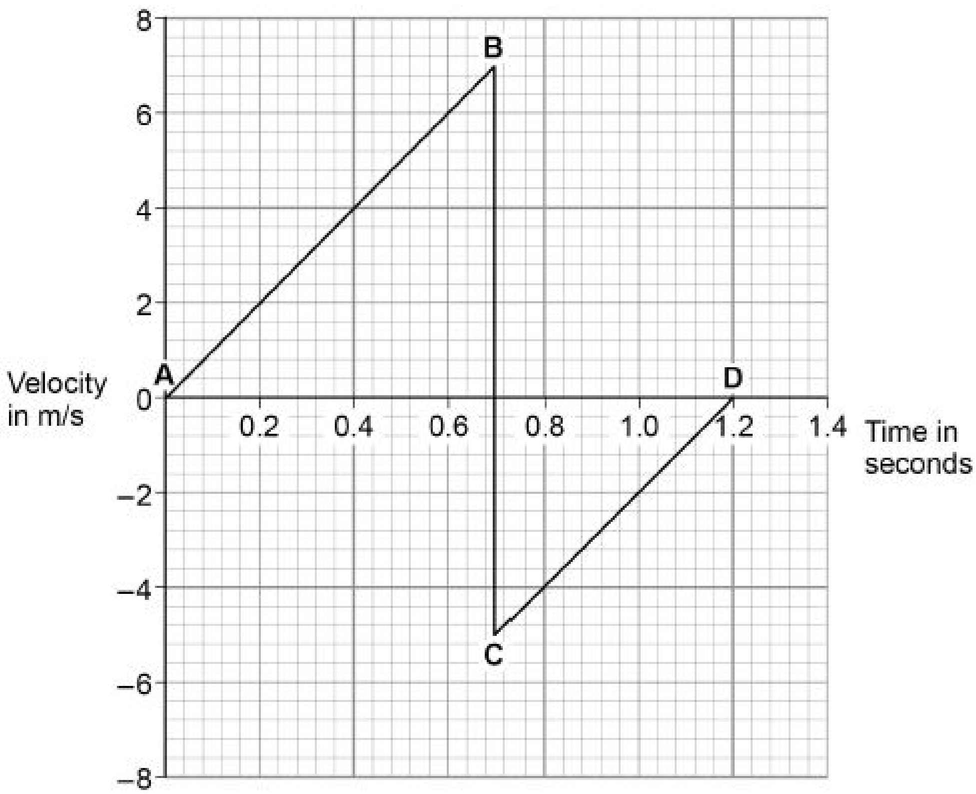
1. A child drops a ball.

The ball hits the ground and bounces.

The graph below shows the velocity-time graph for the ball from when the ball is dropped until when the ball reaches the top of its first bounce.

Air resistance has been ignored.



(a) Describe the motion of the ball between points **A** and **B** on the graph above.

____

____

____

____

(2)

(b) What direction is the ball moving between points **C** and **D** on the graph above?

____

(1)

(c) The ball and the Earth form a system.

What is meant by 'a system'?

Tick **one** box.

A group of objects that interact.	☐
Objects with big differences in mass.	☐
Objects with gravitational potential energy.	☐

(1)

(d) When the ball hits the ground, energy is transferred from the ball to the Earth.

Explain how the data in the graph above shows this energy transfer.

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(4)

(Total 8 marks)

2. (a) The light from distant galaxies shows red-shift.

Complete the sentence.

The term red-shift describes the observed increase

in the ________________________________ of the light from a distant galaxy.

(1)

(b) The Big Bang theory is one model used to explain the origin of the universe.

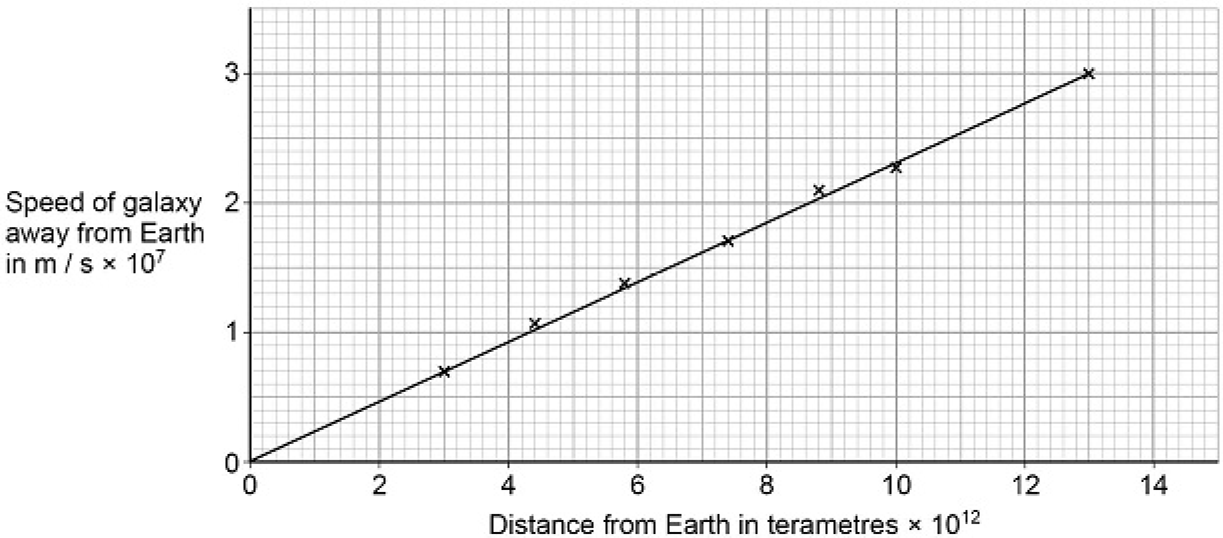
How does the Big Bang theory describe the universe when it began?

____

____

(1)

The figure below shows data scientists have calculated from measurements of red-shift.



(c) Describe the relationship between the speed of a galaxy and the distance the galaxy is from the Earth.

____

____

(1)

(d) Which of the following is the same as 6×10^{12} terametres?

Tick (✓) **one** box.

6×10^{15} m ☐

6×10^{18} m ☐

6×10^{21} m ☐

6×10^{24} m ☐

(1)

(e) Explain how the data in the figure above supports the suggestion that the universe began from a very small region.

___

___

___

___

___

(2)

(f) The Big Bang theory suggested that gravity would slow the rate at which galaxies move away from the Earth.

New observations suggest that distant galaxies are moving away from the Earth at an increasingly fast rate.

What do the new observations suggest is happening to the universe?

___

___

(1)

(g) New observations and data that do not fit existing theories should undergo peer review.

Give **one** reason why peer review is an important process.

___

___

___

(1)

(h) The Andromeda galaxy is moving towards the Earth.

Describe how the wavelength and frequency of the light from Andromeda seem to have changed when viewed from the Earth.

___

___

___

___

(2)

(Total 10 marks)

3. P-waves and S-waves are two types of seismic wave caused by earthquakes.

(a) Which **one** of the statements about P-waves and S-waves is correct?

Tick **one** box.

P-waves and S-waves are transverse. ☐

P-waves and S-waves are longitudinal. ☐

P-waves are transverse and S-waves are longitudinal. ☐

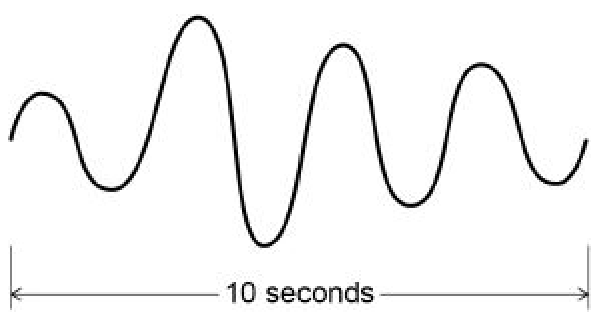
P-waves are longitudinal and S-waves are transverse. ☐

(1)

Seismometers on the Earth's surface record the vibrations caused by seismic waves.

Figure 1 shows the vibration recorded by a seismometer for one P-wave.

Figure 1



(b) Calculate the frequency of the P-wave shown in **Figure 1**.

____

____

Frequency = ____________________ Hz

(1)

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

____

(1)

(d) The P-wave shown in **Figure 1** is travelling at 7200 m/s.

Calculate the wavelength of the P-wave.

____

____

____

____

Wavelength = ______________________ m

(3)

(e) Explain why the study of seismic waves provides evidence for the structure of the Earth's core.

____

____

____

____

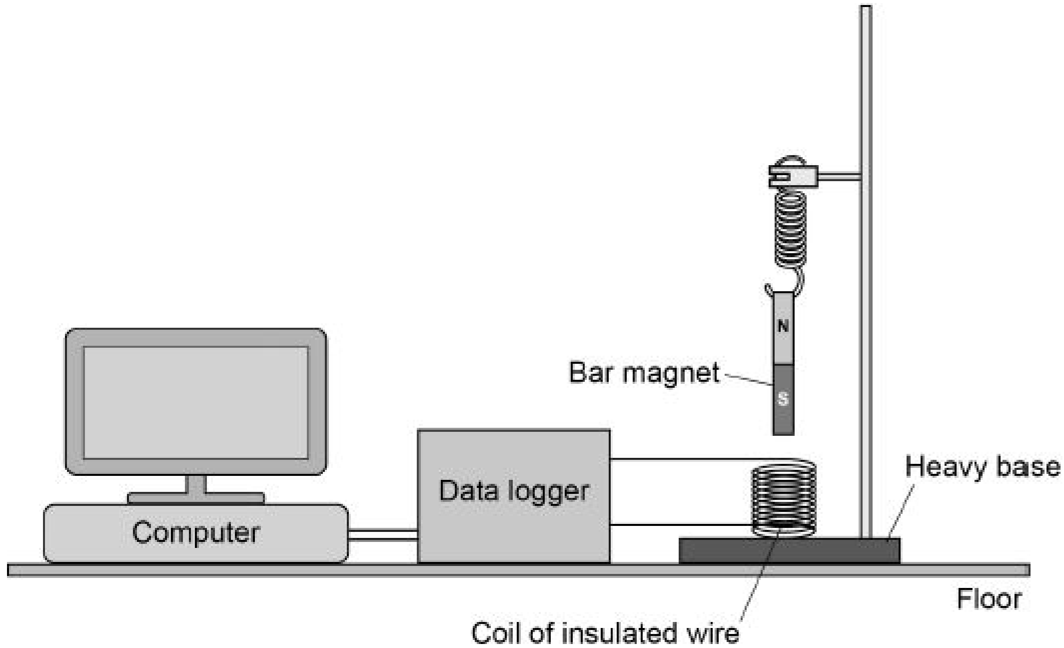
____

____

(2)

Figure 2 shows a simple seismometer made by a student.

Figure 2



To test that the seismometer works, the student pushes the bar magnet into the coil and then releases the bar magnet.

(f) Why does the movement of the bar magnet induce a potential difference across the coil?

____

____

(1)

(g) Why is the induced potential difference across the coil alternating?

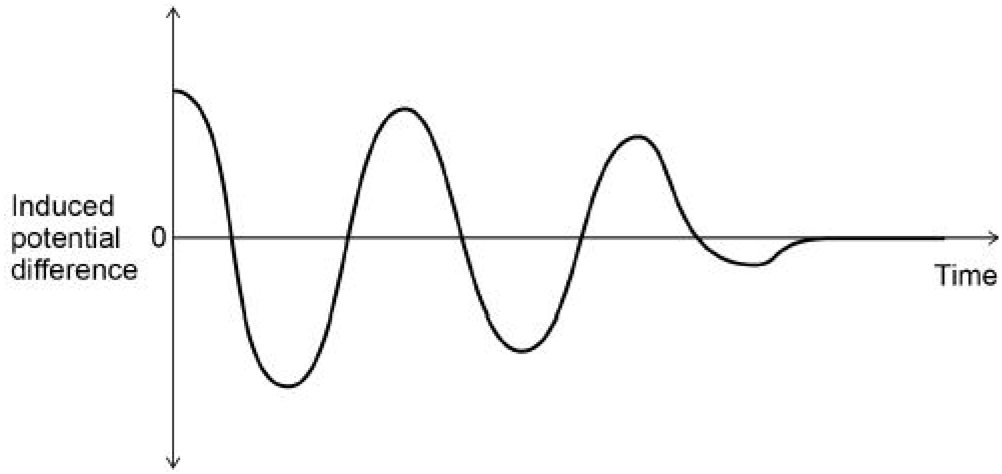
____

____

(1)

(h) **Figure 3** shows how the potential difference induced across the coil varies after the bar magnet has been released.

Figure 3



Which statement describes the movement of the magnet when the induced potential difference is zero?

Tick **one** box.

Accelerating upwards. ☐

Constant speed upwards. ☐

Decelerating downwards. ☐

Stationary. ☐

(1)

(i) The seismometer cannot detect small vibrations.

Suggest **two** changes to the design of the seismometer that would make it more sensitive to small vibrations.

1. ____

____

2. ____

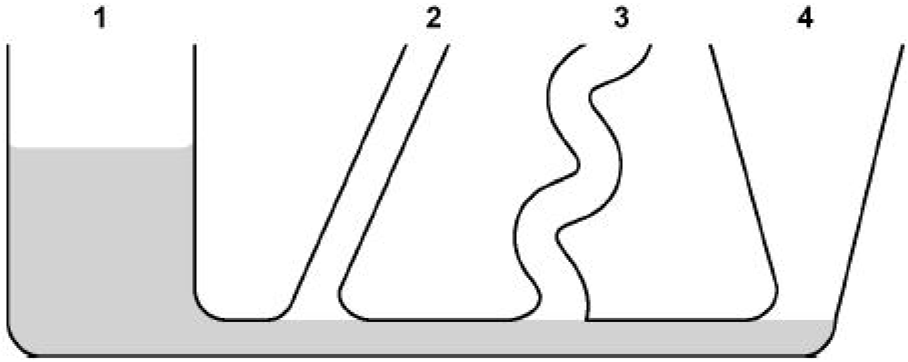
____

(2)

(Total 13 marks)

4. The diagram below shows an unusually shaped container.

The container has four vertical tubes of different shape and size.



Water is poured into the container up to the level shown in tube **1**.

(a) Complete the diagram above to show the height of the water in tubes **2**, **3** and **4**.

(1)

(b) The further a swimmer dives below the surface of the sea, the greater the pressure on the swimmer.

Explain why.

___

___

___

___

(2)

(c) A person swims from a depth of 0.50 m to a depth of 1.70 m below the surface of the sea.

density of the sea water = 1030 kg/m^3

gravitational field strength = 9.8 N/kg

Calculate the increase in pressure on the swimmer.

Give the unit.

Use an equation from the Physics Equation Sheet.

____

____

____

____

Increase in pressure = ______________________ Unit _____________

(4)

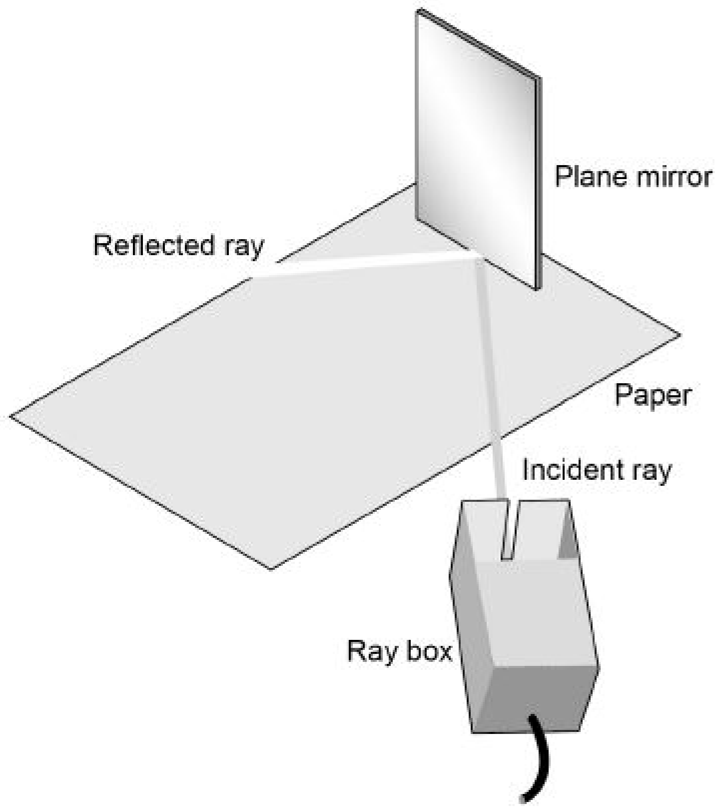
(Total 7 marks)

5. The diagram below shows the apparatus a student used to investigate the reflection of light by a plane mirror.

The student drew four ray diagrams for each angle of incidence.

The student measured the angle of reflection from each diagram.

The table below gives the student's results.



	Angle of reflection			
Angle of incidence	**Test 1**	**Test 2**	**Test 3**	**Test 4**
20°	19°	22°	20°	19°
30°	31°	28°	32°	30°
40°	42°	40°	43°	41°
50°	56°	49°	53°	46°

(a) For each angle of incidence, the angle of reflection has a range of values.

This is caused by an error.

What type of error will have caused each angle of reflection to have a range of values?

____

(1)

(b) Suggest what the student may have done during the investigation to cause each angle of reflection to have a range of values.

____

____

(1)

(c) Estimate the uncertainty in the angle of reflection when the angle of incidence is 50°.

Show how you determine your estimate.

____

____

____

____

Uncertainty = ± ____________________ °

(2)

(d) The student concluded that for a plane mirror, the angle of incidence is equal to the angle of reflection.

Explain whether you agree with this conclusion.

Use examples from the results in the table below in your answer.

____

____

____

____

(2)

(e) What extra evidence could be collected to support the student's conclusion?

____

____

(1)

(f) State **one** change the student should make to the apparatus if he wants to use the same method to investigate diffuse reflection.

____

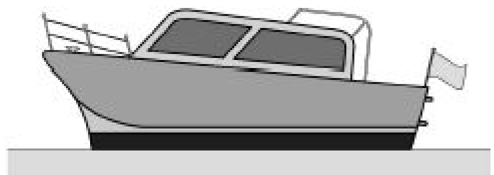
____

(1)

(Total 8 marks)

6. **Figure 1** shows a boat floating on the sea. The boat is stationary.

Figure 1



(a) **Figure 2** shows part of the free body diagram for the boat.

Complete the free body diagram for the boat.

Figure 2

(2)

(b) Calculate the mass of the boat.

Use the information given in **Figure 2**.

gravitational field strength = 9.8 N/kg

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

____

____

____

____

Mass = ______________________ kg

(4)

(c) When the boat propeller pushes water backwards, the boat moves forwards.
The force on the water causes an equal and opposite force to act on the boat.

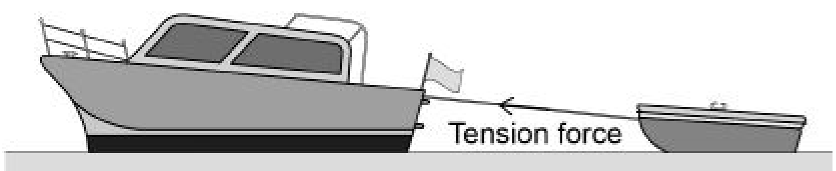
Which law is this an example of?

____

(1)

(d) **Figure 3** shows the boat towing a small dinghy.

Figure 3



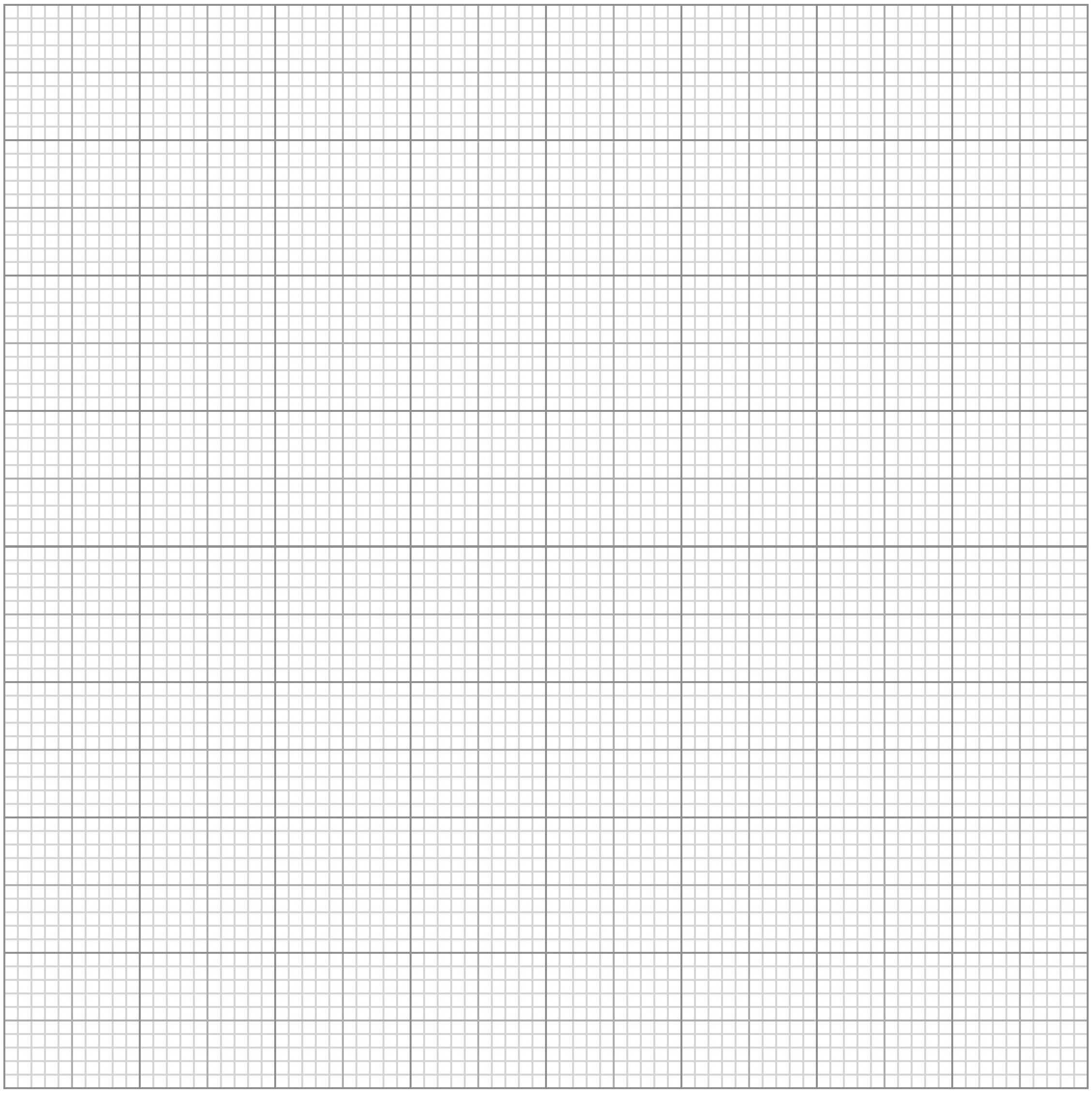
The tension force in the tow rope causes a horizontal force forwards and a vertical force upwards on the dinghy.

horizontal force forwards = 150 N
vertical force upwards = 50 N

Figure 4 shows a grid.

Draw a vector diagram to determine the magnitude of the tension force in the tow rope and the direction of the force this causes on the dinghy.

Figure 4



Magnitude of the tension force in the tow rope = ______________________ N

Direction of the force on the dinghy caused by the tension force in the tow rope = ________________________

(4)

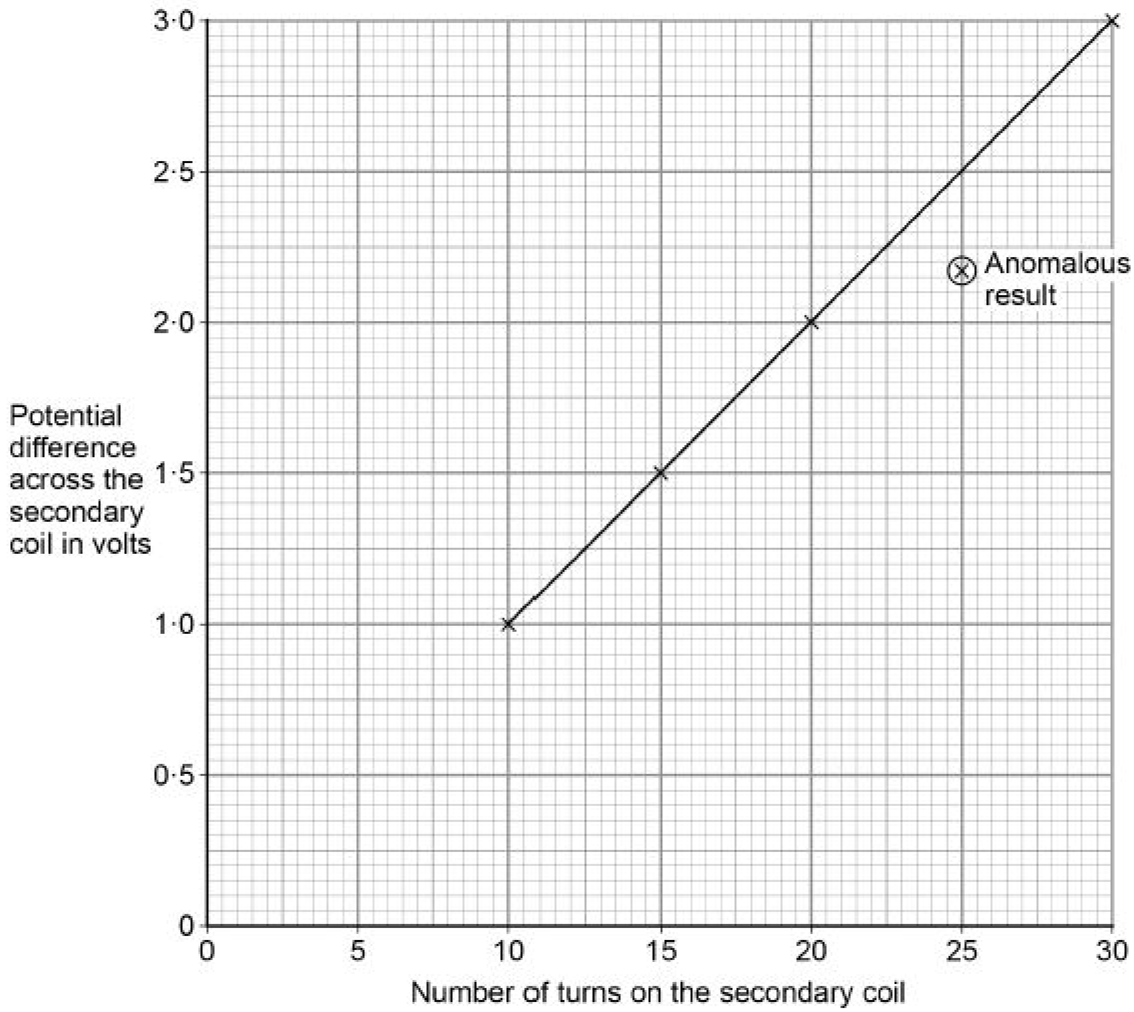
(Total 11 marks)

7. A student used a simple transformer to investigate how the number of turns on the secondary coil affects the potential difference (p.d.) across the secondary coil.

The student kept the p.d. across the primary coil fixed at 2V.

Figure 1 shows the results collected by the student.

Figure 1



(a) **Figure 1** contains one anomalous result.

Suggest **one** possible reason why this anomalous result occurred.

____

____

(1)

(b) The transformer changes from being a step-down to a step-up transformer.

How can you tell from **Figure 1** that this happens?

___

___

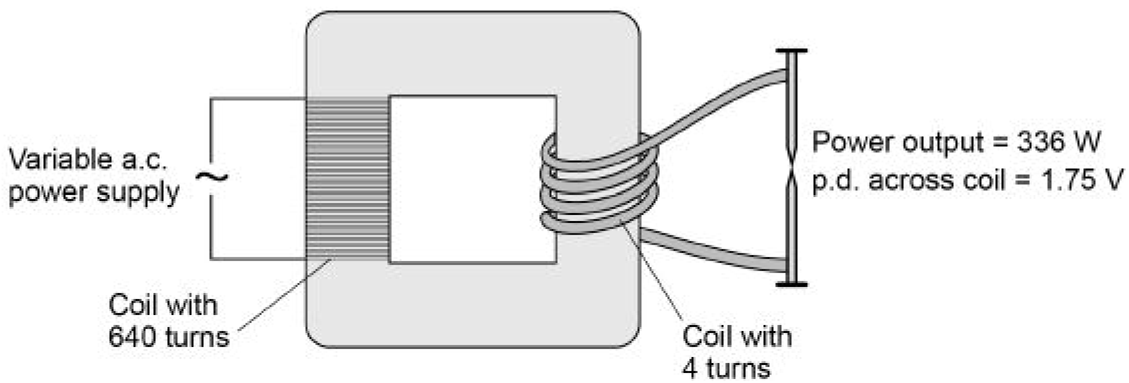
___

(1)

A spot-welder is a device that uses a transformer to produce a large current to join sheets of metal together.

Figure 2 shows a transformer demonstrating how a large current can heat and join two nails together.

Figure 2



(c) How does the amount of infrared radiation emitted by the nails change when the power supply is switched on?

___

___

(1)

(d) Calculate the current from the power supply needed to provide a power output of 336 W.

Use the data in **Figure 2**.

The transformer is 100% efficient.

___

___

___

___

___

___

Current = ____________ A

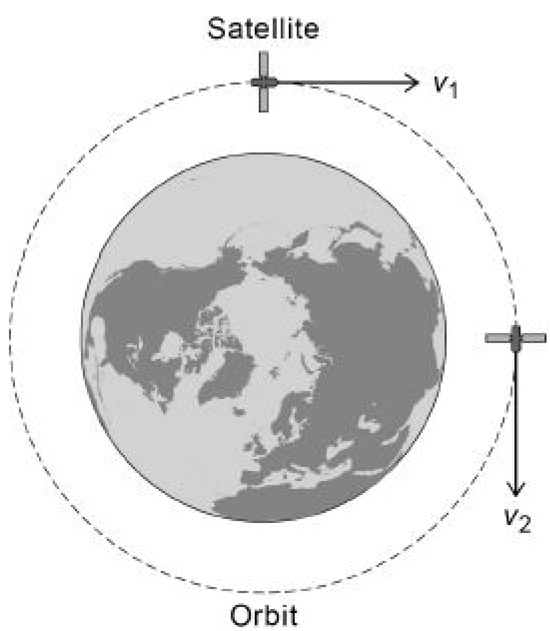
(5)

(Total 8 marks)

8. A satellite is in a circular orbit around the Earth.

Figure 1 shows the velocity of the satellite at two different positions in the orbit.

Figure 1

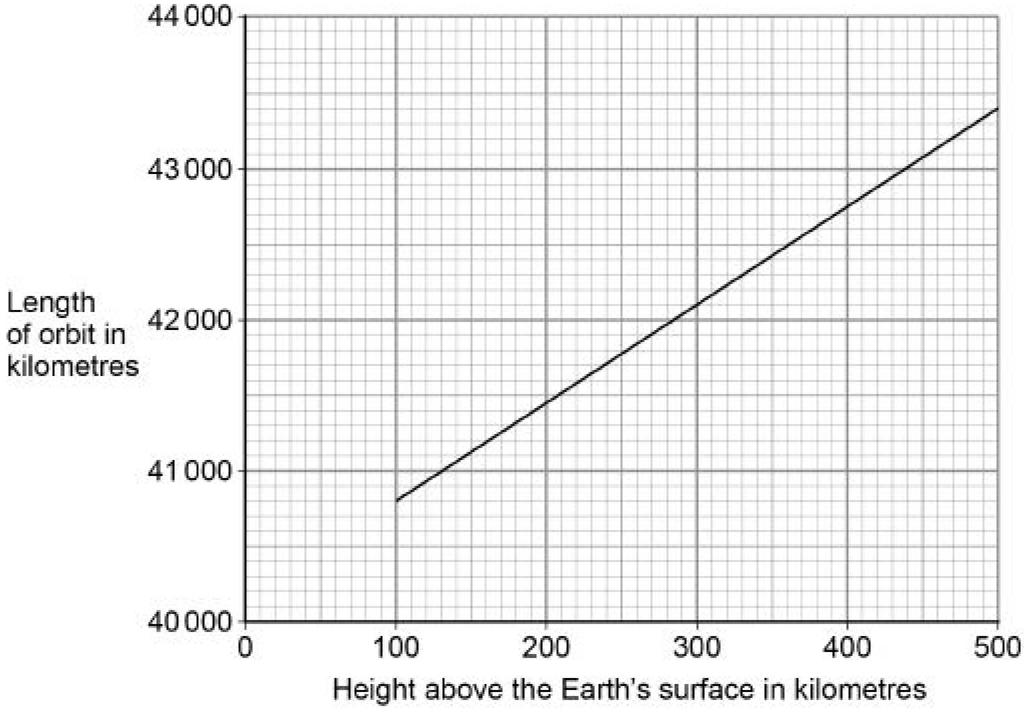


(a) Explain why the velocity of the satellite changes as it orbits the Earth.

(3)

(b) **Figure 2** shows how the length of a satellite orbit depends on the height of the satellite above the Earth's surface.

Figure 2



A satellite orbits 300 km above the Earth's surface at a speed of 7.73 km/s.

Calculate how many complete orbits of the Earth the satellite will make in 24 hours.

____

____

____

____

____

____

____

Number of complete orbits = ____________________________

(5)

In 1772, an astronomer called J Bode developed an equation to predict the orbital radii of the planets around the Sun.

The table shows Bode's predicted orbital radii and the actual orbital radii for the planets that were known in 1772.

Planet	**Predicted orbital radius in millions of kilometres**	**Actual orbital radius in millions of kilometres**
Mercury	60	58
Venus	105	108
Earth	150	150
Mars	240	228
Jupiter	780	778
Saturn	1500	1430

(c) The predicted data can be considered to be accurate.

Give the reason why.

____

____

(1)

(d) J Bode used his equation to predict the existence of a planet with an orbital radius of 2940 million kilometres.

The planet Uranus was discovered in 1781.

Uranus has an orbital radius of 2875 million kilometres.

Explain why the discovery of Uranus was important.

____

____

____

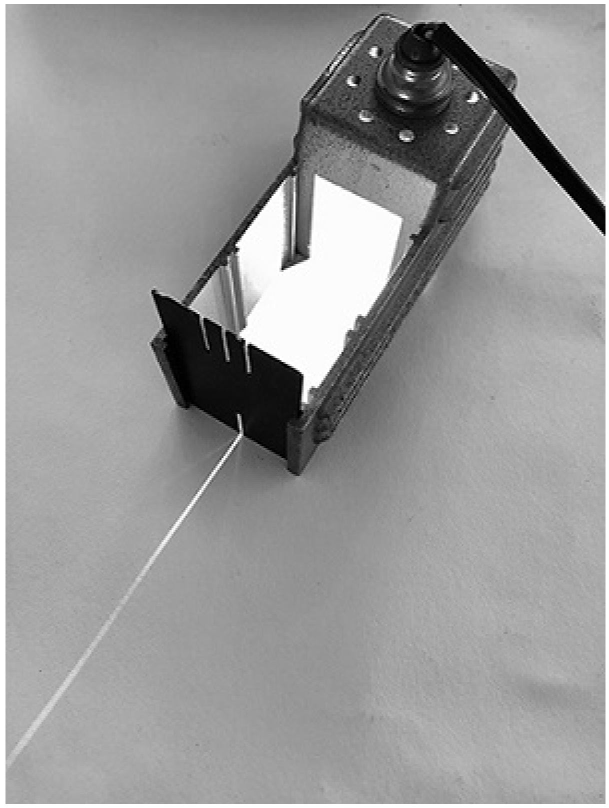
____

(2)

(Total 11 marks)

9. A student investigated the refraction of light at the boundary between air and glass.

The photograph below shows the ray box used.



(a) The ray of light from the ray box should be as narrow as possible.

Explain why using a wider ray would give less accurate results than using a narrower ray.

____

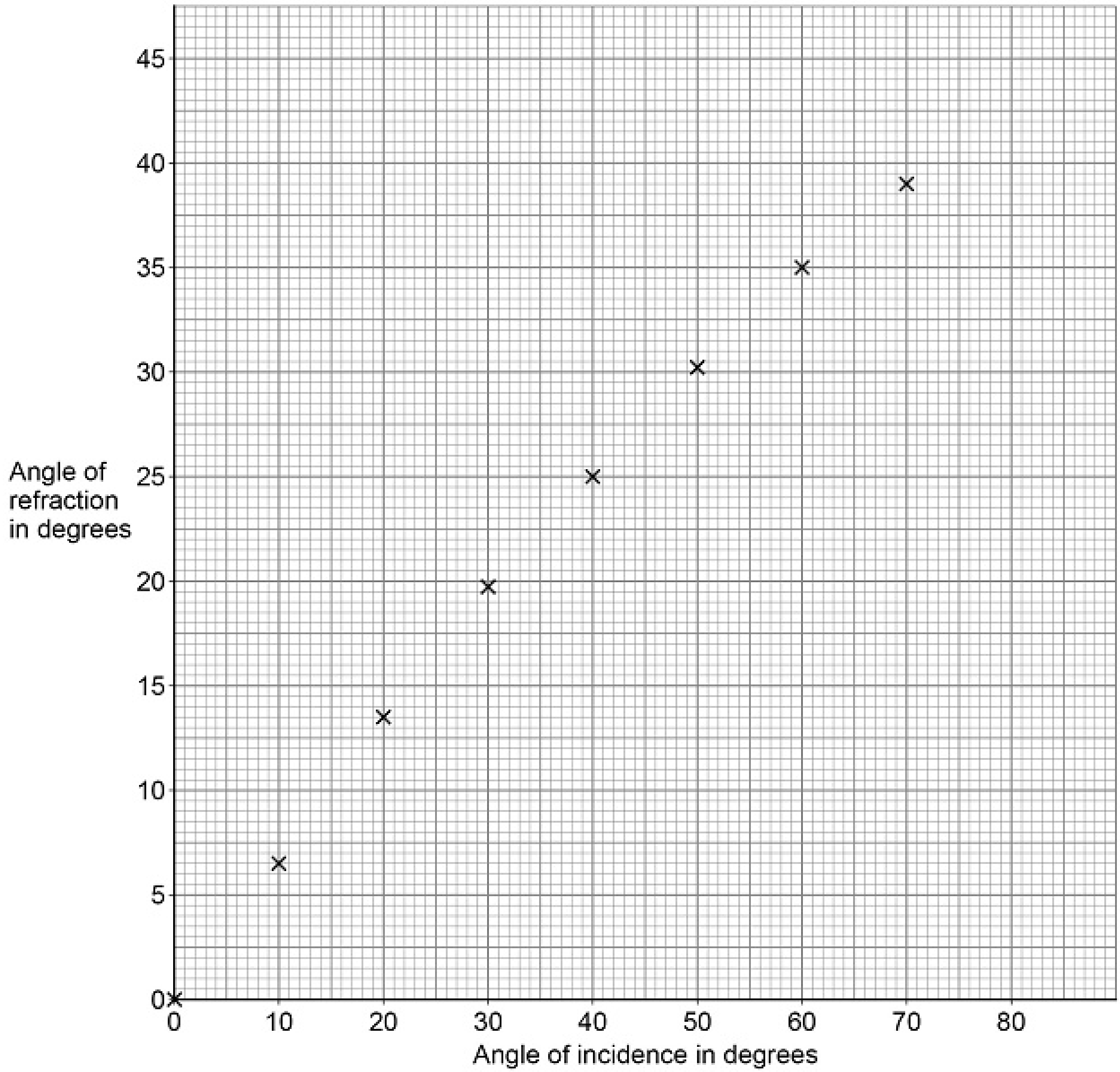
____

____

____

(2)

The graph below shows the results.



(b) Estimate the angle of refraction when the angle of incidence is 80°.

Show how you obtained your answer on the graph above.

Angle of refraction = _______________°

(2)

(c) Describe a method the student could have used to obtain the results shown in the graph above.

____

(6)

(d) The student repeated each measurement three times.

When the angle of incidence was 40° the three measured values for the angle of refraction were

28°   25°   22°

Estimate the uncertainty in the angle of refraction when the angle of incidence was 40°.

Show how you determine your estimate.

Uncertainty = ± ___________°

(2)

(e) What property of the light wave changes when it is refracted?

Tick (✓) **one** box.

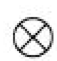
Colour	☐
Frequency	☐
Velocity	☐

(1)

(Total 13 marks)

10. The circle in **Figure 1** represents a straight wire carrying a current. The cross shows that the current is into the plane of the paper.

Figure 1



(a) Complete **Figure 1** to show the magnetic field pattern around the wire.

(2)

(b) The magnetic flux density 10 cm from the wire is 4 microtesla.

Which of the following is the same as 4 microtesla?

Tick **one** box.

4×10^{-2} T ☐

4×10^{-3} T ☐

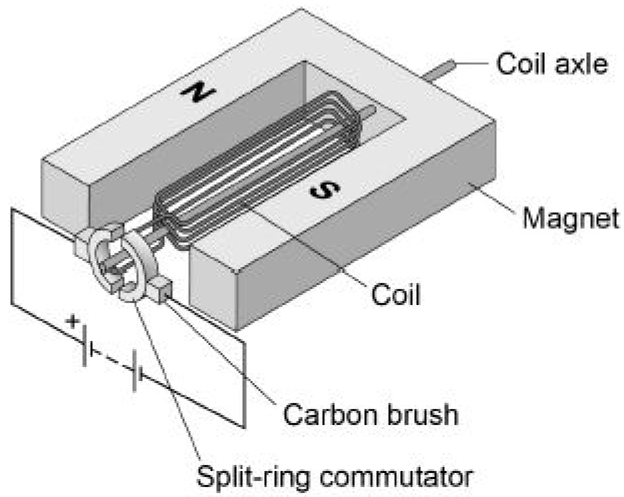
4×10^{-6} T ☐

4×10^{-9} T ☐

(1)

(c) **Figure 2** shows a simple electric motor.

Figure 2



When there is a current in the coil, the coil rotates continuously.

Explain why.

____

____

____

____

____

____

____

____

____

____

(4)

(Total 7 marks)