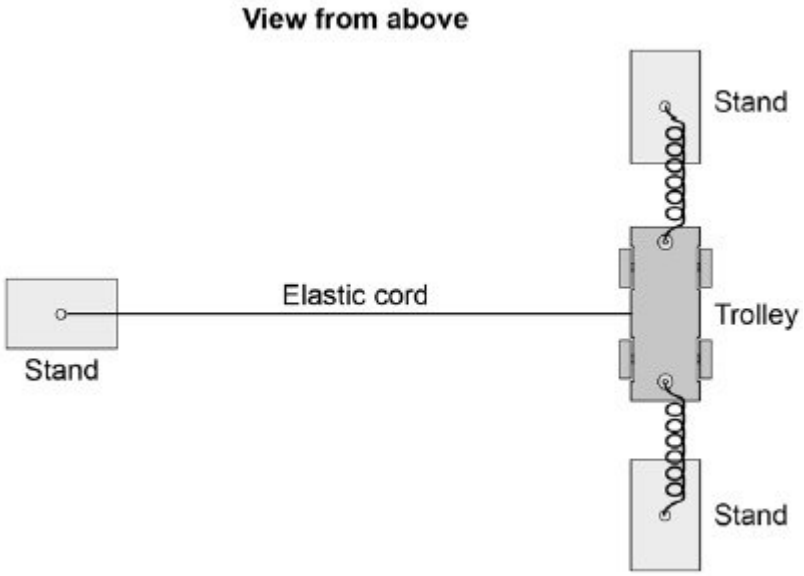
(4)

An elastic cord is fixed to the trolley.

Figure 2 shows the arrangement viewed from above.

Figure 2

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When the trolley is pushed and released a wave travels along the cord.

(c) What type of wave travels along the cord?

_____

Give the reason for your answer.

_____

_____

(2)

(d) Suggest one change that could be made to the apparatus shown in **Figure 2** to produce a wave with a lower frequency.

_____

_____

(1)

(Total 8 marks)

Q4.

Two students investigated how the acceleration of a trolley depends on the force applied to the trolley.

Before starting the investigation, each student wrote a hypothesis.

Hypothesis of student **A**:

'The acceleration of the trolley is directly proportional to the force applied to the trolley.'

Hypothesis of student **B**:

'Changing the force applied to the trolley will change the acceleration of the trolley.'

(a) Consider the hypothesis of student **A**.

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Predict what would happen to the acceleration of the trolley if the force applied to the trolley is doubled.

_____

_____

(1)

(b) Why is it difficult to make a valid prediction using the hypothesis of student **B**?

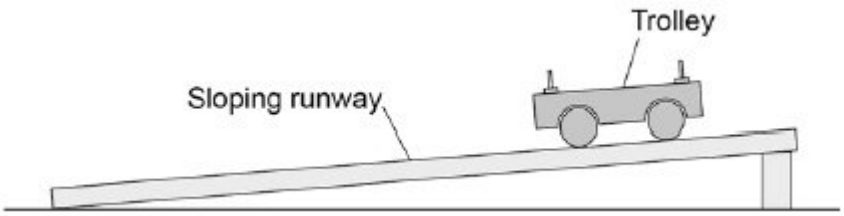
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_____

(1)

Figure 1 shows some of the equipment used by the students.

Figure 1



(c) Write a list of any other equipment the students will need to complete the investigation.

_____

_____

_____

_____

_____

(2)

(d) Why should the students use a sloping runway?

Tick **one** box.

To reduce the effect of friction on the trolley. ☐

To decrease the acceleration of the trolley. ☐

To stop the trolley rolling back up the runway. ☐

(1)

(e) Describe a method the students could have used for their investigation.

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(6)

(f) The students used the same trolley throughout the investigation.

Suggest why.

_____

_____

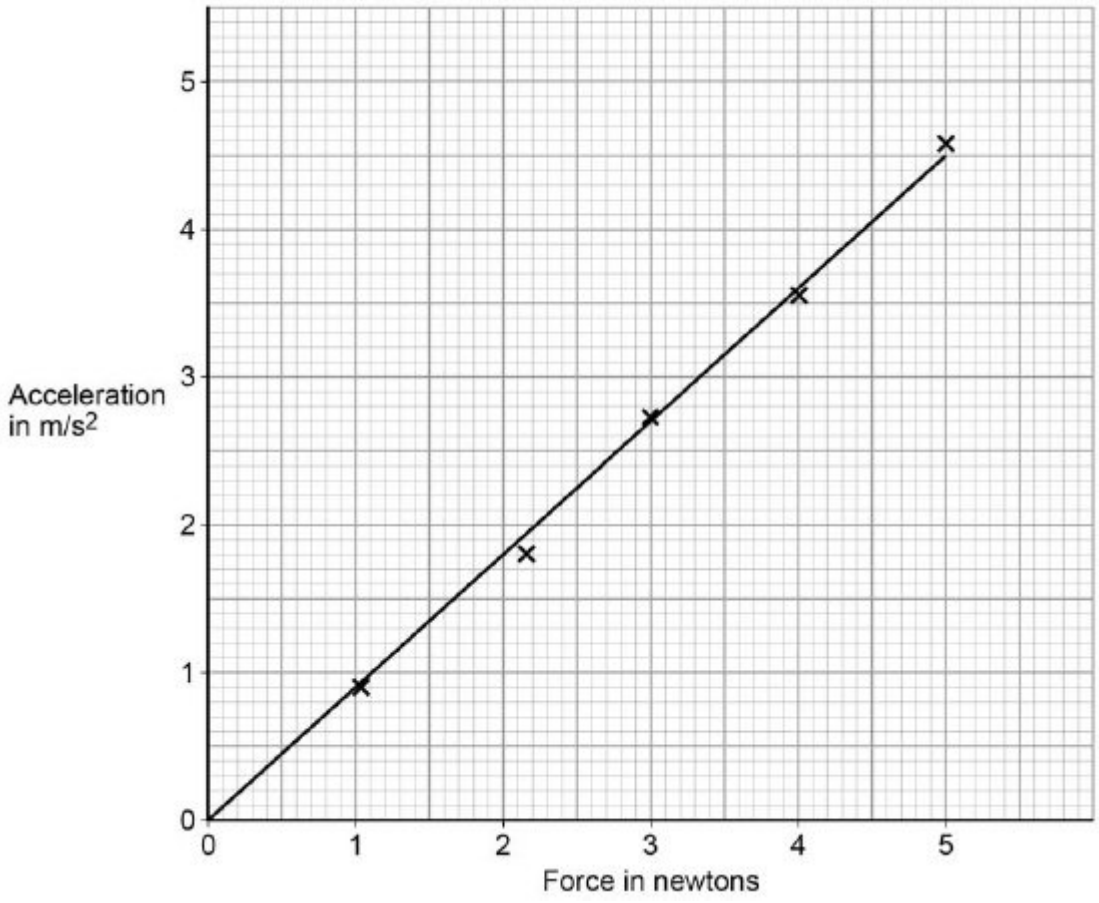
_____

_____

(2)

The students' results are shown as a graph in **Figure 2**.

Figure 2



(g) Explain why hypothesis **A** gives a better explanation of the results.

_____

_____

_____

_____

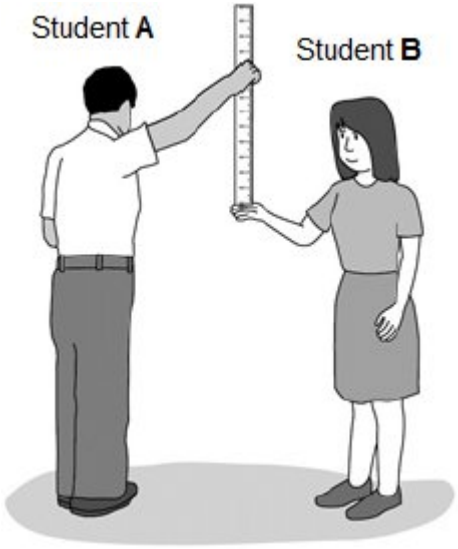
(2)

(Total 8 marks)

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Q5.

(a) The figure below shows two students investigating reaction time.



Student **A** lets the ruler go.

Student **B** closes her hand the moment she sees the ruler fall.

This investigation can be used to find out if listening to music changes the reaction times of a student.

Explain how.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(b) A second group of students used a stop clock and computer simulation test to measure their reaction times.

The table below shows their results.

Student	**Reaction time in seconds**		
	Test 1	**Test 2**	**Test 3**

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X	0.44	0.40	0.34
Y	0.28	0.24	0.22
Z	0.36	0.33	0.47

Give **one** conclusion that can be made from the results for student **X** and student **Y**.

_____

_____

(1)

(c) Test **3** for student **Z** gave an anomalous result.

Suggest **two** possible reasons why this anomalous result occurred.

1. _____

_____

2. _____

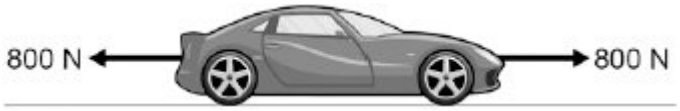
_____

(2)

(Total 7 marks)

Q6.

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?

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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 9 m/s to 18 m/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.

_____

_____

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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)

Q7.

(a) When a force is applied to a spring, the spring extends by 0.12 m.
The spring has a spring constant of 25 N/m.

Calculate the force applied to the spring.

_____

_____

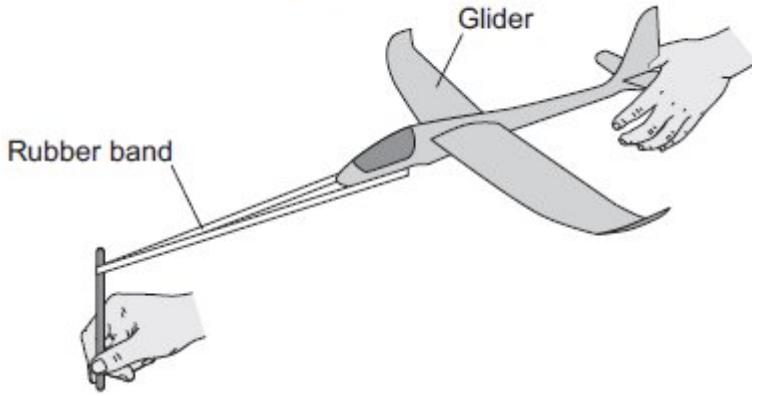
Force = _____ N

(2)

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(b) **Figure 1** shows a toy glider. To launch the glider into the air, the rubber band and glider are pulled back and then the glider is released.

Figure 1



(i) Use the correct answers from the box to complete the sentence.

chemical	**elastic potential**	**kinetic**	**thermal**

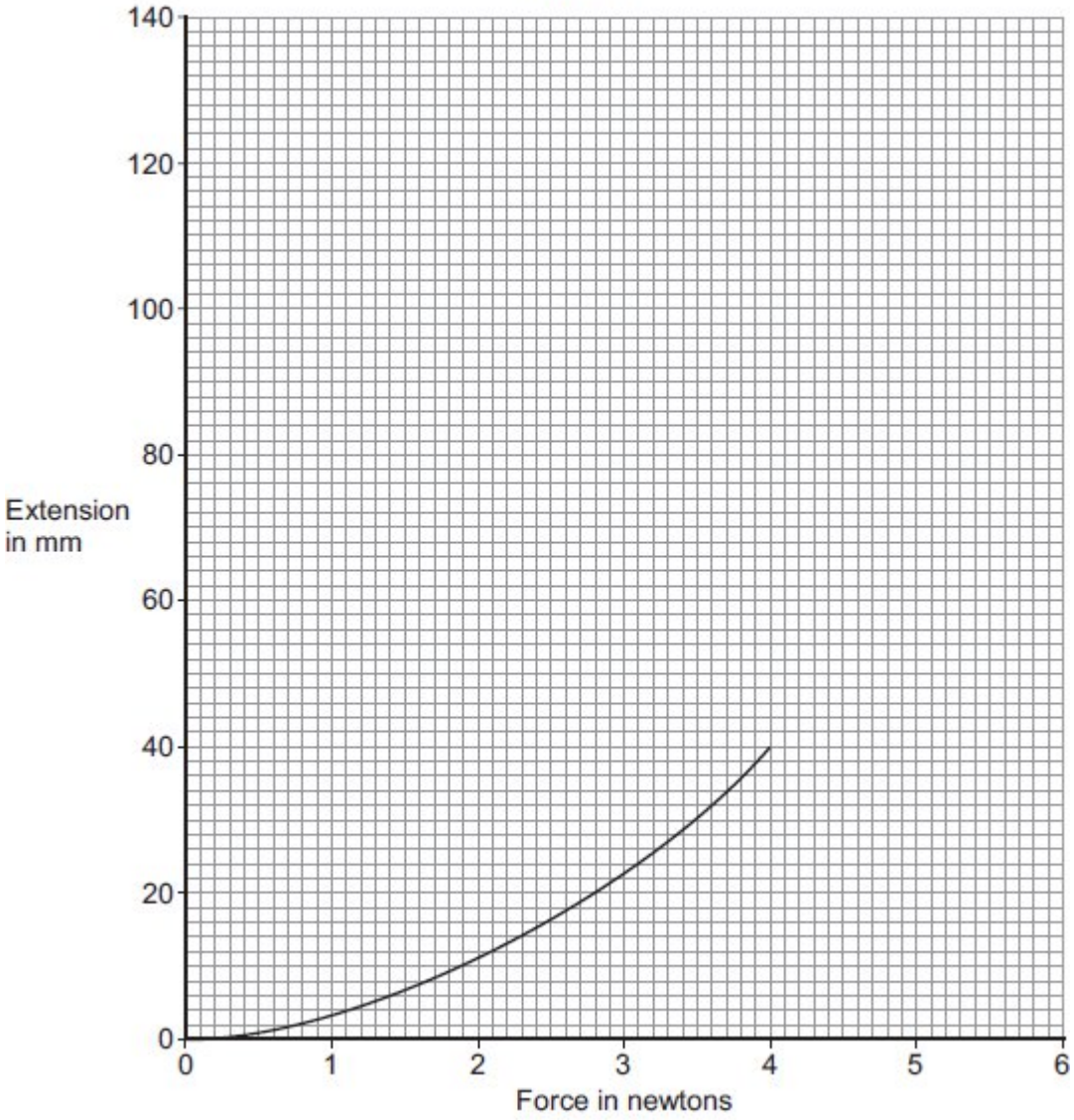
When the glider is released, the _____ energy stored in the rubber band decreases and the glider gains _____ energy.

(2)

(ii) **Figure 2** shows how the extension of the rubber band varies with the force applied to the rubber band.

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Figure 2



What can you conclude, from **Figure 2**, would happen to the extension of the rubber band if the force applied to the rubber band was increased to 6 N?

The rubber band does **not** break.

_____

_____

_____

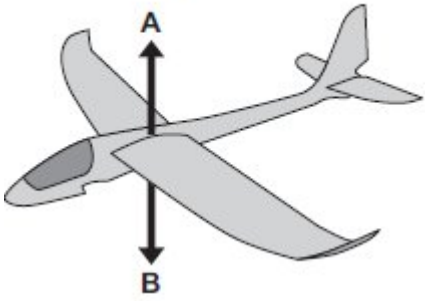
_____

(2)

(c) **Figure 3** shows the vertical forces, **A** and **B**, acting on the glider when it is flying.

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Figure 3



(i) What name is given to the force labelled **B**?

Draw a ring around the correct answer.

drag **friction** **weight**

(1)

(ii) Which **one** of the following describes the downward speed of the glider when force **B** is greater than force **A**?

Tick (✓) **one** box.

Downward speed increases ☐

Downward speed is constant ☐

Downward speed decreases ☐

(1)

(Total 8 marks)

Q8.

When two objects interact, they exert forces on each other.

(a) Which statement about the forces is correct?

Tick (✓) **one** box.

	Tick (✓)
The forces are equal in size and act in the same direction.	
The forces are unequal in size and act in the same direction.	
The forces are equal in size and act in opposite directions.	
The forces are unequal in size and act in opposite directions.	

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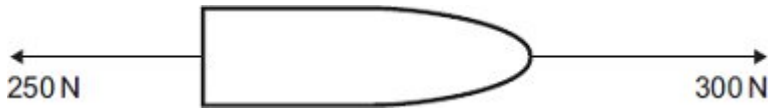
(1)

(b) A fisherman pulls a boat towards land.

The forces acting on the boat are shown in **Diagram 1**.

The fisherman exerts a force of 300 N on the boat.
The sea exerts a resistive force of 250 N on the boat.

Diagram 1



(i) Describe the motion of the boat.

_____

_____

_____

_____

(2)

(ii) When the boat reaches land, the resistive force increases to 300 N.
The fisherman continues to exert a force of 300 N.

Describe the motion of the boat.

Tick (✓) **one** box.

Accelerating to the right ☐

Constant velocity to the right ☐

Stationary ☐

(1)

(iii) Explain your answer to part **(b)(ii)**.

_____

_____

_____

_____

(2)

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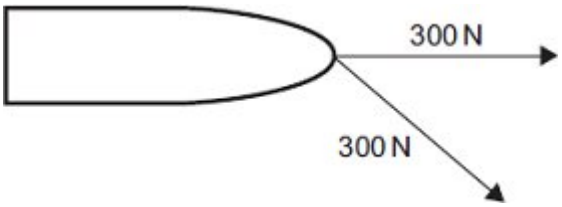
(iv) Another fisherman comes to help pull the boat. Each fisherman pulls with a force of 300 N, as shown in **Diagram 2**.

Diagram 2 is drawn to scale.

Add to **Diagram 2** to show the single force that has the same effect as the two 300 N forces.

Determine the value of this resultant force.

Diagram 2



Resultant force = _____ N

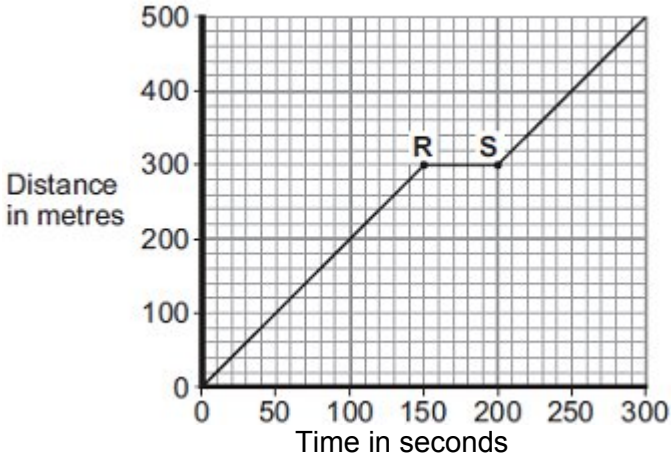
(4)

(Total 10 marks)

Q9.

(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 ☐

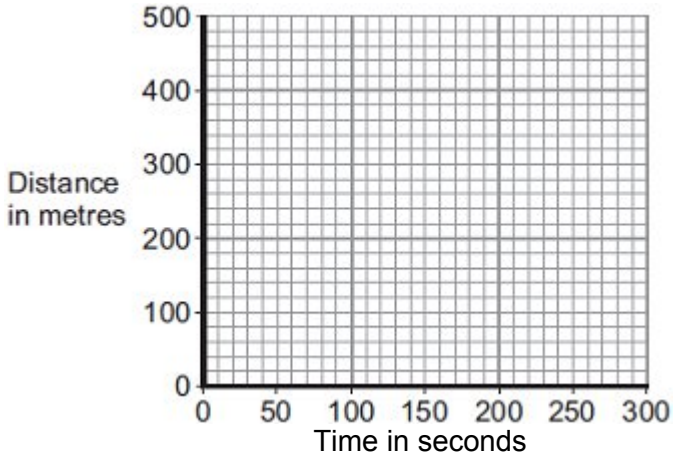
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(1)

(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.

_____

_____

_____

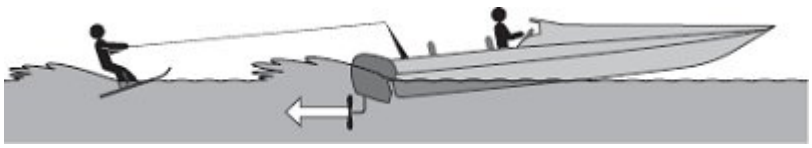
Resultant force = _____ N

(2)

(Total 4 marks)

Q10.

The diagram shows a boat pulling a water skier.



(a) The arrow represents the force on the water produced by the engine propeller. This force causes the boat to move.

Explain why.

_____

_____

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_____

_____

(2)

(b) The boat accelerates at a constant rate in a straight line. This causes the velocity of the water skier to increase from 4.0 m/s to 16.0 m/s in 8.0 seconds.

(i) Calculate the acceleration of the water skier and give the unit.

_____

_____

_____

Acceleration = _____

(3)

(ii) The water skier has a mass of 68 kg.

Calculate the resultant force acting on the water skier while accelerating.

_____

_____

_____

Resultant force = _____ N

(2)

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

The force from the boat pulling the water skier forwards

will be

less than
the same as
greater than

the answer to part **(b)(ii)**.

Give the reason for your answer.

_____

_____

(2)

(Total 9 marks)

Q11.

Some students designed and built an electric-powered go-kart.
The go-kart is shown below.

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(a) Suggest **two** changes that could be made to the design of the go-kart to increase its top speed.

1. _____

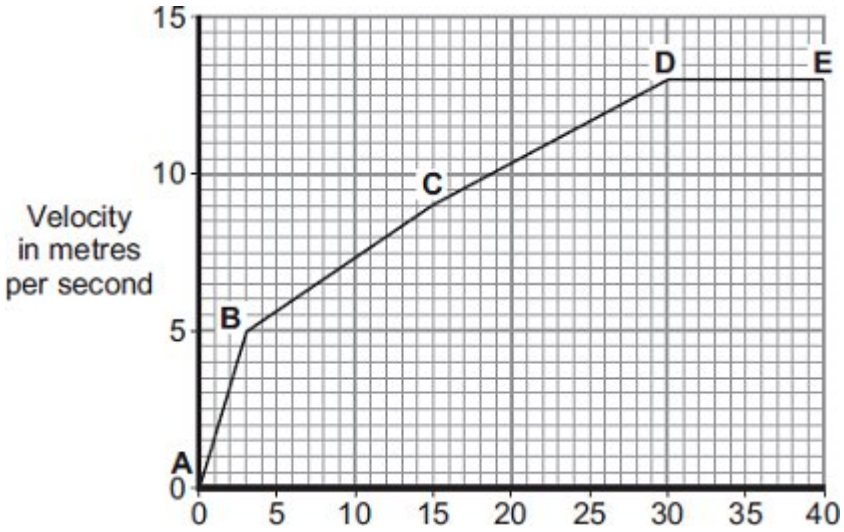
_____

2. _____

_____

(2)

(b) A go-kart with a new design is entered into a race.
The velocity-time graph for the go-kart, during the first 40 seconds of the race, is shown below.



(i) Between which **two** points did the go-kart have the greatest acceleration?

Tick (✓) **one** box.

A–B ☐

B–C ☐

C–D ☐

Give a reason for your answer.

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_____

_____

(2)

(ii) The go-kart travels at a speed of 13 m/s between points **D** and **E**.
The total mass of the go-kart and driver is 140 kg.

Calculate the momentum of the go-kart and driver between points **D** and **E**.

_____

_____

Momentum = _____ kg m/s

(2)

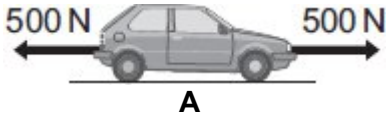
(Total 6 marks)

Q12.

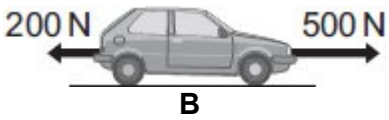
(a) The diagrams, **A**, **B** and **C**, show the horizontal forces acting on a **moving** car.

Draw a line to link each diagram to the description of the car's motion at the moment when the forces act.

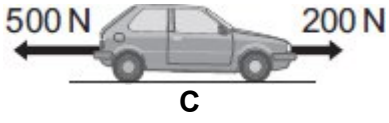
Draw only **three** lines.



A



B



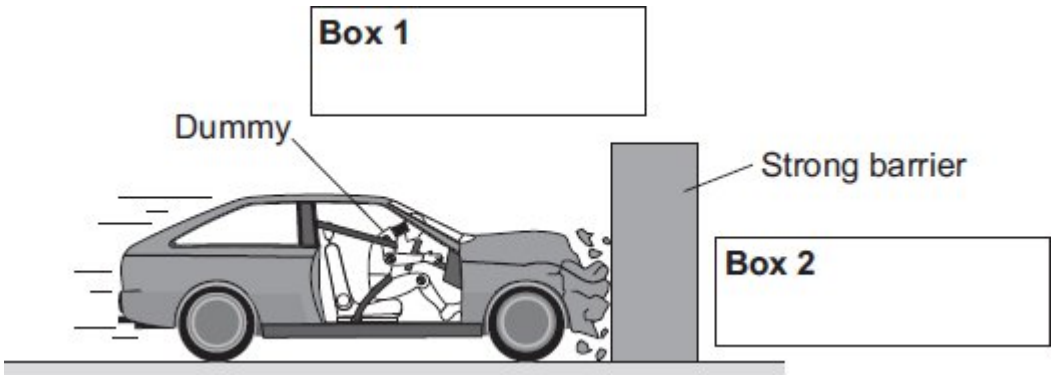
C

stationary
constant speed
slowing down
accelerating forwards

(3)

(b) 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 a dummy inside the car.

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(i) Draw an arrow in **Box 1** to show the direction of the force that the car exerts on the barrier.

(1)

(ii) Draw an arrow in **Box 2** to show the direction of the force that the barrier exerts on the car.

(1)

(iii) Complete the following by drawing a ring around the correct line in the box.

The car exerts a force of 5000 N on the barrier. The barrier does not move.

The force exerted by the barrier on the car will be | more than / equal to / less than | 5000 N.

(1)

(iv) Which **one** of the following gives the most likely reason for attaching electronic sensors to the dummy?

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

To measure the speed of the car just before the impact. ☐

To measure the forces exerted on the dummy during the impact. ☐

To measure the distance the car travels during the impact. ☐

(1)

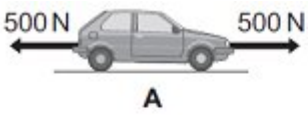
(Total 7 marks)

Q13.

(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**.

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A



B

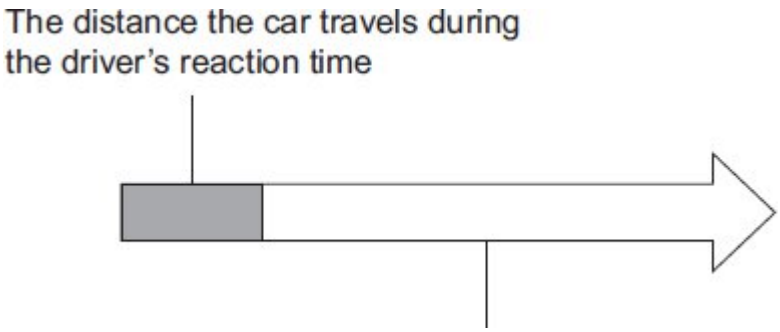


C

(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.

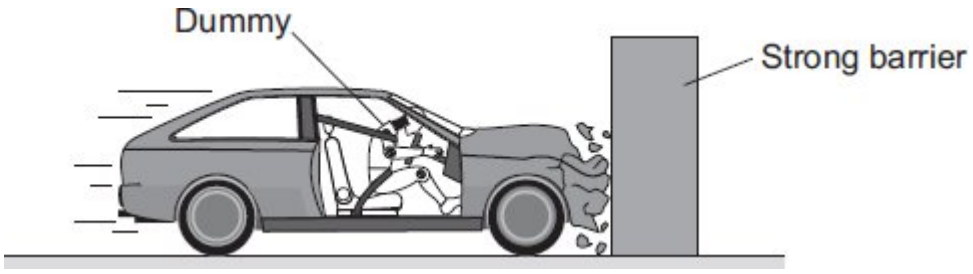


(1)

(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.



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(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)

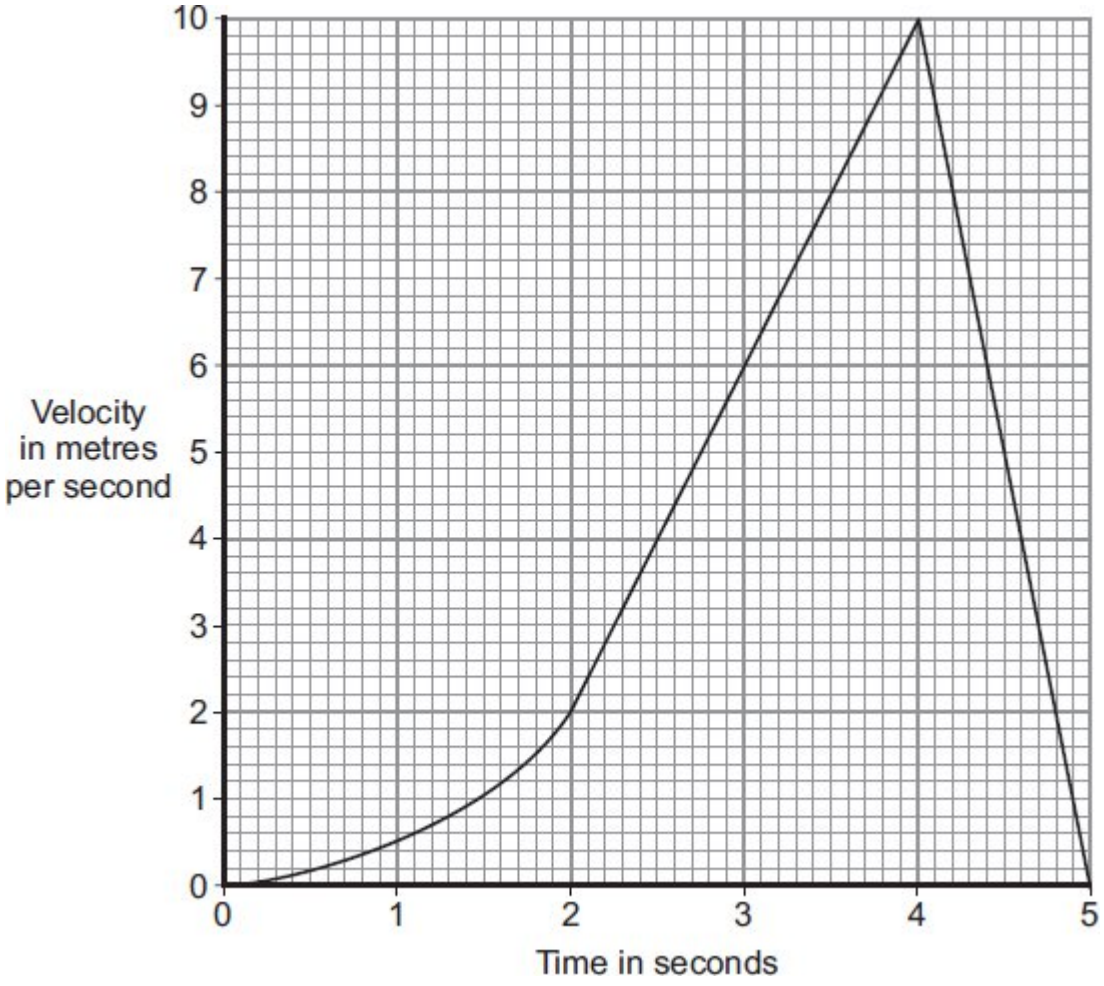
(ii) Suggest why the dummy is fitted with electronic sensors.

_____

_____

(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.

_____

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_____

_____

_____

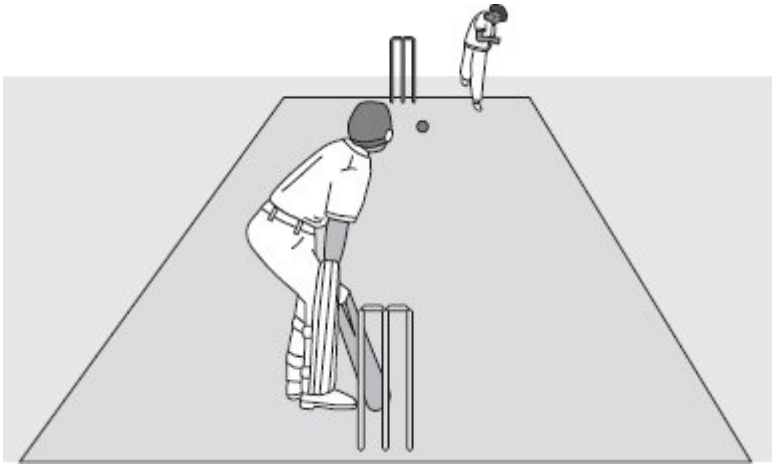
Acceleration = _____

(3)

(Total 10 marks)

Q14.

The picture shows players in a cricket match.



(a) A fast bowler bowls the ball at 35 m/s. The ball has a mass of 0.16 kg.

Use the equation in the box to calculate the kinetic energy of the cricket ball as it leaves the bowler's hand.

$$\text{kinetic energy} = \frac{1}{2} \times \text{mass} \times \text{speed}^2$$

Show clearly how you work out your answer.

_____

_____

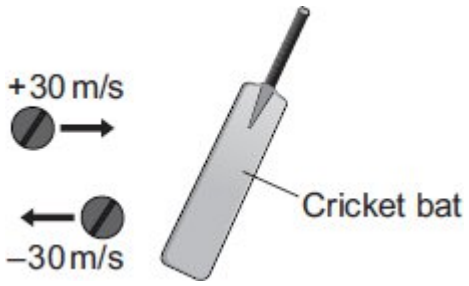
_____

Kinetic energy = _____ J

(2)

(b) When the ball reaches the batsman it is travelling at 30 m/s. The batsman strikes the ball which moves off at 30 m/s in the opposite direction.

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(i) Use the equation in the box to calculate the change in momentum of the ball.

momentum = mass × velocity

Show clearly how you work out your answer.

_____

_____

Change in momentum = _____ kg m/s

(2)

(ii) The ball is in contact with the bat for 0.001 s.

Use the equation in the box to calculate the force exerted by the bat on the ball.

$$\text{force} = \frac{\text{change in momentum}}{\text{time taken for change}}$$

Show clearly how you work out your answer.

_____

_____

Force = _____ N

(1)

(c) A fielder, as he catches a cricket ball, pulls his hands backwards.

Explain why this action reduces the force on his hands.

_____

_____

_____

_____

_____

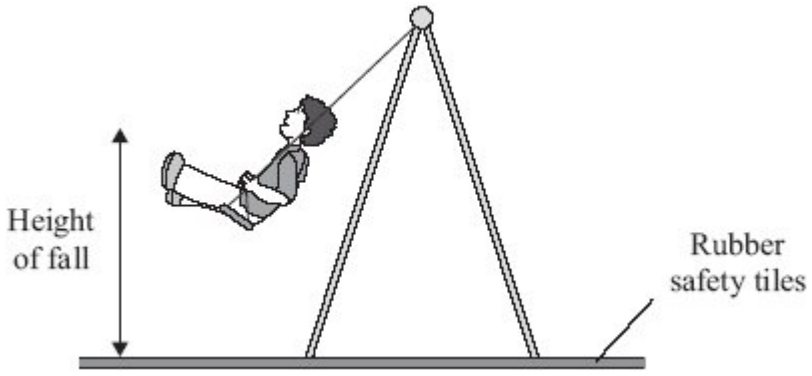
(2)

(Total 7 marks)

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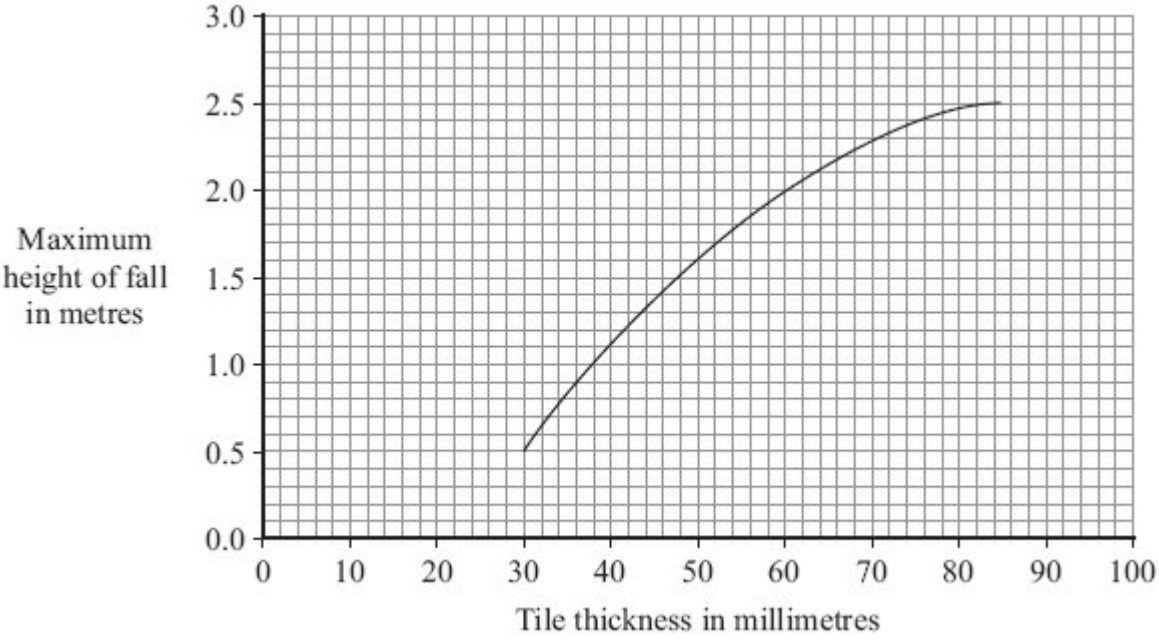
Q15.

The diagram shows a child on a playground swing.



The playground surface is covered in rubber safety tiles. The tiles reduce the risk of serious injury to children who fall off the swing.

The graph gives the maximum height that a child can fall onto rubber safety tiles of different thicknesses and be unlikely to get a serious head injury.



(i) Describe how the maximum height of fall relates to the thickness of the rubber safety tile.

_____

_____

(1)

(ii) The maximum height of any of the playground rides is 2 metres.

What tile thickness should be used in the playground?

_____

Give a reason for your answer.

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_____

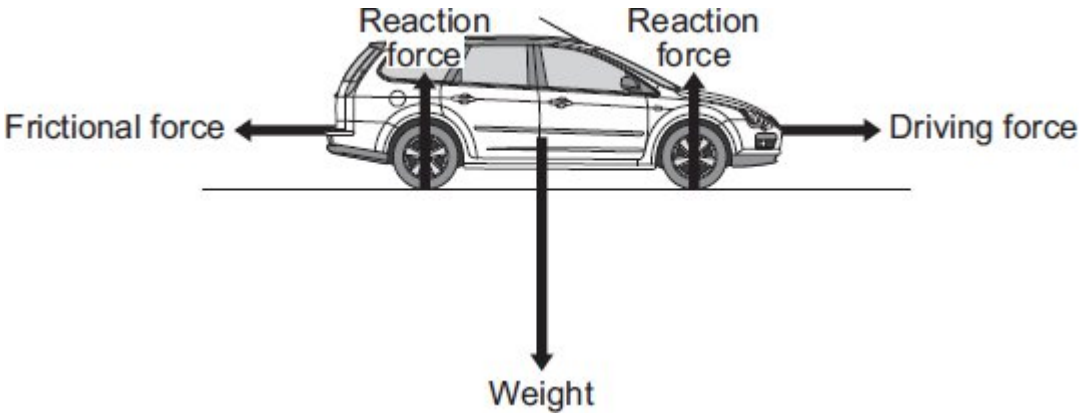
_____

(2)

(Total 3 marks)

Q16.

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.

_____

_____

_____

_____

_____

_____

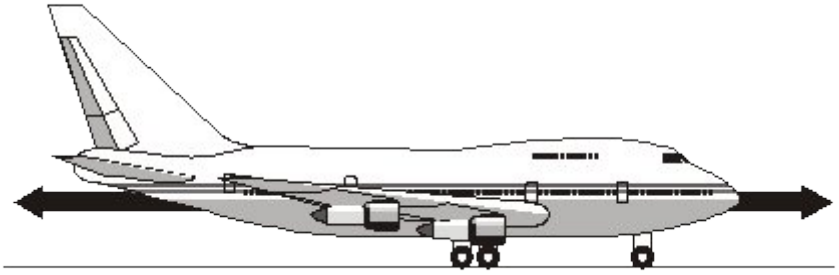
(3)

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(Total 6 marks)

Q17.

(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.

_____

_____

_____

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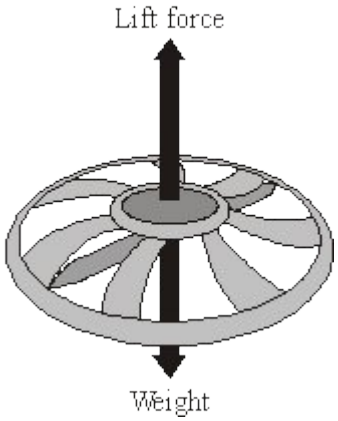
_____

(2)

(Total 7 marks)

Q18.

The diagram shows the forces on a small, radio-controlled, flying toy.



(a) (i) The mass of the toy is 0.06 kg.
Gravitational field strength = 10 N/kg

Calculate the weight of the toy.

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

_____

_____

Weight = _____

(3)

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

When the toy is hovering stationary in mid-air, the lift force is

bigger than
the same as
smaller than

the weight of the toy.

(1)

(b) When the motor inside the toy is switched off, the toy starts to *accelerate* downwards.

(i) What does the word *accelerate* mean?

_____

(1)

(ii) What is the direction of the resultant force on the falling toy?

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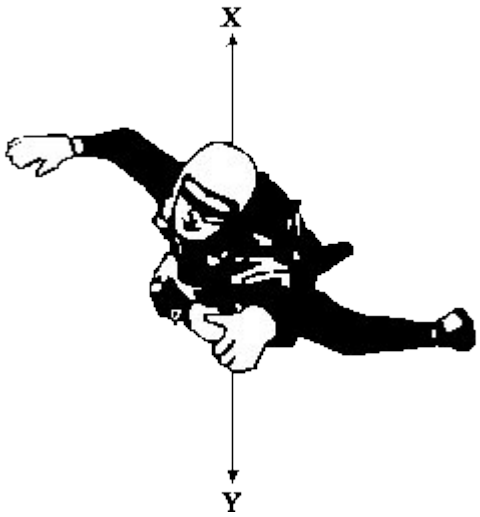
_____

(1)

(Total 6 marks)

Q19.

The diagram shows a sky-diver in free fall. Two forces, **X** and **Y**, act on the sky-diver.



(a) Complete these sentences by crossing out the **two** lines in each box that are wrong.

(i) Force **X** is caused by

friction
gravity
weight

.

(1)

(ii) Force **Y** is caused by

air resistance
friction
gravity

.

(1)

(b) The size of force **X** changes as the sky-diver falls. Describe the motion of the sky-diver when:

(i) force **X** is smaller than force **Y**,

_____

_____

(2)

(ii) force **X** is equal to force **Y**.

_____

_____

(1)

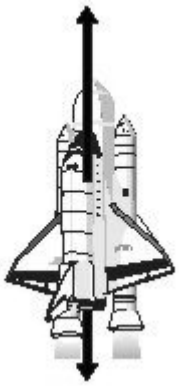
(Total 5 marks)

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Q20.

(a) The arrows in the diagram represent the size and direction of the forces on a space shuttle, fuel tank and booster rockets one second after launch. The longer the arrow the bigger the force.

Thrust force



Weight of shuttle, fuel tanks and booster rockets plus air resistance

(i) Describe the upward motion of the space shuttle one second after launch.

_____

(1)

(ii) By the time it moves out of the Earth's atmosphere, the total weight of the space shuttle, fuel tank and booster rockets has decreased and so has the air resistance.

How does this change the motion of the space shuttle? (Assume the thrust force does not change).

_____

(1)

(b) The space shuttle takes 9 minutes to reach its orbital velocity of 8100 m/s.

(i) Write down the equation that links acceleration, change in velocity and time taken.

_____

(1)

(ii) Calculate, in m/s^2, the average acceleration of the space shuttle during the first 9 minutes of its flight. Show clearly how you work out your answer.

_____

_____

average acceleration = _____ m/s^2

(2)

(iii) How is the velocity of an object different from the speed of an object?

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_____

_____

(1)

(Total 6 marks)

Q21.

(a) Two skydivers jump from a plane. Each holds a different position in the air.



A



B

Adapted from Progress with Physics by Nick England, reproduced by permission of Hodder Arnold

Complete the following sentence.

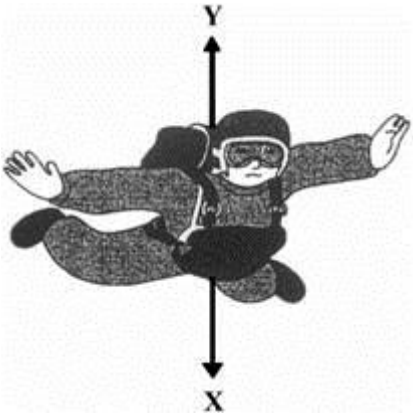
Skydiver _____ will fall faster because_____

_____

_____

(2)

The diagram shows the direction of the forces acting on one of the skydivers.



Adapted from Progress with Physics by Nick England, reproduced by permission of Hodder Arnold

(b) In the following sentences, cross out in each box the **two** lines that are wrong.

(i) Force **X** is caused by

air resistance friction gravity

(1)

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(ii) Force **Y** is caused by

air resistance gravity weight

(1)

(iii) When force **X** is bigger than force **Y**, the speed of the skydiver will

go up stay the same go down

(1)

(iv) After the parachute opens, force **X**

goes up stays the same goes down

(1)

(c) How does the area of an opened parachute affect the size of force **Y**?

_____

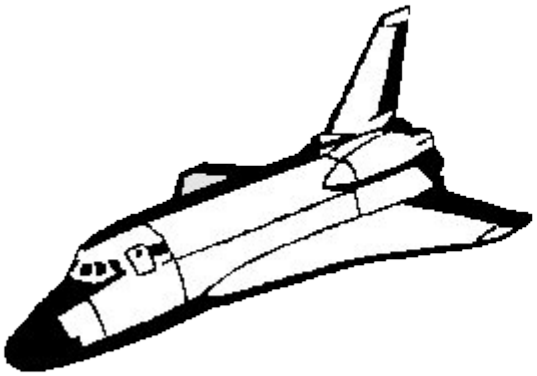
_____

(1)

(Total 7 marks)

Q22.

The diagram shows an orbiter, the reusable part of a space shuttle. The data refers to a typical flight.



Orbiter data	
Mass	78 000 kg
Orbital speed	7.5 km/s
Orbital altitude	200 km
Landing speed	100 m/s
Flight time	7 days

(a) (i) What name is given to the force which keeps the orbiter in orbit around the Earth?

_____

(1)

(ii) Use the following equation to calculate the kinetic energy, in joules, of the orbiter while it is in orbit.

$$\text{kinetic energy} = \tfrac{1}{2}\, mv^2$$

_____

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_____

Kinetic energy = _____ joules

(2)

(iii) What happens to most of this kinetic energy as the orbiter re-enters the Earth's atmosphere?

_____

_____

(1)

(b) After touchdown the orbiter decelerates uniformly coming to a halt in 50 s.

(i) Give the equation that links acceleration, time and velocity.

_____

(1)

(ii) Calculate the deceleration of the orbiter. Show clearly how you work out your answer and give the unit.

_____

_____

Deceleration = _____

(2)

(c) (i) Give the equation that links acceleration, force and mass.

_____

(1)

(ii) Calculate, in newtons, the force needed to bring the orbiter to a halt. Show clearly how you work out your answer.

_____

_____

Force = _____ newtons

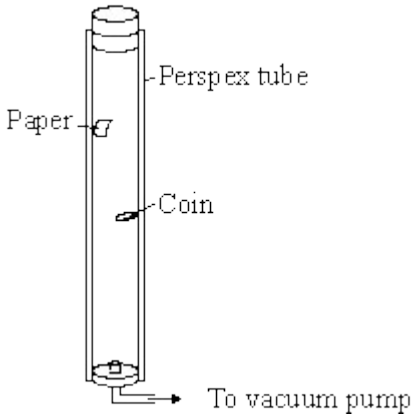
(1)

(Total 9 marks)

Q23.

The apparatus shown is used to compare the motion of a coin with the motion of a piece of paper as they both fall.

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(a) When the tube is filled with air the coin falls faster than the piece of paper. Why?

_____

_____

(1)

(b) The air in the tube is removed by the vacuum pump. The tube is turned upside down.
State **two** ways in which the motion of the coin and piece of paper will change compared to when there was air in the tube.

1. _____

_____

_____

2. _____

_____

_____

(2)

(Total 3 marks)

Q24.

(a) A shopping trolley is being pushed at a constant speed. The arrows represent the horizontal forces on the trolley.



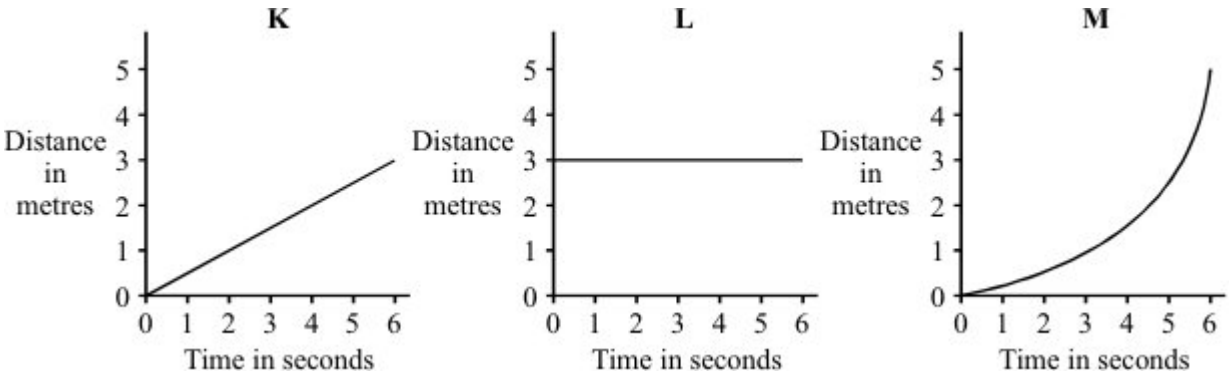
(i) How big is force **P** compared to force **F**?

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_____

(1)

(ii) Which **one** of the distance-time graphs, **K**, **L** or **M**, shows the motion of the trolley? Draw a circle around your answer.



(1)

(b) Complete the sentence by crossing out the **two** words in the box that are wrong.

Acceleration is the rate of change of

energy.
speed.
velocity.

(1)

(c) Three trolleys, **A**, **B** and **C**, are pushed using the same size force. The force causes each trolley to accelerate.



Which trolley will have the smallest acceleration?

_____

Give a reason for your answer.

_____

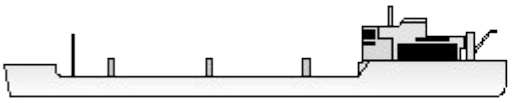
(2)

(Total 5 marks)

Q25.

The table contains typical data for an oil tanker.

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Mass	56 000 000 kg
Cruising speed	12 m/s
Deceleration force	392 000 N
Stopping distance	10 000 m

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

_____

(1)

(ii) Calculate the deceleration of the oil tanker. Show clearly how you work out your answer.

_____

_____

_____

Deceleration = _____ m/s^2

(2)

(Total 3 marks)

Q26.

The manufacturer of a family car gave the following information.

Mass of car 950 kg

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

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

_____

_____

_____

(2)

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

_____

_____

_____

(2)

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

_____

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_____

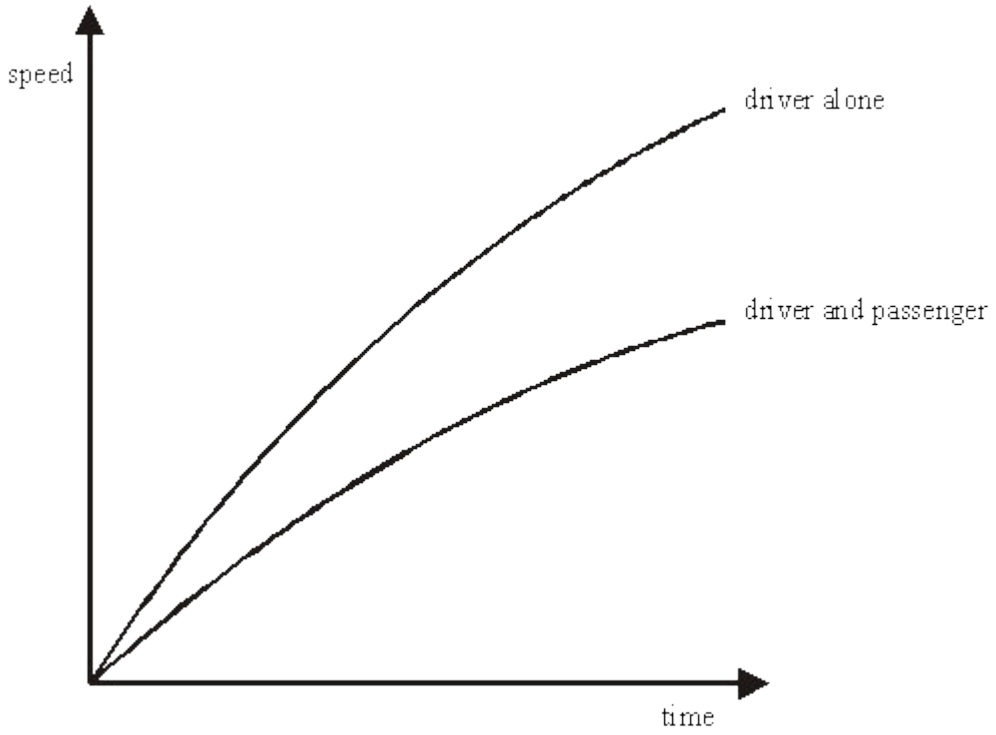
_____

(3)

(Total 7 marks)

Q27.

(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.

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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.

_____

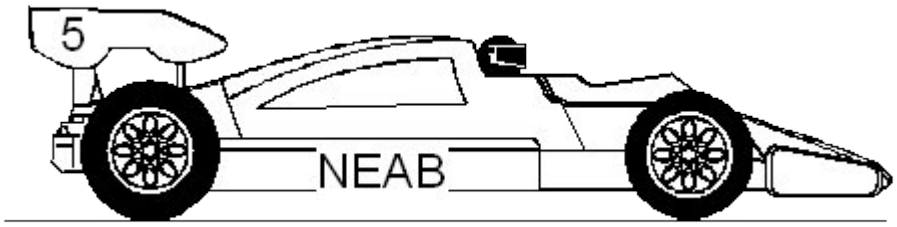
_____

(2)

(Total 9 marks)

Q28.

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.

_____

_____

_____

_____

_____

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

_____

_____

_____

_____

(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.

_____

_____

_____

_____

_____

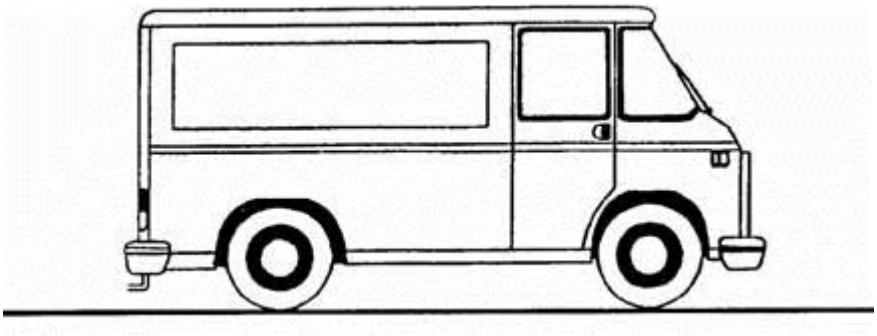
_____

(12)

(Total 16 marks)

Q29.

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(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

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(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)

Q31.

A rollercoaster car stops above a vertical drop. Suddenly it falls under gravity.



The drop is 60 metres high and at the bottom of the drop the car travels at 125 km/h. The acceleration experienced by the people in the car is 10 m/s^2. The mass of the car and its passengers is 1210 kg.

Calculate the force exerted on the car and its passengers. Show your working.

_____

_____

_____

_____

_____

Force = _____ N

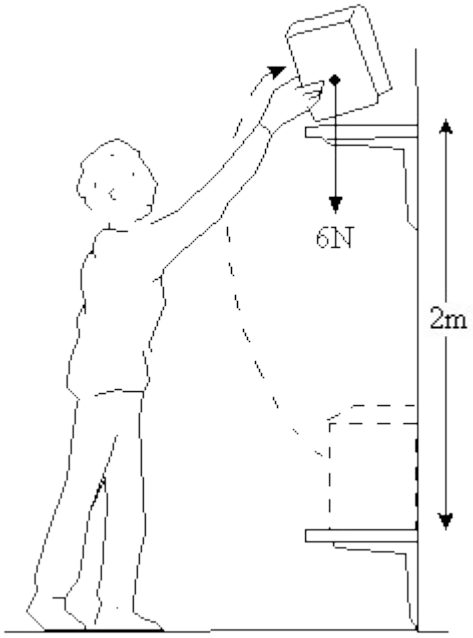
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(Total 3 marks)

Q32.

A book weighs 6 newtons.

A librarian picks up the book from one shelf and puts it on a shelf 2 metres higher.



(a) Calculate the work done on the book. [Show your working].

_____

_____

_____

(3)

(b) The next person to take the book from the shelf accidentally drops it.

The book accelerates at 9.8m/s².

Use this information to calculate the mass of the book. [Show your working].

_____

_____

_____

Answer _____ kg.

(3)

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(c) If the book was dropped from an aeroplane high in the sky, it would accelerate to begin with. Eventually it would fall at a steady speed.

Explain, in as much detail as you can, why this happens.

_____

_____

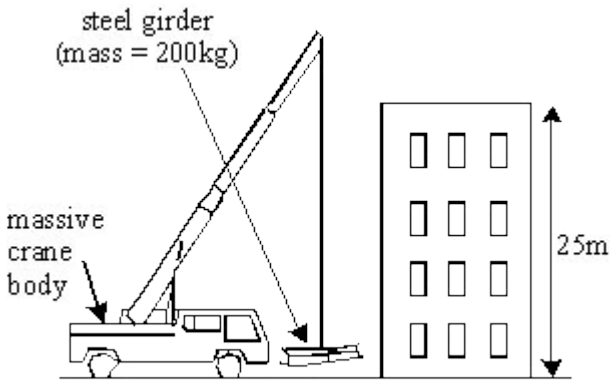
_____

(3)

(Total 9 marks)

Q33.

A crane is used to lift a steel girder to the top of a high building.



When it is lifted by the crane:

- the girder accelerates from rest to a speed of 0.6 m/s in the first 3 seconds;
- it then rises at a steady speed.

(a) Calculate the **acceleration** of the girder.

(Show your working.)

_____

_____

_____

_____

(3)

(b) (i) What is the **weight** of the steel girder?

Answer _____ N

(1)

(ii) Calculate the **power** of the crane motor as it lifts the girder at a steady speed of 0.6 m/s.

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(*Show your working. You can ignore the weight of the cable and hook which is small compared to the weight of the girder.*)

_____

_____

_____

Answer _____ W

(2)

(c) A new motor is fitted to the crane. This motor accelerates the girder at 0.3 m/s^2.

Calculate the **force** which the crane applies to the girder to produce this acceleration.

(Show your working.)

_____

_____

_____

Answer _____ N

(3)

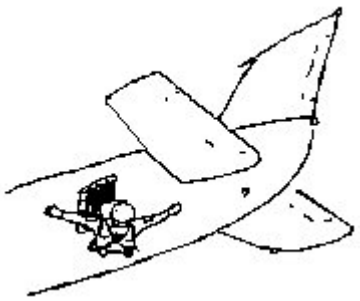
(Total 9 marks)

Q34.

A sky-diver steps out of an aeroplane.

After 10 seconds she is falling at a steady speed of 50m/s.

She then opens her parachute.



After another 5 seconds she is once again falling at a steady speed.

This speed is now only 10m/s.

(a) Calculate the sky-diver's average acceleration during the time from when she opens her parachute until she reaches her slower steady speed. (Show your working.)

_____

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_____

_____

(3)

(b) Explain, as fully as you can:

(i) why the sky-diver eventually reaches a steady speed (with or without her parachute).

_____

_____

_____

_____

(3)

(ii) why the sky-diver's steady speed is lower when her parachute is open.

_____

(1)

(c) The sky-diver and her equipment have a total mass of 75kg. Calculate the gravitational force acting on this mass. (Show your working.)

_____

_____

Answer _____ N

(1)

(Total 8 marks)

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