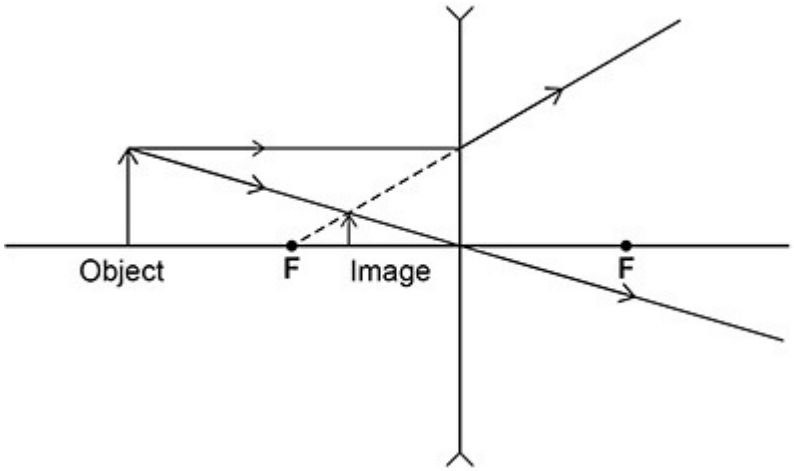
Questions are for both separate science and combined science students unless indicated in the question

1. Lenses are used to form images of objects.

(a) **Figure 1** shows how a concave lens forms an image of an object.

Figure 1



The image of the object in **Figure 1** is upright.

Give **two** other words that describe the image. (separate only)

1 _____

2 _____

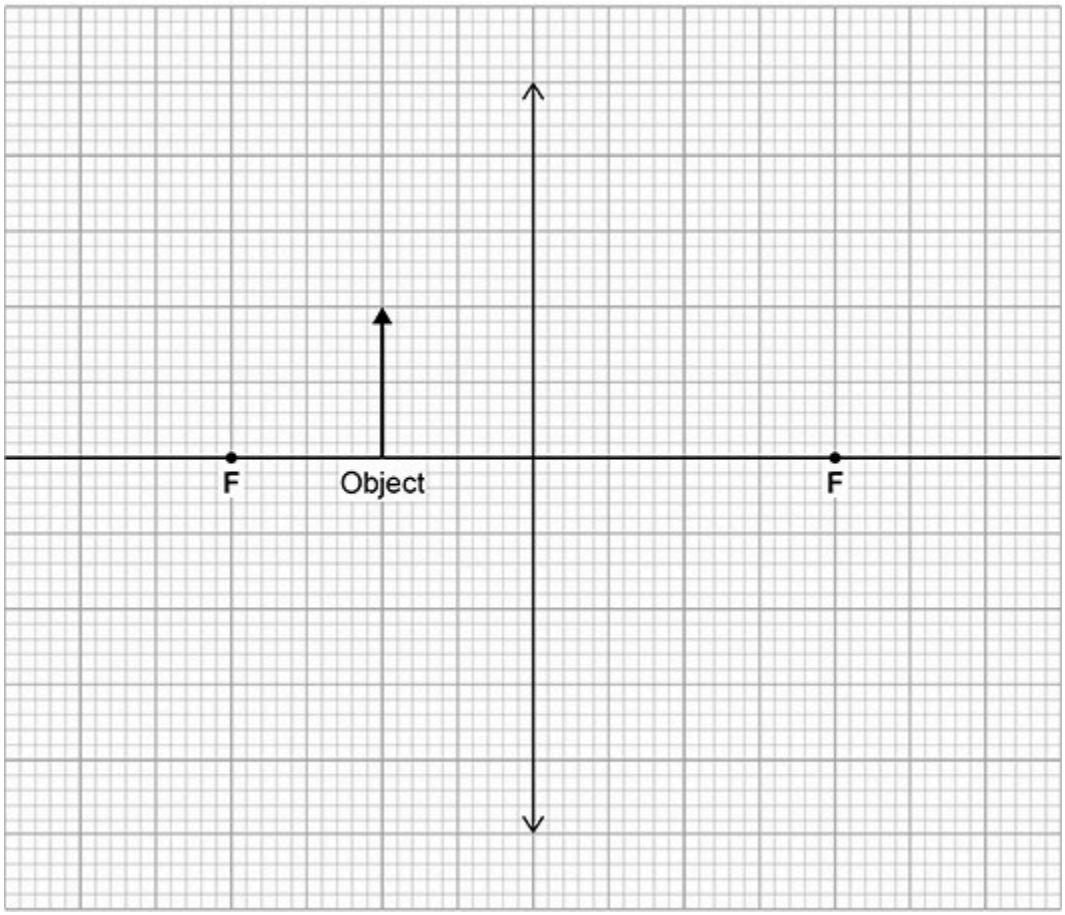
(1)

(b) **Figure 2** shows an object near to a **convex** lens.

Complete the ray diagram to show how the image is formed.

Use an arrow to represent the image.(separate only)

Figure 2

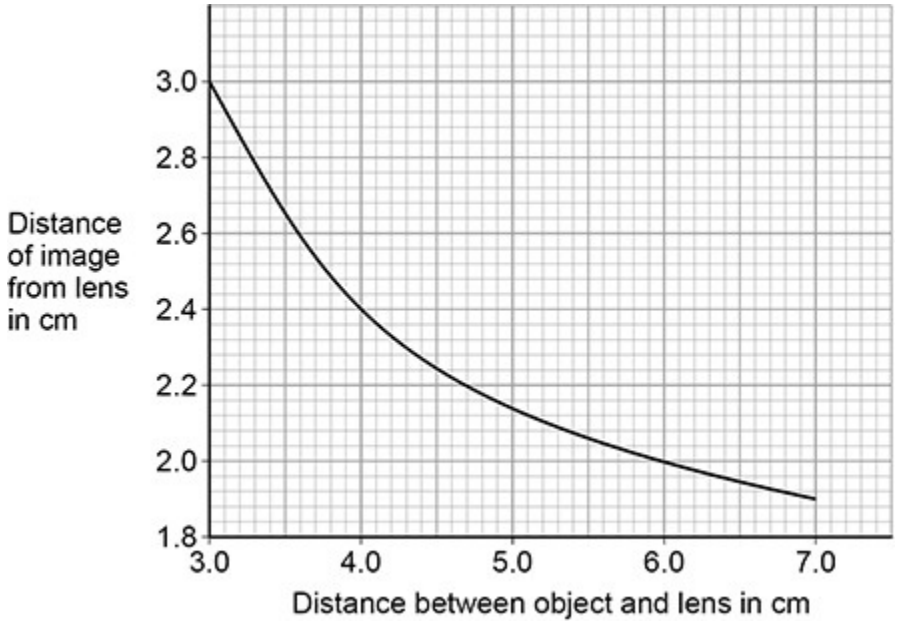


(3)

The position of an image formed by a convex lens varies with the distance between the object and the lens.

Figure 3 shows the results of a student's investigation using a convex lens.

Figure 3



(c) Describe how the distance of the image from the lens decreases as the distance between the object and the lens increases. (separate only)

_____

_____

(1)

(d) The student measured the distance from the image to the lens four times.

The distance between the object and the lens did not change.

The 4 measurements from the image to the lens were:

1.9 cm 1.7 cm 2.2 cm 1.4 cm

Calculate the uncertainty in the measurements.(separate only)

_____

_

_____

_ Uncertainty = ± _____ cm

(2)

_____

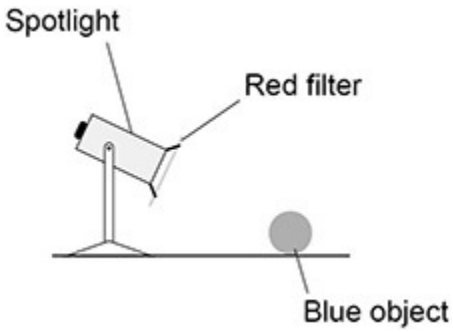
_

(e) **Figure 4** shows a spotlight containing a convex lens.

A red filter is placed in front of the spotlight.

The spotlight is directed at a blue object.

Figure 4



Explain why the blue object appears black.(separate only)

_____

_____

_____

_____

_____

_____

(3)

(Total 10 marks)

2. Ultraviolet is a type of electromagnetic wave.

(a) Give **one** use of ultraviolet.

_____

(1)

(b) An ultraviolet wave has a wavelength of 300 nanometres.

Which of the following is equal to 300 nanometres?

Tick (✓) **one** box.

3 × 107 m ☐

3 × 10–7 m ☐

3 × 109 m ☐

3 × 10–9 m ☐

(1)

(c) The speed of ultraviolet waves is 3 × 108 m/s. Calculate the frequency of the ultraviolet wave. Use your answer to part (b)

_____

_____

_____

_____

_____

Frequency = _____ Hz

(3)

(d) The table below gives the wavelength of an ultraviolet wave and three other electromagnetic waves.

	Ultraviolet	**Wave E**	**Wave F**	**Wave G**
Wavelength in nanometres	300	0.1	600	100 000

Draw **one** line from each wave to the name of the wave.

Wave	**Name**
Wave E	Infrared
Wave F	Visible light
Wave G	X-rays

(1)

(e) Electromagnetic waves are transverse.

Some other types of wave are longitudinal. Describe the difference between transverse and longitudinal waves.

_____

_____

_____

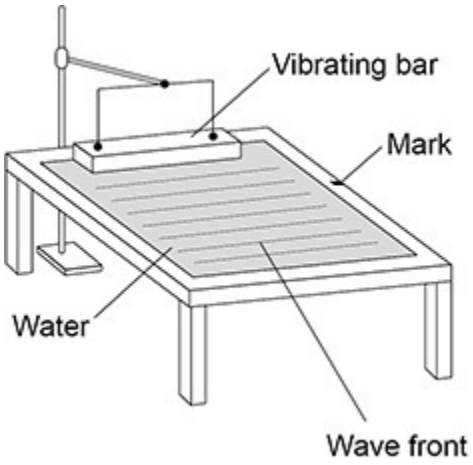
_____

(2)

(Total 8 marks)

3. A teacher demonstrated some features of waves using a ripple tank.

The figure below shows the ripple tank.



(a) The teacher measured the time taken for 10 wave fronts to pass the mark.

The teacher repeated this measurement three times and calculated the mean. What is the advantage of repeating measurements and calculating a mean?

_____

_____

(1)

(b) The teacher's measurements for the time taken for 10 wave fronts to pass the mark were:

8.4 s 7.8 s 8.1 s

Calculate the mean frequency of the wave. Give your answer to 2 significant figures.

_____

_____

_____

_____

_____

_____

_____

_____

_____

Mean frequency (2 significant figures) = _____ Hz

(5)

(c) In a different investigation, the teacher wanted to determine the speed of water waves in the ripple tank. The teacher did **not** measure the wavelength of the wave. Explain how the teacher could determine the speed of the wave.

_____

_____

_____

_____

_____

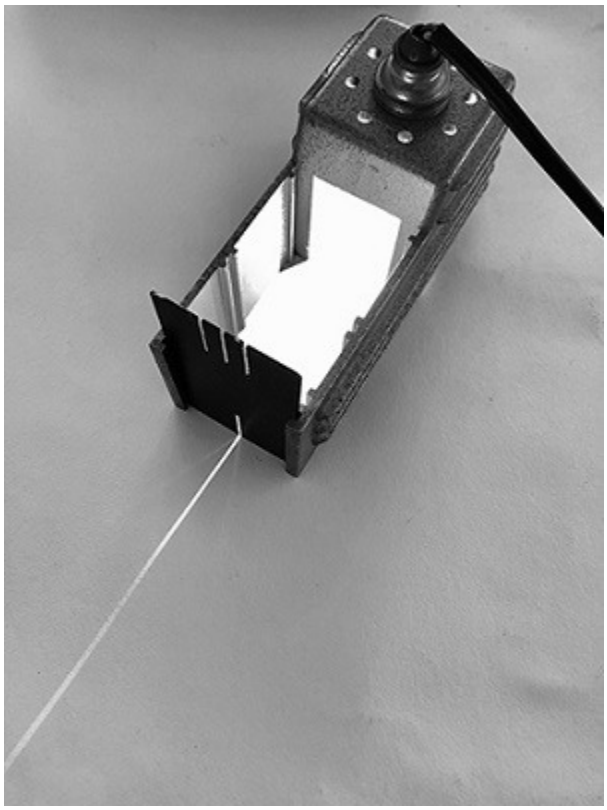
_____

(3)

(Total 9 marks)

4. 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. (separate only)

_____

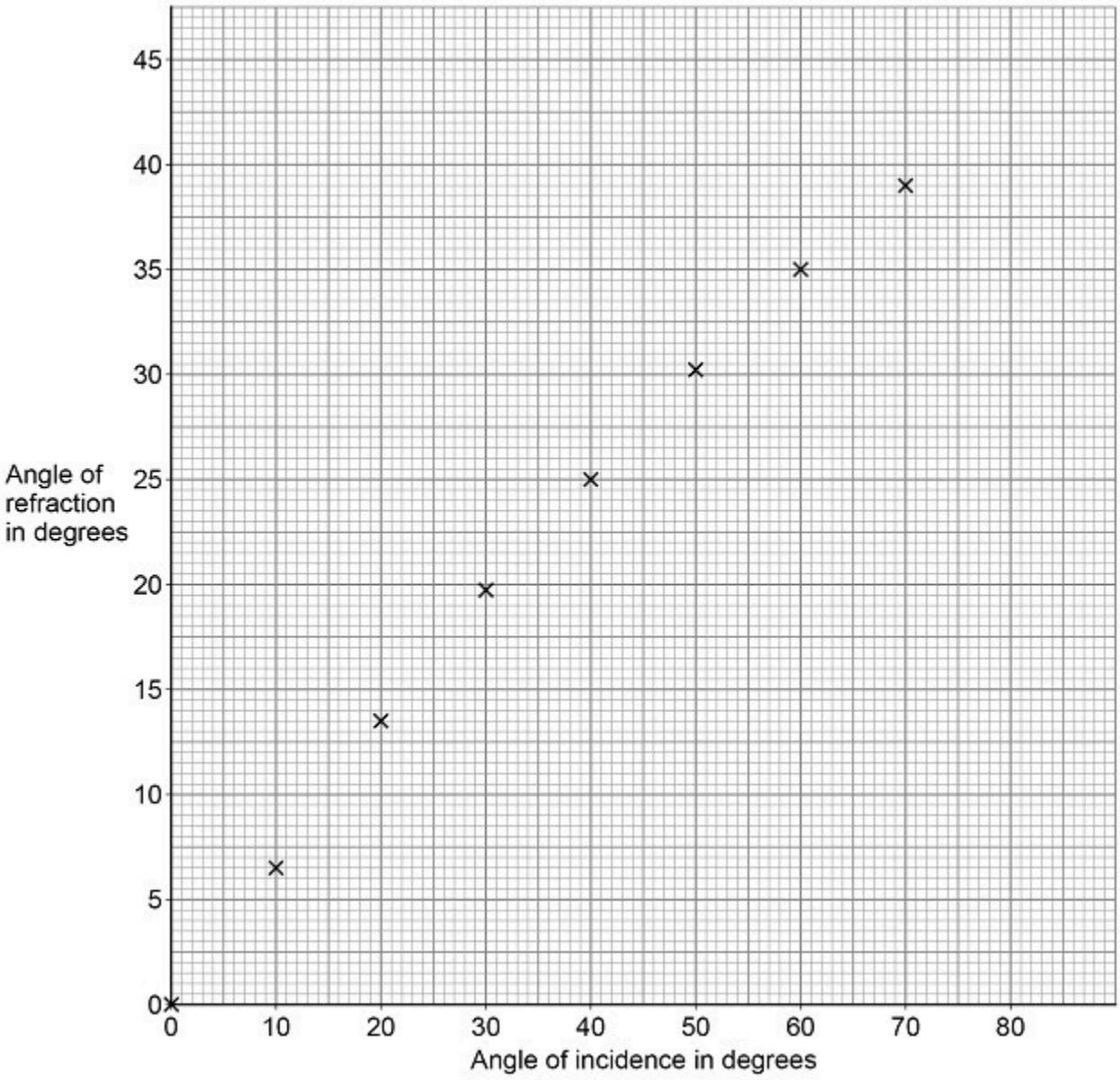
_____

_____

_____

(2)

The graph below shows the results.



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

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.(separate only)

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(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.(separate only)

_____

_____

Uncertainty = ± _____°

(2)

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

Tick (✓) **one** box. (separate only)

Colour ☐

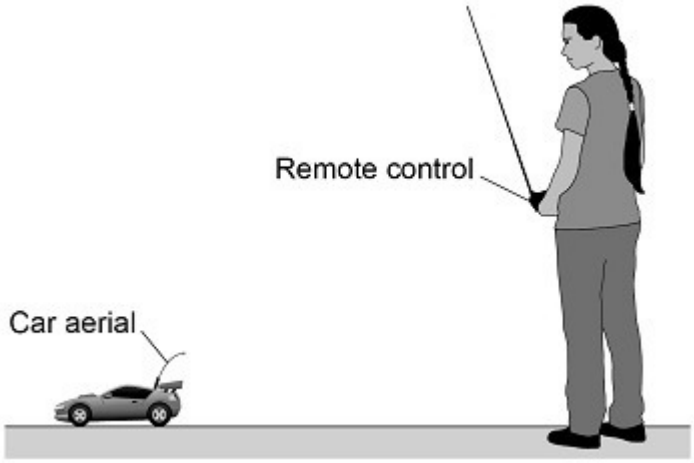
Frequency ☐

Velocity ☐

(1)

(Total 13 marks)

5. The image below shows a student playing with a remote-controlled car.



(a) The remote control transmits radio waves to the car aerial.

The transmitted radio waves have a frequency of 320 MHz. speed of radio waves =

3.0 × 108 m/s

Calculate the wavelength of the radio waves.

Give the unit.

_____

_____

_____

_____

_____

_____

_____

_____

Wavelength = _____ Unit _____

(5)

(b) The car aerial is connected to an electrical circuit in the car.

Describe what happens in the electrical circuit when the car aerial absorbs radio waves.

_____

_____

_____

_____

_____

(2)

(c) The car produces sound waves.

Give **two** ways in which radio waves are different to sound waves.

1 _____

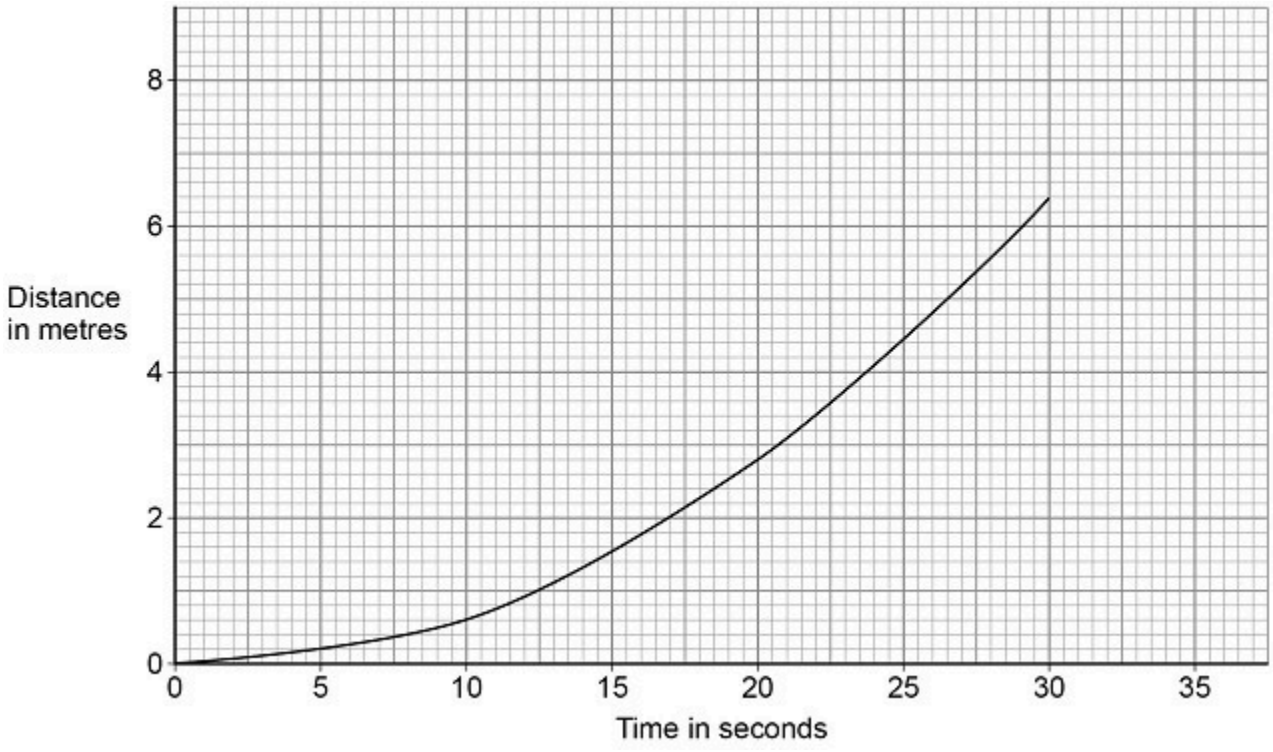
_____

2 _____

_____

(2)

The graph below shows the distance-time graph for the first 30 seconds of the car's motion.



(d) Describe the motion of the car during the first 30 seconds.

_____

(1)

(e) Determine the speed of the car 20 seconds after it started to move.

_____

_____

_____

_____

_____

Speed = _____ m/s

(4)

(f) A different car accelerated from 0.12 m/s to 0.52 m/s.

The acceleration of the car was 0.040 m/s2. The work done to accelerate the car was 0.48 J. Calculate the resultant force needed to accelerate the car.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Resultant force = _____ N

(6)

(g) Explain why the car has a maximum speed.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 24 marks)

6. (a) The table below gives the frequencies in the hearing ranges of five different animals.

Animal	**Frequencies of hearing range**
Cat	55 Hz to 77 kHz
Chicken	125 Hz to 2 kHz
Dog	20 Hz to 30 kHz
Gerbil	56 Hz to 60 kHz
Horse	55 Hz to 33 kHz

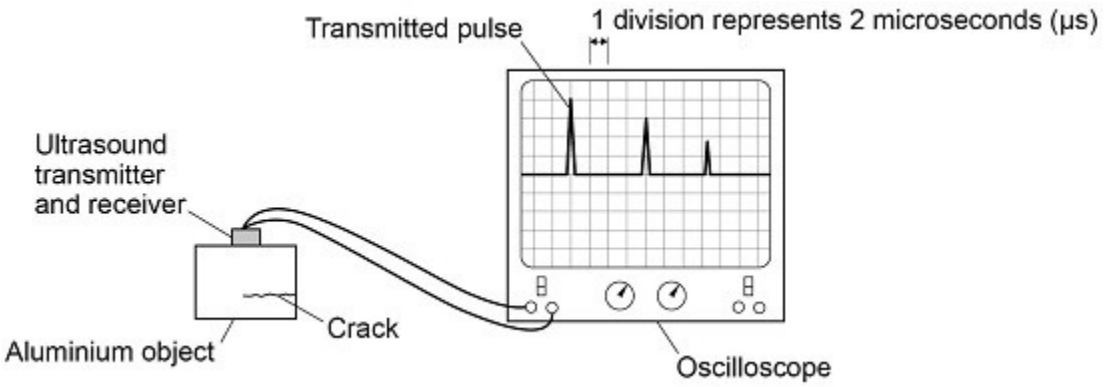
Which **one** of the animals from the table would not be able to hear ultrasound? (separate only)

_____

(1)

Figure 1 shows ultrasound being used to detect a hidden crack in a solid aluminium object. The transmitted and reflected pulses of ultrasound are shown on the screen.

Figure 1



(b) Which of the following is the same as 2 microseconds?

Tick (✓) **one** box.

2×103 s ☐

2×10^{-3} s ☐

2×10^{-6} s ☐

2×10^{-9} s ☐

(1)

(c) Ultrasound travels at 6300 m/s in aluminium.

Determine the depth of the crack below the top surface of the aluminium. Use information from **Figure 1**. Give your answer to two significant figures.

_____

_____

_____

_____

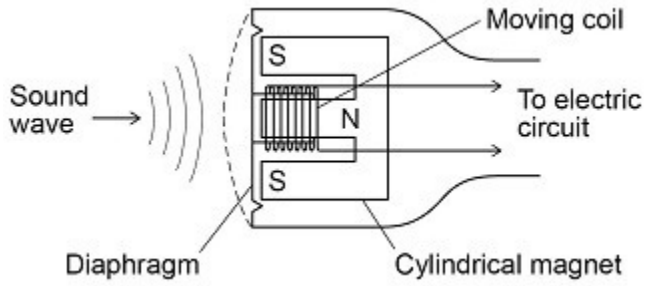
_____

Depth = _____ m

(4)

Figure 2 shows the parts of a moving-coil microphone.

Figure 2



(d) What is the function of a microphone? (separate only)

_____

_____

(1)

(e) Explain how a moving-coil microphone works. (separate only)

_____

_____

_____

_____

_____

_____

_____

_____

_____

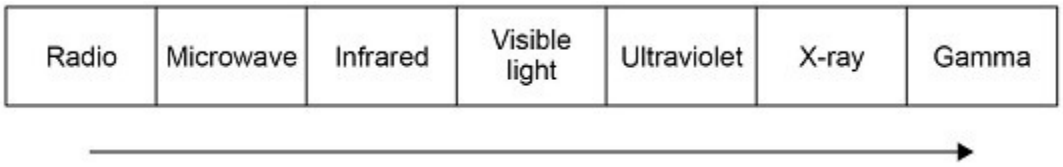
_____

(4)

(Total 11 marks)

7. (a) **Figure 1** shows the electromagnetic spectrum.

Figure 1



Which statement is correct for the direction of the arrow in **Figure 1**?

Tick (✓) **one** box.

The wavelength decreases and the wave speed in air increases. ☐

The frequency increases and the wavelength increases. ☐

The frequency increases and the wave speed in air stays the same. ☐

The wavelength increases and the wave speed in air increases. ☐

(1)

(b) Explain how the properties of X-rays make them suitable for the medical imaging of bones.

_____

_____

_____

_____

_____

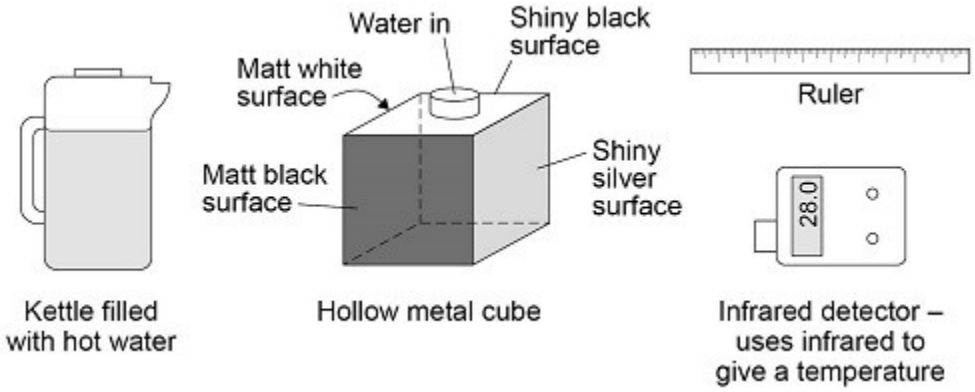
(2)

A student investigated the infrared radiation emitted from the sides of a hollow metal cube.

The sides of the cube are different colours or textures.

Figure 2 shows the equipment used.

Figure 2



Boiling water was poured into the cube. The amount of infrared radiation emitted from each vertical surface was then measured.

(c) Boiling water is a hazard in this investigation.

Suggest how the risk of harm could be reduced in this investigation.

_____

_____

_____

(1)

(d) What is the control variable in this investigation?

_____

_____

(1)

The following table shows the results.

Type of surface	Temperature in °C
Matt black Matt	68.0
white Shiny	65.6
black Shiny	66.3
silver	28.0

(e) The four temperature values in the table cannot be used to show that the infrared detector gives precise readings.

Give the reason why.

_____

_____

_____

(1)

(f) The student looked at the data in the table above and concluded:

'A black surface always emits more infrared radiation than a white surface.'

Explain how using an infrared detector with a resolution of 1 °C would have affected the student's conclusion.

_____

_____

_____

_____

_____

(2)

Albedo is a measure of the amount of solar radiation reflected by an object compared to the total solar radiation incident on the object.

A perfect reflector has an Albedo value of 1.0

A perfect absorber has an Albedo value of 0.0

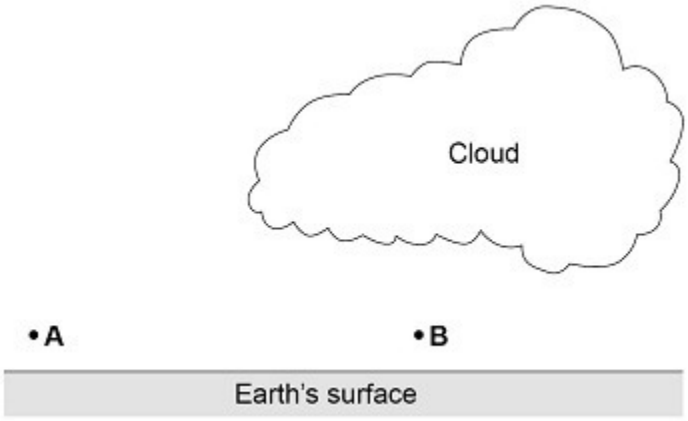
(g) What is the Albedo value of a perfect black body? (separate only)

_____

(1)

(h) **Figure 3** shows two points, **A** and **B**, just above the Earth's surface.

Figure 3



The average Albedo value of the Earth's surface is 0.3 The Albedo value of thick cloud varies between 0.6 and 0.9

At night the air at point **A** cools faster than the air at point **B**.

Explain why.(separate only)

_____

_____

_____

_____

_____

_____

(3)

(Total 12 marks)

8. Light is usually described as a wave. Light can also be described as a stream of particles.

These are two different scientific models of light.

(a) Which statement describes a scientific model?

Tick **one** box.

A small scale version of a real object. ☐

A way of guessing what will happen. ☐

An idea used to explain observations and data. ☐

(1)

(b) Why do scientists sometimes have different models like the wave and particle models of light?

_____

_____

(1)

(c) Sometimes an old scientific model is replaced by a new model.

Explain why scientists replace an old scientific model with a new model. Include an example from Physics in your answer.

_____

_____

_____

_____

_____

_____

_____

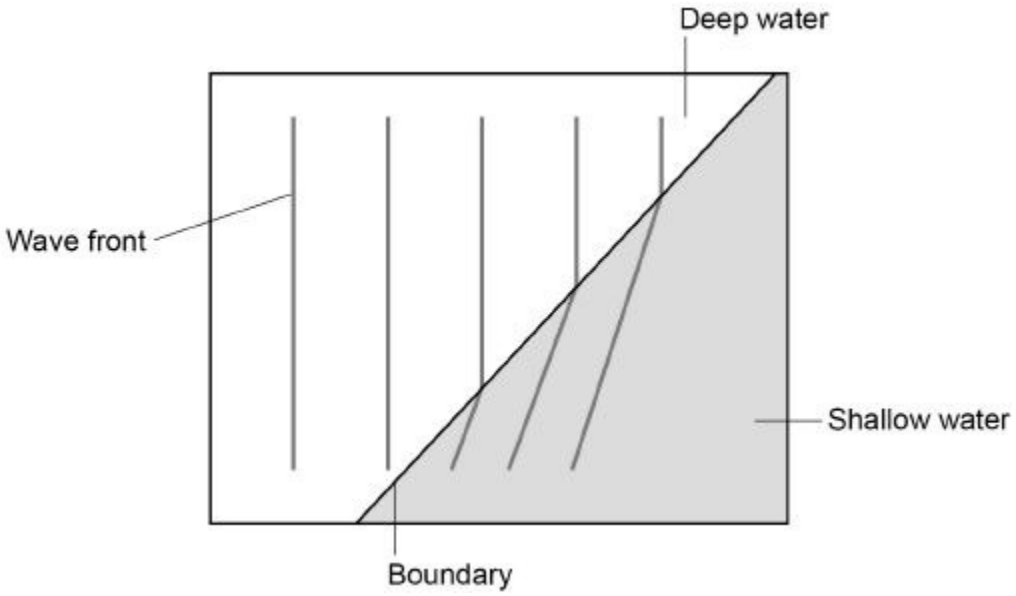
_____

(4)

Some students used water waves in a ripple tank to model the behaviour of light waves.

(d) **Figure 1** shows what happens to the wave fronts as they pass the boundary between deep water and shallower water.

Figure 1



Explain why refraction happens at the boundary between the deep water and shallower water.(separate only)

_____

_____

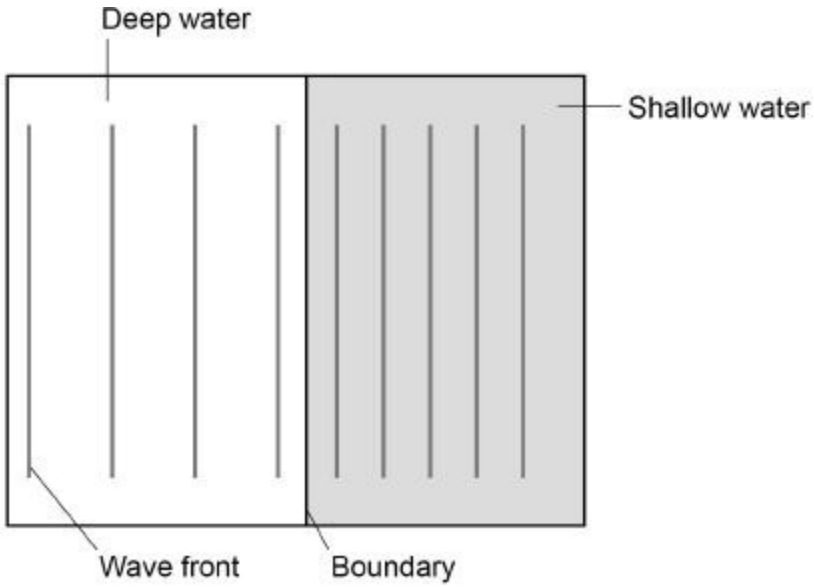
_____

_____

(3)

(e) **Figure 2** shows the wave fronts travelling parallel to the boundary between deep water and shallower water.

Figure 2



Explain why the wave fronts in **Figure 2** do not refract at the boundary. (separate only)

_____

_____

_____

_____

(2)

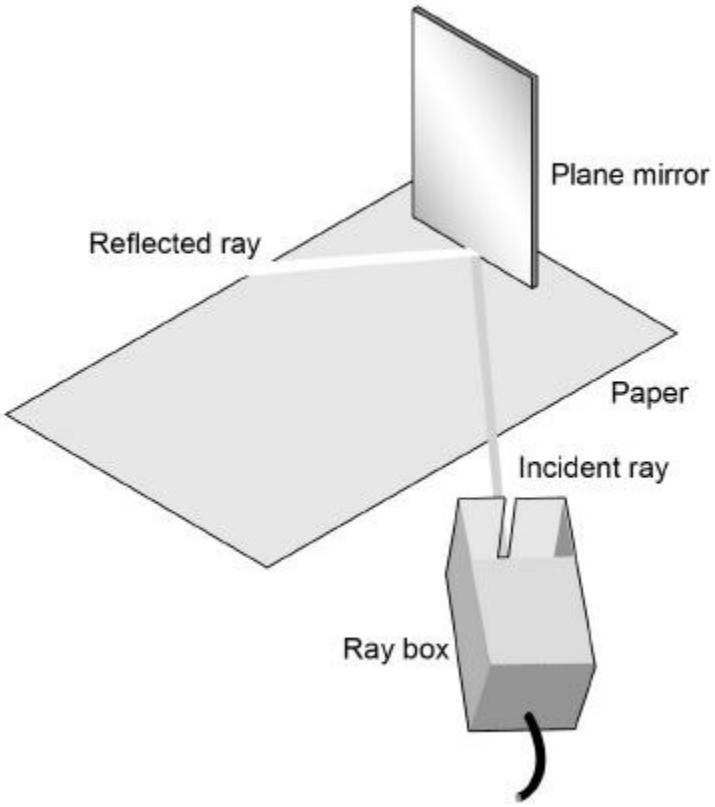
(Total 11 marks)

9. 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? (separate only)

_____

(1)

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

_____

_____

(1)

(c) Estimate the uncertainty in the angle of reflection when the angle of incidence is 50°. Show how you determine your estimate.(separate only)

_____

_____

_____

_____

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. (separate only)

_____

_____

_____

_____

(2)

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

_____

_____

(1)

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

_____

_____

(1)

(Total 8 marks)

10. 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.(separate only)

P-waves and S-waves are transverse. ☐

P-waves and S-waves are longitudinal. ☐

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

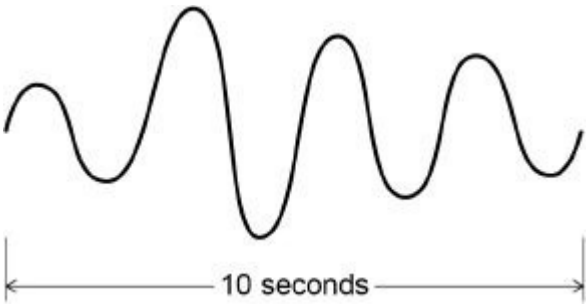
P-waves are longitudinal and S-waves are transverse. ☐

(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. (separate only)

_____

_____

_____

_____

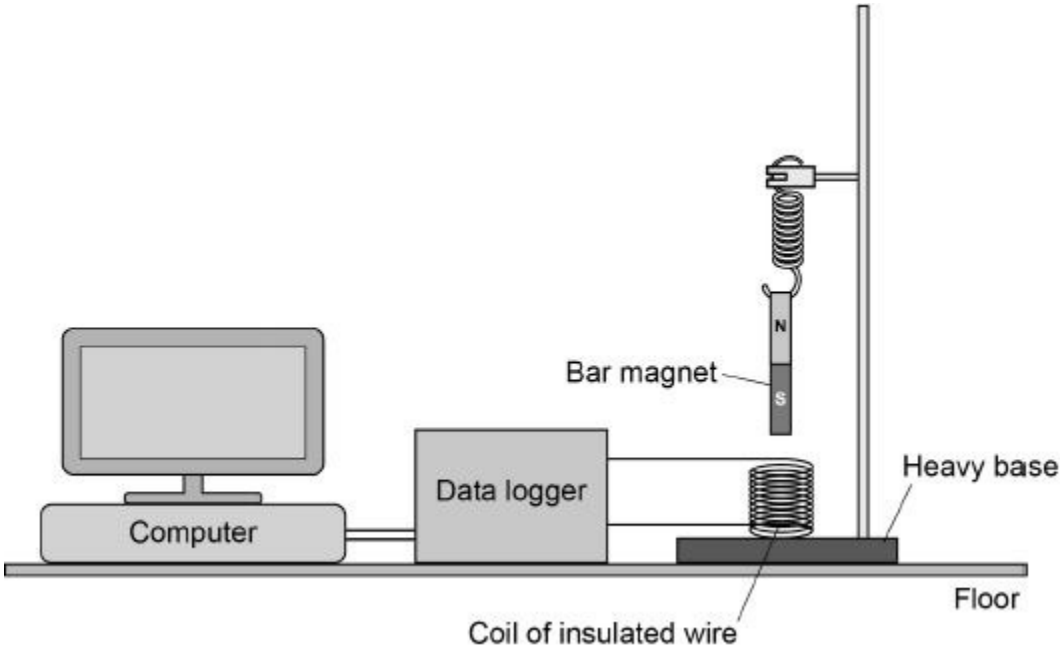
_____

_____

(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? (separate only)

_____

_____

(1)

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

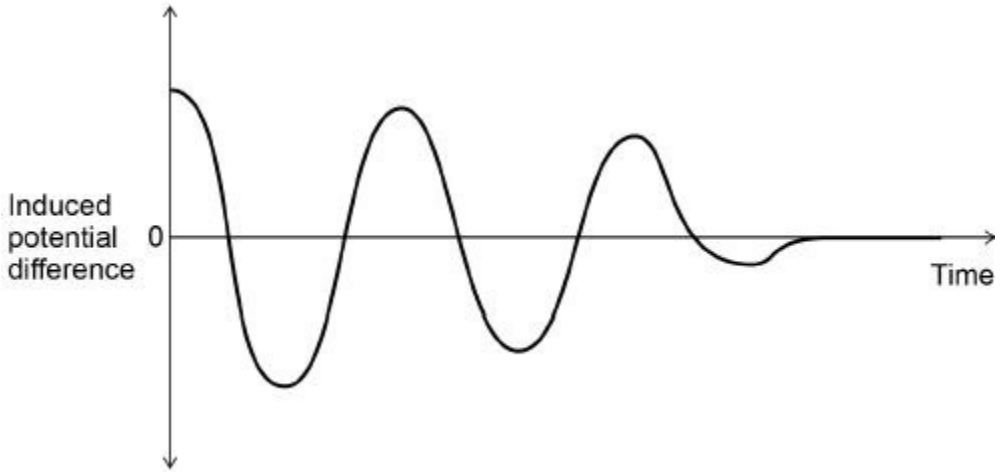
_____

_____

(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.(separate only)

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.(separate only)

1. _____

_____

2. _____

_____

(2)

(Total 13 marks)

11. (a) Which one of the following types of electromagnetic wave has the highest frequency?

Tick **one** box.

Gamma rays	☐
Infrared	☐
Microwaves	☐
Ultraviolet	☐

(1)

(b) What makes microwaves suitable for sending communications to a satellite in space?

_____

_____

(1)

(c) Scientists have detected short bursts of radio waves emitted from a distant galaxy.

The scientists think that the radio waves may have been emitted from a neutron star.

What event leads to a neutron star forming?(separate only)

_____

_____

(1)

(d) Some of the radio waves from the distant galaxy have a frequency of 1.2 gigahertz (GHz).

Which of the following is the same as 1.2 GHz?

Tick **one** box.

1.2 × 103 Hz ☐

1.2 × 106 Hz ☐

1.2 × 109 Hz ☐

1.2 × 10^{12} Hz ☐

(1)

(e) Radio waves travel through space at a speed of 3.0 × 108 m/s Calculate the wavelength of the 1.2 GHz radio waves emitted from the distant galaxy.

_____

_____

_____

_____

_____

Wavelength = _____ m

(3)

(f) When radio waves are absorbed by an aerial they may create an alternating current in an electrical circuit.

If an alternating current is created what frequency would it have?

_____

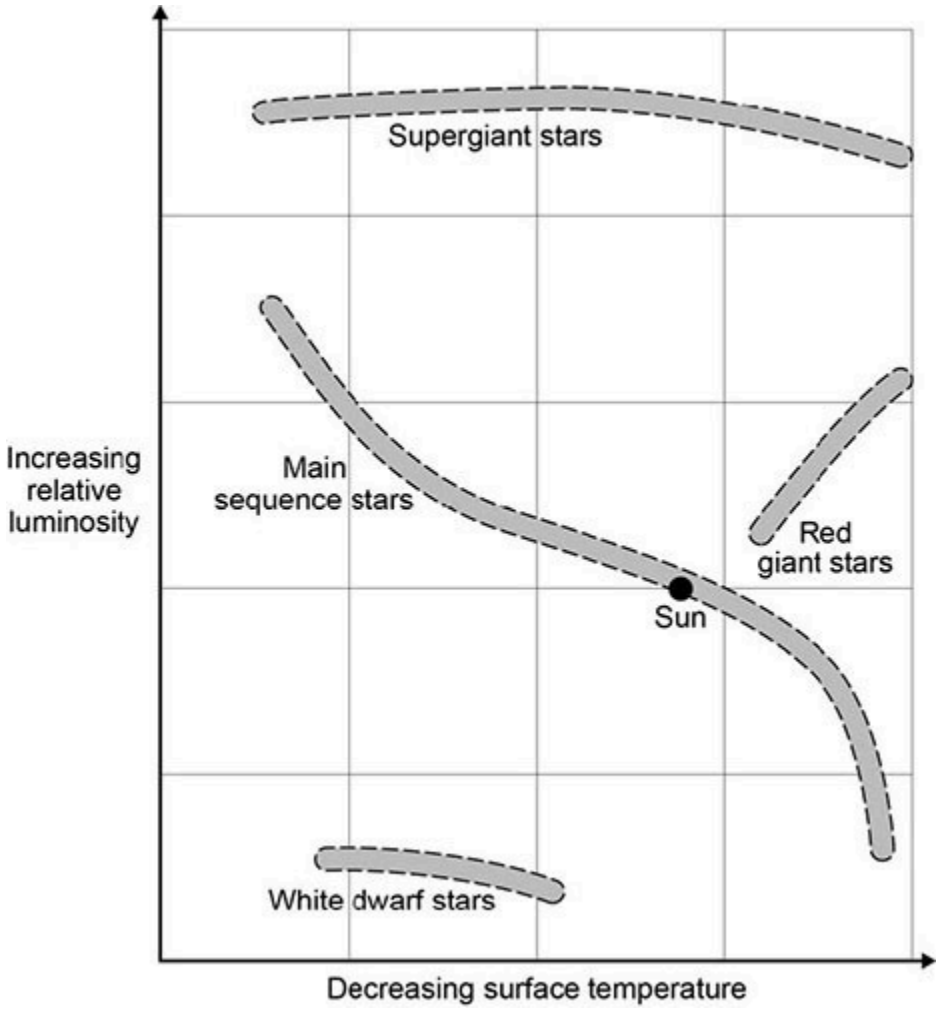
_____

(1)

The diagram shows four groups of stars.

The surface temperature and relative luminosity determine which group a star is in.

A star with a relative luminosity of 1 emits the same amount of energy every second as the Sun.



(g) The Sun is in the group of main sequence stars. These stars are stable.

Explain why a star remains stable. (separate only)

_____

_____

_____

_____

(2)

(h) At different points in their lifecycle stars change from one group to another.

Describe what will happen to the Sun between it leaving the main sequence group and becoming a white dwarf.
Use information from the diagram.

(separate only)

_____

_____

_____

_____

_____

_____

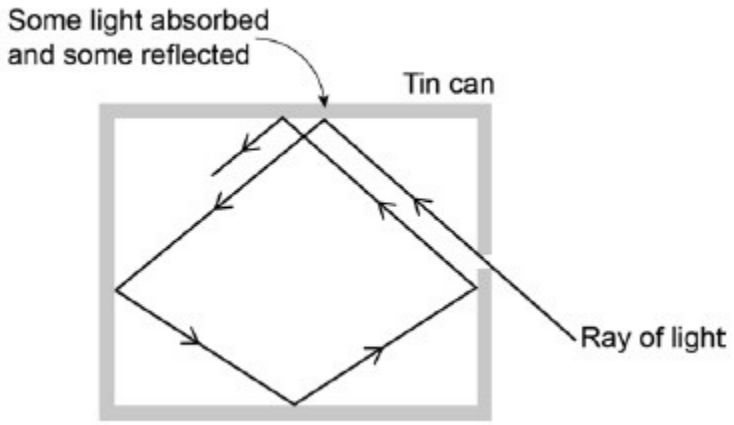
_____

_____

(4)
(Total 8 marks)

12. **Figure 1** shows what happens when a ray of light enters a tin can through a small hole.

Figure 1



(a) Explain why the small hole looks black. (separate only)

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(2)

(b) All objects absorb and emit radiation. What is meant when an object is described as a perfect black body? (separate only)

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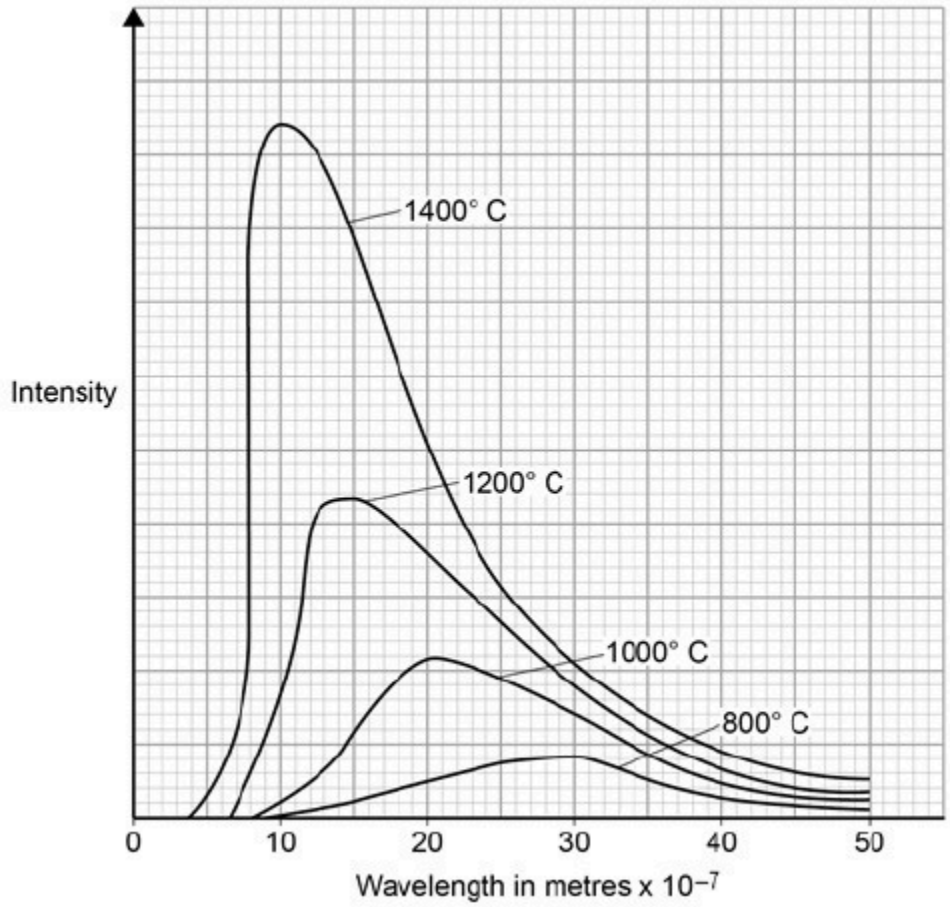
(1)

Figure 2 shows how the intensity of different wavelengths of radiation from a hot object varies with temperature.

Figure 2



(c) What can be concluded from **Figure 2** about how the distribution of the intensity of radiation from an object changes as the temperature of the object increases? (separate only)

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(3)

(d) The wavelength at which the Sun emits the maximum intensity of radiation is approximately $5 \times 10-7$ m

Estimate the surface temperature of the Sun. (separate only)

Use **Figure 2**.

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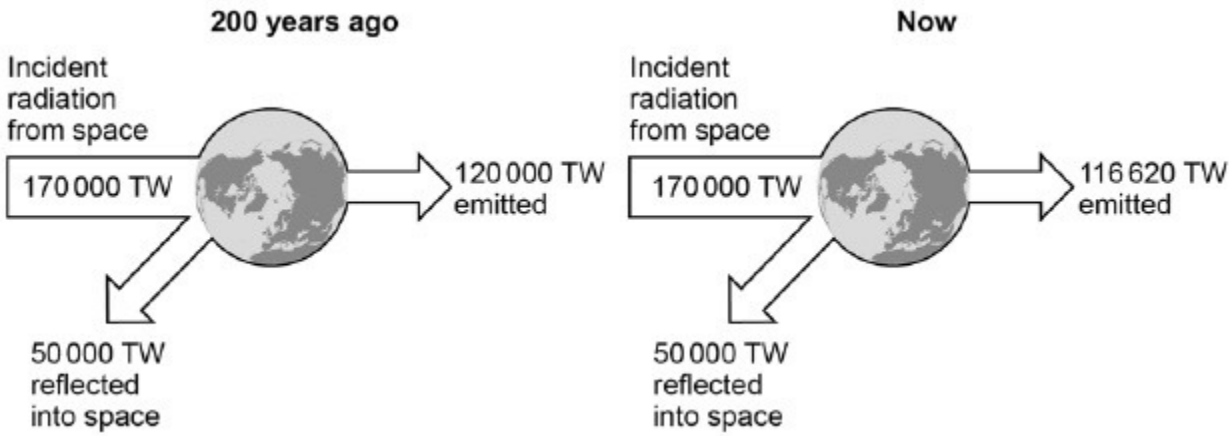
(1)

(e) **Figure 3** shows how the balance between the incident radiation from space and the radiation emitted by the Earth into space has changed over the last 200 years.

Figure 3



Explain how the temperature of the Earth and its atmosphere has changed over the last 200 years.

Use the information in **Figure 3**.(separate only)

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(3)

(Total 10 marks)

13. Waves may be either longitudinal or transverse.

(a) Describe the difference between a longitudinal and a transverse wave.

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(2)

(b) Describe **one** piece of evidence that shows when a sound wave travels through the air it is the wave and not the air itself that travels.(separate only)

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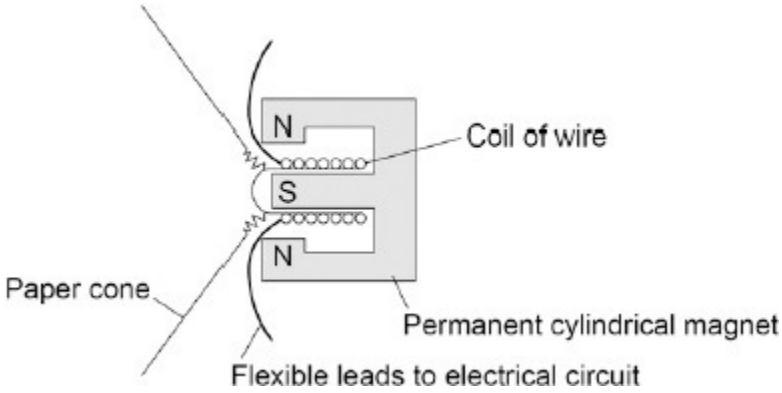
(1)

(c) The figure below shows the parts of a moving-coil loudspeaker.

A coil of wire is positioned in the gap between the north and south poles of the cylindrical magnet.



Explain how the loudspeaker converts current in an electrical circuit to a sound wave. (separate only)

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(6)

(Total 9 marks)