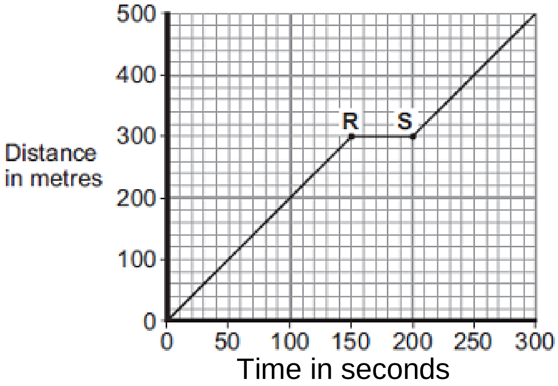
Q1. (a) **Figure 1** shows the distance–time graph for a person walking to a bus stop.

Figure 1



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

Tick (✓) **one** box.

Not moving ☐

Moving at constant speed ☐

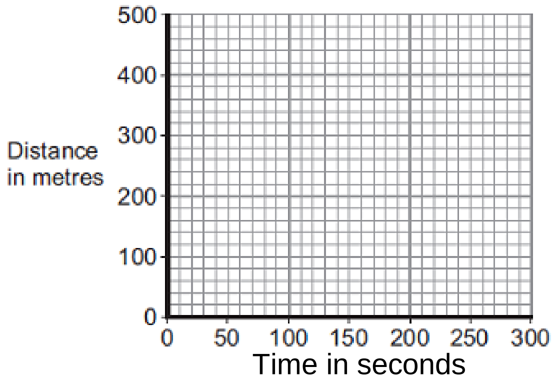
Moving with increasing speed ☐

(1)

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

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

Figure 2



(1)

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

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

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

___

___

___

Resultant force = ______________________ N

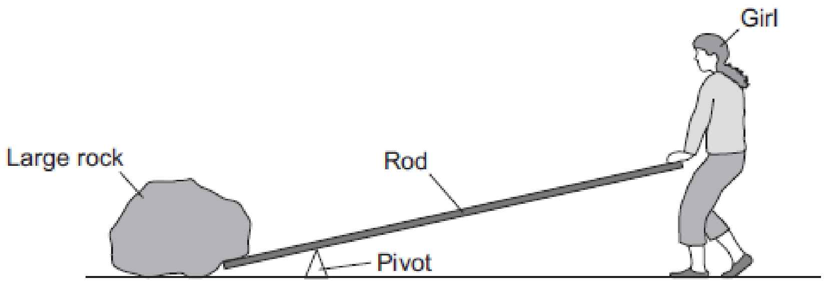
(2)

(Total 4 marks)

Q2. Levers and hydraulic systems can act as force multipliers.

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

Figure 1



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

Which of the following changes would allow her to lift the rock?

Tick (✓) **two** boxes.

Change	**Tick (✓)**
Move the pivot away from the rock	
Make the rod longer	
Push the rod upwards	
Push down on the rod with a greater force	

(2)

(b) Liquids are used in hydraulic systems because they are virtually incompressible. Explain how the spacing of particles in a liquid cause it to be virtually incompressible.

___

___

___

___

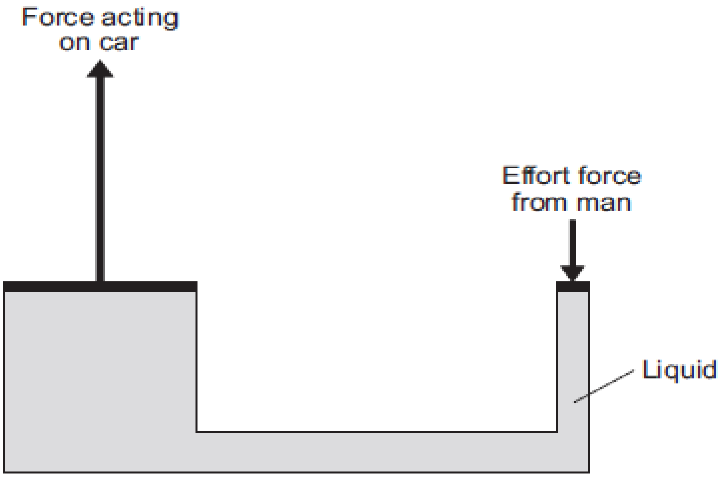
(2)

(c) **Figure 2** shows a man using a car jack to lift his car.

Figure 2

Figure 3 shows a simple diagram of a car jack.

Figure 3



(i) The man pushes down with an effort force. This results in a much larger force acting upwards on the car. Use information from **Figure 3** to explain how.

___

___

___

___

___

___

___

(4)

(ii) Which of the following statements about the forces in **Figure 3** is correct?

Tick (✓) **one** box.

	Tick (✓)
The force acting on the car moves a greater distance than the effort force.	
The force acting on the car moves less distance than the effort force.	
The force acting on the car moves the same distance as the effort force.	

(1)
(Total 9 marks)

Q3. A paintball gun is used to fire a small ball of paint, called a paintball, at a target.

The figure below shows someone just about to fire a paintball gun. The paintball is inside the gun.

(a) What is the momentum of the paintball before the gun is fired?

____

Give a reason for your answer.

____

____

(2)

(b) The gun fires the paintball forwards at a velocity of 90 m / s.

The paintball has a mass of 0.0030 kg.

Calculate the momentum of the paintball just after the gun is fired.

____

____

____

Momentum = ____________________ kg m / s

(2)

(c) The momentum of the gun and paintball is conserved. Use the correct answer from the box to complete the sentence.

equal to	greater than	less than

The total momentum of the gun and paintball just after the gun is fired

will be ____________________________ the total momentum of the gun and

paintball before the gun is fired.

(1)
(Total 5 marks)

Q4. When two objects interact, they exert forces on each other.

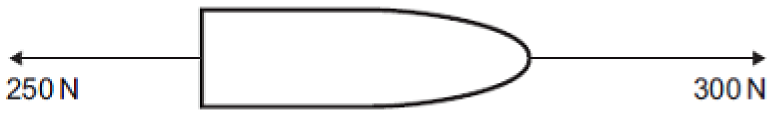
(a) Which statement about the forces is correct? Tick (✓) **one** box.

	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.	

(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)**.

____

____

____

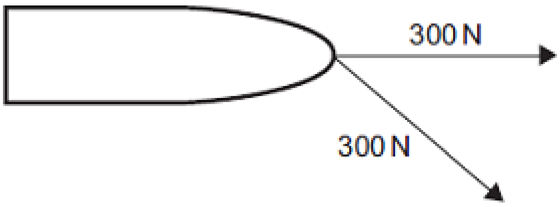
____

(2)

(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)

Q5. Some students fill an empty plastic bottle with water.The weight of the water in the bottle is 24 N and the cross-sectional area of the bottom of the bottle is 0.008 m^2.

(a) Calculate the pressure of the water on the bottom of the bottle and give the unit.

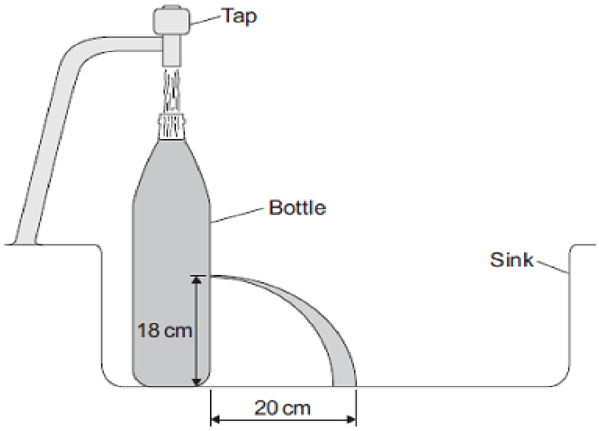
____

____

Pressure = ____________________

(3)

(b) The students made four holes in the bottle along a vertical line.
They put the bottle in a sink. They used water from a tap to keep the bottle filled to the top.



The students measured and recorded the vertical heights of the holes above the sink.
They also measured the horizontal distances the water landed away from the bottle.
A pair of measurements for one of the holes is shown in the diagram.

The complete data from the experiment is shown in the table.

Hole	**Vertical height in cm**	**Horizontal distance in cm**
J	24	15
K	18	20
L	12	30
M	6	40

(i) Which hole is shown in the diagram? Draw a ring around the correct answer.

J **K** **L**

(1)

(ii) On the diagram, draw the path of the water coming out of hole **M**.

Use the information in the table to help you.

(2)

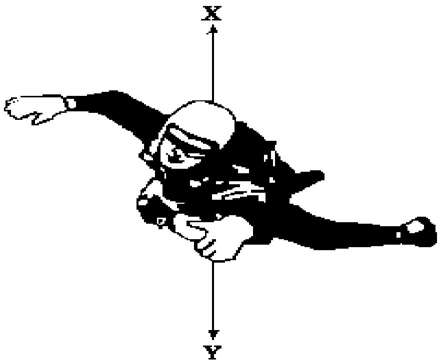
(c) Suggest **one** problem that might arise from trying to collect data from a fifth hole with a vertical height of 1 cm above the sink.

____

____

(1)
(Total 7 marks)

Q6. 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**,

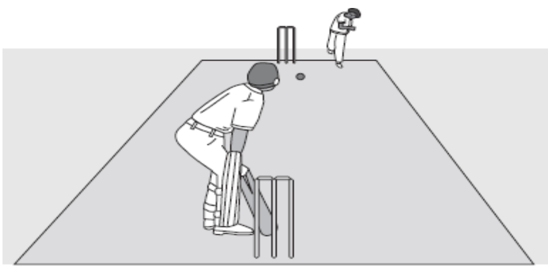
(2)

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

(1)

(Total 5 marks)

Q7. 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.

____

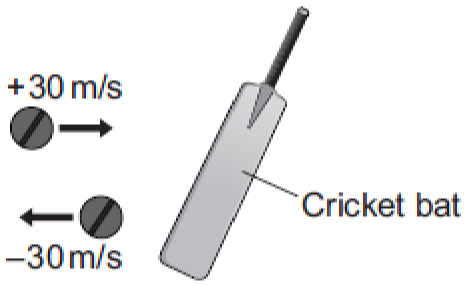
____

____

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.



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

$$\text{momentum} = \text{mass} \times \text{velocity}$$

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.

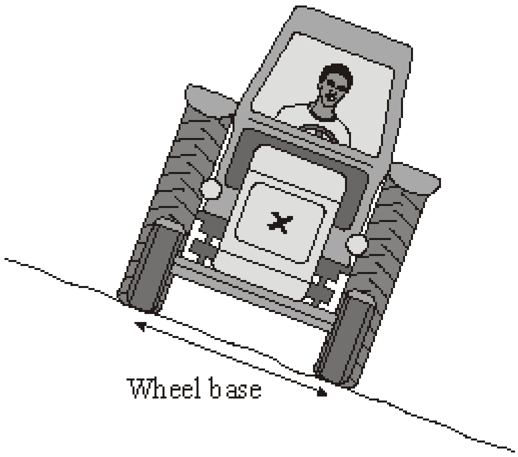
Explain why this action reduces the force on his hands.

(2)

(Total 7 marks)

Q8. Tractors are often used on sloping fields, so stability is important in their design.

On the diagram, the centre of the **X** marks the centre of mass of the tractor.



(a) Explain why the tractor has **not** toppled over. You may add to the diagram to help you to explain.

(3)

(b) Give **two** features of the tractor which affect its stability and state how each feature could be changed to increase the tractor's stability.

Feature 1 ____

____

Feature 2 ____

____

(2)

(Total 5 marks)

Q9. A cyclist travelling along a straight level road accelerates at 1.2 m/s^2 for 5 seconds.
The mass of the cyclist and the bicycle is 80 kg.

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

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

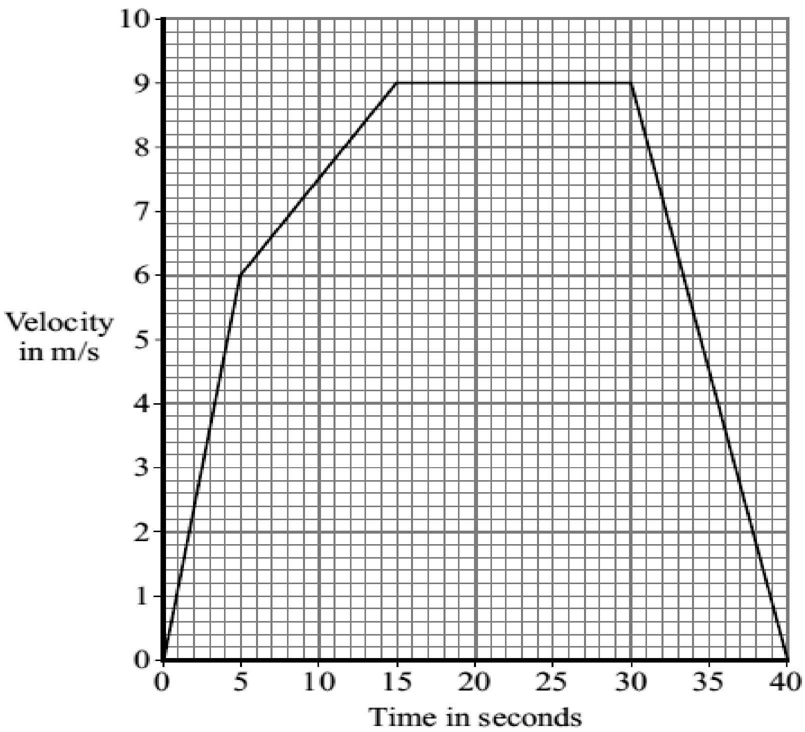
____

____

Resultant force = ________________________

(3)

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



(i) Complete the following sentence.

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

(1)

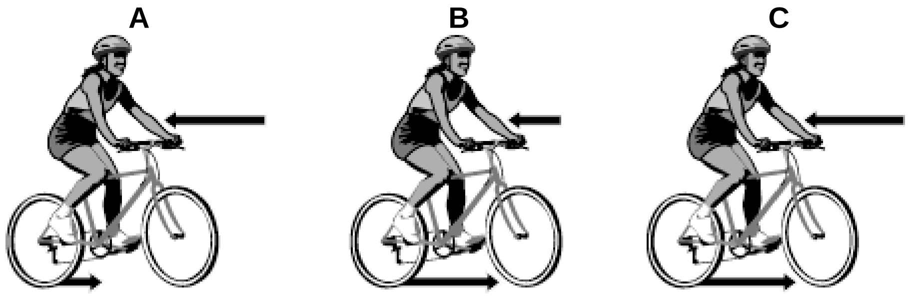
(ii) Why has the data for the cyclist been shown as a line graph instead of a bar chart?

____

____

(1)

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



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

____

Explain the reason for your choice.

____

____

____

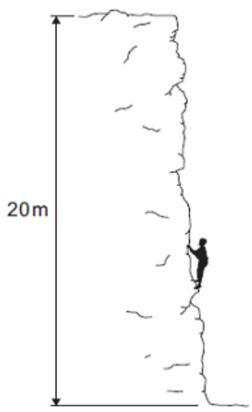
____

____

(3)

(Total 8 marks)

Q10. The diagram shows a climber part way up a cliff.



(a) Complete the sentence.

When the climber moves up the cliff, the climber

gains gravitational ______________________ energy.

(1)

(b) The climber weighs 660 N.

(i) Calculate the work the climber must do against gravity, to climb to the top of the cliff.

____

____

Work done = _________________________ J

(2)

(ii) It takes the climber 800 seconds to climb to the top of the cliff.
During this time the energy transferred to the climber equals the work done by the climber.

Calculate the power of the climber during the climb.

____

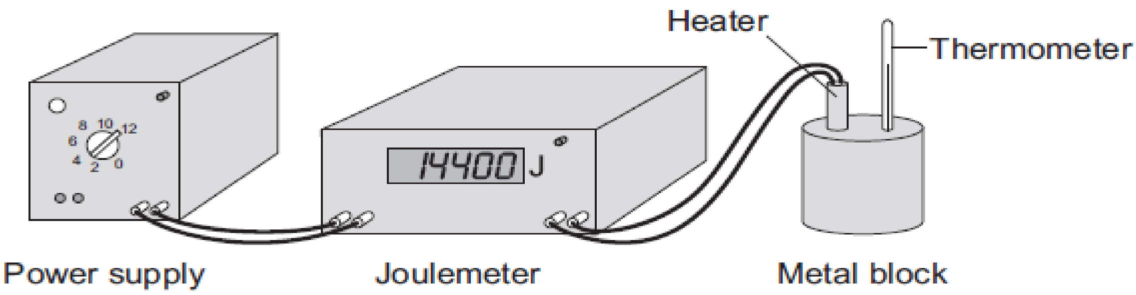
____

Power = _________________________ W

(2)

(Total 5 marks)

Q11. A student used an electric heater to heat a metal block. The student measured the energy input to the heater with a joulemeter.



Before starting the experiment, the student reset the joulemeter to zero. The student switched the power supply on for exactly 10 minutes. During this time, the reading on the joulemeter increased to 14 400.

(a) (i) Calculate the energy transferred each second from the power supply to the heater.

Show clearly how you work out your answer.

____

____

Energy transferred each second = ___________________ J/s

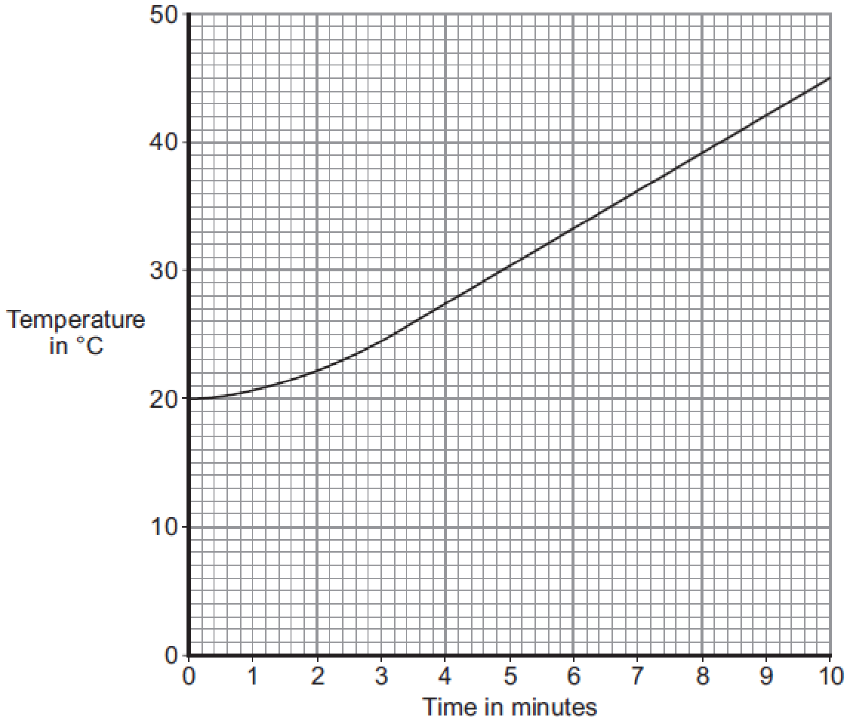
(2)

(ii) What is the power of the heater?

____

(1)

(b) The student measured the temperature of the metal block every minute. The data obtained by the student is displayed in the graph.



(i) What range of temperatures did the student measure?

From ______________________ °C to ______________________ °C

(1)

(ii) Before starting the experiment, the student had calculated that the temperature of the block would go up by 36 °C.

The student's data shows a smaller increase.

Which **one** of the following statements gives the most likely reason for this?

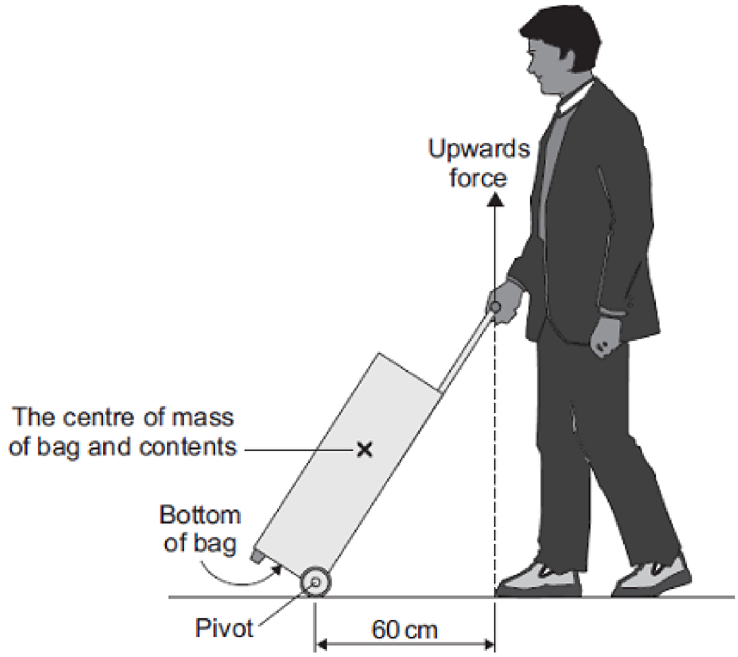
Put a tick (✓) in the box next to your answer.

The student does not read the thermometer accurately.	☐
The block transfers energy to the surroundings.	☐
The power supply is not connected correctly to the joulemeter.	☐

(1)

(Total 5 marks)

Q12. The diagram shows a man standing in an airport queue with his wheeled bag.



(a) The man applies an upward force to the handle of his bag to stop the bag from falling. The moment of this force about the pivot is 36 Nm.

Calculate the upward force the man applies to the handle of his bag.

____

____

____

____

Force = ____________________________ N

(2)

(b) When the man lets go of the bag handle, the bag falls and hits the floor. Explain why.

____

____

____

____

____

____

(2)

(Total 4 marks)

Q13.

(a) In any collision, the total momentum of the colliding objects is usually conserved.

(i) What is meant by the term 'momentum is conserved'?

____

____

(1)

(ii) In a collision, momentum is **not always** conserved.

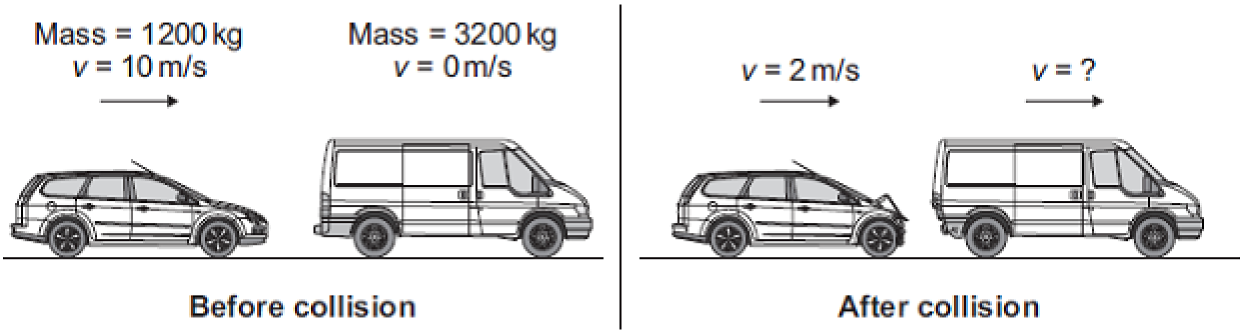
Why?

____

____

(1)

(b) The diagram shows a car and a van, just before and just after the car collided with the van.



(i) Use the information in the diagram to calculate the **change** in the momentum of the car.

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

____

____

____

____

Change in momentum = ____________________

(3)

(ii) Use the idea of conservation of momentum to calculate the velocity of the van when it is pushed forward by the collision.

Show clearly how you work out your answer.

Velocity = ________________________ m/s forward

(2)

(Total 7 marks)

Q14. A car has an oil leak. Every 5 seconds an oil drop falls from the bottom of the car onto the road.

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

(1)

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

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

Explain the reason for your answer.

(3)

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

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

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

(1)

(ii) A braking force of 3 kN is used to slow down and stop the car in a distance of 25 m. Calculate the work done by the brakes to stop the car and give the unit.

Work done =________________________

(3)

(Total 8 marks)

Q15. Forces have different effects.

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

slowing	**stretching**	**turning**

The moment of a force is the ________________________________ effect of the force.

(1)

(ii) What is meant by the centre of mass of an object?

____

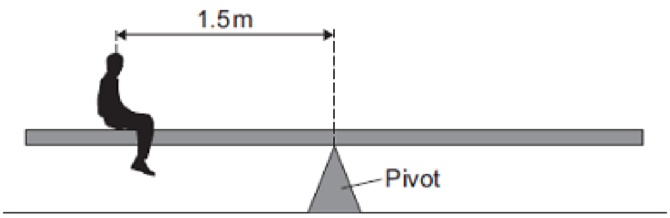
____

(1)

(b) Some children build a see-saw using a plank of wood and a pivot.
The centre of mass of the plank is above the pivot.

Figure 1 shows a boy sitting on the see-saw. His weight is 400 N.

Figure 1



Calculate the anticlockwise moment of the boy in Nm.

____

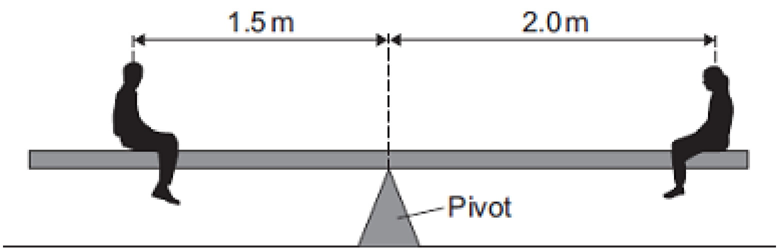
____

Anticlockwise moment = ____________________ Nm

(2)

(c) **Figure 2** shows a girl sitting at the opposite end of the see-saw. Her weight is 300 N.

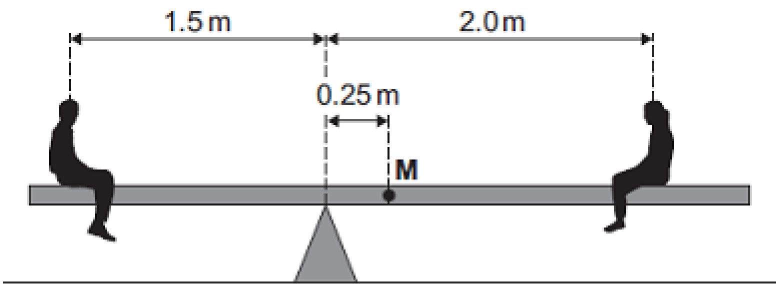
Figure 2



The see-saw is now balanced.

The children move the plank. Its centre of mass, **M**, is now 0.25 m from the pivot as shown in **Figure 3**.

Figure 3



The boy and girl sit on the see-saw as shown in **Figure 3**.

(i) Describe **and** explain the rotation of the see-saw.

___

___

___

___

___

___

___

(3)

(ii) The boy gets off the see-saw and a bigger boy gets on it in the same place. The girl stays in the position shown in **Figure 3**. The plank is balanced. The weight of the plank is 270 N. Calculate the weight of the bigger boy.

___

___

___

___

___

___

Weight of the bigger boy = ____________________ N

(3)

(Total 10 marks)

Q1. (a) **Diagram 1** shows a magnetic closure box when open and shut. It is a box that stays shut, when it is closed, due to the force between two small magnets.

These boxes are often used for jewellery.

Diagram 1

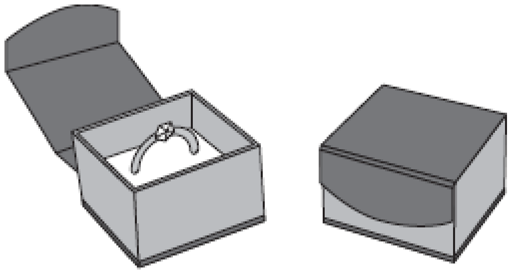
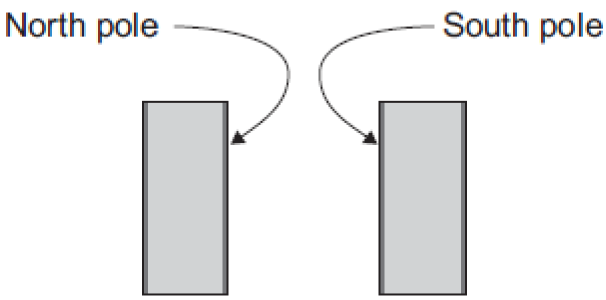


Diagram 2 shows the two magnets. The poles of the magnets are on the longer faces.

Diagram 2



(i) Draw, on **Diagram 2**, the magnetic field pattern between the two facing poles.

(2)

(ii) The magnets in the magnetic closure box must **not** have two North poles facing each other.

Explain why.

____

____

____

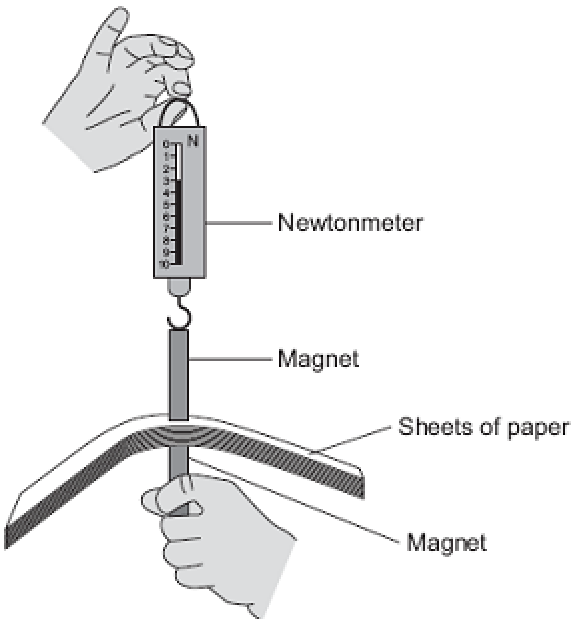
____

(2)

(b) A student is investigating how the force of attraction between two bar magnets depends on their separation.

She uses the apparatus shown in **Diagram 3**.

Diagram 3



She uses the following procedure:

- ensures that the newtonmeter does not have a zero error
- holds one of the magnets
- puts sheets of paper on top of the magnet
- places the other magnet, with the newtonmeter magnetically attached, close to the first magnet
- pulls the magnets apart
- notes the reading on the newtonmeter as the magnets separate
- repeats with different numbers of sheets of paper between the magnets.

The results are shown in the table.

Number of sheets of paper between the magnets	10	20	30	40	50	60	70	80	120
Newtonmeter reading as the magnets separate	3.1	2.6	2.1	1.5	1.1	1.1	1.1	1.1	1.1

(i) Describe the pattern of her results.

(2)

(ii) No matter how many sheets of paper the student puts between the magnets, the force shown on the newtonmeter never reaches zero.

Why?

(1)

(iii) The student is unable to experiment with fewer than 10 sheets of paper without glueing the magnet to the newtonmeter.

Suggest why.

(2)

(iv) Suggest **three** improvements to the procedure that would allow the student to gain more accurate results.

(3)

(v) The thickness of one sheet of paper is 0.1 mm.

What is the separation of the magnets when the force required to separate them is 2.1 N?

___

___

___

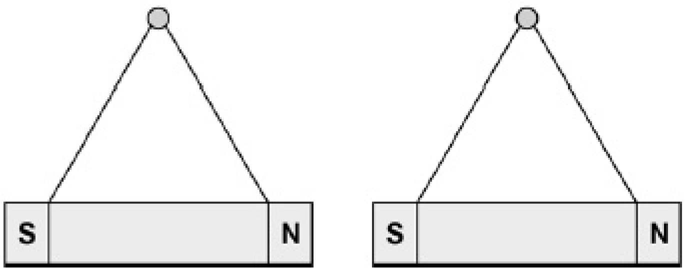
Separation of magnets = ________________ mm

(3)

(Total 15 marks)

Q2. **Figure 1** shows two bar magnets suspended close to each other.

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.

___

___

___

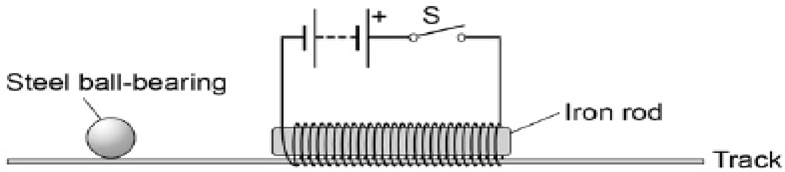
___

___

(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.

____

____

____

____

____

____

____

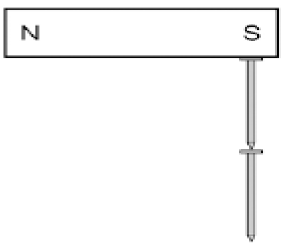
____

(4)

(Total 9 marks)

Q3. Figure 1 shows two iron nails hanging from a bar magnet. The iron nails which were unmagnetised are now magnetised.

Figure 1



(a) Complete the sentence.Use a word from the box.

forced	**induced**	**permanent**

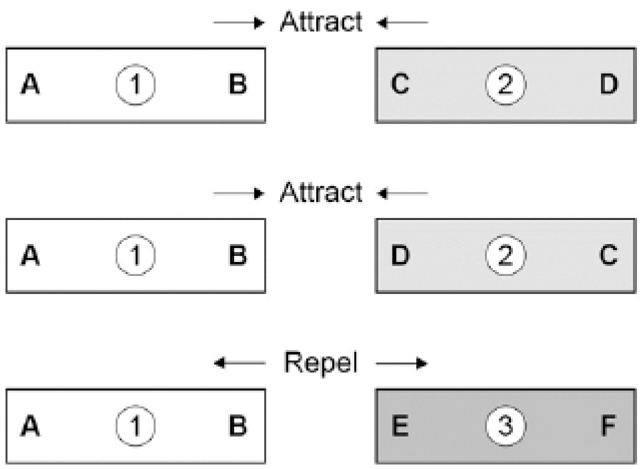
The iron nails have become ______________________ magnets.

(1)

(b) Each of the three metal bars in **Figure 2** is either a bar magnet or a piece of unmagnetised iron.

The forces that act between the bars when different ends are placed close together are shown by the arrows.

Figure 2



Which **one** of the metal bars is a piece of unmagnetised iron?

Tick **one** box.

Bar 1 ☐

Bar 2 ☐

Bar 3 ☐

Give the reason for your answer.

____

____

(2)

(c) A student investigated the strength of different fridge magnets by putting small sheets of paper between each magnet and the fridge door. The student measured the maximum number of sheets of paper that each magnet was able to hold in place.

Why was it important that each small sheet of paper had the same thickness?

____

____

____

(1)

(d) Before starting the investigation the student wrote the following hypothesis:

'The bigger the area of a fridge magnet the stronger the magnet will be.'

The student's results are given in the table below.

Fridge magnet	Area of magnet in mm^2	Number of sheets of paper held
A	40	20
B	110	16
C	250	6
D	340	8
E	1350	4

Give **one** reason why the results from the investigation **do not** support the student's hypothesis.

____

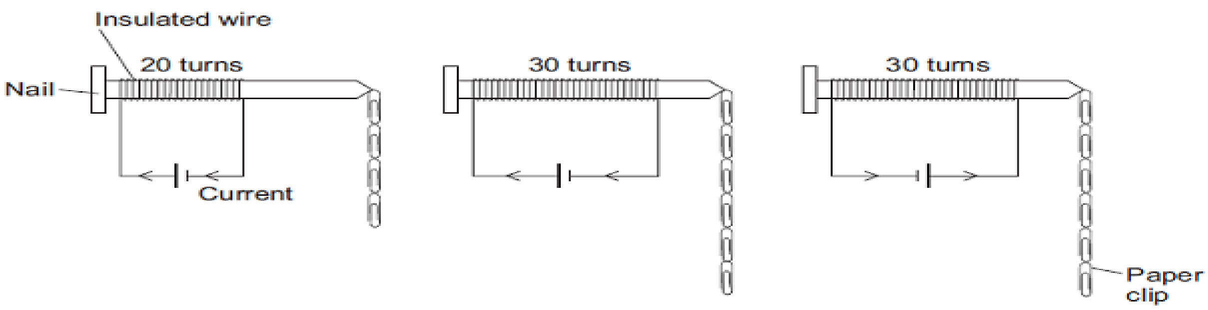
____

(1)
(Total 5 marks)

Q4. A student is investigating the strength of electromagnets. **Figure 1** shows three electromagnets.

The student hung a line of paper clips from each electromagnet.

Figure 1



Electromagnet **A** Electromagnet **B** Electromagnet **C**

No more paper clips can be hung from the bottom of each line of paper clips.

(a) (i) Complete the conclusion that the student should make from this investigation.

Increasing the number of turns of wire wrapped around the nail will

_______________ the strength of the electromagnet.

(1)

(ii) Which **two** pairs of electromagnets should be compared to make this conclusion?

Pair 1: Electromagnets __________ and __________

Pair 2: Electromagnets __________ and __________

(1)

(iii) Suggest **two** variables that the student should control in this investigation.

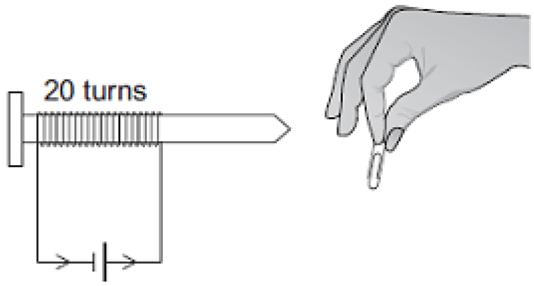
1. ____

2. ____

(2)

(b) The cell in electromagnet **A** is swapped around to make the current flow in the opposite direction. This is shown in **Figure 2**.

Figure 2



What is the maximum number of paper clips that can now be hung in a line from this electromagnet? Draw a ring around the correct answer.

fewer than 4 **4** **more than 4**

Give **one** reason for your answer.

____

____

____

(2)

(c) Electromagnet **A** is changed to have only 10 turns of wire wrapped around the nail.

Suggest the maximum number of paper clips that could be hung in a line from the end of this electromagnet.

Maximum number of paper clips = ________________________

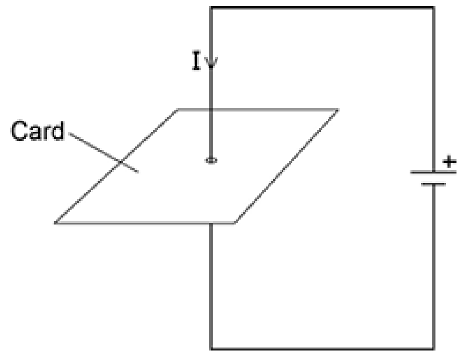
(1)

(Total 7 marks)

Q5. **Figure 1** shows a straight wire passing through a piece of card.

A current (I) is passing down through the wire.

Figure 1



(a) Describe how you could show that a magnetic field has been produced around the wire.

___

___

___

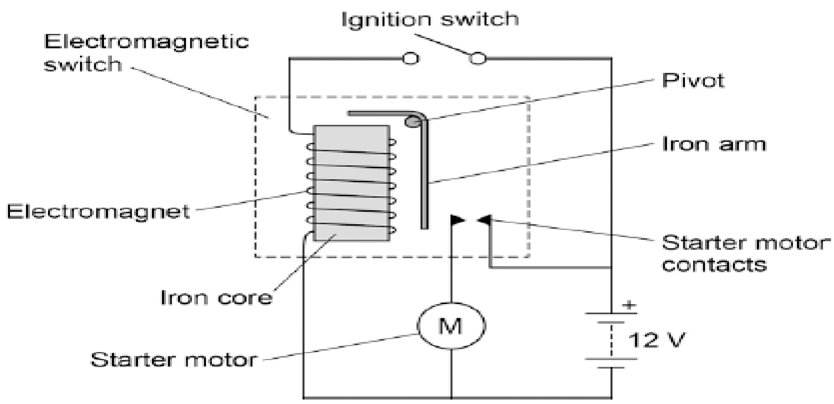
___

(2)

(b) **Figure 2** shows the ignition circuit used to switch the starter motor in a car on.

The circuit includes an electromagnetic switch.

Figure 2



Explain how the ignition circuit works.

___

___

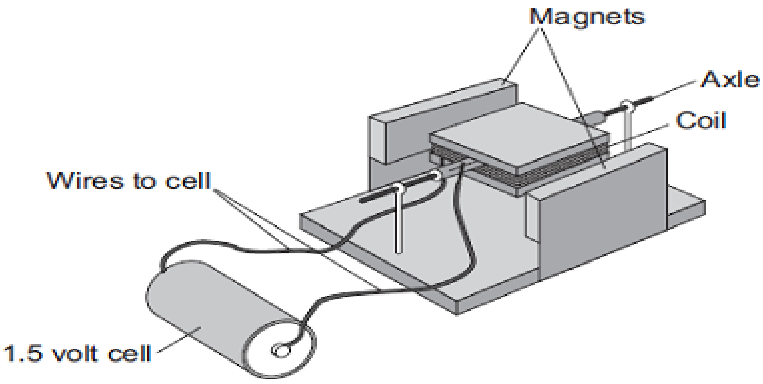
___

___

___

(4)
(Total 6 marks)

Q6. A student has made a simple electric motor. The diagram shows the electric motor.



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

Once the coil is spinning, one side of the coil is pushed by

the cell
the coil
a force

and the other side is pulled, so the coil continues to spin.

(1)

(b) Suggest **two** changes to the electric motor, each one of which would make the coil spin faster.

1. ____

____

2. ____

____

(2)

(c) Suggest **two** changes to the electric motor, each one of which would make the coil spin in the opposite direction.

1. ____

____

2. ____

____

(2)

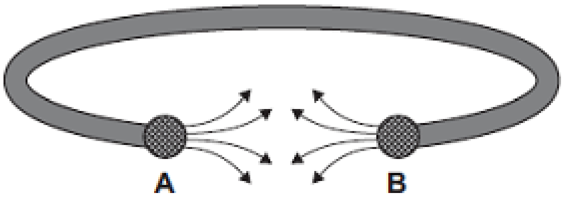
(Total 5 marks)

Q7. (a) Some people wear magnetic bracelets to relieve pain.

Figure 1 shows a magnetic bracelet.

There are magnetic poles at both **A** and **B**.
Part of the magnetic field pattern between **A** and **B** is shown.

Figure 1



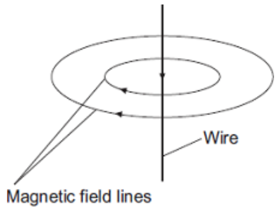
What is the pole at **A**? ______________________

What is the pole at **B**? ______________________

(1)

(b) **Figure 2** shows two of the lines of the magnetic field pattern of a current-carrying wire.

Figure 2



The direction of the current is reversed. What happens to the direction of the lines in the magnetic field pattern?

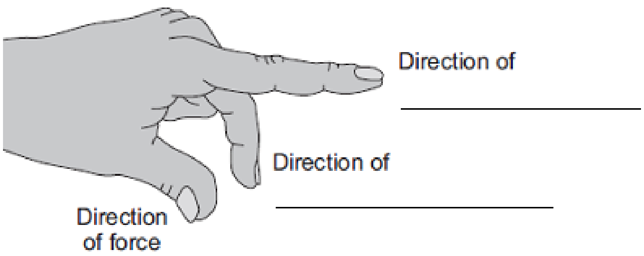
____

(1)

(c) Fleming's left-hand rule can be used to identify the direction of a force acting on a current-carrying wire in a magnetic field.

(i) Complete the labels in **Figure 3**.

Figure 3

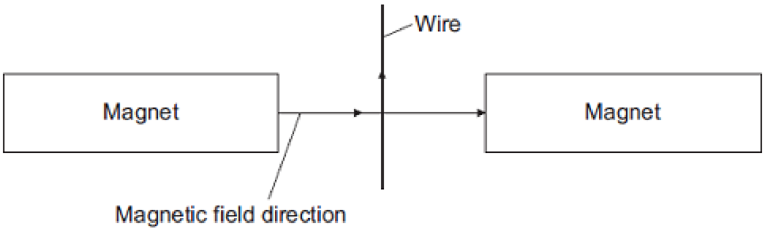


(2)

(ii) **Figure 4** shows:

- the direction of the magnetic field between a pair of magnets
- the direction of the current in a wire in the magnetic field.

Figure 4



In which direction does the force on the wire act?

____

(1)

(iii) Suggest **three** changes that would **decrease** the force acting on the wire.

1. ____

2. ____

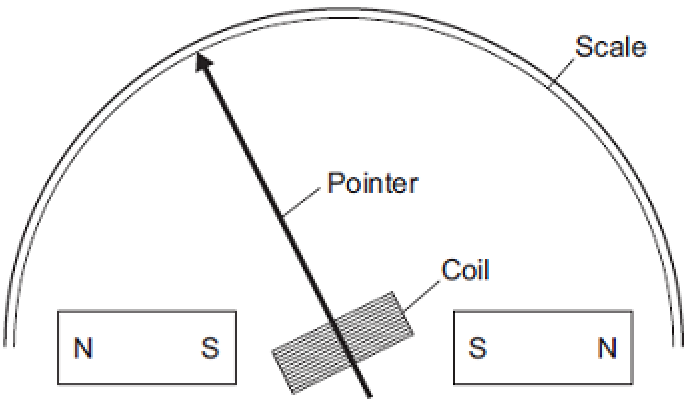
3. ____

(3)

(d) **Figure 5** shows part of a moving-coil ammeter as drawn by a student.

The ammeter consists of a coil placed in a uniform magnetic field.
When there is a current in the coil, the force acting on the coil causes the coil to rotate and the pointer moves across the scale.

Figure 5



(i) The equipment has **not** been set up correctly.

What change would make it work?

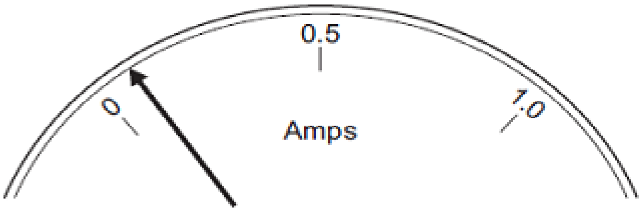
____

____

(1)

(ii) **Figure 6** shows the pointer in an ammeter when there is no current.

Figure 6

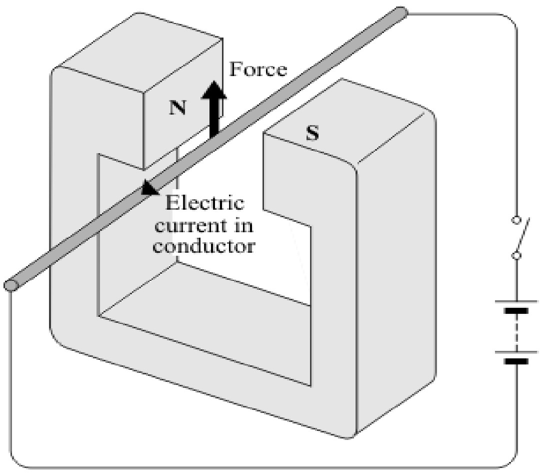


What type of error does the ammeter have?

____

(1)
(Total 10 marks)

Q8. When a conductor carrying an electric current is placed in a magnetic field a force may act on it.



(a) State **two** ways in which this force can be increased.

1. ____

2. ____

(2)

(b) State **two** ways in which this force can be made to act in the opposite direction.

1. ____

2. ____

(2)

(c) In what circumstance will **no** force act on a conductor carrying an electric current and in a magnetic field?

____

____

(1)
(Total 5 marks)

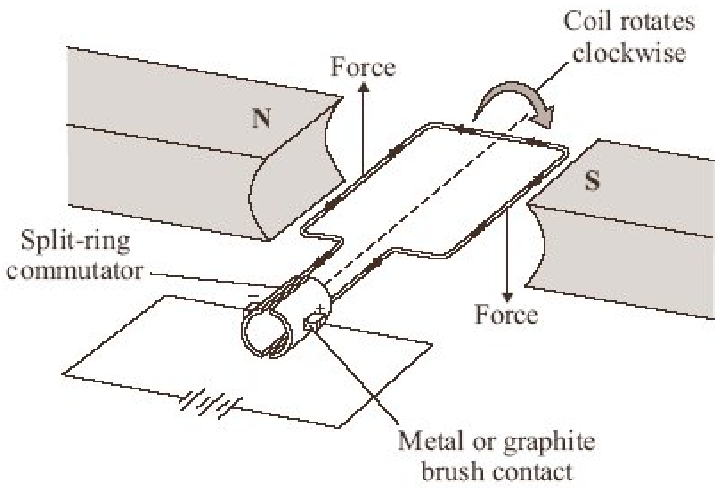
Q9. Many electrical appliances use the circular motion produced by their electric motor.

(a) Put ticks (✓) in the boxes next to **all** the appliances in the list which have an electric motor.

electric drill	☐
electric fan	☐
electric food mixer	☐
electric iron	☐
electric kettle	☐
electric screwdriver	☐

(2)

(b) One simple design of an electric motor is shown in the diagram. It has a coil which spins between the ends of a magnet.



(i) Give **two** ways of reversing the direction of the forces on the coil in the electric motor.

1. ____

____

2. ____

____

(2)

(ii) Give **two** ways of increasing the forces on the coil in the electric motor.

1. ____

____

2. ____

____

(2)

(Total 6 marks)

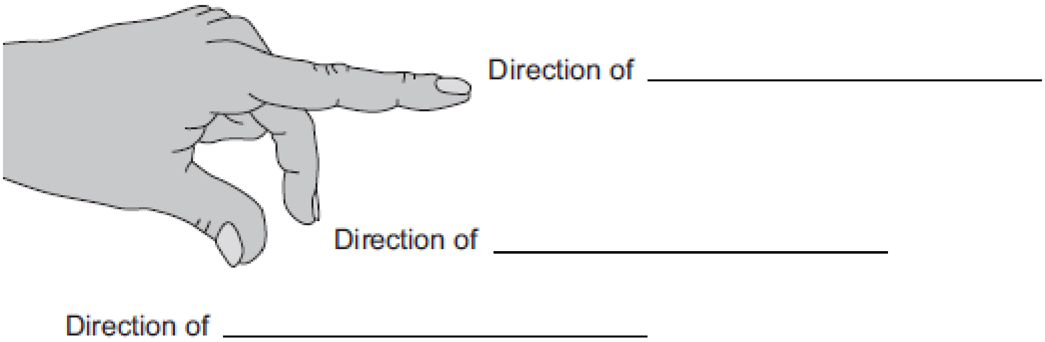
Q10.

The left-hand rule can be used to identify the direction of the force acting on a current-carrying conductor in a magnetic field.

(a) Use words from the box to label **Figure 1**.

current	**field**	**force**	**potential difference**

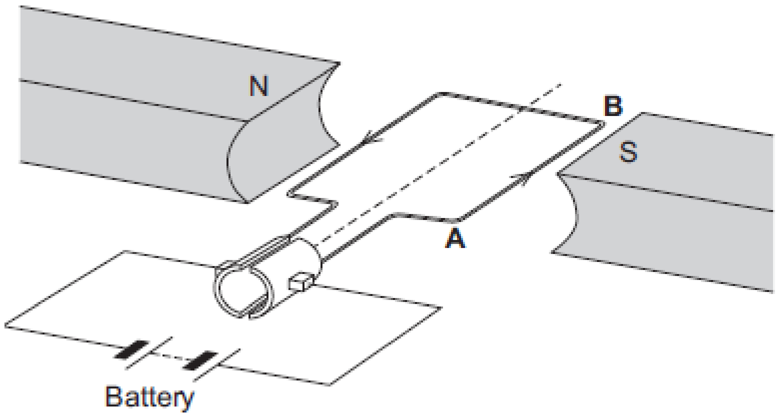
Figure 1



(3)

(b) **Figure 2** shows an electric motor.

Figure 2



(i) Draw an arrow on **Figure 2** to show the direction of the force acting on the wire **AB**.

(1)

(ii) Suggest **two** changes that would increase the force acting on the wire **AB**.

1. ______________________________

2. ______________________________

(2)

(iii) Suggest **two** changes that would reverse the direction of the force acting on the wire **AB**.

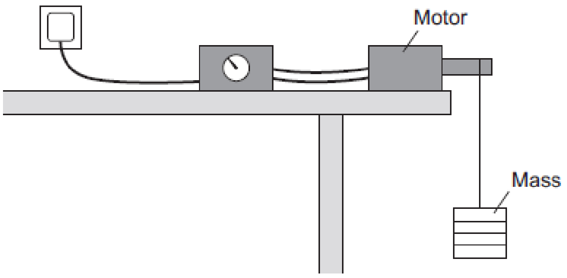
1. ______________________________

2. ______________________________

(2)

(c) A student used an electric motor to lift a mass. This is shown in **Figure 3**.

Figure 3



The student varied the electrical input power to the motor. For each different electrical input power, he recorded the time taken to lift the mass and calculated the output power of the motor.

The results are shown in the table.

Test	Electrical input power in watts	Work done lifting the mass in joules	Time taken to lift the mass in seconds	Output power in watts
A	20	24	2.4	10
B	40	24	1.2	20
C	60	24	0.8	30
D	80	24	0.2	120

The result for **Test D** is anomalous.

(i) Calculate the efficiency of the motor in **Test D**.

____

____

Efficiency = ______________

(2)

(ii) Comment on your answer to part (c)(i).

____

____

(1)

(iii) Suggest a reason for this anomalous result.

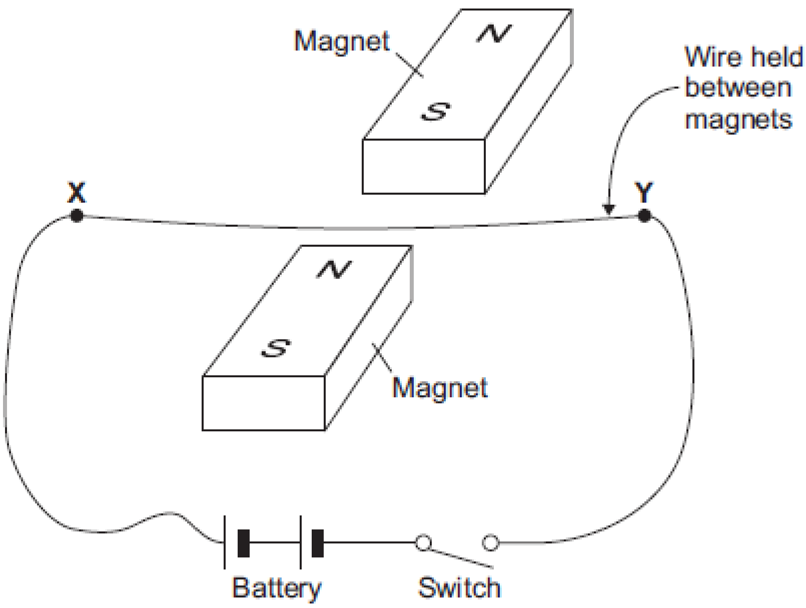
____

____

(1)

(Total 12 marks)

Q11. The diagram shows apparatus set up by a student.



Closing the switch creates a force that acts on the wire **XY**.

(a) (i) Explain why a force acts on the wire **XY** when the switch is closed.

____

____

____

____

____

____

(3)

(ii) The force causes the wire **XY** to move.
Draw an arrow on the diagram above to show the direction in which the wire **XY** will move.

(1)

(iii) State the effect that this experiment demonstrates.

____

(1)

(b) The student replaced the battery with a low frequency alternating current (a.c.) power supply.

The student closed the switch.

(i) Describe the movement of the wire.

____

(1)

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

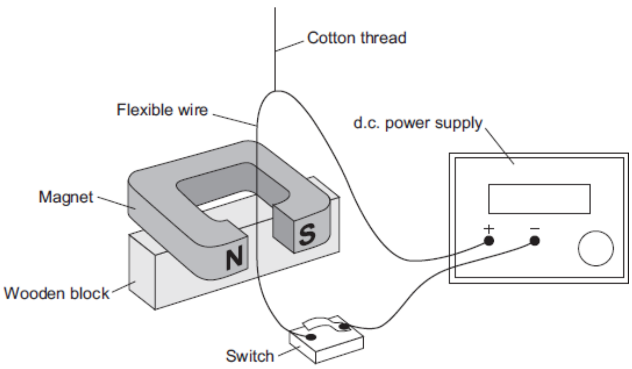
____

____

____

(1)
(Total 7 marks)

Q12. The diagram shows a demonstration carried out by a teacher.



When the switch is closed, there is a current of 2 A through the wire. The wire experiences a force and moves.

(a) Use the correct word from the box to complete the sentence.

generator	**motor**	**transformer**

The demonstration shows the ___________________________ effect.

(1)

(b) State **two** changes that the teacher could make to the demonstration, each of which would increase the force on the wire. The teacher does not touch the wire.

1. ____

____

2. ____

____

(2)

(c) State **one** change that the teacher could make to the demonstration to change the direction of the force on the wire.

____

____

(1)

(d) With the switch closed, the teacher changes the position of the wire so that the force on the wire is zero. What is the position of the wire?

Tick (✓) **one** box.

The wire is at 90° to the direction of the magnetic field. ☐

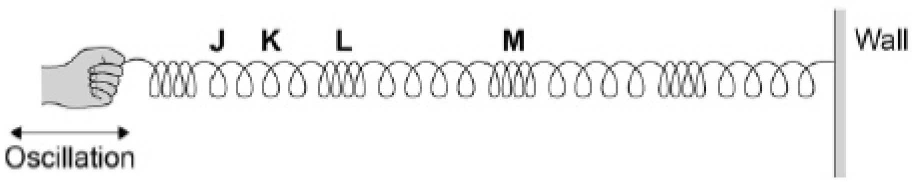
The wire is at 45° to the direction of the magnetic field. ☐

The wire is parallel to the direction of the magnetic field. ☐

(1)

Q1. **Figure 1** shows a longitudinal wave being produced in a stretched spring.

Figure 1



(a) Which of the letters on **Figure 1** shows the centre of a rarefaction?

Tick **one** box.

J ☐ **K** ☐ **L** ☐ **M** ☐

(1)

(b) Which two letters in **Figure 1** have a distance of one wavelength between them?

Tick **one** box.

J and **K** ☐ **K** and **L** ☐ **L** and **M** ☐ **J** and **M** ☐

(1)

(c) Describe how the end of the stretched spring should be moved in order to produce a transverse wave.

____

____

(1)

Figure 2 shows how two students used the sound reflected off a building (an echo) to measure the speed of sound.

Figure 2

This is the method used.

1. Student **A** hit two cymbals together and student **B** started a stopwatch.
2. When student **A** heard an echo she hit the cymbals together again.
3. Student **B** stopped the stopwatch after timing 5 echoes.

The table shows the student's results.

Time for 5 echoes in seconds
3.1
2.7
2.2
3.2

(d) The students decided that the time of 2.2 s was an anomalous result.

What was the most likely cause for this anomalous result?

Tick **one** box.

Not resetting the stopwatch to zero.	☐
Starting the stopwatch too soon.	☐
Timing less than five echoes.	☐
Timing more than five echoes.	☐

(1)

(e) Calculate the mean value of the time for 5 echoes.

Ignore the anomalous result.

____

____

mean time = ____________________ s

(1)

(f) The distance between student A and the building is 75 metres.

Calculate the distance the sound travels in going from student A to the building and back again five times.

____

____

distance = ____________________ m

(1)

(g) Calculate the speed of sound.

Use your answers to Questions (e) and (f) and the equation:

$$\text{speed} = \frac{\text{distance travelled}}{\text{time}}$$

____

____

____

____

speed of sound = ____________________ m/s

(2)

(h) The value for the speed of sound obtained by the students is not very accurate.

Suggest **two** changes to the method used by the students that would improve the accuracy.

1. ____

____

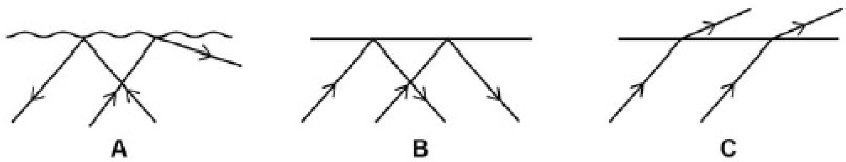
2. ____

____

(2)
(Total 10 marks)

Q2.(a) **Figure 1** shows what happens to rays of light incident on three different surfaces.

Figure 1



Which **one** of the diagrams shows diffuse reflection?

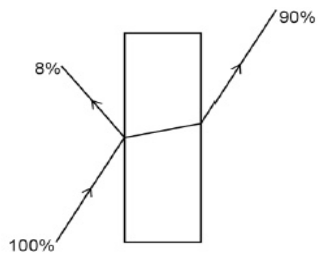
Tick **one** box.

A ☐ **B** ☐ **C** ☐

(1)

(b) **Figure 2** shows what happens to the energy transferred by a ray of light when the ray of light hits a glass block.

Figure 2



Calculate the percentage of the energy absorbed by the glass block.

____

____

Percentage of energy absorbed = ____________________ %

(1)

(c) Viewing an object through a colour filter may make the object look a different colour.

Complete the sentences. Choose the answers from the box.

absorbs	**black**	**blue**
red	**reflects**	**transmits**

A red object viewed through a blue filter will look ____________________.

This is because the red object only ____________________ red light and the

blue filter only ____________________ blue light.

(3)

(d) A white surface is viewed through a green filter.

What colour will the surface look?

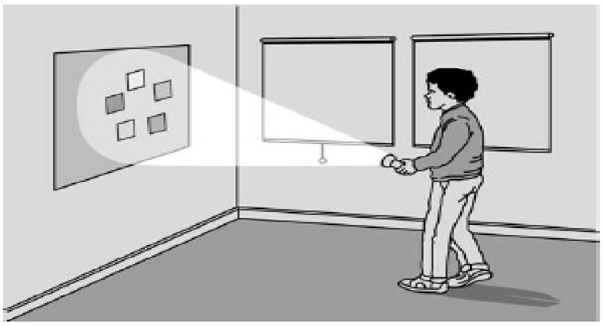
____

(1)

Cyclists often wear clothing that reflects a lot of light.

Figure 3 shows a student investigating which colours are best at reflecting light.

Figure 3



This is the method used.

1. Small squares of different coloured material were stuck onto a piece of black paper at one end of a darkened laboratory.
2. The student switched on a torch and walked slowly towards the coloured squares.
3. The student stopped walking as soon as he could clearly see a coloured square.
4. The student measured the distance between the torch and the coloured square.

(e) Give a reason why it was important the student did the investigation in a darkened laboratory.

____

____

(1)

(f) Give a reason why it was important the area of each coloured square was the same.

___

___

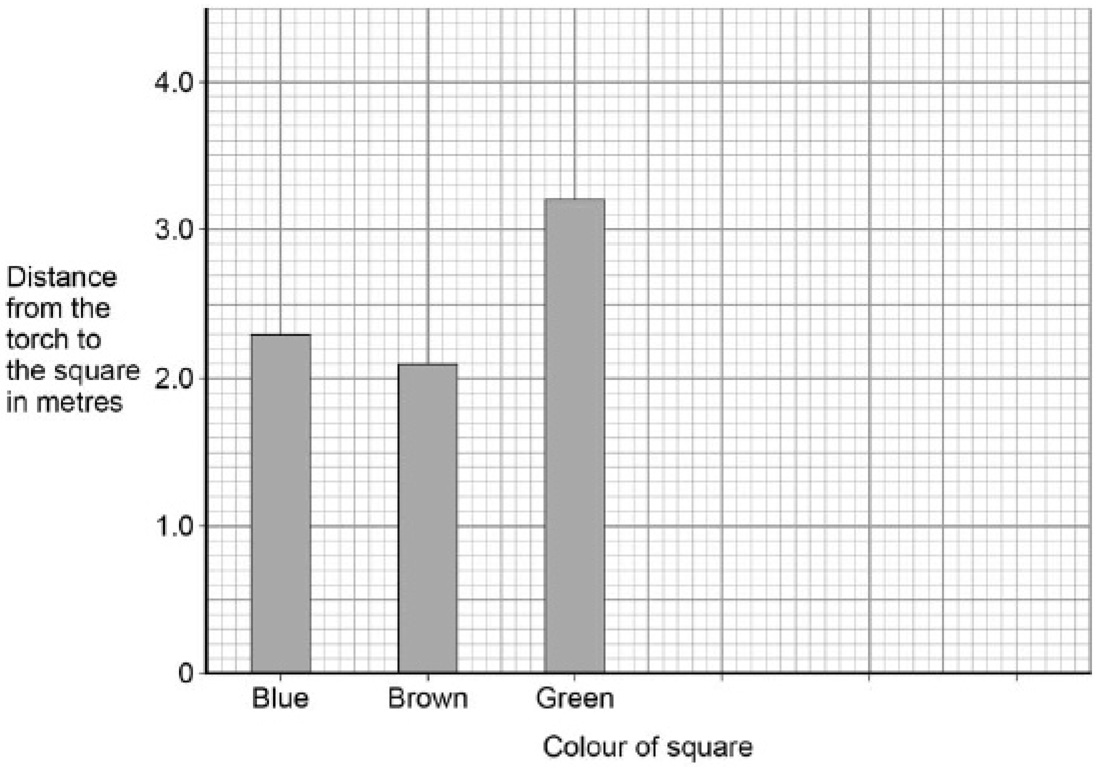
(1)

The table shows the student's results.

Colour of square	**Distance from the torch to the square in metres**
Blue	2.3
Brown	2.1
Green	3.2
Orange	3.4
Red	2.6

Figure 4 shows a bar chart with only three of the student's results.

Figure 4



(g) Complete the bar chart to show all of the results.

(3)

(h) Which colour clothing would be best for a cyclist to wear? Use the data from the table. Tick **one** box.

Blue ☐ Brown ☐ Green ☐ Orange ☐ Red ☐

Give a reason for your answer.

____

____

(2)

(i) The student did the investigation again to obtain a second set of results.

The second set of results showed the same pattern as the first set.

Complete the sentence. Choose the answer from the box.

accurate	**precise**	**repeatable**	**reproducible**

The measurements taken by the student were ____________________ .

(1)

(Total 14 marks)

Q3. (a) Which one of the following is not an electromagnetic wave? Tick **one** box.

Gamma rays ☐

Sound ☐

Ultraviolet ☐

X-rays ☐

(1)

(b) What type of electromagnetic wave do our eyes detect?

____

(1)

(c) What is a practical use for infrared waves?Tick **one** box.

Cooking food ☐

Energy efficient lamps ☐

Medical imaging ☐

Satellite communications ☐

(1)

Scientists have detected radio waves emitted from a distant galaxy.

Some of the radio waves from the distant galaxy have a frequency of 1 200 000 000 hertz.

(d) Which is the same as 1 200 000 000 hertz?

Tick **one** box.

1.2 gigahertz ☐

1.2 kilohertz ☐

1.2 megahertz ☐

1.2 millihertz ☐

(1)

(e) Radio waves travel through space at 300 000 kilometres per second (km/s).

How is 300 000 km/s converted to metres per second (m/s)?

Tick **one** box.

300 000 ÷ 1000 = 300 m/s ☐

300 000 × 1000 = 300 000 000 m/s ☐

300 000 + 1000 = 301 000 m/s ☐

300 000 – 1000 = 299 000 m/s ☐

(1)

(f) Write the equation which links frequency, wavelength and wave speed.

____

(1)

(g) Calculate the wavelength of the radio waves emitted from the distant galaxy.

Give your answer in metres.

____

____

wavelength = ______________________ m

(3)

(Total 9 marks)

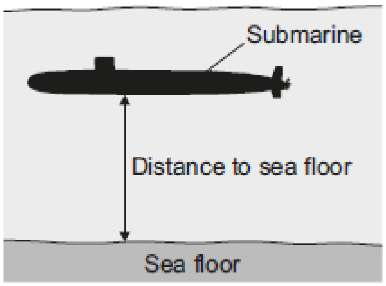
Q4. (a) Ultrasound is sound above the maximum frequency that humans can hear.

Tick (✓) **one** box.

20 Hz	☐
2000 Hz	☐
20 000 Hz	☐

(1)

(b) The image shows a submerged submarine.



The submarine sends a pulse of ultrasound to the sea floor.
The pulse takes 0.25 seconds to travel from the submarine to the sea floor.

The speed of sound in water is 1600 m/s.

Calculate the distance from the submarine to the sea floor.

____

____

____

____

Distance = ____________ m

(2)

(c) The ultrasound is reflected from the sea floor back to the submarine.
Use the correct answer from the box to complete the sentence.

half	**the same as**	**twice**

The total distance the ultrasound pulse travelled is ___________ the distance to the sea floor.

(1)

(d) The submarine moves through the sea and every few seconds sends a pulse of ultrasound to check the distance to the sea floor.

The table shows the time taken for five ultrasound pulses to travel from the submarine to the sea floor and back to the submarine.

Pulse number	Time for pulse to return in seconds
1	0.50
2	0.45
3	0.38
4	0.40
5	0.48

Describe how the distance from the submarine to the sea floor changed over these five pulses.

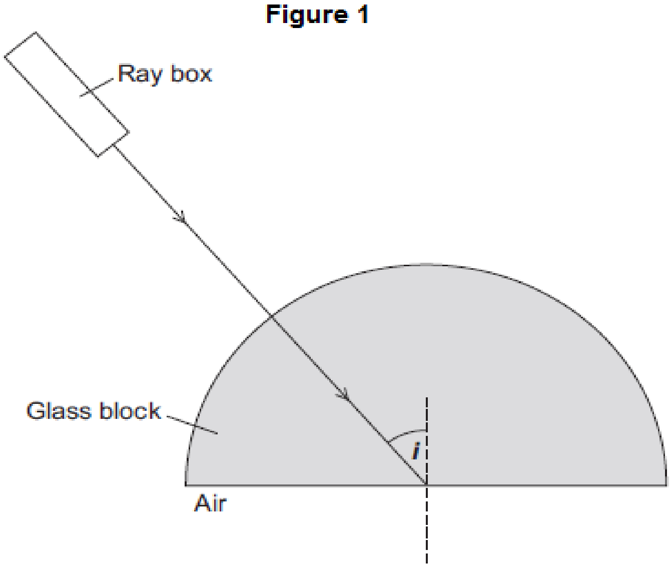
(2)

(Total 6 marks)

Q5.

Figure 1 shows a ray of light travelling through a semicircular glass block.
The angle of incidence is labelled ***i***.

Figure 1



(a) (i) The angle of incidence ***i*** equals the critical angle for the glass.

Complete **Figure 1** to show what happens to the ray of light at the glass-to-air boundary.

(1)

(ii) The critical angle for the glass is 41°.

Calculate the refractive index of the glass.

___

___

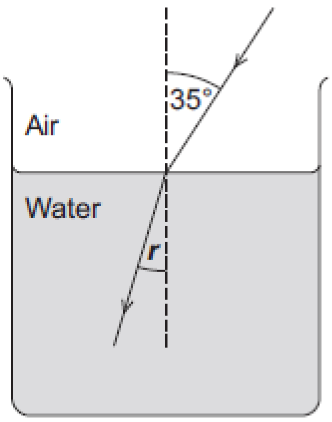
___

Refractive index = ___

(2)

(b) **Figure 2** shows what happens to a ray of light as it meets the boundary between air and water.

Figure 2



Not to scale

The refractive index of the water is 1.3.

Calculate the angle of refraction ***r***.

___

___

___

___

___

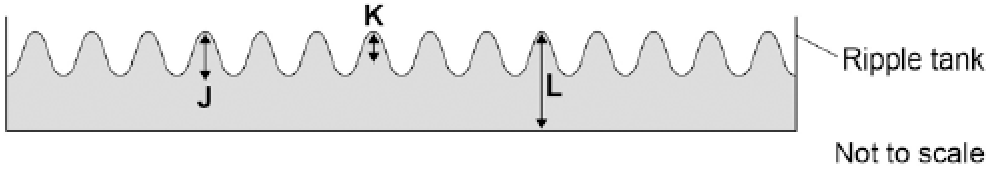
Angle of refraction = ___ degrees

(3)

(Total 6 marks)

Q6.

Small water waves are created in a ripple tank by a wooden bar. The wooden bar vibrates up and down hitting the surface of the water. The figure below shows a cross-section of the ripple tank and water.



(a) Which letter shows the amplitude of a water wave?

Tick **one** box.

J ☐

K ☐

L ☐

(1)

(b) The speed of the wooden bar is changed so that the bar hits the water fewer times each second.

What happens to the frequency of the waves produced?

Tick **one** box.

Increases ☐

Does not change ☐

Decreases ☐

(1)

(c) Describe how the wavelength of the water waves in a ripple tank can be measured accurately.

___

___

___

___

___

(2)

(d) The speed of a wave is calculated using the following equation.

wave speed = frequency × wavelength

The water waves in a ripple tank have a wavelength of 1.2 cm and a frequency of 18.5 Hz. How does the speed of these water waves compare to the typical speed of a person walking?

____

____

____

____

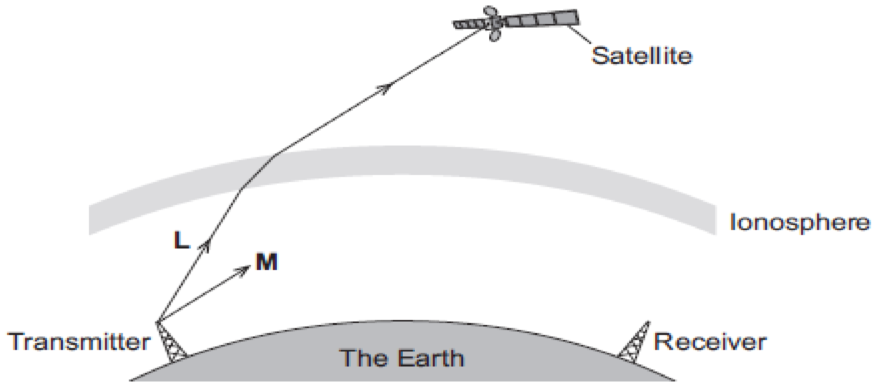
____

____

(4)
(Total 8 marks)

Q7. Different parts of the electromagnetic spectrum are useful for different methods of communication.

The diagram shows a transmitter emitting two electromagnetic waves, **L** and **M**.



(a) (i) Wave **L** is used to send a signal to a satellite.
Which part of the electromagnetic spectrum does wave **L** belong to?

____

(1)

(ii) What name is given to the process that occurs as wave **L** passes into the ionosphere?

____

(1)

(b) Wave **M** is **reflected** by the ionosphere.

(i) On the diagram above, draw the path of wave **M** until it reaches the receiver.

(2)

(ii) On the daigram above, draw a line to show the normal where wave **M** meets the ionosphere. Label the line **N**.

(1)

(c) Give **two** properties of all electromagnetic waves.

1. ____

____

2. ____

____

(2)

(Total 7 marks)

Q8. X-rays and ultrasound can both be used for scanning internal organs.

(a) Ultrasound is used to scan unborn babies but X-rays are **not** used to scan unborn babies. Explain why.

____

____

____

____

(3)

(b) The behaviour of ultrasound waves when they meet a boundary between two different materials is used to produce an image. Describe how.

____

____

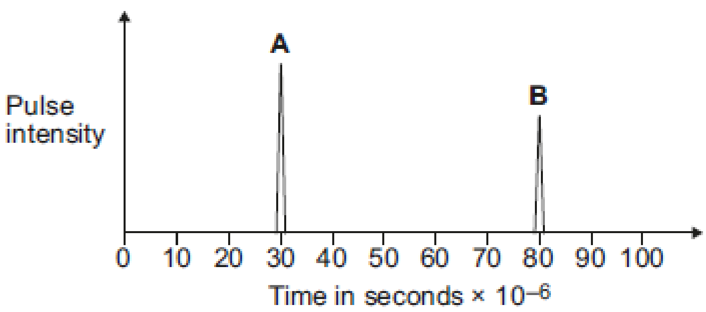
____

____

(2)

(c) **Figure 1** shows two pulses from a scan of an unborn baby. The emitted pulse is labelled **A**. The returning pulse picked up by the receiver is labelled **B**.

Figure 1



The closest distance between the unborn baby and the mother’s skin is 4.0 cm. Use information from **Figure 1** to calculate the average speed of the pulse.

Average speed = _______ m/s

(3)

(d) **Figure 2** shows an X-ray of an arm with a broken bone.

Figure 2

(i) Describe how X-rays are able to produce an image of bones.

(3)

(ii) Complete the following sentence.

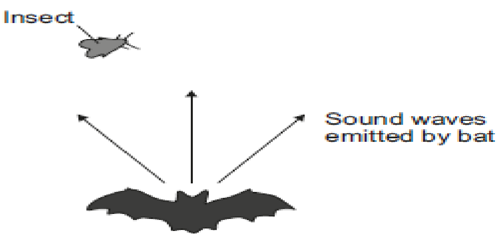
X-rays are able to produce detailed images because their wavelength

is very _____________ .

(1)

(Total 12 marks)

Q9. Bats use the reflection of high pitched sound waves to determine the position of objects. The image below shows a bat and an insect flying in front of the bat.



(a) What determines the pitch of a sound wave?Tick (✓) **one** box.

	Tick (✓)
amplitude	
frequency	
speed	

(1)

(b) State the name given to reflected sound waves.

____

(1)

(c) The bat emits a sound wave with a frequency of 25.0 kHz and a wavelength of 0.0136 metres.

Calculate the speed of this sound wave.

____

____

____

Speed = _____________ m/s

(2)

(d) Sound waves are longitudinal. Describe a longitudinal sound wave.

____

____

____

____

(2)
(Total 6 marks)

Q10. **Figure 1** shows an X-ray of an arm with a broken bone.

Figure 1

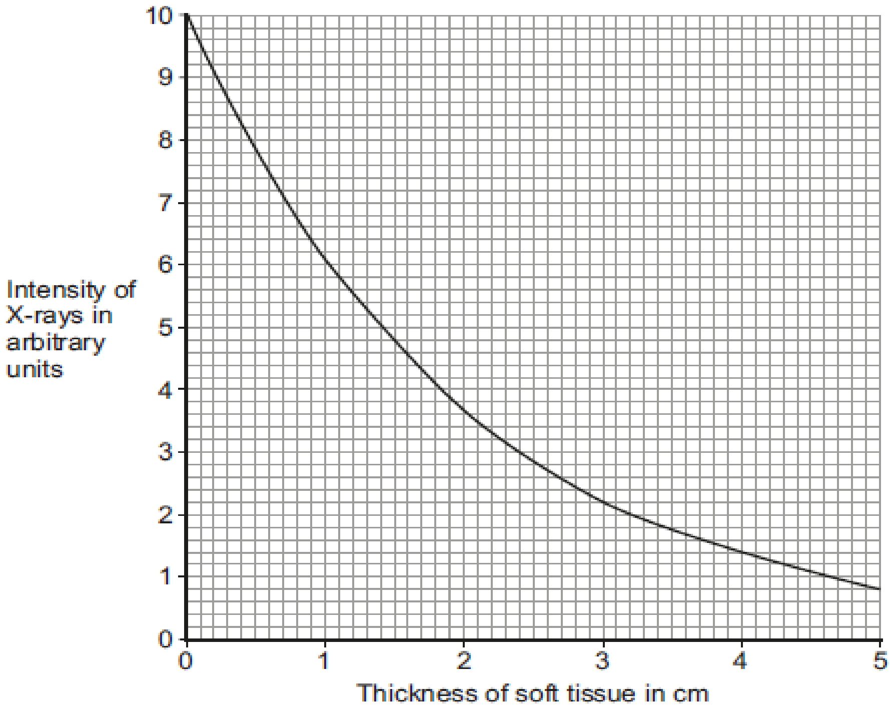
(a) Complete the following sentence.

X-rays are part of the _______________ spectrum.

(1)

(b) **Figure 2** shows how the intensity of the X-rays changes as they pass through soft tissue and reach a detector.

Figure 2



(i) Use **Figure 2** to determine the intensity of X-rays reaching the detector for a 3 cm thickness of soft tissue.

Intensity of X-rays = _________ arbitrary units

(1)

(ii) Describe how the thickness of soft tissue affects the intensity of the X-rays.

___

___

___

___

(2)

(iii) The data in **Figure 2** are shown as a line graph and not as a bar chart.

Choose the reason why.

Tick (✓) **one** box.

Both variables are categoric ☐

Both variables are continuous ☐

One variable is continuous and one is categoric ☐

(1)

(c) What happens to X-rays when they enter a bone?

___

___

(1)

(d) How are images formed electronically in a modern X-ray machine?

Tick (✓) **one** box.

With a charge-coupled device (CCD) ☐

With an oscilloscope ☐

With photographic film ☐

(1)

(e) Radiographers who take X-ray photographs may be exposed to X-rays.

(i) X-rays can increase the risk of the radiographer getting cancer.

Why can X-rays increase the risk of getting cancer? Tick (✓) **one** box.

X-rays travel at the speed of light ☐

X-rays can travel through a vacuum ☐

X-rays are ionising ☐

(1)

(ii) What should the radiographer do to reduce the risk from X-rays?

___

___

(1)

(Total 9 marks)

Q11.

The data given in the table below was obtained from an investigation into the refraction of light at an air to glass boundary.

Angle of incidence	**Angle of refraction**
20°	13°
30°	19°
40°	25°
50°	30°

(a) Describe an investigation a student could complete in order to obtain similar data to that given in the table above.

Your answer should consider any cause of inaccuracy in the data.

A labelled diagram may be drawn as part of your answer.

___

___

___

___

___

___

___

___

___

(6)

(b) State the reason why light is refracted as it crosses from air into glass.

___

___

(1)

(Total 7 marks)

Q12.

The figure below shows an incomplete electromagnetic spectrum.

A	**microwaves**	**B**	**C**	**ultraviolet**	**D**	**gamma**

(a) What name is given to the group of waves at the position labelled **A** in the figure above?

Tick **one** box.

infrared ☐

radio ☐

visible light ☐

X-ray ☐

(1)

(b) Electromagnetic waves have many practical uses.

Draw **one** line from each type of electromagnetic wave to its use.

Electromagnetic wave	**Use**
Gamma rays	For fibre optic communications
Microwaves	For communicating with a satellite
Ultraviolet	To see security markings
	To sterilise surgical instruments

(3)

(c) Complete the sentence. Use an answer from the box.

black body	ionising	nuclear

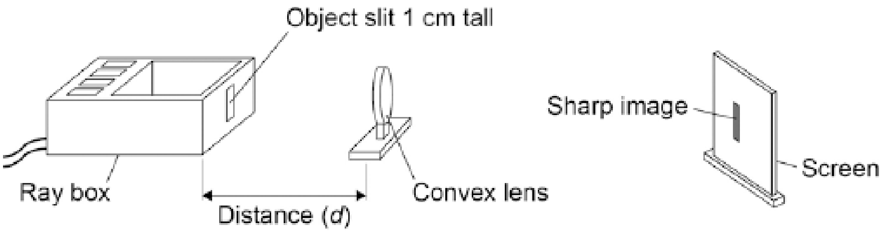
X-rays can be dangerous to people because X-rays are

____________________ radiation.

(1)
(Total 5 marks)

Q13. A student investigated how the magnification produced by a convex lens varies with the distance (*d*) between the object and the lens. The student used the apparatus shown in **Figure 1**.

Figure 1



(a) The student measured the magnification produced by the lens by measuring the image height in centimetres.

Explain why the image height in centimetres was the same as the magnification.

____

____

____

____

(2)

(b) The data recorded by the student is given in **Table 1**.

Table 1

Distance between the object and the lens in cm	Magnification
25	4.0
30	2.0
40	1.0
50	0.7
60	0.5

It would be difficult to obtain accurate magnification values for distances greater than 60 cm.

Suggest **one** change that could be made so that accurate magnification values could be obtained for distances greater than 60 cm.

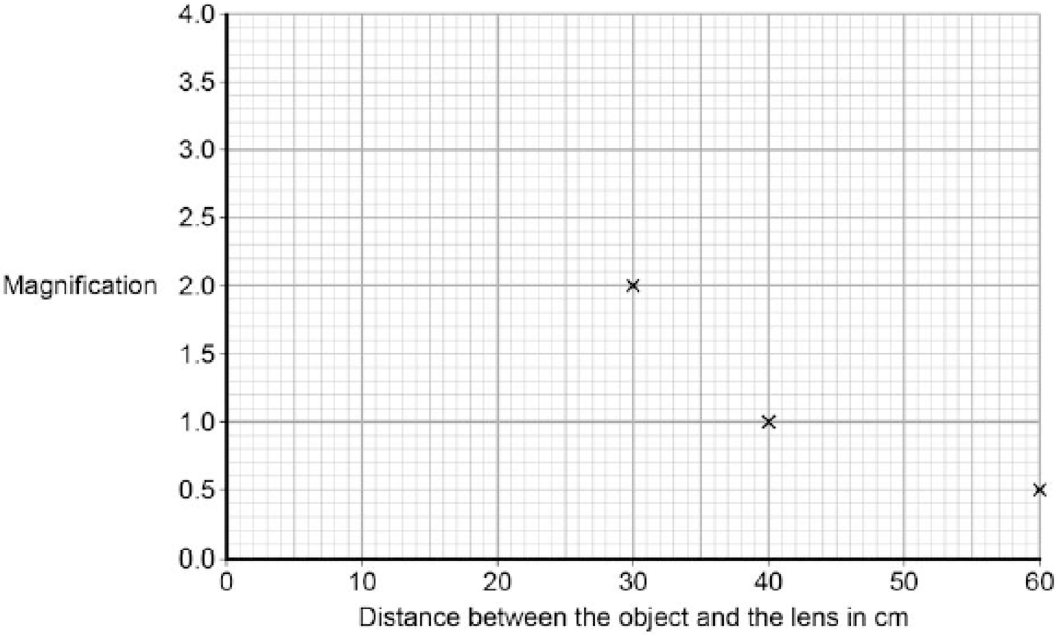
____

____

(1)

(c) The graph in **Figure 2** is incomplete.

Figure 2



Complete the graph in **Figure 2** by plotting the missing data and then drawing a line of best fit.

(2)

(d) How many times bigger is the image when the object is 35 cm from the lens compared to when the object is 55 cm from the lens?

____

____

____

(2)

(e) During the investigation the student also measured the distance between the lens and the image.

Table 2 gives both of the distances measured and the magnification.

Table 2

Distance between the lens and the image in cm	Distance between the lens and the object in cm	Magnification
100	25	4.0
60	30	2.0
40	40	1.0
33	50	0.7
30	60	0.5

Consider the data in **Table 2**.

Give a second way that the student could have determined the magnification of the object.

Justify your answer with a calculation.

___

___

___

___

___

(2)

(Total 9 marks)

8.Space & other PHYSICS GCSE ONLY

Mastery Booklet

(Physics Paper 2)

Q1. (a) There are eight planets in orbit around the Sun.

Which other type of object orbits the Sun?

Tick **one** box.

Dwarf planet	☐
Galaxy	☐
Moon	☐
Star	☐

(1)

(b) Complete the sentences.

Choose the answers from the box.

black hole	**gravity**	**friction**
nebula	**protostar**	**upthrust**

The Sun was formed when a ____________________ in space was pulled

together by ____________________ .

(2)

(c) The Sun has reached the Main Sequence stage in its lifecycle.

What stage in the lifecycle of the Sun will follow the Main Sequence stage?

____

(1)

The table shows some data about the eight planets that orbit the Sun.

Planet	**Distance from the Sun compared to the Earth**	**Time to orbit the Sun in years**	**Mean surface temperature in °C**
Mercury	0.4	0.2	+125
Venus	0.7	0.6	+465
Earth	1.0	1.0	+22
Mars	1.5	1.9	–48
Jupiter	**X**	12	–108
Saturn	9.6	30	–180
Uranus	19.3	84	–216
Neptune	30.0	165	–201

(d) What pattern links the distance a planet is from the Sun and the time taken by the planet to orbit the Sun?

____

____

____

(1)

(e) Estimate the value of **X** in the table.

Distance = ______________________

(1)

(f) A student looked at the data in the table and wrote the following conclusion:

'The mean surface temperature of a planet decreases the further the planet is from the Sun.'

Explain why this conclusion is **not** totally correct.

____

____

____

____

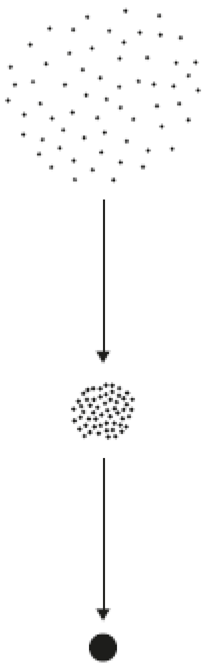
____

____

(3)
(Total 9 marks)

Q2.

(a) The figure below shows how a star is formed.
Use **one** answer from each box to complete the sentences.



gas	**rock**	**water**

A star starts as a huge cloud of dust and ____________________ particles in space.

friction	**fusion**	**gravity**

The force of ____________________ pulls the particles in the cloud closer together.

protostar	**red giant**	**white dwarf**

The compressed mass of particles

forms a ____________________ .

(3)

(b) Elements heavier than iron are formed in a supernova.
What is a supernova?

Tick (✓) **one** box.

the explosion of a massive star ☐

a very bright, hot young star ☐

a very cool super giant star ☐

(1)

(c) Brown dwarf stars are small stars too cool to give out visible light. They were first discovered in 1995. Scientists think that there are millions of these stars spread throughout the Universe.

Which **one** of the following is the most likely reason why brown dwarf stars were not discovered before 1995?

Tick (✓) **one** box.

Brown dwarf stars did not exist before 1995.	☐
Scientists were looking in the wrong part of the Universe.	☐
The telescopes and measuring instruments were not sensitive enough.	☐

(1)

(Total 5 marks)

Q3.

(a) Brown dwarf stars are thought to have been formed in the same way as other stars. They are too small for nuclear fusion reactions to take place in them.
Brown dwarf stars emit infrared radiation but are not hot enough to emit visible light.

(i) Describe how a star is formed.

____

____

____

____

(2)

(ii) Describe the process of nuclear fusion.

____

____

____

(1)

(iii) Scientists predicted that brown dwarf stars existed before the first one was discovered in 1995.

Suggest **one** reason why scientists are now able to observe and identify brown dwarf stars.

____

____

____

(1)

(b) In the 18th century some scientists suggested a theory about how the planets formed in the Solar System. The theory was that after the Sun formed, there were cool discs of matter rotating around the Sun. These cool discs of matter formed the planets. The scientists thought this must have happened around other stars too.

(i) Thinking about this theory, what would the scientists have predicted to have been formed in other parts of the Universe?

____

____

(1)

(ii) Since the 1980s scientists studying young stars have shown the stars to be surrounded by cool discs of rotating matter.

What was the importance of these observations to the theory the scientists suggested in the 18th century?

____

____

(1)

(c) The Earth contains elements heavier than iron.

Why is the presence of elements heavier than iron in the Earth evidence that the Solar System was formed from material produced after a massive star exploded?

____

____

(1)

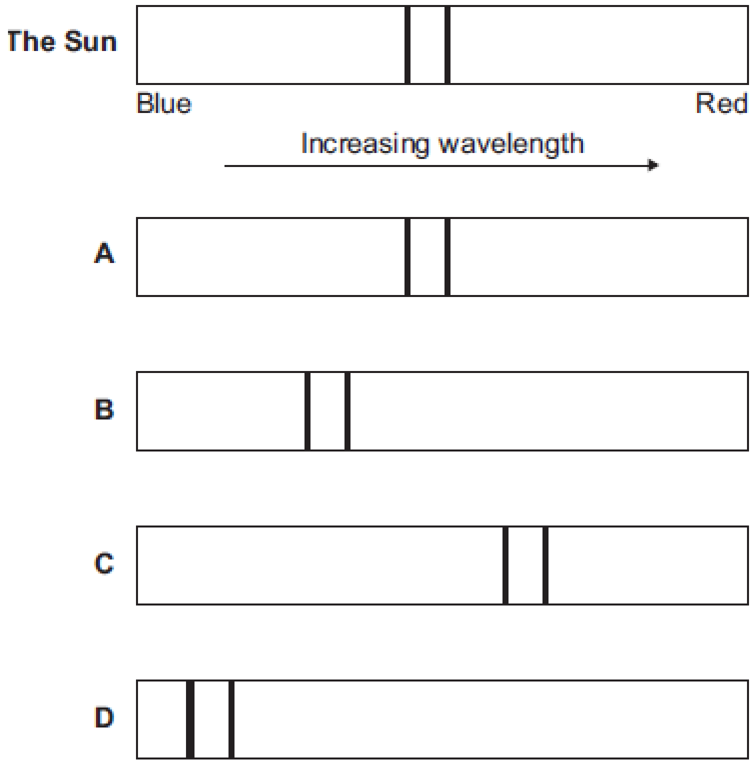
(Total 7 marks)

Q4.

Scientists can use the visible light spectrum from distant stars to determine whether the stars are moving.

The visible light spectrum from stars includes dark lines at specific wavelengths.

(a) The diagram shows the visible light spectrum from the Sun and from four other stars, **A**, **B**, **C** and **D**.



(i) Which star, **A**, **B**, **C** or **D**, is moving away from the Earth? ☐

(1)

(ii) How does the speed of star **B** compare with the speed of star **D**?

Tick (✓) **one** box.

	Tick (✓)
The speed of star **B** is greater than the speed of star **D**.	
The speed of star **B** is less than the speed of star **D**.	
The speed of star **B** is the same as the speed of star **D**.	

(1)

(b) A radio wave is emitted by a star.
The radio wave has a wavelength of 1500 m and a frequency of 200 000 Hz.

Calculate the speed of this radio wave.

Choose the correct unit from the list below.

m **m/s** **m/s^2**

____

____

____

Speed = ____________________ unit ______________

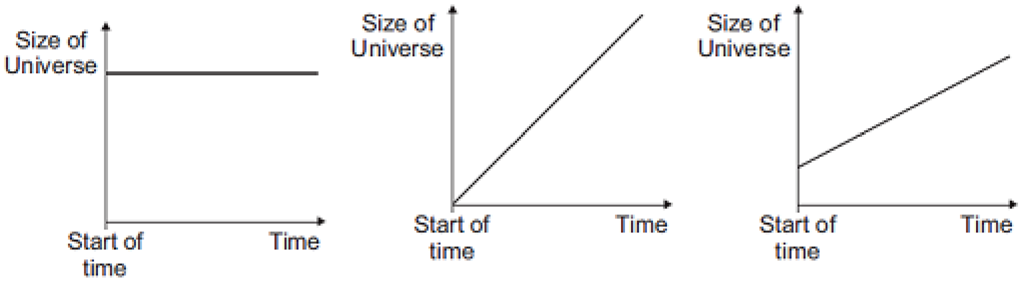
(3)

(Total 5 marks)

Q5.

The 'big bang' theory is one theory explaining the origin of the Universe.

(a) The graphs **X**, **Y** and **Z**, show how the size of the Universe may have changed with time.



Which graph would the 'big bang' theory suggest is correct?

Write your answer, **X**, **Y** or **Z**, in the box.

Explain the reason for your answer.

____

____

____

____

(3)

(b) In 1948, an alternative to the 'big bang' theory, called the 'steady state' theory, was developed.
The 'steady state' theory suggested that the Universe, although expanding, has always existed without a beginning in time.

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

The measurement of red-shift in the light from distant galaxies provides evidence

	only the 'big bang' theory.
to support	only the 'steady state' theory.
	both the 'big bang' and 'steady state' theories.

(1)

(ii) In 1965, scientists rejected the 'steady state' theory in favour of the 'big bang' theory.

Suggest what might cause scientists to stop supporting one theory and to start supporting an alternative theory.

___

___

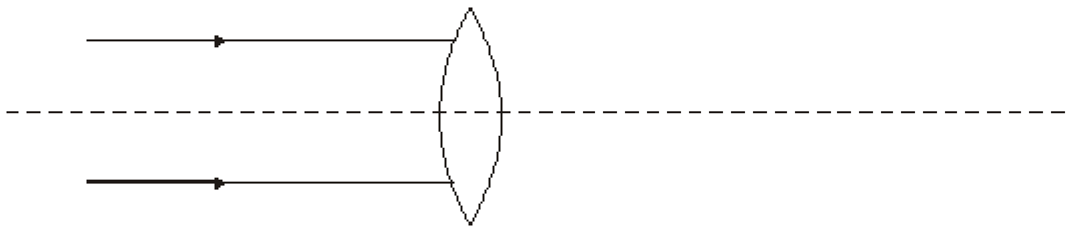
___

(1)
(Total 5 marks)

Q6.

(a) The diagram shows two parallel rays of light, a lens and its axis.

(i) Complete the diagram to show what happens to the rays.



(2)

(ii) Name the point where the rays come together.

___

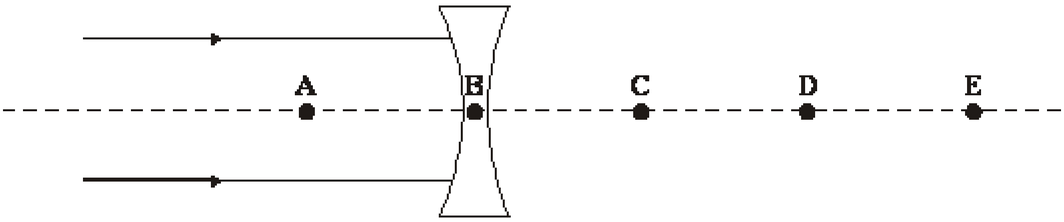
(1)

(iii) What word can be used to describe this type of lens?

___

(1)

(b) The diagram shows two parallel rays of light, a lens and its axis.



(i) Which point **A**, **B**, **C**, **D** or **E** shows the focal point for this diagram?

Point _________

(1)

(ii) Explain your answer to part (b)(i).

____

____

(1)

(iii) What word can be used to describe this type of lens?

____

(1)

(c) Complete the following **three** sentences by crossing out the **two** lines in each box which are wrong

In a camera a converging lens is used to produce an image on a

film
lens
screen

The image is

larger than
smaller than
the same size as

the object.

Compared to the distance of the image from the lens, the object is

further away from
nearer to
the same distance from

the lens.

(3)

(d) Explain the difference between a *real* image and a *virtual* image.

____

____

____

____

____

____

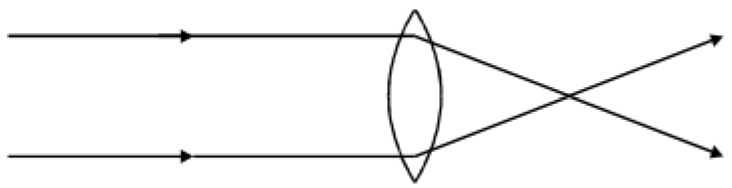
(3)

(Total 13 marks)

Q7.

(a) The diagram shows how parallel rays of light pass through a convex lens.

(i) Mark the position of the focus.



(1)

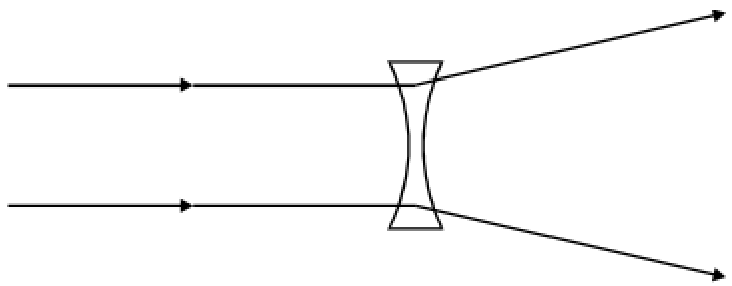
(ii) Is this a **converging** lens, a **diverging** lens, **both** or **neither**?

____

(1)

(b) The diagram shows how parallel rays of light pass through a concave lens.

(i) Mark the position of the focus.



(1)

(ii) Is this a **converging** lens, a **diverging** lens, **both** or **neither**?

____

(1)

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

In a camera, a

converging diverging parallel

lens is used to produce an image of an

object on a

film lens screen

.

The image is

larger than smaller than the same size as

the object.

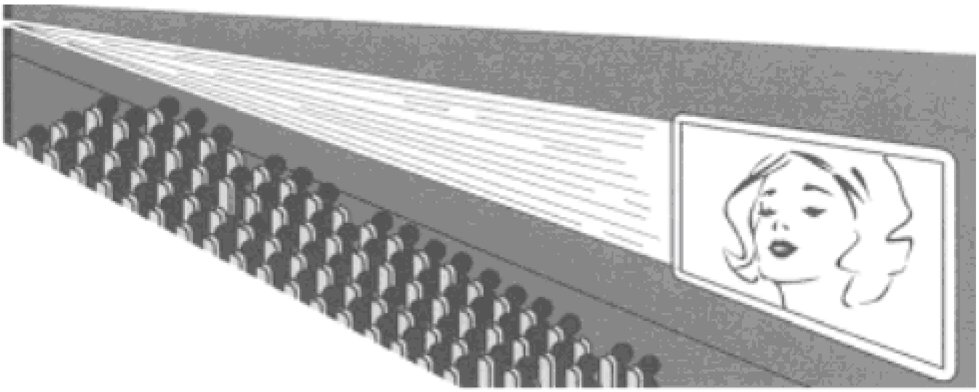
The image is

further from nearer to the same disrtance from

the lens, compared to the distance of the object from the lens.

(4)

(d) In a cinema projector, a convex lens is used to produce a *magnified*, *real* image.



(i) What does *magnified* mean?

____

____

(1)

(ii) What is a *real* image?

____

____

(1)

(e) You are in a dark room. You have a box containing some lenses. Only **one** of them is a converging lens.

Describe how, by just feeling the lenses, you can pick out the converging lens.

____

____

____

____

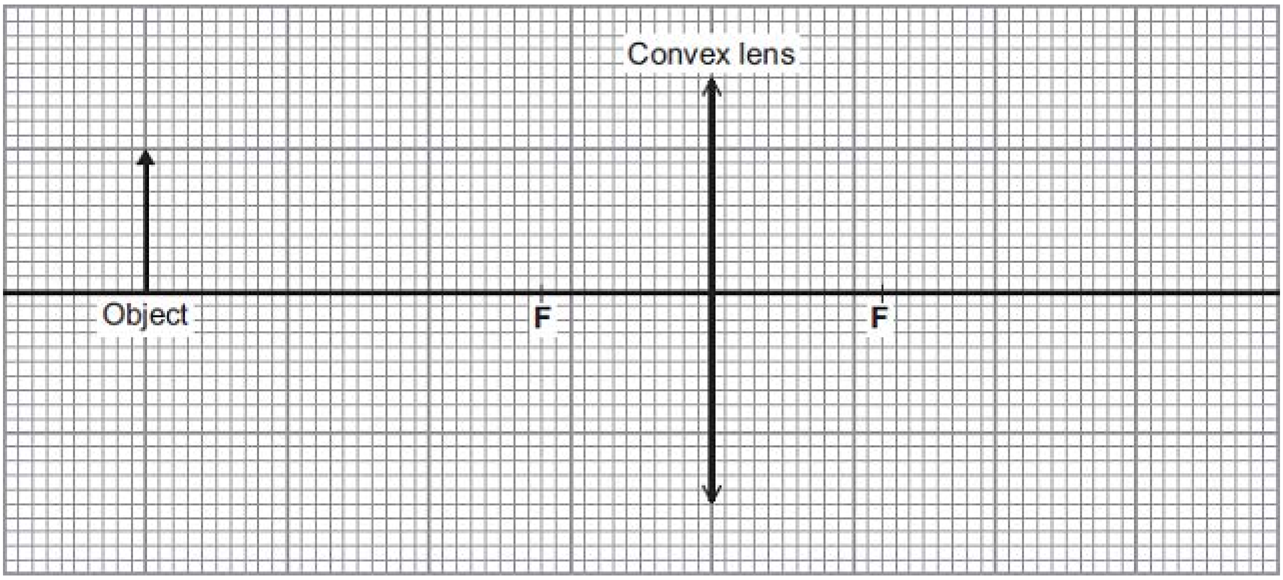
(2)

(Total 12 marks)

Q8.

(a) A camera was used to take a photograph. The camera contains a convex (converging) lens.

Complete the ray diagram to show how the lens produces an image of the object.



F = Principal focus

(4)

(b) State **two** words to describe the nature of the image produced by the lens in the camera.

1. ____

2. ____

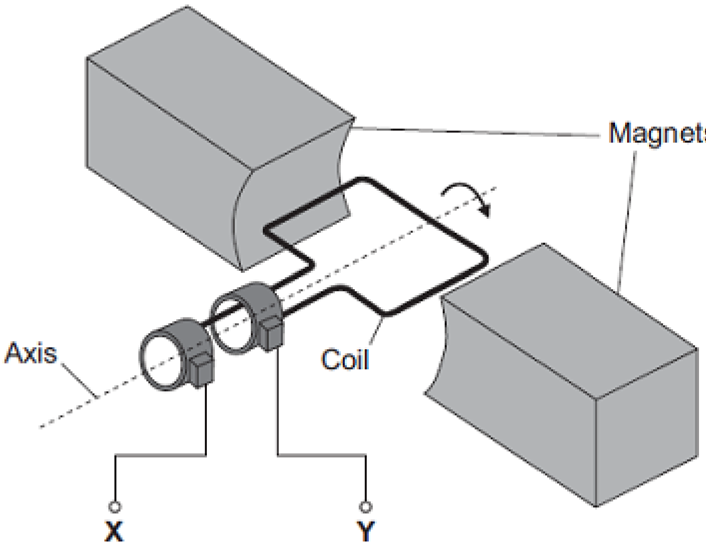
(2)

(Total 6 marks)

Q9.

The diagram shows an a.c. generator.

The coil rotates about the axis shown and cuts through the magnetic field produced by the magnets.



(a) (i) A potential difference is induced between **X** and **Y**.

Use the correct answer from the box to complete the sentence.

electric	**generator**	**motor**	**transformer**

This effect is called the ______________________________ effect.

(1)

(ii) What do the letters a.c. stand for?

____

(1)

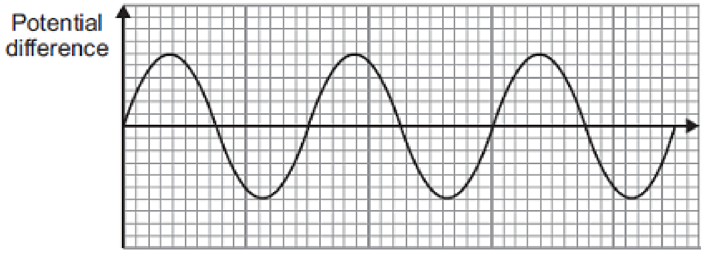
(iii) Name an instrument that could be used to measure the potential difference between **X** and **Y**.

____

(1)

(b) **Graph 1** shows the output from the a.c. generator.

Graph 1



(i) One of the axes on **Graph 1** has been labelled 'Potential difference'.

What should the other axis be labelled?

____

(1)

(ii) The direction of the magnetic field is reversed.

On **Graph 1**, draw the output from the a.c. generator if everything else remains the same.

(2)

(c) The number of turns of wire on the coil is increased. This increases the maximum induced potential difference.

State **two** other ways in which the maximum induced potential difference could be increased.

1. ____

2. ____

(2)
(Total 8 marks)

Q10.

A transformer is used to reduce the 230 V a.c. mains to the 12 V supply required for the lighting system. The transformer has 1150 turns on its primary coil.

Calculate the number of turns on the secondary coil of the transformer. Show clearly how you work out your answer.

____

____

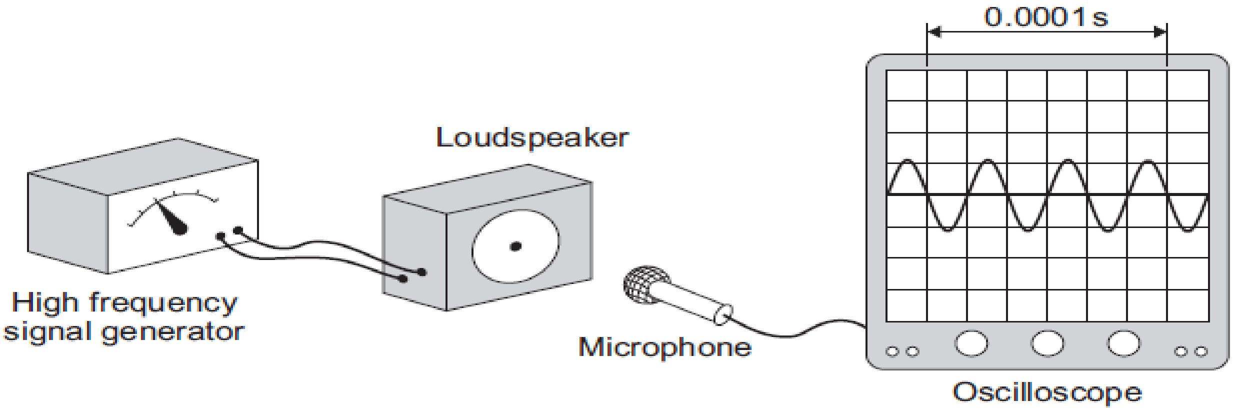
____

number of turns on the secondary coil = ______________

(2)
(Total 2 marks)

Q11.

(a) The diagram shows a microphone being used to detect the output from a loudspeaker.
The oscilloscope trace shows the wave pattern produced by the loudspeaker.



(i) How many waves are produced by the loudspeaker in 0.0001 seconds?

____

(1)

(ii) How many waves are produced by the loudspeaker every second?
Assume the input to the loudspeaker does not change.

____

____

(1)

(iii) A person with normal hearing cannot hear the sound produced by the loudspeaker. Explain why.

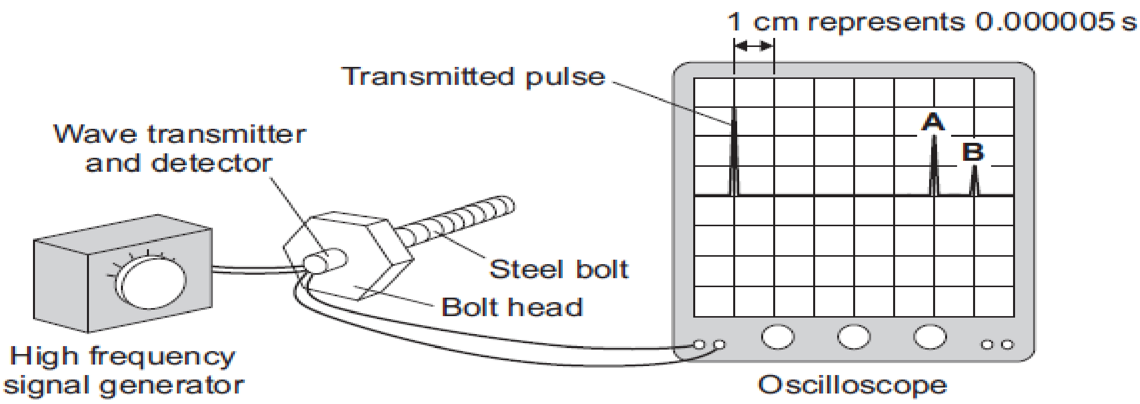
____

____

____

(2)

(b) The diagram shows how a very high frequency sound wave can be used to check for internal cracks in a large steel bolt. The oscilloscope trace shows that the bolt does have an internal crack.



(i) Explain what happens to produce pulse **A** and pulse **B**.

____

____

____

____

(2)

(ii) Use the information in the diagram and the equation in the box to calculate the distance from the head of the bolt to the internal crack.

distance = speed × time

Speed of sound through steel = 6000 m/s

Show clearly how you work out your answer.

____

____

____

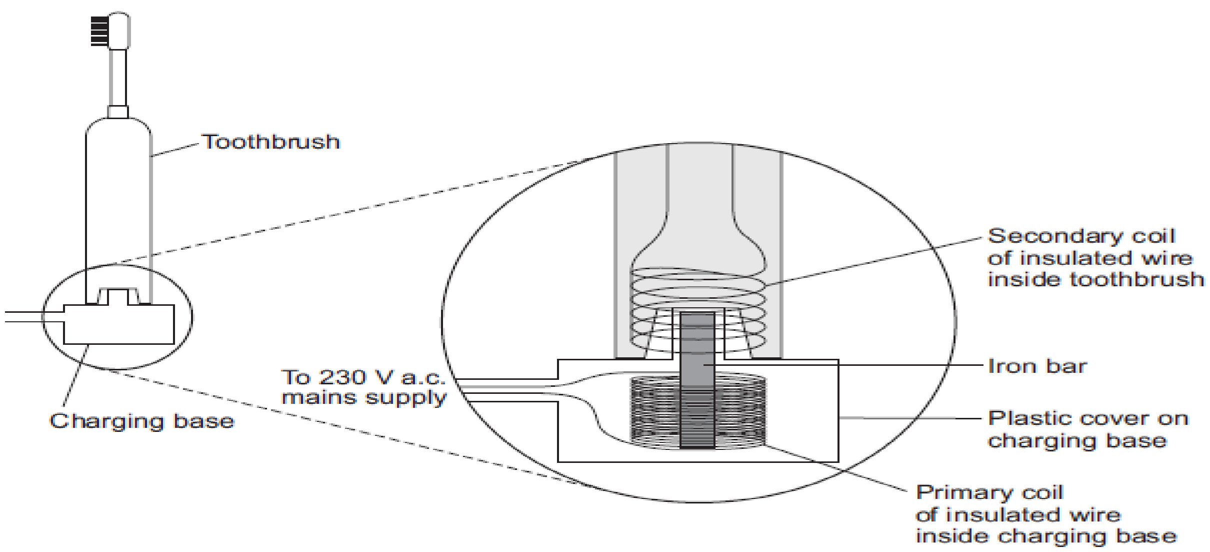
____

____

____

(3)
(Total 9 marks)

Q12. An electric toothbrush is charged by standing it on a separate charging base.
The diagram shows the inside of the electric toothbrush and the charging base.



(a) An alternating potential difference (p.d.) across the coil in the charging base creates an alternating current in the coil inside the toothbrush.

Explain how.

____

____

____

____

____

(3)

(b) When the toothbrush is being charged, the p.d. across the primary coil in the charging base is 230 V. The charging p.d. across the secondary coil in the toothbrush is 7.2 V. The primary coil in the charging base has 575 turns of wire on its coil. Calculate the number of turns on the secondary coil inside the toothbrush.

____

____

____

____

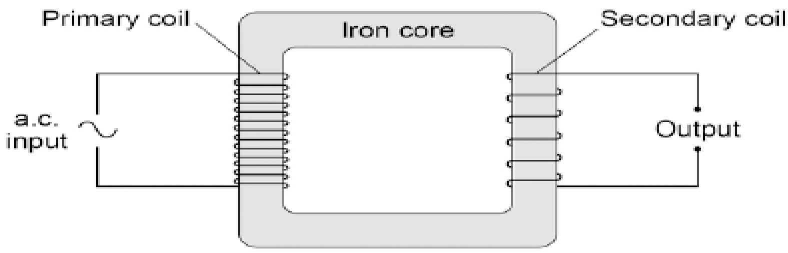
Number of turns on the secondary coil = ___________________

(2)

(Total 5 marks)

Q13. Figure 1 shows the construction of a simple transformer.

Figure 1



(a) Why is iron a suitable material for the core of a transformer?

Tick **one** box.

It is a metal. ☐

It will not get hot. ☐

It is easily magnetised. ☐

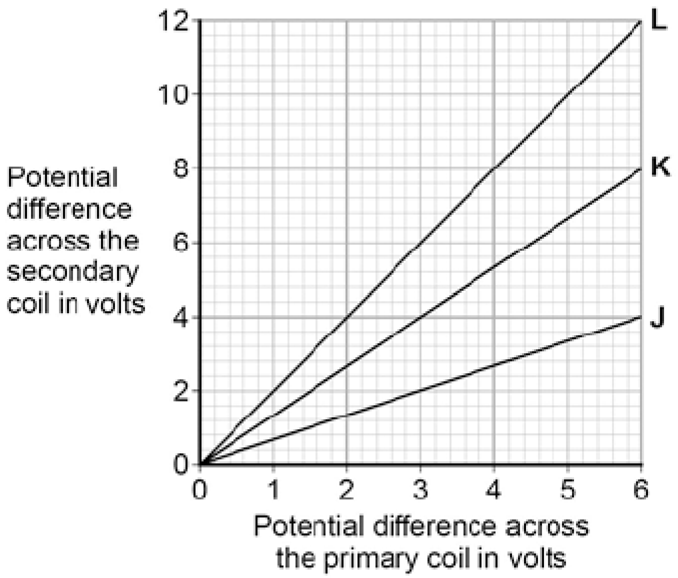
It is an electrical conductor. ☐

(1)

(b) A student makes three simple transformers, **J**, **K** and **L**.

Figure 2 shows how the potential difference across the secondary coil of each transformer varies as the potential difference across the primary coil of each transformer is changed.

Figure 2



How can you tell that transformer **J** is a step-down transformer?

____

____

(1)

(c) Each of the transformers has 50 turns on the primary coil.

Calculate the number of turns on the secondary coil of transformer **L**.

Use the correct equation from the Physics Equations Sheet.

____

____

____

Number of turns on the secondary coil = __________________

(3)

(Total 5 marks)

Q14.

(a) The 'Big Bang' theory uses red-shift as evidence to explain the beginning of the Universe.

How does the red-shift from distant galaxies provide evidence for the beginning of the Universe?

____

____

____

____

____

____

(3)

(b) Cosmic microwave background radiation (CMBR) is a type of electromagnetic radiation. CMBR fills the Universe. It was first discovered in 1965 by two astronomers called Penzias and Wilson.

(i) What do scientists believe is the origin of CMBR?

____

____

(1)

(ii) Why was the discovery of CMBR so important to the scientists believing the 'Big Bang' theory to be correct?

____

____

(1)

(iii) How is the wavelength of CMBR likely to change, if at all, over the next billion years?

____

Give a reason for your answer.

____

____

(2)

(Total 7 marks)

Q15. (a) Human ears can detect a range of sound frequencies.

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

2	**20**	**200**	**2000**	**20 000**

The range of human hearing is from about __________ Hz to __________ Hz.

(2)

(ii) What is ultrasound?

____

____

(1)

(iii) Ultrasound can be used to find the speed of blood flow in an artery. State **one** other medical use of ultrasound.

____

(1)

(b) The speed of an ultrasound wave in soft tissue in the human body is 1.5×10^3 m / s and the frequency of the wave is 2.0×10^6 Hz. Calculate the wavelength of the ultrasound wave.

____

____

Wavelength = ____________________ m

(2)

(c) When ultrasound is used to find the speed of blood flow in an artery:

- an ultrasound transducer is placed on a person's arm
- ultrasound is emitted by the transducer
- the ultrasound is reflected from blood cells moving **away** from the transducer
- the reflected ultrasound is detected at the transducer.

Describe the differences between the ultrasound waves emitted by the transducer and the reflected waves detected at the transducer.

____

____

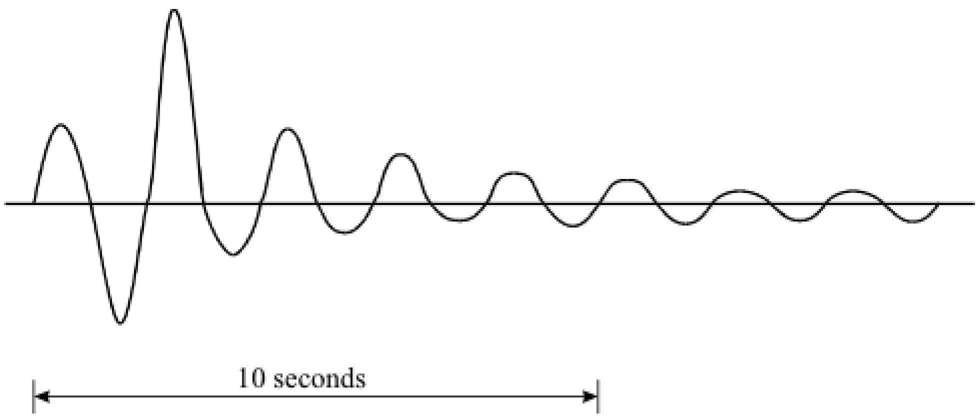
____

(2)

(Total 8 marks)

Q16.

The vibration caused by a P wave travelling at 7.6 km/s has been recorded on a seismic chart.



(i) How many waves are produced in one second?

____

(1)

(ii) Write down the equation which links frequency, wavelength and wave speed.

____

(1)

(iii) Calculate the wavelength of the P wave. Show clearly how you work out your answer and give the unit.

____

____

____

Wavelength = _________________

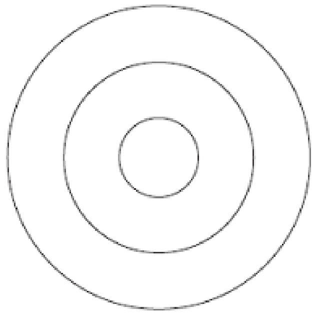
(2)

(Total 4 marks)

Q17. A teacher demonstrates the production of circular waves in a ripple tank.

Diagram 1 shows the waves at an instant in time.

Diagram 1



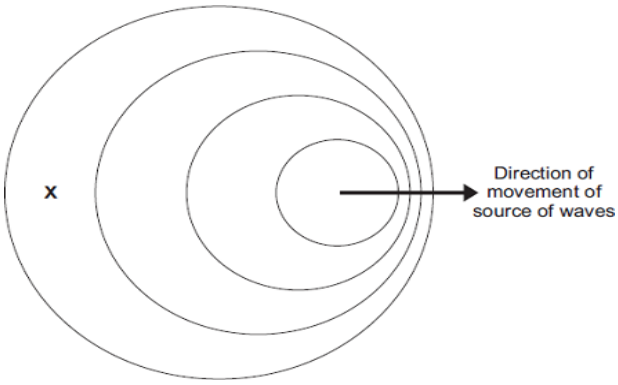
(a) Show on **Diagram 1** the wavelength of the waves.

(1)

(b) The teacher moves the source of the waves across the ripple tank.

Diagram 2 shows the waves at an instant in time.

Diagram 2
(Actual size)



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

decreased	increased	stayed the same

In **Diagram 2**, the observed wavelength of the waves at **X**

has ____ .

In **Diagram 2**, the frequency of the waves at **X**

has ____ .

(2)

(ii) Take measurements from **Diagram 2** to determine the wavelength of the waves received at **X**. Give the unit.

____

____

Wavelength = ____________________

(3)

(c) The teacher uses the waves in the ripple tank to model the changes in the wavelengths of light observed from distant galaxies. When observed from the Earth, there is an increase in the wavelength of light from distant galaxies.

(i) State the name of this effect.

____

(1)

(ii) What does this increase in wavelength tell us about the movement of most galaxies?

(1)

(iii) Explain how this observation supports the Big Bang theory of the formation of the Universe.

(4)

(iv) State **one** other piece of evidence that supports the Big Bang theory of the formation of the Universe.

(1)

(Total 13 marks)

Mark schemes

Q1.

(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]

Q2.

(a) make the rod longer 1

push down on the rod with a greater force 1

(b) particles are close together 1

so no room for more movement

dependent on 1st marking point 1

(c) (i) downward force produces pressure in liquid

reference to compression of liquid negates this mark 1

this pressure is the same at all points in a liquid

or

this pressure is transmitted equally through the liquid

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

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

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

[9]

Q3.

(a) Zero / 0

Accept none

Nothing is insufficent

1

velocity / speed = 0

accept it is not moving

paintball has not been fired is insufficient

1

(b) 0.27

*allow **1** mark for correct substitution, ie p = 0.003(0) × 90 provided no subsequent step*

2

(c) equal to

1

[5]

Q4.

(a) the forces are equal in size and act in opposite directions

1

(b) (i) forwards / to the right / in the direction of the 300 N force

answers in either order

1

accelerating

1

(ii) constant velocity to the right

1

(iii) resultant force is zero

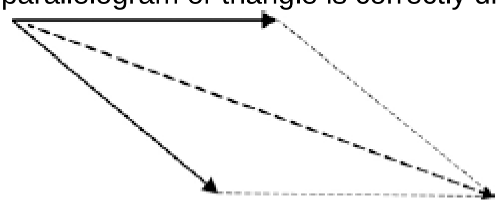
accept forces are equal / balanced

1

so boat continues in the same direction at the same speed

1

(iv) parallelogram or triangle is correctly drawn with resultant



3

value of resultant in the range 545 N – 595 N

*parallelogram drawn without resultant gains **1** mark*

If no triangle or parallelogram drawn:

*drawn resultant line is **between** the two 300 N forces gains **1** mark*

*drawn resultant line is between and longer than the two 300 N forces gains **2** marks*

1

[10]

Q5.

(a) 3000

correct substitution of 24 / 0.008 gains ***1*** *mark provided no subsequent steps are shown*

2

N / m^2 or Pa

1

(b) (i) K

accept ringed K in table

1

(ii) water exiting bottle one-third of vertical height of K

allow less than half vertical height of spout shown, judged by eye

1

water landing twice the distance of the spout shown in the diagram

accept at least one and a half times further out than spout shown, judged by eye

do ***not*** *accept water hitting the side of the sink*

ignore trajectory

1

(c) water will land on the (vertical) side of the sink

accept sink ***not*** *long / wide / big enough*

or

water will dribble down very close to the bottle

or

that part of the bottle is curved

do ***not*** *accept goes out of the sink*

1

[7]

Q6.

(a) (i) friction

accept any way of indicating the correct answer

1

(ii) gravity

accept any way of indicating the correct answer

1

(b) (i) accelerates **or** <u>speed</u> / velocity increases

accept faster <u>and</u> faster (1 mark)

do ***not*** *accept faster pace / falls faster or suggestions of a greater but constant speed*

1

downwards / falls

accept towards the Earth / ground

this may score in part (b)(ii) if it does not score here and there is no contradiction between the two parts

1

(ii) constant speed / velocity **or** terminal velocity / speed or zero acceleration

stays in the same place negates credit

1

[5]

Q7.

(a) 98

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

ie ½ × 0.16 × 35 × 35 provided no subsequent step shown

an answer of 98 000 scores 0

2

(b) (i) 9.6

*allow **1** mark for (change in velocity =) 60*

ignore negative sign

2

(ii) 9600

ignore negative sign

or

their (b)(i) ÷ 0.001 correctly calculated, unless (b) (i) equals 0

1

(c) increases the time

1

to reduce/change <u>momentum</u> (to zero)

only scores if 1st mark scored

decreases rate of change of momentum scores both marks provided there are no contradictions

accept decreased acceleration/deceleration

equations on their own are insufficient

1

[7]

Q8.

(a) (line of action of) its weight

1

falls inside its wheel base

accept 'falls between the wheels'

*the first **two** points may be credited by adding a vertical line from the centre of the X on the diagram (1)*
and labelling it weight / force / with a downwards arrow (1)
provided there is no contradiction between what is added to the diagram and anything which may be written

1

(so there is) no (resultant / clockwise) moment / turning effect

1

(b) centre of mass should be lower

accept '… centre of gravity'
accept 'weight / mass low down'
***not** just 'lower the roof'*

1

wheel base should be wider

accept 'long axle(s)' for 'wide wheel base'
allow bigger / larger wheel base
*do **not** credit '<u>long</u> wheel base'*

responses in either order

1

[5]

Q9.

(a) 96

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

ie 80 × 1.2

2

newton or N

allow Newton

*do **not** allow n*

1

(b) (i) direction

1

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

answers must refer to both variables

accept the variables are continuous / not categoric

accept the data / 'it' is continuous

accept the data / 'it' is not categoric

1

(iii) **C**

1

velocity is not changing

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

accept speed for velocity

accept speed is constant (9 m/s)

*accept **not** decelerating*

*accept **not** accelerating*

accept reached terminal velocity

1

forces must be balanced

accept forces are equal

accept arrows are the same length / size

or

resultant force is zero

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

1

[8]

Q10.

(a) potential

1

(b) (i) 13 200

*allow **1** mark for correct substitution, ie 660 × 20 provided no subsequent step shown*

2

(ii) 16.5

allow 1 mark for correct

or

$\frac{\text{their (b)(i)}}{800}$ correctly calculated

substitution, ie $\frac{13\,200}{800}$ ***or*** $\frac{\text{their (b)(i)}}{800}$

provided no subsequent step shown

2

[5]

Q11.

(a) (i) 24

*allow **1** mark for converting time to 600 seconds*

***or** showing method ie 14400/10*

or $\frac{14400}{10 \times 60}$

provided no further steps shown

2

(ii) 24

ignore any unit

or

their (a)(i)

1

(b) (i) 20 45

***both** required – either order*

1

(ii) the block transfers energy to the surroundings

1

[5]

Q12.

(a) 60

*allow **1** mark for correct substitution (with d in metres),*
ie 36 = F × 0.6

*an answer of 0.6 **or** 6 gains **1** mark*

2

(b) the line of action of the weight lies outside the base / bottom (of the bag)

accept line of action of the weight acts through the side

accept the weight (of the bag) acts outside the base / bottom (of the bag)

1

a resultant / overall / unbalanced moment acts (on the bag)

accept the bag is not in equilibrium

*do **not** accept the bag is unbalanced*

1

[4]

Q13.

(a) (i) momentum before = momentum after

accept no momentum is lost

accept no momentum is gained

or
(total) momentum stays the same

1

(ii) an external force acts (on the colliding objects)

accept colliding objects are not isolated

1

(b) (i) 9600

allow 1 mark for correct calculation of momentum before or after ie 12000 or 2400
or
correct substitution using change in velocity = 8 m/s
ie 1200 × 8

2

kg m/s
or
Ns

this may be given in words rather than symbols
*do **not** accept nS*

1

(ii) 3 or their (b)(i) 3200 correctly calculated

allow 1 mark for stating momentum before = momentum after

or

clear attempt to use conservation of momentum

2

[7]

Q14.

(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]

Q15.

(a) (i) turning

accept turning ringed in the box

1

(ii) point at which mass (or weight) may be thought to be concentrated

accept the point from which the weight appears to act

allow focused for concentrated

*do **not** accept most / some of the mass*

*do **not** accept region / area for point*

1

(b) 600 (Nm)

*400 × 1.5 gains **1** mark provided no subsequent steps shown*

2

(c) (i) plank rotates clockwise

accept girl moves downwards

*do **not** accept rotates to the right*

1

(total) CM > (total) ACM

accept moment is larger on the girl's side

1

weight of see-saw provides CM

answer must be in terms of moment

*maximum of **2** marks if there is no reference to the weight of the see-saw*

1

(ii) W = 445 (N)

*W × 1.5 = (270 × 0.25) + (300 × 2.0) gains **2** marks*

*allow for **1** mark:*

total CM = total ACM either stated or implied

or

(270 × 0.25) + (300 × 2.0)

if no other marks given

3

[10]

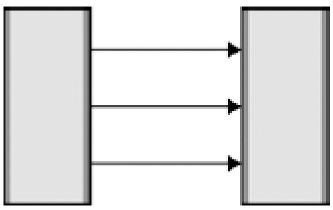
Mark schemes

Q1.

(a) (i) field pattern shows:
some straight lines in the gap

1

direction N to S



1

(ii) north poles repel

1

(so) box will not close

1

(b) (i) as paper increases (rapid) decrease in force needed

1

force levels off (after 50 sheets)

1

(ii) the newtonmeter will show the weight of the top magnet

1

(iii) (top) magnet and newtonmeter separate before magnets separate

accept reverse argument

1

(because) force between magnets is greater than force between magnet and hook of newtonmeter

1

(iv) any **three** from:

- means of reading value of force at instant the magnets are pulled apart
- increase the pulling force gently
  or
  use a mechanical device to apply the pulling force
- clamp the bottom magnet
- use smaller sheets of paper
- fewer sheets of papers between readings (smaller intervals)
- ensure magnets remain vertical
- ensure ends of magnet completely overlap
- repeat the procedure several times for each number of sheets and take a mean
- make sure all sheets of paper are the same thickness

3

(v) 3 (mm)

30 × 0.1 ecf gains ***2*** *marks*

2.1 N corresponds to 30 sheets gains ***1*** *mark*

3

[15]

Q2.

(a) the magnets are not touching

1

but (each) experiences a force

allow but there is a force of attraction between them

1

(b) place a (plotting) compass near the (north / south) pole of the magnet and mark the direction that the compass points

1

move the (plotting) compass around the bar magnet (to the other pole) marking at (regular) intervals the direction the compass points

1

join the points up and add an arrow pointing from the north pole to the south pole

1

(c) (closing switch S) causes a current in the coil

allow switches on the electromagnet

1

a magnetic field is created

1

a force of attraction acts on the ball bearing

1

so the ball bearing accelerates (towards the iron rod)

1

[9]

Q3.

(a) induced

1

(b) bar 2

1

(the same end) of bar 1 attracts both ends of bar 2

or

only two magnets can repel so cannot be bar 1 or bar 3

1

(c) so the results for each magnet can be compared

or

so there is only one independent variable

fair test is insufficient

allow different thickness of paper would affect number of sheets each magnet could hold

accept it is a control variable

1

(d) because the magnet with the biggest area was not the strongest

accept any correct reason that confirms the hypothesis is wrong eg smallest magnet holds more sheets than the largest

1

[5]

Q4.

(a) (i) increase

1

(ii) A and B
and
B and C

both required for the mark

either order

1

(iii) any **two** from:

- size of nail
  or
  nail material
  allow (same) nail
- current
  allow (same) cell
  allow p.d.
  same amount of electricity is insufficient
- (size of) paper clip
- length of wire
  accept type / thickness of wire

2

(b) 4

1

B picks up the same number as C, so this electromagnet would pick up the same number as A
or
direction of current does not affect the strength of the electromagnet

allow it has got the same number of turns as A

1

(c) 2

allow 1 or 3

1

[7]

Q5.

(a) move a (magnetic / plotting) compass around the wire

1

the changing direction of the compass needle shows a magnetic field has been produced

OR

sprinkle iron filings onto the card (1)

tapping the card will move the filings to show the magnetic field (pattern) (1)

1

(b) **Level 2 (3–4 marks):**
A detailed and coherent explanation is provided. The response makes logical links between clearly identified, relevant points that explain how the ignition circuit works.

Level 1 (1–2 marks):
Simple statements are made. The response may fail to make logical links between the points raised.

0 marks:
No relevant content.

Indicative content
- closing the (ignition) switch causes a current to pass through the electromagnet
- the iron core (of the electromagnet) becomes magnetised
- the electromagnet / iron core attracts the (short side of the) iron arm
- the iron arm pushes the (starter motor) contacts (inside the electromagnetic switch) together
- the starter motor circuit is complete
- a current flows through the starter motor (which then turns)

4

[6]

Q6.

(a) a force

1

(b) any **two** from:

- more powerful magnet
  *do **not** allow 'bigger magnet'*
- reduce the gap (between magnet and coil)
- increase the area of the coil
- more powerful cell
  *do **not** allow 'bigger cell'*
  accept battery for cell
  accept add a cell
  accept increase current / potential difference
- more turns (on the coil)
  allow 'more coils on the coil'
  *do **not** allow 'bigger coil'*

2

(c) reverse the (polarity) of the cell
allow 'turn the cell the other way round'
accept battery for cell

1

reverse the (polarity) of the magnet
allow 'turn the magnet the other way up'

1

[5]

Q7.

(a) north (pole)

accept N

north (pole)

both needed for mark

1

(b) reverses

accept changes direction

1

(c) (i) first finger:
(direction of) (magnetic) field

1

second finger:
(direction of) (conventional) current

1

(ii) into (plane of the) paper

1

(iii) less current in wire

accept less current / voltage / more resistance / thinner wire

1

weaker field

allow weaker magnets / magnets further apart

*do **not** accept smaller magnets*

1

rotation of magnets (so) field is no longer perpendicular to wire

1

(d) (i) reverse one of the magnets

*do **not** accept there are no numbers on the scale*

1

(ii) systematic or zero error

accept all current values will be too big

accept it does not return to zero
accept it does not start at zero

1

[10]

Q8.

(a) increase the current (1)

credit increase the p.d./voltage
credit reduce the resistance
credit have thicker wiring
credit add extra / more cells

1

increase the magnetic field (strength) (1)

credit 'have stronger magnet(s)
*do **not** credit 'bigger magnets' either order*

1

(b) **either** reverse polarity

or connect the battery the other way round

1

either reverse direction of the magnetic field

or put the magnet the other way round / reverse the magnet

*do **not** give any credit to a response in which both are done at the same time*

either order

1

(c) **either**

conductor parallel to the magnetic field

or lines of magnetic force and path of electricity do not cross

1

[5]

Q9.

(a) electric drill, electric fan, electric food mixer and electric screwdriver

all four ticked and no others (2)

***either** all four of these ticked and only one other (1)*

***or** any three of these ticked and none/one/two of the others (1)*

2

(b) (i) reverse (the direction of the) current (1)

***or** reverse the connections (to the battery)*

reverse (the direction of the) magnetic field (1)

***or** reverse the (magnetic) poles /ends*

*do **not** credit 'swap the magnets (around)'*

2

(ii) any **two** from:

- increase the strength of the magnet(s)/(magnetic) field

  *do **not** credit 'use a bigger magnet'*

- increase the current

  allow 'increase the voltage/p.d.'
  allow add cells/batteries
  allow increase the (electrical) energy
  allow increase the power supply
  allow 'decrease the resistance'
  allow 'increase charge'
  allow ' increase the electricity'

*do **not** credit 'use a bigger battery'*

- reduce the gap (between coil/armature and poles/magnets)
  allow increase the (number of) coils

- increase the turns (on the coil/armature)
  *do **not** credit 'use a bigger coil'*

2

[6]

Q10.

(a) field

correct order only

1

current

1

force

accept motion

accept thrust

1

(b) (i) arrow pointing vertically downwards

1

(ii) increase current / p.d.

accept voltage for p.d.

1

increase strength of magnetic field

accept move poles closer together

1

(iii) reverse (poles of) magnets

1

reverse battery / current

1

(c) (i) 1.5 or 150%

efficiency = 120 / 80 (× 100)

*gains **1** mark*

an answer of 1.5 % or 150

*gains **1** mark*

2

(ii) efficiency greater than 100%
or
output is greater than input
or
output should be 40 (W)

1

(iii) recorded time much shorter than actual time

accept timer started too late
accept timer stopped too soon

1

[12]

Q11.

(a) (i) (closing the switch makes) a current (through the wire)

1

(the current flowing) creates a magnetic field (around the wire)

1

this field interacts with the permanent magnetic field

accept links / crosses attracts / repels is insufficient

1

(ii) arrow drawn showing upwards force on XY

judge vertical by eye the arrow must be on or close to the wire XY

1

(iii) motor

accept catapult

1

(b) (i) the wire moves up and down
or
the wire vibrates

back and forth or side to side is insufficient for vibrate

1

(ii) the force (continually) changes direction (from upwards to downwards, on the wire)

accept the direction of the magnetic field (of the wire) changes

1

[7]

Q12.

(a) motor

1

(b) increase the strength of the magnetic field

accept use a stronger magnet
use a larger / bigger magnet is insufficient
*do **not** accept move magnets closer*

1

increase the (size of the) current

accept use a current greater than 2 (A)
accept increase the p.d. / voltage (of the power supply)
increase the power supply is insufficient

1

(c) any **one** from:

- (reverse the) direction of the current

  accept swap the wires at the power supply connections

  swap the wires around is insufficient
- (change the) direction of the magnetic field

  accept turn the magnet around

  *do **not** accept use an a.c. supply*

1

(d) The wire is parallel to the direction of the magnetic field.

1

[5]

Mark schemes

Q1.

(a) **K**

1

(b) **L** and **M**

1

(c) the oscillation should be perpendicular to the direction of the stretched spring

allow up and down

1

(d) timing less than five echoes

1

(e) 3 (.0)

1

(f) 750 (m)

1

(g) speed = $\frac{750}{3}$

*an answer of 250 (m/s) scores **2** marks*

2

speed = 250 (m/s)

allow ecf from parts (e) and (f)

1

(h) any **two** from:

- time more than 5 echoes
- students stand further from the building
- have 2 or more students (independently) measuring the time taken

use a stopwatch with a higher resolution is insufficient

2

[10]

Q2.

(a) **A**

1

(b) 2 (%)

1

(c) black

correct order only

1

reflects

1

transmits

1

(d) green

1

(e) without a darkened laboratory would not be able to see reflected light

allow would see all squares all of the time

1

(f) so same ‘amount’ of light is incident on each square

a fair test is insufficient

control variable is insufficient

1

(g) two bars drawn at the correct height

*allow **1** mark for 1 correct bar*

2

both bars correctly labelled

1

(h) orange

reason only scores if orange chosen

1

can be seen from the furthest away

allow it reflects the most light

1

(i) repeatable

1

[14]

Q3.

(a) sound

1

(b) (visible) light

1

(c) cooking food

1

(d) 1.2 gigahertz

1

(e) 300 000 × 1000 = 300 000 000 m/s

1

(f) wave speed = frequency × wavelength

allow $v = f\lambda$

1

(g) 300 000 000 = 1200 000 000 × λ

*an answer of 0.25 scores **3** marks*

1

$$\lambda = \frac{300\,000\,000}{1\,200\,000\,000}$$

*allow ecf from **(e)***

1

λ = 0.25 (m)

1

[10]

Q4.

(a) 20 000 Hz

1

(b) 400 (m)

*allow **1** mark for correct substitution ie 1600 × 0.25 provided no subsequent steps shown*

*an answer of 200 (m) gains **1** mark*

2

(c) twice

1

(d) From pulse 1 to pulse 3 the distance (to the sea floor) decreased

accept the sea got shallower

or

the submarine went deeper for the distance decreased

1

then (after pulse 3) the distance (to the sea floor) increased

accept the sea got deeper

or

the submarine rose for the distance increased

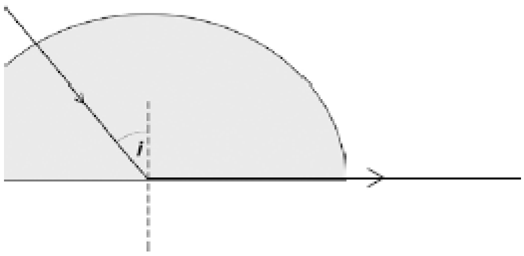
*An answer of the distance decreased then increased gains **1** mark*

1

[6]

Q5.

(a) (i) line drawn at 90 degrees to the normal:



ignore (partial) reflection of the ray

1

(ii) 1.5

award both marks for an answer that rounds to 1.5

*award **1** mark for correct substitution ie 1 / sin 41 **or** 1 / 0.656(059)*

2

(b) 26

*award **3** marks for an answer that rounds to 26*

*award **2** marks for*

$1.3 = \frac{0.57(3576)}{\sin r}$

or

$r = \sin^{-1}(0.57(3576) / 1.3)$

*award **1** mark for correct substitution.ie* $1.3 = \frac{\sin 35}{\sin r}$

or

sin 35° shown correctly, ie 0.57(3576), or used correctly in the calculation

an answer of 0.44 scores 2 marks

an answer of 26.9 scores 0

3

[6]

Q6.

(a) K

1

(b) Decreases

1

(c) use a metre rule / 30 cm ruler to measure across 10 (projected) waves

accept any practical number of waves number for 10

1

and then divide by 10

1

(d) 1.2 cm = 0.012 m

1

18.5 × 0.012 = 0.22(2) (m / s)

1

*allow 0.22(2) with no working shown for **2** marks*

typical walking speed = 1.5m / s

accept any value e.g. in the range 0.7 to 2.0 m / s

1

so the water waves are slower (than a typical walking speed)

this cannot score on its own

1

[8]

Q7.

(a) (i) microwave

1

(ii) refraction

1

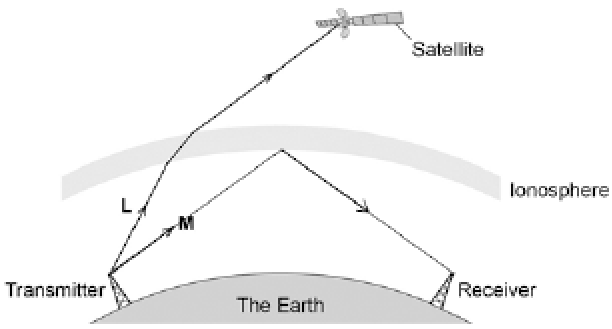
(b) (i) wave M continues as a straight line to the ionosphere and shown reflected

accept reflection at or within the ionosphere

1

correctly reflected wave shown as a straight line reaching the top of the receiver

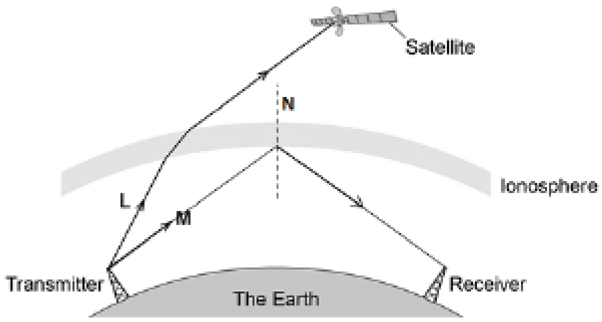
if more than 2 rays shown 1 mark maximum



ignore arrows

1

(ii) normal drawn at point where their **M** meets the ionosphere



1

(c) any **two** from:

- transverse
- same speed (through air)
  accept speed of light ***or*** *3 × 10^8 m / s*
- can be reflected
- can be refracted
- can be diffracted
- can be absorbed
- transfer energy
- can travel through a vacuum
  an answer travel at the same speed though a vacuum scores ***2*** *marks*
- can be polarised
- show interference.
  travel in straight lines is insufficient

2

[7]

Q8.

(a) ultrasound is not ionising
allow ultrasound does not harm the (unborn) baby

1

but X-rays are ionising

1

so X-rays increase the health risk to the (unborn) baby
accept specific examples of health risks, eg cancer, stunted growth, impaired brain function etc
X-rays are dangerous is insufficient

1

(b) ultrasound/waves are partially <u>reflected</u>

(when they meet a boundary) (between two different media / substances / tissues) *must be clear that not all of the wave is reflected*

1

the time taken is measured (and is used to determine distances)

1

(c) 1600 (m/s)

*800 (m/s) gains **2** marks*

*160 000 (m/s) gains **2** marks*

*0.0016 (m/s) gains **2** marks*

*allow **2** marks for*

$$\frac{0.04}{25 \times 10^{-6}}$$

or

$$\frac{0.08}{50 \times 10^{-6}}$$

*80 000 (m/s) gains **1** mark*

*0.0008 (m/s) gains **1** mark*

*allow **1** mark for*

$$\frac{0.04}{25}$$

or

$$\frac{0.08}{50}$$

*allow **1** mark for evidence of doubling the distance or halving the time*

3

(d) (i) they are absorbed by bone

allow stopped for absorbed

X-rays are reflected negates this mark

1

they are transmitted by soft tissue

allow pass through for transmitted

allow flesh / muscle / fat

accept less (optically) dense material for soft tissue

1

(the transmitted) X-rays are detected

1

(ii) short

accept small

1

[12]

Q9.

(a) frequency

1

(b) echo(es)

1

(c) 340 (m/s)

*allow **1** mark for correct substitution ie 25 000 × 0.0136 provided no subsequent step*

or

*allow **1** mark for a correct calculation showing an incorrect value from conversion to hertz × 0.0136*

*an answer of 0.34 gains **1** mark*

2

(d) (a wave where the) oscillations are parallel to the direction of energy transfer

both marking points may appear as labels on a diagram

accept vibrations for oscillations
accept in same direction as for parallel to
allow direction of wave (motion) for direction of energy transfer

*allow **1** mark for a correct calculation showing an incorrect value from conversion to hertz × 0.0136*

1

causing (areas of) compression and rarefaction

accept correct description in terms of particles

mechanical wave is insufficient
needs a medium to travel through is insufficient

1

[6]

Q10.

(a) electromagnetic

accept e.m.

1

(b) (i) 2.2 (arbitrary units)

allow an answer between 2.1 and 2.3

1

(ii) the thicker the tissue the lower the intensity

accept more intensity is needed to pass through thicker tissue

1

the relationship is not linear

accept the line is not straight

*allow for **1** mark*

it still goes through with thicker tissue

or

intensity does not reach zero

or

at 5 cm X rays still pass through

1

(iii) Both variables are continuous

1

(c) (they are) absorbed

accept (they are) stopped

1

(d) With a charge-coupled device (CCD).

1

(e) (i) X-rays are ionising

1

(ii) stand behind a (protective) screen

accept leave the room

accept wear a lead apron

1

[9]

Q11.

(a) **Level 3 (5–6 marks):**

A detailed and coherent plan covering all the major steps is provided. The steps in the method are logically ordered. The method would lead to the production of valid results.

A source of inaccuracy is provided.

Level 2 (3–4 marks):

The bulk of a method is described with mostly relevant detail. The method may not be in a completely logical sequence and may be missing some detail.

Level 1 (1–2 marks):

Simple statements are made. The response may lack a logical structure and would not lead to the production of valid results.

0 marks:

No relevant content.

Indicative content

place a glass block on a piece of paper

draw around the glass block and then remove from the paper

draw a line at 90° to one side of the block (the normal)

use a protractor to measure and then draw a line at an angle of 20° to the normal

replace the glass block

using a ray box and slit point the ray of light down the drawn line

mark the ray of light emerging from the block

remove the block and draw in the refracted ray

measure the angle of refraction with a protractor repeat the procedure for a range of values of the angle of incidence

possible source of inaccuracy

the width of the light ray

which makes it difficult to judge where the centre of the ray is

6

(b) velocity / speed of the light decreases

allow velocity / speed of the light changes

1

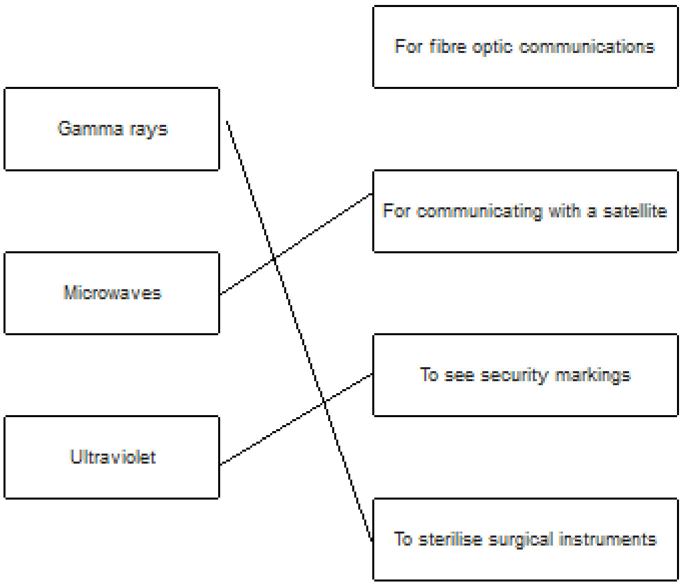
[7]

Q12.

(a) radio

1

(b)



*award **1** mark for each correct line*

if more than one line is drawn from any em wave then none of those lines gain credit

3

(c) ionising

1

[5]

Q13.

(a) magnification = $\frac{\text{image height}}{\text{object height}}$

1

dividing by an object height of 1 cm gives the same (numerical) value

1

(b) accept anything practical that would work eg:

use a taller object

use a (travelling) microscope

attach a scale to the screen and use a magnifying glass

1

(c) both points plotted correctly

1

correct line of best fit drawn

a curve passing through all points (within ½ square), judge by eye

1

(d) values of 1.4 and 0.6 extracted from the graph

1

2.33 times bigger

accept any number between 2.3 and 2.5 inclusive

1

(e) by dividing the distance between the lens and the image by the distance between the lens and the object

1

at least one correct calculation and comparison eg 100÷25 = 4 which is the same as the measured magnification

1

[9]

Mark schemes

Q1.

(a) dwarf planet

1

(b) nebula

correct order only

1

gravity

1

(c) (becomes a) red giant

1

(d) the greater the distance (from the Sun) the greater the time taken to orbit the Sun

1

(e) any value between 3 and 7 inclusive

1

(f) because some planets do not fit the pattern

1

named planet that does not fit pattern

eg Venus

1

reason why named planet does not fit pattern

its temperature is higher than expected

or

Uranus: its temperature is lower than expected

or

Neptune: its temperature is higher than expected

or

Mercury: its temperature is lower than expected

1

[9]

Q2.

(a) gas

correct order only

1

gravity

1

protostar

accept correct word circled in box provided no answer given in answer space

1

(b) the explosion of a massive star

1

(c) The telescopes and measuring instruments were not sensitive enough.

1

[5]

Q3.

(a) (i) (enough) dust and gas (from space) is pulled together

accept nebula for dust and gas

accept hydrogen for gas

accept gas on its own

dust on its own is insufficient

mention of air negates this mark

1

by:
gravitational attraction
or
gravitational forces

or
gravitaty

ignore any (correct) stages beyond this

1

(ii) joining of two (atomic) nuclei (to form a larger one)

do not accept atoms for nuclei

1

(iii) more sensitive astronomical instruments / telescopes
or
infrared telescopes developed

accept better technology

more knowledge is insufficient

1

(b) (i) (other) planets / solar systems

do not accept galaxy

moons is insufficient

1

(ii) provided evidence to support theory

accept proves the theory

1

(c) elements heavier than iron are formed only when a (massive) star explodes

accept materials for elements

accept supernova for star explodes

accept stars can only fuse elements up to (and including) iron

1

[7]

Q4.

(a) (i) C

1

(ii) The speed of star **B** is less than the speed of star **D**.

1

(b) 300 000 000

allow ***1*** *mark for correct substitution ie 200 000 × 1500 provided no subsequent step shown*

2

m / s

allow unit correctly indicated in list if not written in answer space

1

[5]

Q5.

(a) **Y**

accept cannot be ***X*** *as size is increasing*

1

shows Universe expanding

*this scores if **Y** or **Z** is chosen*

accept exploding outwards

1

from a (very small) point

*this only scores if **Y** is chosen*

accept from zero (size)

answers in terms of planets

negate the last two mark points

1

(b) (i) both the ‘big bang’ and ‘steady state’ theories

1

(ii) (new) evidence that supports / disproves a theory

accept proves for supports

or

(new) evidence not supported by current theory

accept there may be more evidence supporting one (theory) than the other (theory)

accept new evidence specific to this question eg measurement of CBR

or

some types of star only found in distant parts of Universe (steady state suggests should be same throughout Universe)

1

[5]

Q6.

(a) (i) rays continued to meet on the right hand side of the lens and beyond

must be straight lines from the right hand side of the lens
ignore details through the lens
allow if no arrows

1

meet exactly on the axis

negate mark if contradictory arrow(s) added
do not need to go beyond the focus for this mark

1

(ii) (principal) focus

or *focal (point)*

1

(iii) converging

or *convex*

1

(b) (i) **A**

1

(ii) rays seem to come from this point

__or__ words to this effect
__or__ shows this on the diagram

1

(iii) diverging

__or__ concave

1

(c) film

accept any unambiguous method of showing the correct response

1

smaller than

1

further away from

1

(d) any **three** from:

- real image can be put on a screen
  allow film
- virtual image cannot be put on a screen / film
- virtual image is imaginary
- real image is formed where (real) rays cross / converge
  allow real image has light travelling through it
- virtual image is where virtual / imaginary rays (seem to) come from
  __or__ virtual image is where rays seem to come from
- virtual image formed where virtual rays intersect / cross

3

[13]

Q7.

(a) (i) point where the rays cross

do not credit if ambiguous

1

(ii) converging (lens)

do __not__ accept convex

1

(b) (i) point where the rays appear to diverge from

this should appear to be within 10mm in front of the back of the arrows on the approximate centre line

need not be accurately constructed using a ruler

1

(ii) diverging (lens)

*do **not** accept concave*

1

(c) converging

1

film

1

smaller than

nearer to

accept any clear indication of the response e.g. ticking, ringing, writing in after a mistake

1

(d) (i) (image) bigger than object enlarge

accept just 'made bigger'

1

(ii) it / real image can be put on a screen **or** real image on the opposite side of the lens to the object

accept 'not an imaginary or virtual image'

assume 'it' refers to a real image

*do **not** credit 'it can be seen'*

1

(e) **either** (the converging lens is) thick in the middle thin(ner) at the edge

1

*thick<u>est</u> in the middle gains **2** marks*

1

or (both) sides bend outwards (1) in the middle (1)

*convex gains **2** marks*

*suitable diagrams gains **2** marks*

or one side bends in the middle (1) more than the other side bends inwards (in the middle) (1)

1

[12]

Q8.

(a) any **two** correct construction lines:

if more than 2 construction lines treat as a list

2

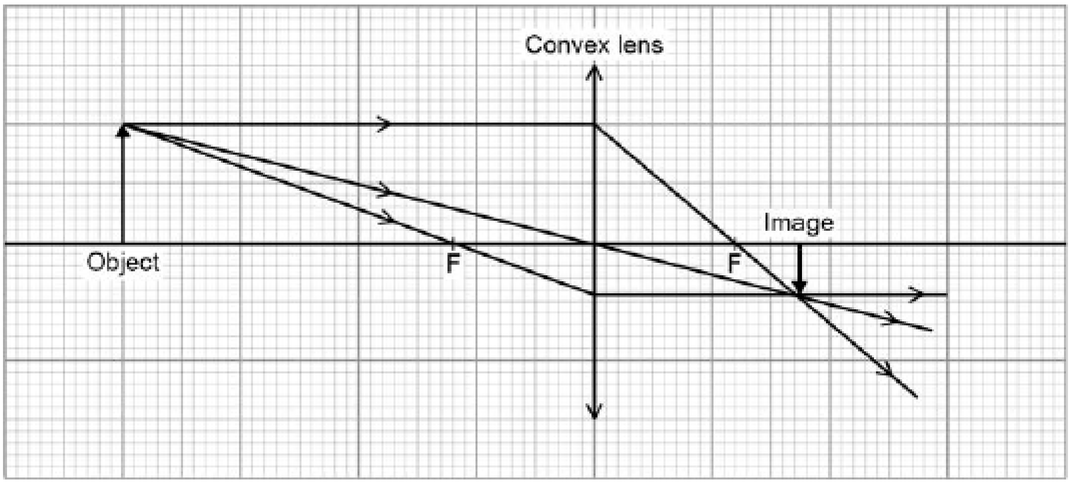
- line passing straight through centre of lens (& out other side)
- line travelling parallel to principal axis & then being refracted through principal focus (on RHS)
- line travelling through principal focus (on LHS) & then being refracted to be parallel to principal axis (on RHS)

<u>inverted</u> image drawn (with arrow) in correct location

1

one arrowhead from object to image on any construction ray

conflicting arrowheads negate this mark



1

(b) any **two** from:

- inverted
  accept upside down
- real
- diminished / smaller
  *allow ecf if ray diagram wrongly drawn but descriptions must relate to **their image***
  a converse negates mark, eg real and virtual scores zero

2

[6]

Q9.

(a) (i) generator

1

(ii) alternating current

1

(iii) voltmeter / CRO / oscilloscope / cathode ray oscilloscope

1

(b) (i) time

1

(ii) peaks and troughs in opposite directions

1

amplitude remains constant
dependent on first marking point

1

(c) any **two** from:

- increase speed of coil
- strengthen magnetic field
- increase area of coil

*do **not** accept larger*

2

[8]

Q10.

60

*allow **1** mark for correct transformation*

2

[2]

Q11.

(a) (i) 3

1

(ii) 30 000 **or** 10 000 × their (a)(i) correctly calculated

1

(iii) any **two** from:

- frequency is above 20 000 (Hz)
  accept the frequency is 30 000
- frequency is above the upper limit of audible range
- upper limit of audible range equals <u>20 000</u> (Hz)
  ignore reference to lower limit
- it is ultrasound/ultrasonic

2

(b) (i) wave (partially) <u>reflected</u>

1

at crack to produce **A** and end of bolt to produce **B**

accept at both ends of the crack

1

(ii) 0.075 (m) allow **2** marks for time = 0.0000125

*allow **1** mark for time = 0.000025*

*answers 0.15 **or** 0.015 **or** 0.09 gain **2** marks*

*answers 0.18 **or** 0.03 gain **1** mark*

the unit is not required but if given must be consistent with numerical answer for the available marks

3

[9]

Q12.

(a) an alternating current through the primary coil (in the charging base)

it must be clear which coil is being referred to

1

causes a changing / alternating magnetic field in / around the (iron) bar 1

which <u>induces</u> an (alternating) p.d. across the secondary coil (in the toothbrush)

accept induces an (alternating) current in the secondary coil 1

(b) 18

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

$$\frac{230}{7.2} = \frac{575}{n_s}$$

2

[5]

Q13.

(a) It is easily magnetised. 1

(b) p.d. across the secondary coil is smaller (than p.d. across the primary coil) 1

(c) ratio $\frac{V_p}{V_s} = \frac{6}{12}$

accept any other correct ratio taken from the graph 1

$\frac{6}{12} = \frac{50}{N_p}$

use of the correct turns ratio and substitution or correct transformation and substitution 1

$N_p = 100$

*allow 100 with no working shown for **3** marks* 1

[5]

Q14.

(a) any **three** from:

- red-shift shows galaxies are moving away (from each other / the Earth)
- more distant galaxies show bigger red-shift

  or

  more distant galaxies show a greater increase in wavelength

  accept correct reference to frequency in place of wavelength
- (in all directions) more distant galaxies are moving away faster

  accept (suggests) universe is expanding

• suggests single point of origin (of the universe)

3

(b) (i) (radiation produced shortly after) 'Big Bang'

accept beginning of time / beginning of the universe for 'Big Bang'

1

(ii) any **one** from:

- can only be explained by 'Big Bang'
- existence predicted by 'Big Bang'
- provides (further) evidence for 'Big Bang'

ignore proves 'Big Bang' (theory)

ignore reference to red-shift

1

(iii) increase

accept becomes radio waves

1

universe continues to accelerate outwards

accept as universe continues to expand

or

greater red-shift

1

[7]

Q15.

(a) (i) 20

1

20 000

either order

accept ringed answers in box

1

(ii) (frequency) above human range

accept pitch for frequency

or

(frequency) above 20 000 (Hz)

*do **not** accept outside human range*

*allow ecf from incorrect value in **(a)(i)***

1

(iii) any **one** from:

- pre-natal scanning

accept any other appropriate scanning use *do **not** accept pregnancy testing*

- removal / destruction of kidney / gall stones
- repair of damaged tissue / muscle

accept examples of repair, eg alleviating bruising, repair scar damage, ligament / tendon damage, joint inflammation

accept physiotherapy

accept curing prostate cancer or killing prostate cancer cells

- removing plaque from teeth

cleaning teeth is insufficient

1

(b) 7.5×10^{-4} (m)

*$1.5 \times 10^{3} = 2.0 \times 10^{6} \times \lambda$ gains **1** mark*

2

(c) for reflected waves

must be clear whether referring to emitted or detected / reflected waves

if not specified assume it refers to reflected wave

any **two** from:

- frequency decreased
- wavelength increased
- intensity has decreased

allow amplitude / energy has decreased
allow the beam is weaker

2

[8]

Q16.

(i) 0.5

1

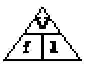
(ii) wave speed = frequency × wavelength

accept $v = f \times \lambda$

accept s for v

accept m/s = Hz × m

accept



providing subsequent method correct

1

(iii) 15.2 km

both numerical answer and unit are required for both marks

numerical answer and unit must be consistent

*allow **1** mark for 15.2 with incorrect or no unit*

*allow **2** marks for an answer of 1.52 km if the answer to (b)(i) was given as 5*

***r** 1 mark for correct transformation*

***or** 1 mark for correct use of speed = distance/time* *unit on its own gains no credit*

2

[4]

Q17.

(a) wavelength correctly shown

1

(b) (i) increased

1

decreased

1

(ii) 17-18 inclusive

1

evidence of measurement divided by 3 or mean of 3 separate measurements

1

mm

accept cm if consistent with answer

1

(c) (i) red shift

1

(ii) moving away

1

(iii) the furthest galaxies show the biggest red shift

1

(meaning that) the furthest galaxies are moving fastest

1

(so the) Universe is expanding

1

(extrapolating backwards this suggests that) the Universe started from an initial point

1

(iv) cosmic microwave background radiation

allow CMBR

1

[13]