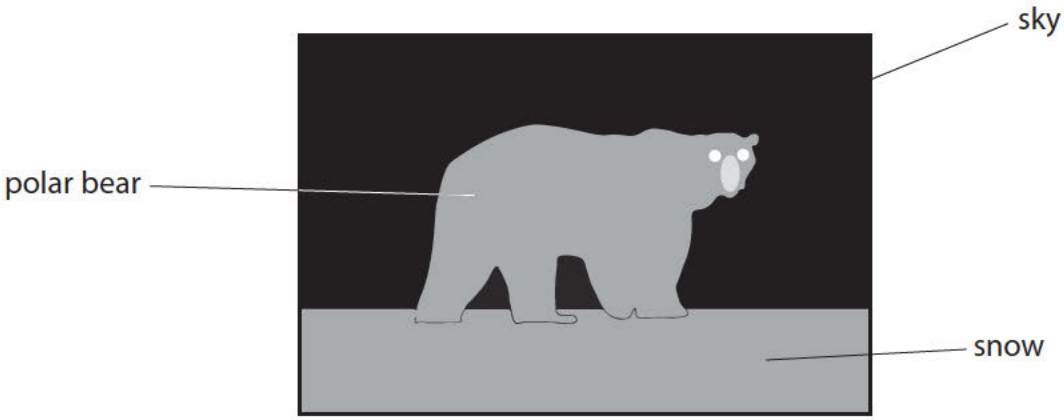
1 Polar bears have thick fur to keep them warm.

(a) This photograph of a polar bear was taken using visible light.



The diagram shows a thermal image of the same scene.



Darker colours in this image indicate lower temperatures.

Discuss what information the image gives about the temperatures of the objects shown.

(2)

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(b) The polar bear's fur includes short hairs and longer hairs.

These longer hairs are hollow and contain air.

(i) Explain how its fur reduces the amount of thermal energy lost by the polar bear.

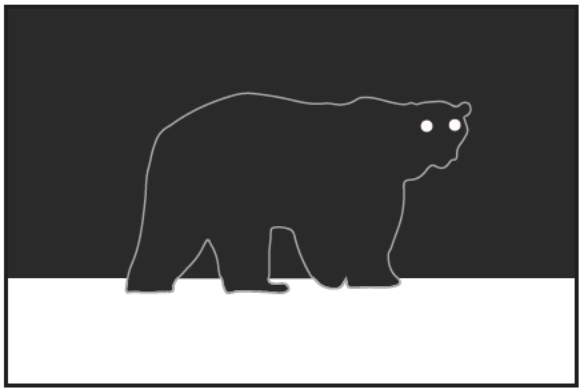
(2)

(ii) Underneath its white fur, a polar bear has black skin.

Discuss how these colours affect the overall amount of thermal energy lost by the polar bear's body.

(3)

(c) The diagram shows another image of the same scene.



The image was made during the day using ultraviolet rays from the Sun.

Brighter colours in this image indicate larger amounts of ultraviolet radiation.

The grey line is added to show the position of the polar bear.

(i) Compare the absorption and reflection of ultraviolet rays by the objects shown in the image.

(2)

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(ii) Suggest why the sky appears dark, even though the Sun emits ultraviolet rays.

(1)

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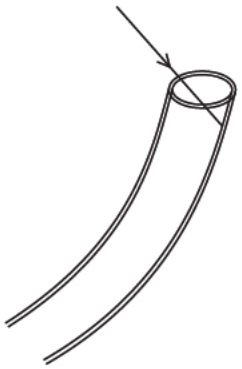
.....

(iii) The hollow hairs in polar bear fur are transparent tubes filled with air.

It was thought that these hairs could act like optical fibres and guide ultraviolet rays down to the polar bear's skin.

It is now known that this idea is **incorrect**. The ultraviolet rays do **not** reach the polar bear's skin.

The diagram shows an ultraviolet ray entering the air inside a hollow hair.



Suggest why this radiation does not pass down to the polar bear's skin.

(2)

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(Total for Question 1 = 12 marks)

2 This question is about electromagnetic waves.

(a) (i) Which of these has the shortest wavelength?

(1)

- ☒ **A** infrared
- ☒ **B** microwaves
- ☒ **C** ultraviolet
- ☒ **D** visible light

(ii) Which of these statements is **not** correct?

(1)

- ☒ **A** electromagnetic waves are longitudinal
- ☒ **B** electromagnetic waves can transfer energy
- ☒ **C** electromagnetic waves can travel between stars
- ☒ **D** electromagnetic waves travel at the same speed in free space

(iii) Which of these is a use for x-rays?

(1)

- ☒ **A** broadcasting television
- ☒ **B** cooking a potato
- ☒ **C** looking at the internal structure of objects
- ☒ **D** looking through night vision goggles

(b) Gamma radiation is used in hospitals even though it can be dangerous.

(i) Describe one use of gamma radiation in hospitals.

(2)

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(ii) Explain the risks to patients and doctors of using gamma radiation.

(2)

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(iii) State one way of reducing the risks to a doctor who uses gamma radiation.

(1)

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(Total for Question 2 = 8 marks)

3 The table shows the main sections of the electromagnetic spectrum.

Gamma rays	X-rays	Ultraviolet	Visible	Infrared	Microwaves	Radio



(a) (i) State two sections of the spectrum that are used for communications.

(2)

1 .....

2 .....

(ii) State two sections of the spectrum that are used for cooking.

(2)

1 .....

2 .....

(b) The arrow below the table shows the direction of

(1)

- ☒ **A** increasing wave amplitude
- ☒ **B** increasing wave frequency
- ☒ **C** increasing wave speed
- ☒ **D** increasing wavelength

(c) A radio station broadcasts at a frequency of 200 kHz.

The wavelength of the radio waves is 1500 m.

(i) State the equation linking wave speed, frequency and wavelength.

(1)

(ii) Calculate the speed of these radio waves and give the unit.

(3)

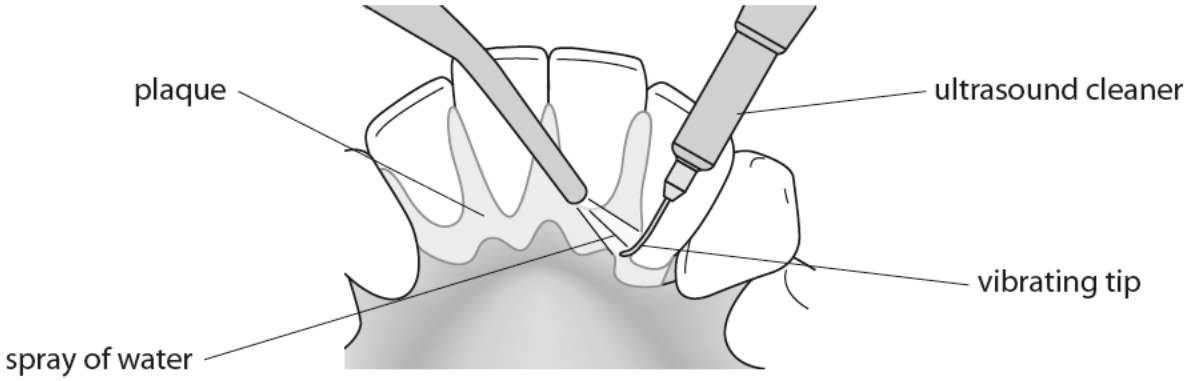
speed = ... unit .....

(Total for Question 3 = 9 marks)

4 Ultrasound waves are sound waves with a very high frequency. They are often used for medical purposes.

(a) Dentists use ultrasound waves to clean patients' teeth.

The diagram shows an ultrasound cleaner removing plaque from teeth.



The tip of the ultrasound cleaner vibrates 96 million times per second and is sprayed with water.

(i) State the frequency of the ultrasound emitted by the cleaner and give the unit.

(2)

frequency = ... unit .....

(ii) Suggest how the cleaner removes plaque.

(1)

.....

.....

(iii) Suggest why water is sprayed on the tip of the cleaner.

(1)

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(b) Ultrasound waves are also used to produce images.

This is an ultrasound image of a fetus surrounded by fluid.



(i) The ultrasound image is caused by waves which bounce off the fetus.

This is an example of waves that are

(1)

☒ **A** absorbed

☒ **B** reflected

☒ **C** refracted

☒ **D** repelled

(ii) State the equation linking wave speed, frequency and wavelength.

(1)

(iii) The ultrasound waves have a wavelength of 0.00044 m and travel at a speed of 1540 m/s in the fluid.

Calculate the frequency, in MHz, of the ultrasound waves.

(3)

frequency = ... MHz

(c) Other waves also have medical uses.

Ultraviolet waves are used by doctors to cure some skin conditions.

Suggest two differences between ultrasound waves and ultraviolet waves.

(2)

1 .....

.....

2 .....

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(Total for Question 4 = 11 marks)

5 The Earth receives different types of electromagnetic wave from the Sun.

These include

- infrared
- ultraviolet
- visible light

(a) Complete the table by arranging these three types of electromagnetic wave in order of decreasing wavelength.

(1)

longest wavelength →		**shortest wavelength**

(b) Name two other types of electromagnetic wave.

(2)

1 .....

2 .....

(c) Ultraviolet waves are useful, but they can be dangerous.

(i) State two uses of ultraviolet waves.

(2)

1 .....

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2 .....

.....

(ii) State two dangers of ultraviolet waves.

(2)

1 .....

.....

2 .....

.....

(Total for Question 5 = 7 marks)

6 This question is about parts of the electromagnetic spectrum.

radio waves	**A**	infrared	visible light	ultraviolet	**B**	gamma rays

(a) The names of two parts of the electromagnetic spectrum are missing.

Complete the table with the names of the missing parts.

(2)

	Name
A	
B	

(b) The Sun emits different types of electromagnetic waves.

(i) Which of these is the same for all the waves?

(1)

- ☒ **A** amplitude
- ☒ **B** frequency
- ☒ **C** speed
- ☒ **D** wavelength

(ii) Which type of electromagnetic wave causes sunburn and snow blindness?

(1)

- ☒ **A** gamma rays
- ☒ **B** infrared
- ☒ **C** radio waves
- ☒ **D** ultraviolet

(Total for Question 6 = 4 marks)

7 The Sun emits visible light, infrared and ultraviolet that travel through space and reach the surface of the Earth.

(a) State two similarities between visible light, infrared and ultraviolet.

(2)

1 .....

2 .....

(b) Too much exposure to infrared and ultraviolet can cause damage to the human body.

State the damage that each can cause.

(2)

infrared .....

.....

ultraviolet .....

.....

(c) Seven colours can be seen in the visible light spectrum.

Which colour has the longest wavelength?

(1)

.....

(Total for Question 7 = 5 marks)