Waves part 3 AQA Triple Physics

Name:

Class:

Date:

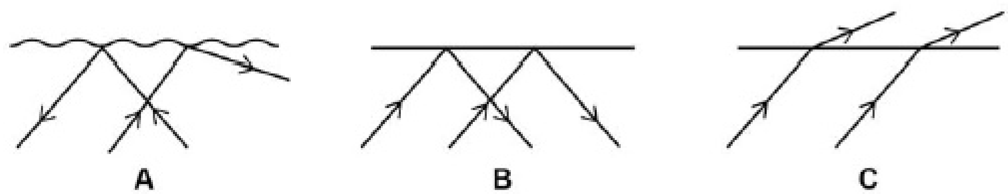
Time: **84 minutes**

Marks: **78 marks**

Comments:

1. (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?

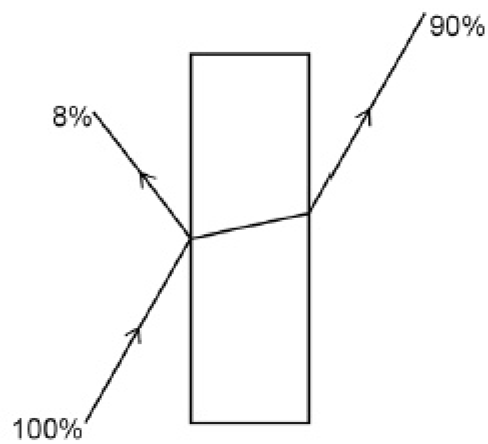
Tick **one** box.

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?

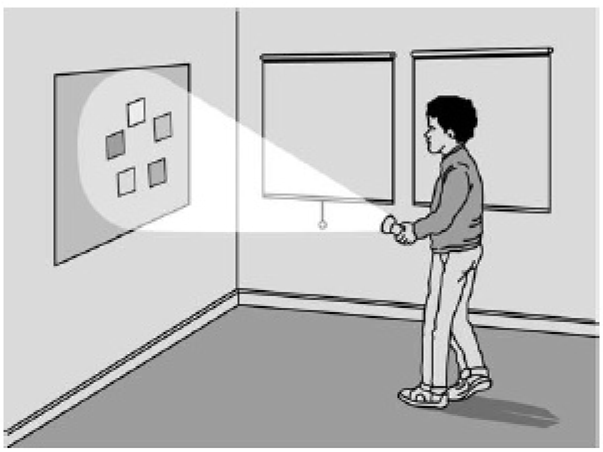
____

(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.

____

____

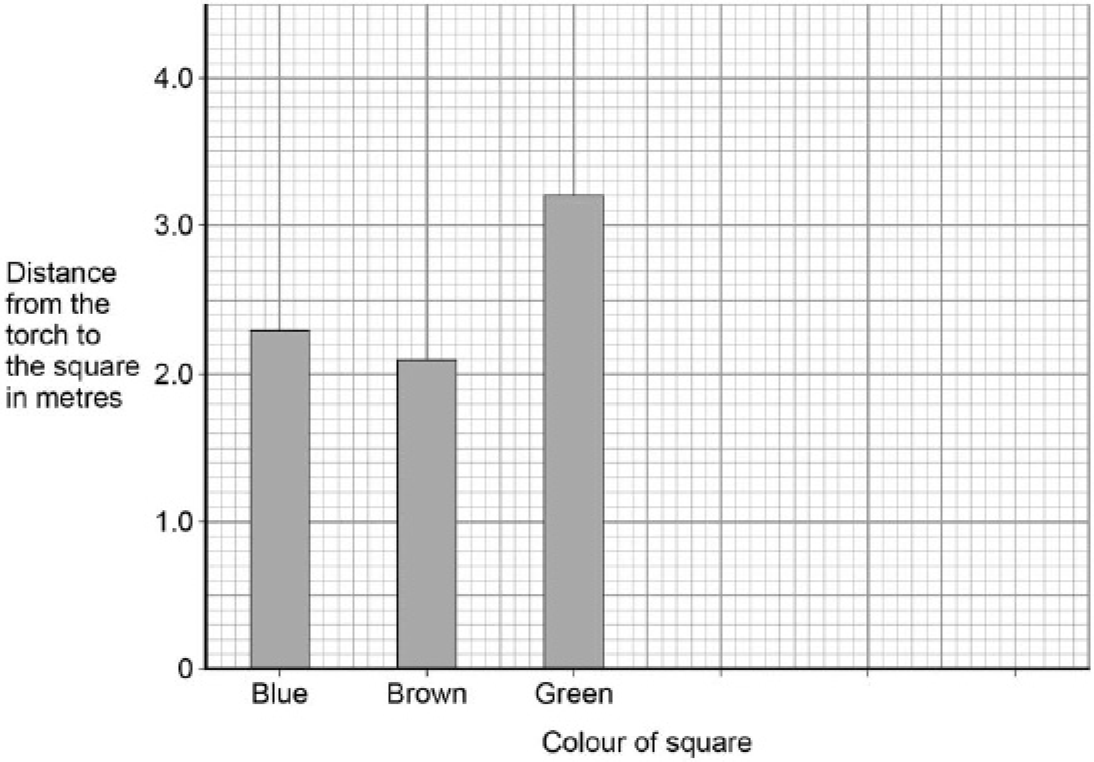
(1)

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)

2. 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.

____

____

____

____

____

____

____

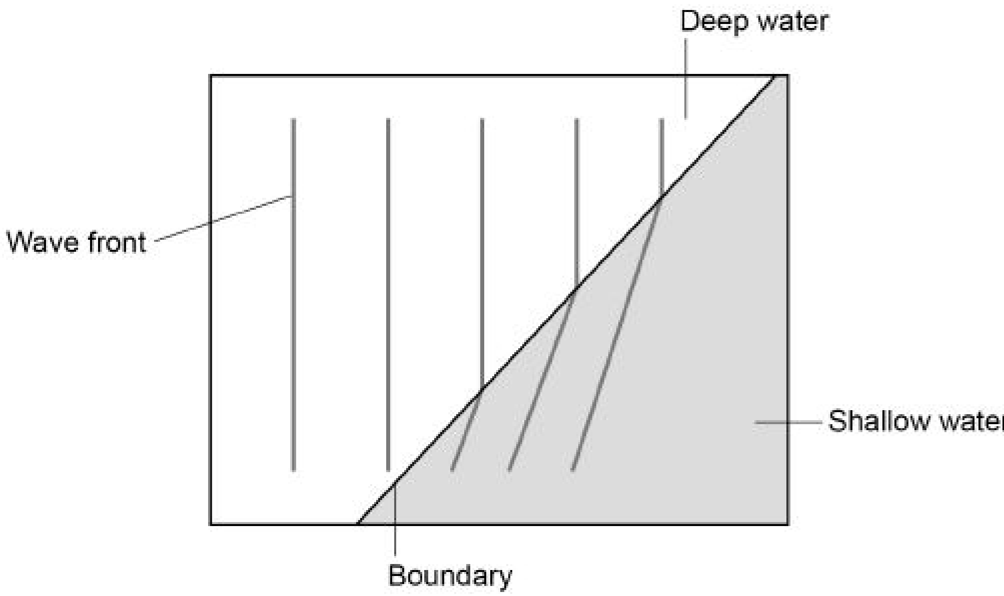
____

(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.

____

____

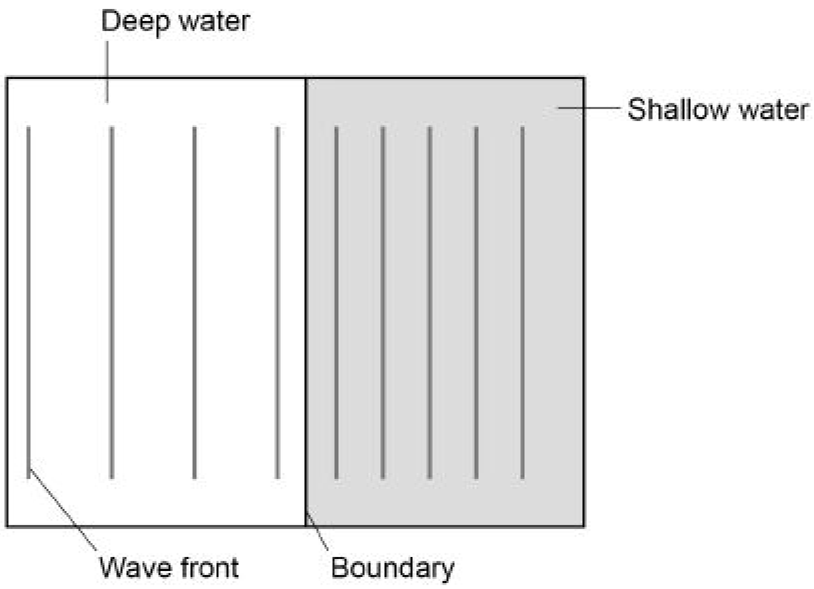
____

____

(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.

____

____

____

____

(2)

(Total 11 marks)

3. (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.

____

____

____

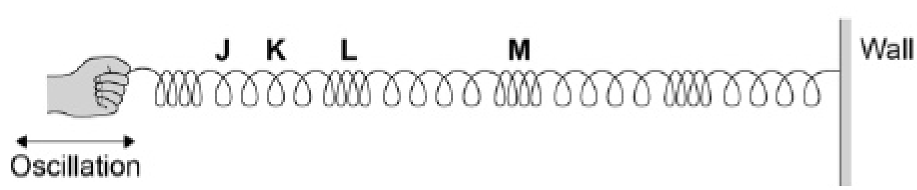
wavelength = ____________________ m

(3)

(Total 9 marks)

4. **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.

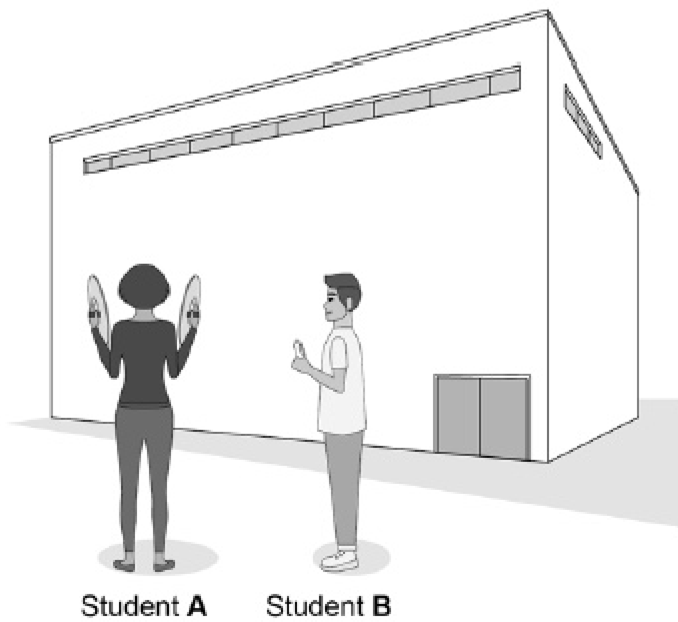
____

____

(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. ____

____

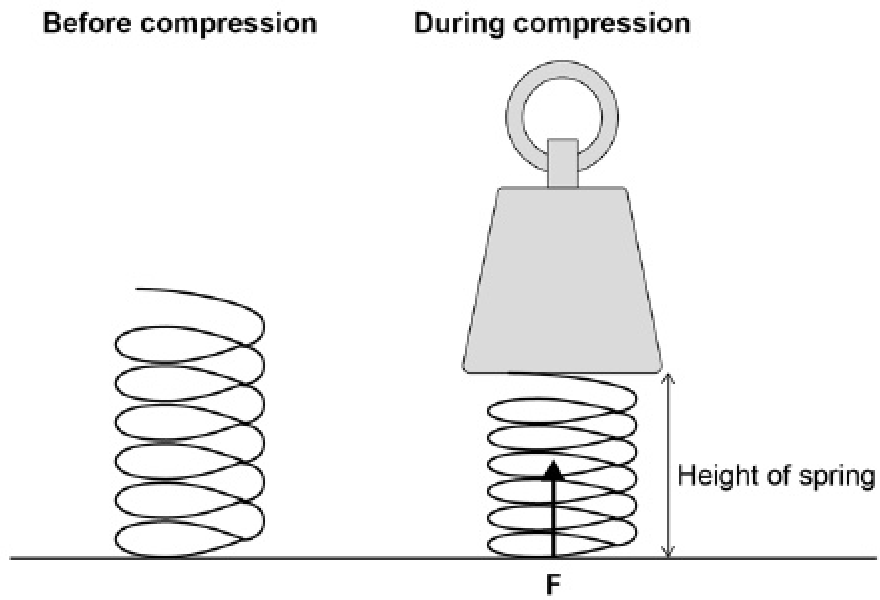
(2)

(Total 10 marks)

5. **Figure 1** shows a spring before and during compression.

The arrow F represents one of the two forces involved in compressing the spring.

Figure 1



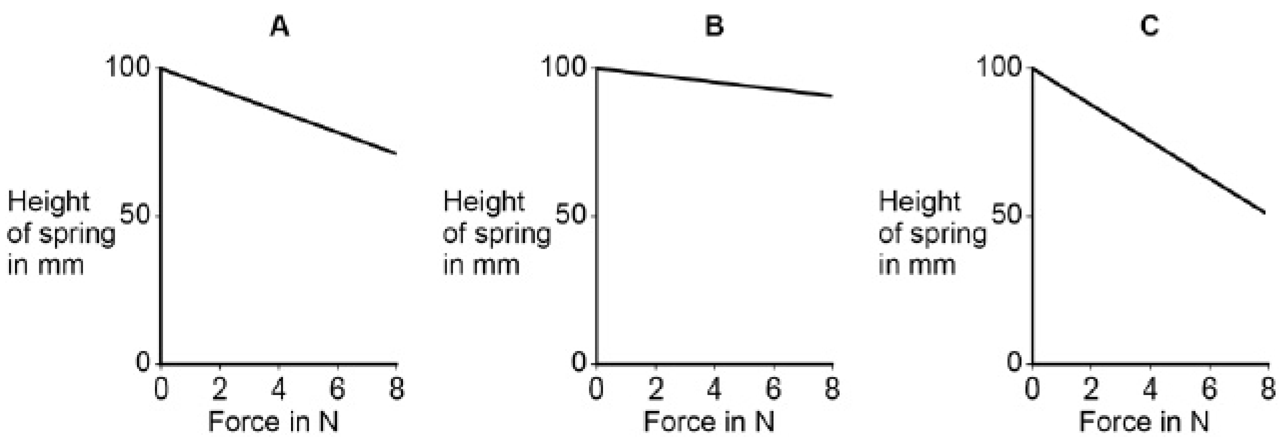
(a) Draw another arrow on **Figure 1** to represent the second force involved in compressing the spring.

(2)

A student investigated three different springs to compare the spring constants.

The results of the investigation are shown in **Figure 2**.

Figure 2



(b) Which **one** of the springs has the smallest spring constant?

Tick **one** box.

A ☐ **B** ☐ **C** ☐

Give the reason for your answer.

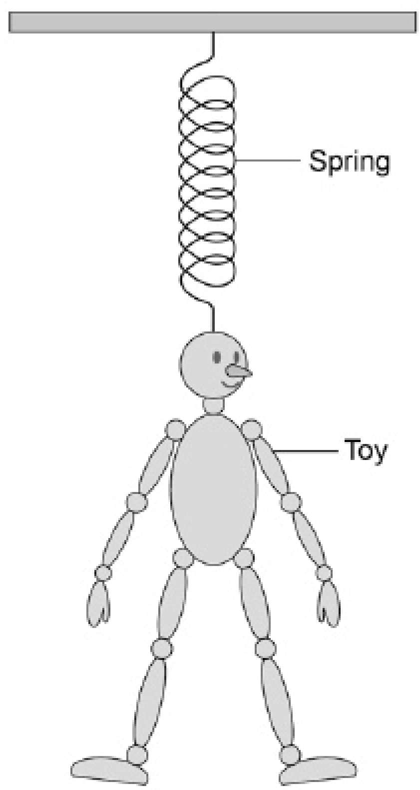
___

___

(2)

Figure 3 shows a child's toy. The toy hangs from a hook in the ceiling.

Figure 3



A child pulls the toy downwards and then releases it.

The toy oscillates up and down with a frequency of 1.25 Hz

(c) How many times each second will the toy oscillate up and down?

___

(1)

(d) Calculate the period of the oscillating toy.

Use the Physics Equations Sheet.

____

____

____

Period = ____________________ s

(2)

(e) When the toy is stationary, its weight causes the length of the spring to increase from 0.05 m to 0.25 m

The spring constant = 7.0 N/m

Calculate the elastic potential energy stored in the spring.

____

____

____

____

____

Elastic potential energy stored = ____________________ J

(3)

(Total 10 marks)

6. (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?

____

____

(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.

1.2×10^{3} Hz ☐

1.2×10^{6} Hz ☐

1.2×10^{9} Hz ☐

1.2×10^{12} Hz ☐

(1)

(e) Radio waves travel through space at a speed of 3.0×10^8 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?

____

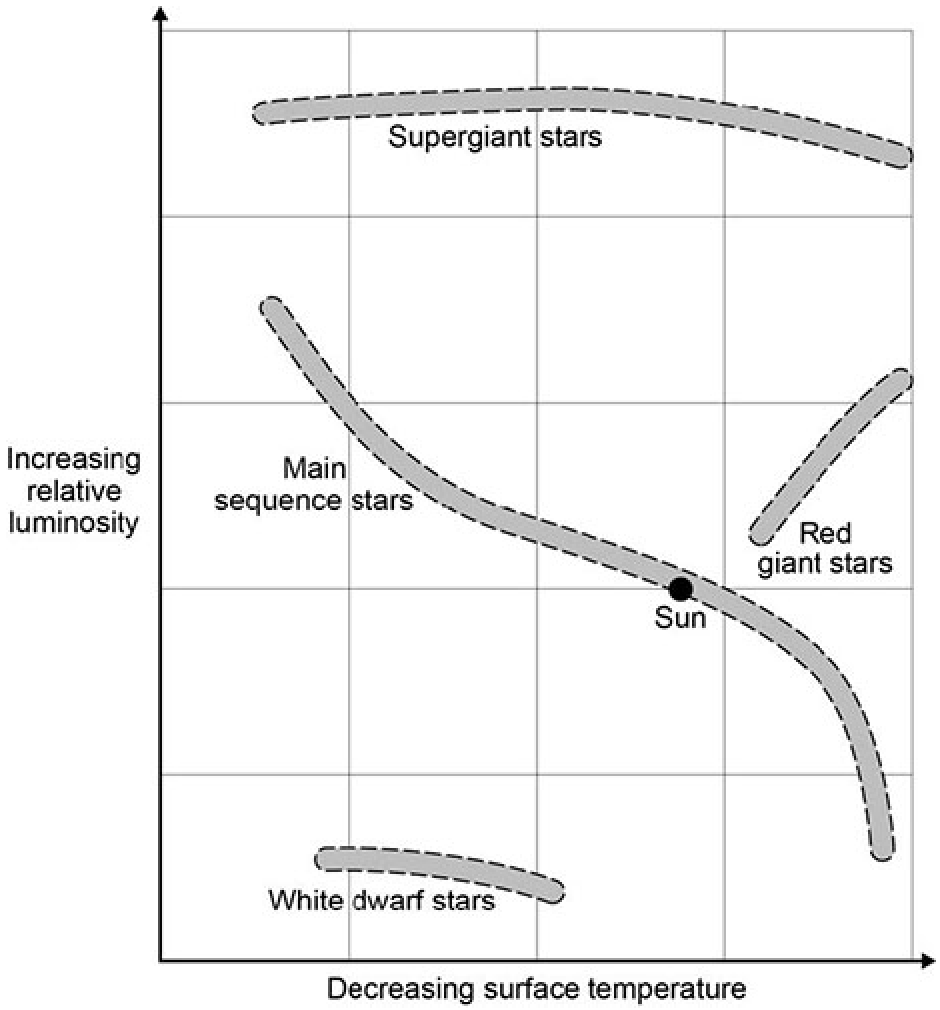
____

(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.

____

____

____

____

(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.

___

___

___

___

___

___

___

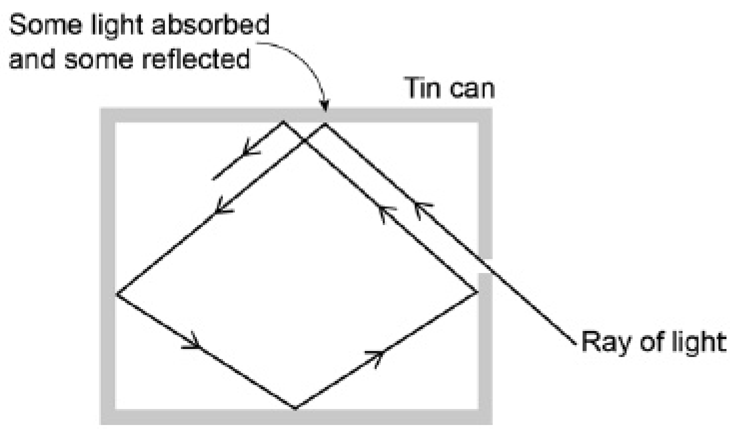
___

(4)

(Total 8 marks)

7. **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.

___

___

___

___

___

(2)

(b) All objects absorb and emit radiation.

What is meant when an object is described as a perfect black body?

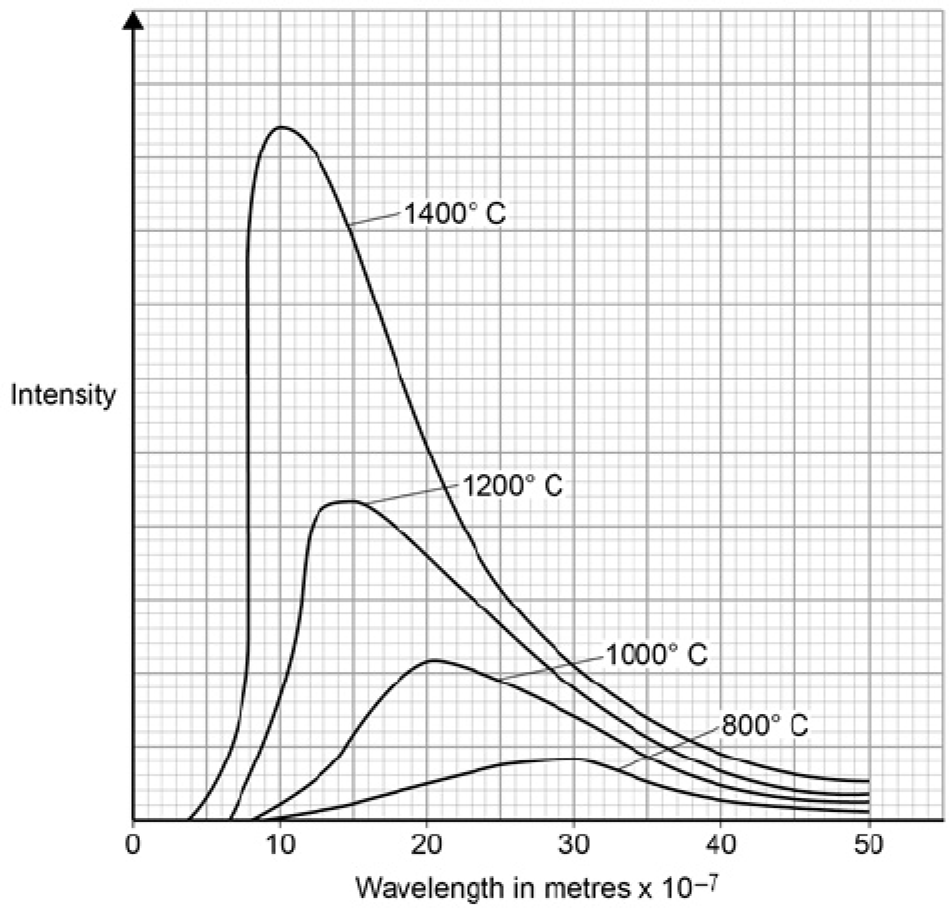
____

____

(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?

(3)

(d) The wavelength at which the Sun emits the maximum intensity of radiation is approximately 5 × 10–7 m

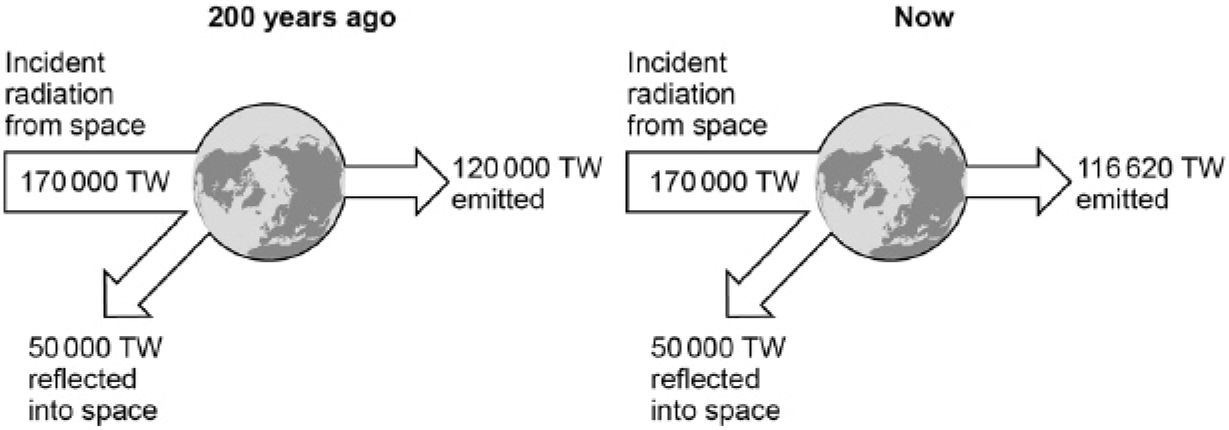
Estimate the surface temperature of the Sun.

Use **Figure 2**.

(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**.

____

____

____

____

____

____

____

____

____

(3)

(Total 10 marks)

Mark schemes

1.

(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]

2.

(a) an idea used to explain observations and data

1

(b) different models may be appropriate in different situations

allow one particular model may not be able to explain all observations

1

(c) new (experimental) evidence / data

1

evidence cannot be explained using an existing model
or
predictions made using old model are shown to be incorrect

allow old model based on data now shown to be incorrect

1

new model explains new evidence
or
predictions made with new model are shown to be correct

1

a suitable example given
e.g. nuclear model of the atom replacing the plum pudding model

allow tectonic plates replacing static land masses

big bang theory replacing other theories for the creation of the universe

allow heliocentric model of solar system replacing geocentric model

1

(d) velocity / speed is slower in shallow water

1

so edge of wave (front) entering shallow water slows down

1

but the part of the wave (front) in deeper water continues at a higher speed (leading to a change in direction of the wave fronts)

allow one part of the wave (front) changes speed before other parts

allow an answer in terms of wave (front) travelling from shallow to deep water

1

(e) every point on the wave (front) enters / hits the shallow water at the same time

1

and so every point slows down at the same time

allow changes speed for slows down

allow an answer in terms of wave (front) travelling from shallow to deep water

1

[11]

3. (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]

4. (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]

5. (a) arrow drawn vertically downwards from the weight

1

same length as given arrow

1

(b) **C**

*reason only scores if **C** is chosen*

1

smallest force required for the same compression

steepest gradient is insufficient

1

(c) 1.25

1

(d) period = $\frac{1}{25}$

*an answer of 0.8 (s) scores **2** marks*

1

period = 0.8 (s)

1

(e) extension = 0.20 m

1

$E_e = 0.5 \times 7.0 \times (0.20)^2$

1

$E_e = 0.14$ (J)

*an answer of 0.14 scores **3** marks*

1

[10]

6. (a) gamma rays

1

(b) can travel through the atmosphere

1

(c) explosion of a red super giant
or
a supernova

1

(d) 1.2×10^9 Hz

1

(e) $3.0 \times 10^8 = 1.2 \times 10^9 \times \lambda$

*an answer of 0.25 (m) scores **3** marks*

*allow ecf from **(d)***

1

$$\lambda = \frac{3.0 \times 10^8}{1.2 \times 10^9}$$

1

$\lambda = 0.25$ (m)

1

(g) same as the radio wave

1

(f) expansion due to fusion energy

1

in equilibrium with gravitational collapse

*forces acting inwards equal forces acting outwards gains **1** mark*

1

(h)

Level 2: Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account.	3-4
Level 1: Facts, events or processes are identified and simply stated but their relevance is not clear.	1-2
No relevant content	0
Indicative content • Sun goes from main sequence to red giant • then from red giant to white dwarf • when the Sun changes to a red giant the surface temperature will decrease • and the relative luminosity will increase • when changing from a red giant to a white dwarf the surface temperature increases • and the relative luminosity decreases	

4

[14]

7. (a) light (inside the tin can) is reflected many times before incident on the hole

1

at each reflection energy / light is absorbed so (very) little light / energy leaves the hole

1

(b) the object absorbs all of the radiation incident on it
or
the object does not reflect or transmit any radiation
or
the object is the best possible emitter of radiation

1

(c) the intensity of every wavelength increases

1

the shorter the wavelength the more rapid the increase in intensity

1

the peak intensity occurs at shorter wavelength

1

(d) accept any value between 1600 (°C) and 10 000 (°C)

1

(e) the temperature has increased

1

as 200 years ago the energy / radiation from space = energy / radiation emitted (and reflected) into space

1

but now less radiation is emitted so there is a net absorption

allow energy for radiation

1

[10]