Waves 5

Name: _____

Class: _____

Date: _____

Time: **59 minutes**

Marks: **59 marks**

Comments:

1. Radio waves and microwaves are two types of electromagnetic wave.

Both waves:

- can be used for communications
- travel at the same speed through air.

(a) Give **two** more properties that are the same for both radio waves and microwaves.

1. _____

_____

2. _____

_____

(2)

(b) Some satellites are used to transmit television programmes. Signals are sent to, and transmitted from, the satellites using microwaves.

What is the property of microwaves that allows them to be used for satellite communications?

_____

_____

(1)

(c) Electromagnetic waves travel at a speed of 3.0×10^8 m/s.

A radio station transmits waves with a wavelength of 2.5×10^2 m.

Calculate the frequency of the radio waves.

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

_____

_____

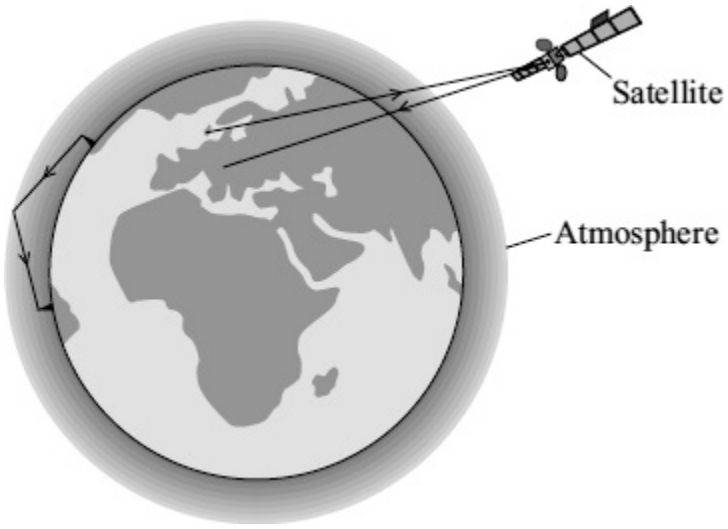
_____

Frequency = _____

(3)

(Total 6 marks)

2. (a) Electromagnetic waves have many uses. The diagram shows two ways of sending information using electromagnetic waves.



(i) What type of wave is used to send information to and from satellites?

_____

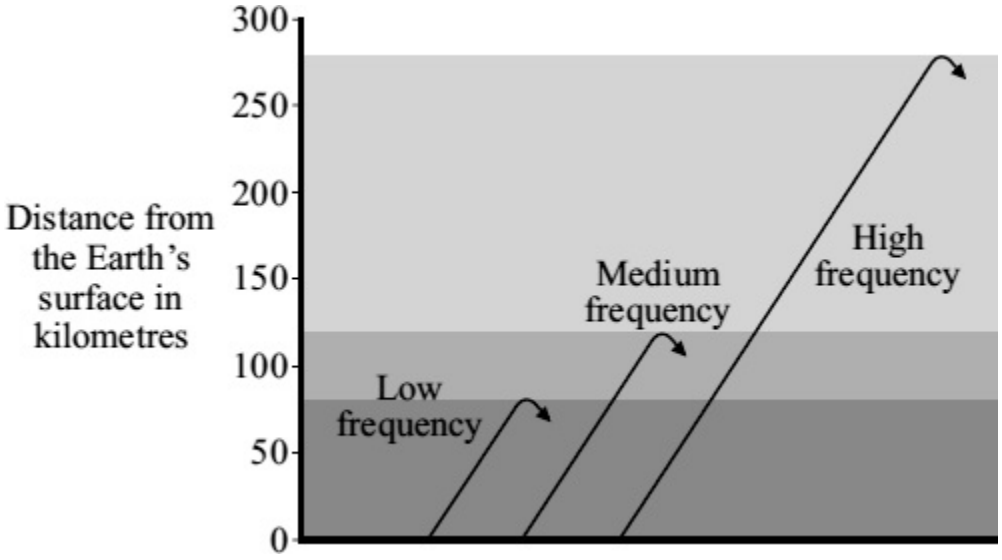
(1)

(ii) What property of this type of wave makes it suitable for satellite communications?

_____

(1)

(b) Different frequency radio waves travel different distances through the atmosphere before being reflected.



Use the information in the diagram to describe the connection between the frequency of a radio wave and the distance the radio wave travels through the atmosphere before it is reflected.

_____

_____

(1)

(c) Electromagnetic waves travel at a speed of 300 000 000 m/s.

A radio station transmits waves with a wavelength of 20 metres.

Calculate the frequency, in kilohertz (kHz), of these waves.

Show clearly how you work out your answer.

_____

_____

_____

_____

Frequency = _____ kHz

(2)

(Total 5 marks)

3. (a) The table gives information about the frequencies in the hearing ranges of six different mammals.

Name of mammal	Frequencies in hearing range
Bat	20 Hz → 160 kHz
Dog	20 Hz → 30 kHz
Dolphin	40 Hz → 110 kHz
Elephant	5 Hz → 10 kHz
Human	20 Hz → 20 kHz
Tiger	30 Hz → 50 kHz

(i) Which mammal in the table can hear the highest frequency?

_____

(1)

(ii) Which mammal in the table, apart from humans, **cannot** hear ultrasound?

_____

(1)

(iii) Give **one** example of a frequency which an elephant can hear but which a tiger **cannot** hear.

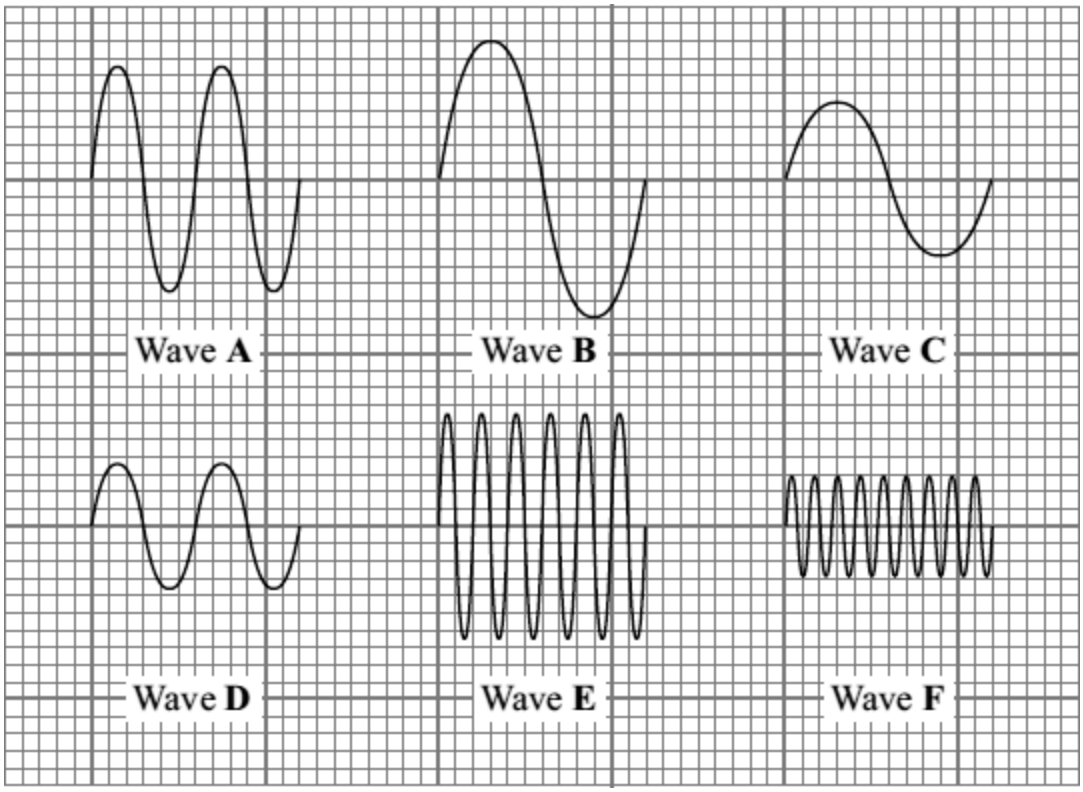
Include the unit in your answer.

Frequency _____

(1)

(b) The diagrams show six sound waves, **A**, **B**, **C**, **D**, **E** and **F**, represented on an oscilloscope screen.

They are all drawn to the same scale.



(i) Which **one** of the waves has the greatest amplitude?

Wave _____

(1)

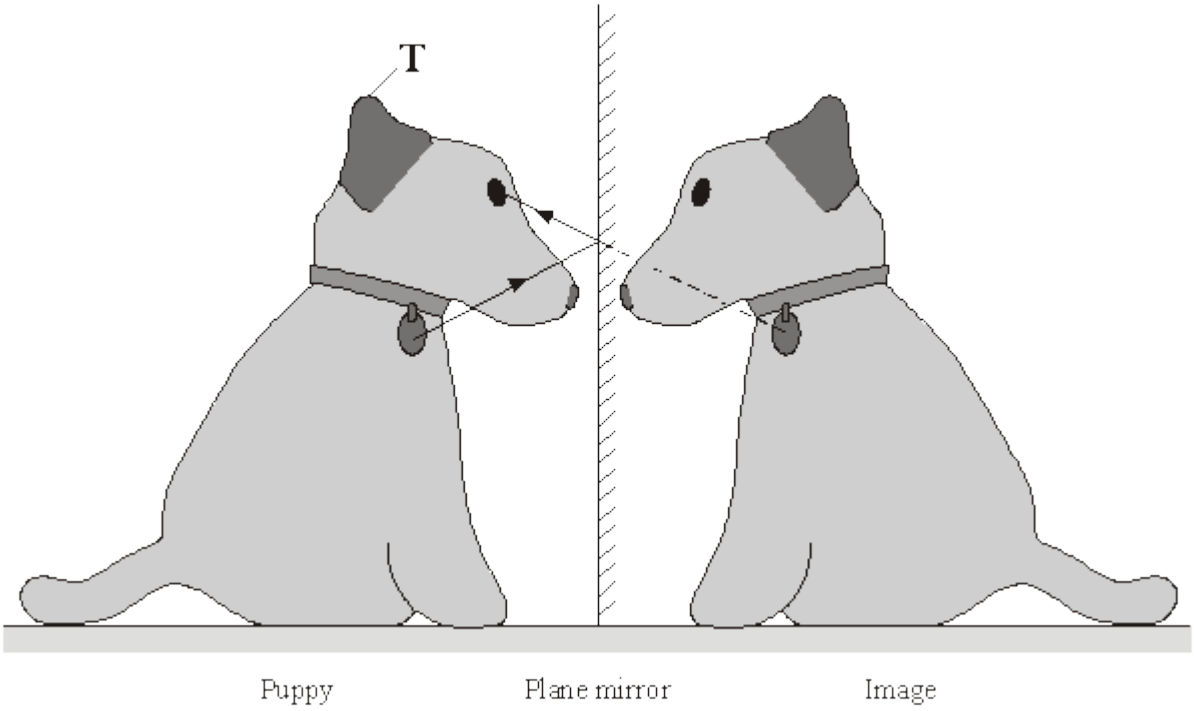
(ii) Which **one** of the waves has the highest frequency?

Wave _____

(1)

(Total 5 marks)

4. A puppy can see an image of himself in a plane mirror.



The diagram shows how the puppy can see his disc.

(a) On the diagram, use a ruler to draw a ray to show how the puppy can see the top of his ear, which is marked as **T**.

(3)

(b) What is a plane mirror?

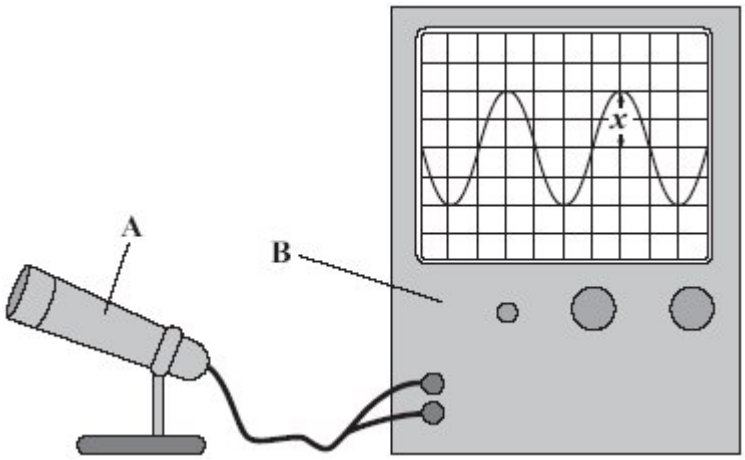
_____

_____

(1)

(Total 4 marks)

5. (a) A student uses two pieces of equipment, **A** and **B**, to display a sound wave.



(i) Use words from the box to complete the sentence.

a loudspeaker	a microphone	an oscilloscope	a screen

A is _____ and **B** is _____ .

(2)

(ii) Use words from the box to complete the sentence.

the amplitude	half the amplitude	the frequency	half the frequency

The distance ***x*** marked on the diagram measures _____ of the sound wave.

(1)

(iii) Complete the sentence.

The distance ***x*** becomes smaller. This is because the sound has

become _____ .

(1)

(b) There is no air in space.

Astronauts in space cannot hear sounds from outside their spacesuits.

Explain this.

_____

_____

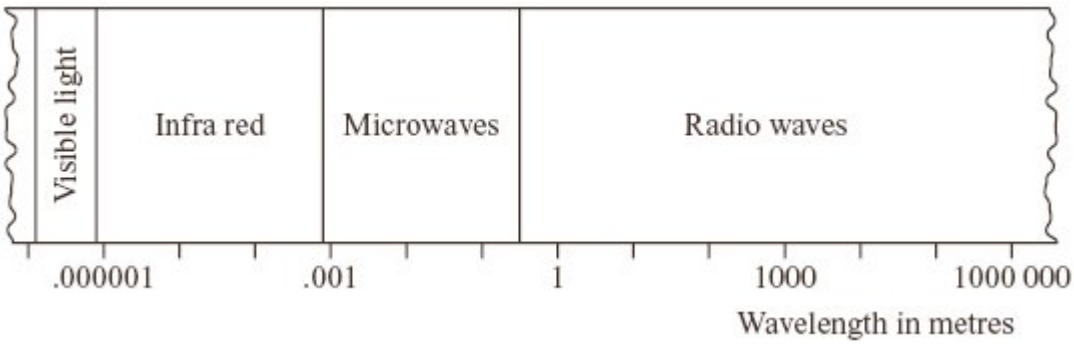
_____

_____

(2)

(Total 6 marks)

6. The diagram represents part of the electromagnetic spectrum.



(i) Visible light travels through air at 300 000 000 m/s.

Why can we assume that radio waves travel through air at the same speed as light?

_____

(1)

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

Calculate the wavelength of the waves broadcast by this radio station. Show clearly how you work out your answer.

_____

_____

Wavelength = _____ m

(2)

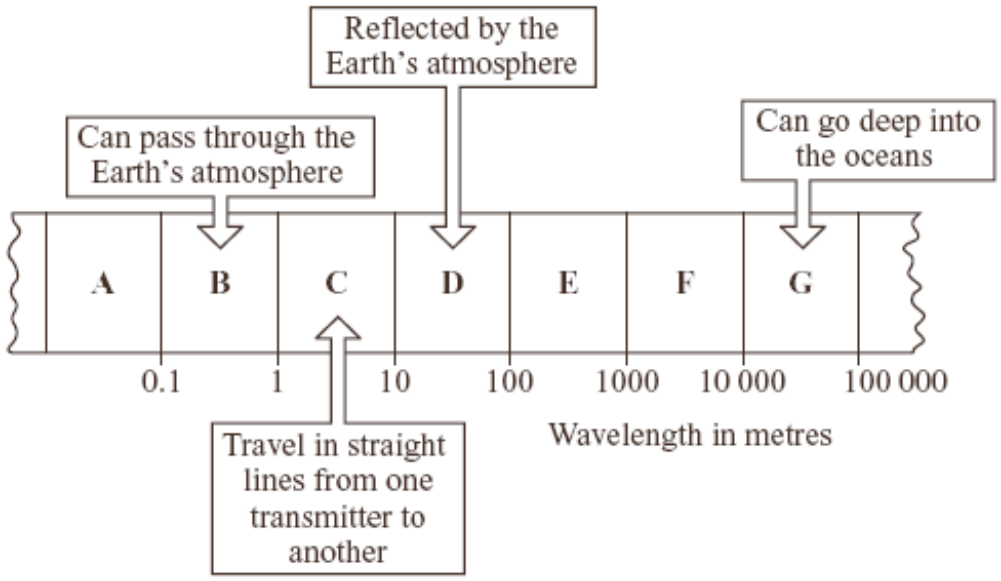
(iii) Draw a vertical line on the diagram above to show the position of this radio wave in the electromagnetic spectrum.

(1)

(Total 4 marks)

7. The diagram shows a small part of the electromagnetic spectrum divided into seven sections.

The different properties of the waves in each section make them useful in different ways.



The waves in which section, **A**, **B**, **C**, **D**, **E**, **F** or **G**, are:

(a) used to send a signal to a satellite in space

_____

(1)

(b) used to communicate with a submarine under the water

_____

(1)

(c) used by a radio station to broadcast programmes around the world

_____

(1)

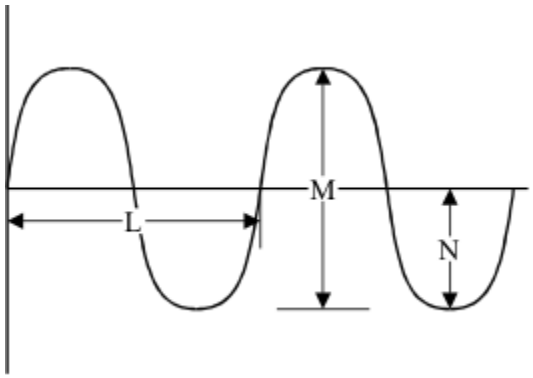
(d) the waves with the shortest wavelength?

_____

(1)

(Total 4 marks)

8. (a) The diagram shows a wave pattern.



Which letter, **L**, **M** or **N** shows:

(i) the wavelength? _____

(ii) the amplitude? _____

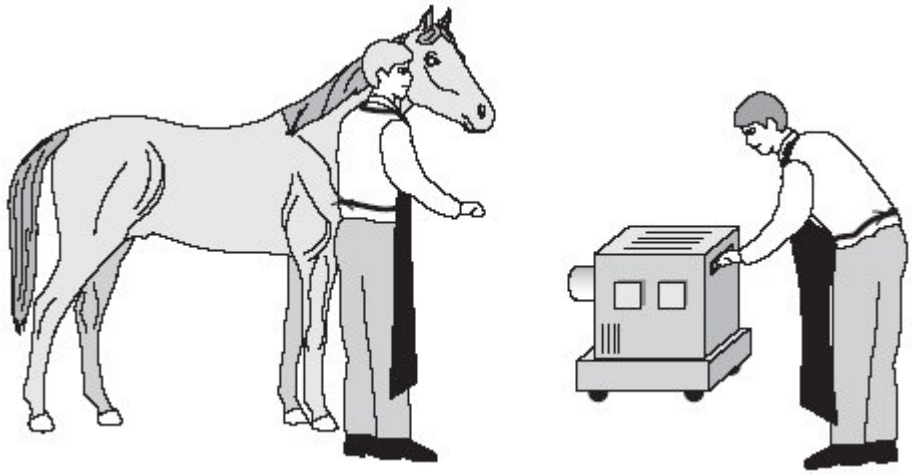
(2)

(b) Describe how you could show that visible light travels in straight lines. You may wish to draw a diagram to help explain your answer.

(2)

(Total 4 marks)

9. The picture shows a horse being prepared for an X-ray.



The person who will take the X-ray and the person holding the horse are wearing special aprons. These aprons have a lead lining.

Explain why the lead lining is important.

To gain full marks in this question you should write your ideas in good English.
Put them into a sensible order and use the correct scientific words.

_____

_____

_____

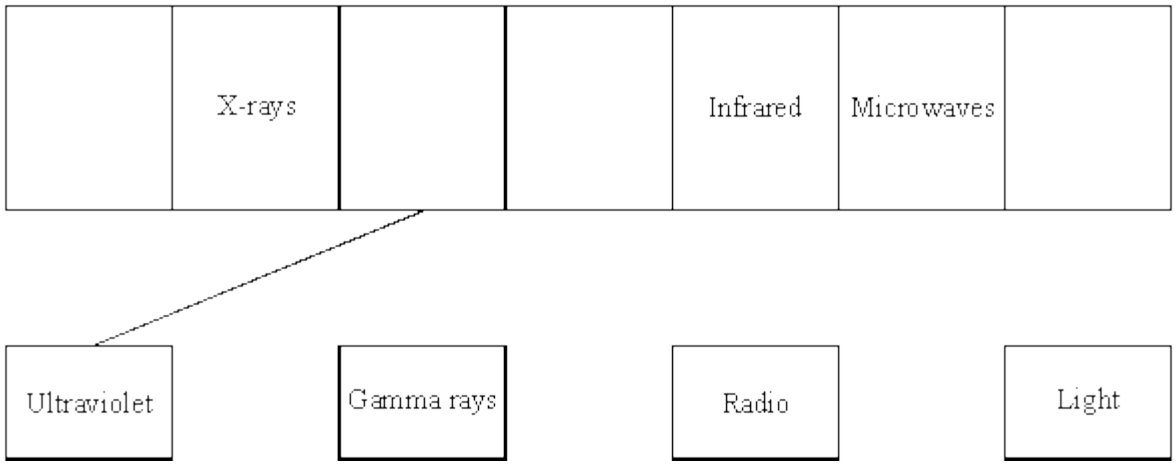
_____

_____

_____

(Total 3 marks)

10. (a) The diagram represents the electromagnetic spectrum. Four of the waves have not been named. Draw lines to join each of the waves to its correct position in the electromagnetic spectrum. One has been done for you.



(2)

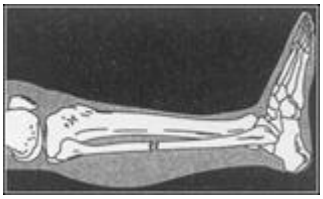
(b) Complete the following sentence by choosing the correct answer and crossing out in the box the two lines which are wrong.

The speed of radio waves through a vacuum is | faster than
the same as
slower than | the speed of

light through a vacuum.

(1)

(c) The diagram shows an X-ray photograph of a broken leg.



Bones show up white on the photographic film. Explain why.

_____

_____

_____

(2)

(Total 5 marks)

11. Radio waves, ultra-violet, visible light and X-rays are all types of electromagnetic radiation.

(a) Choose wavelengths from the list below to complete the table.

3×10^{-8} m 1×10^{-11} m 5×10^{-7} m 1500 m

TYPE OF RADIATION	WAVELENGTH (m)
Radio waves	
Ultra-violet	
Visible light	
X-rays	

(4)

(b) Microwaves are another type of electromagnetic radiation.

Calculate the frequency of microwaves of wavelength 3 cm.
(The velocity of electromagnetic waves is 3×10^8 m/s.)

_____

_____

_____

_____

(4)

(Total 8 marks)

12. Most young people can hear sounds in the frequency range 20 Hz to 20 000 Hz.

(a) Tick the box beside the statement which best describes frequency.

the maximum disturbance caused by a wave ☐

the number of complete vibrations per second ☐

the distance between one crest of a wave and the next one ☐

the distance travelled by a wave in 1 second ☐

(1)

(b) Diagram **X** shows a trace on an oscilloscope screen.

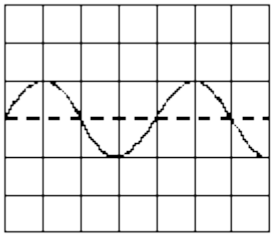


Diagram **X**

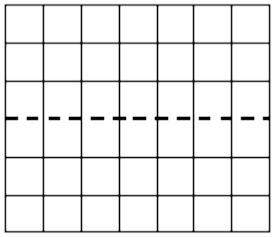


Diagram **Y**

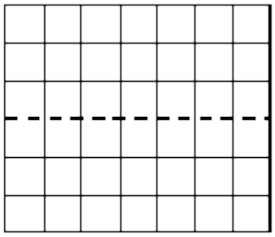


Diagram **Z**

(i) Draw a trace on diagram **Y** which has a higher frequency than that shown in diagram **X**.

(ii) Draw a trace on diagram **Z** which has a larger amplitude than that shown in diagram **X**.

(2)

(c) Choose words from the list below to complete the following sentences.

higher **louder** **lower** **quieter**

(i) A musical note with a high frequency sounds _____ than one with a low frequency.

(ii) A noise of small amplitude sounds _____ than one with large amplitude.

(2)

(Total 5 marks)

1. (a) any **two** from:

- travel (at same speed) through a vacuum / space
  *do **not** accept air for vacuum*
- transverse
- transfer energy
- can be reflected
- can be refracted
- can be diffracted
- can be absorbed
- travel in straight lines

2

(b) can pass through the ionosphere
accept atmosphere for ionosphere
*do **not** accept air for ionosphere*
accept travel in straight lines
accept not refracted / reflected / absorbed by the ionosphere

1

(c) $v = f \times \lambda$

1.2×10^6 / 1200 000
*allow **1** mark for correct substitution*
ie $3.0 \times 10^8 = f \times 2.5 \times 10^2$

2

hertz / Hz
*do **not** accept hz **or** HZ*
*accept kHz **or** MHz*
*answers 1.2 MHz **or** 1200 kHz gain all **3** marks*
for full credit the unit and numerical value must be consistent

1

[6]

2. (a) (i) microwaves

1

(ii) can pass through the ionosphere
accept travels in a straight line
accept atmosphere for ionosphere
*do **not** accept air for ionosphere*

1

(b) higher the frequency, further the wave travels
(into the atmosphere before reflection)

1

(c) 15 000

*allow **1** mark for correct transformation and substitution*

ie $\frac{300\,000\,000}{20}$

*an answer of 15 000 000 only gains **1** mark*

allow both marks for an answer of 15 MHz (unit must be changed)

an answer of 15 gains no credit

2

[5]

3.

(a) (i) bat(s)

1

(ii) elephant(s)

1

(iii) any example in the inclusive range 5 ↔ 29 Hz / hertz

appropriate number and unit both required

1

(b) (i) **B**

1

(ii) **F**

1

[5]

4.

(a) reflection at the mirror of ray from tip of real puppy's ear to real puppy's eye (1)

may be drawn freehand

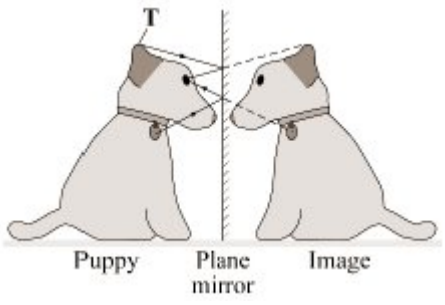
accurate (1)

ruler must have been used and the reflected ray is an extension of the straight line from point virtual ear however the virtual part of the line need not be shown

arrow to show correct direction (1)

only one arrow needs to be shown but there must be no contradiction

example of (3) mark response



3

(b) flat

accept 'it's not curved/bent'

accept 'it's straight'

1

[4]

5.

(a) (i)

correct order essential

(**A** =) a microphone

1

(**B** =) an oscilloscope

***or** cathode ray oscilloscope **or** CRO*

1

(ii) the amplitude

accept any unambiguous indication

1

(iii) quieter / softer

*do **not** accept less (which could refer to the amplitude, frequency or wavelength)*

1

(b) sound cannot travel through a vacuum / (empty) space / free space

accept there is no medium for the sound to travel through

1

(because) there is / are nothing / no particles to vibrate

accept (because) there is / are nothing / no particles between them and the source (of the sound)

1

[6]

6.

(i) all electromagnetic waves travel at the same speed through a vacuum, (so assume same speed in air)

accept 'all parts of spectrum' for electromagnetic waves

1

(ii) 1500 (m)

allow 1 mark for correct transformation and substitution

allow 1 mark for using 200 000 Hz

*answers 1 500 000 = **1** mark*

2

(iii) line drawn at correct position

anywhere between 1000 and next section (10 000)

accept their value for (a)(ii) drawn in

the correct position

1

[4]

7. (a) B

1

(b) G

1

(c) D

1

(d) A

1

[4]

8. (a) (i) L

1

(ii) N

1

(b) the answer should be in the form:

not *inside the eye*

either for **both** marks an arrangement which could demonstrate visibly light travels in straight lines

full credit should be given for answer presented as a diagram

and
an explanation of how it shows the straightness

or for one mark

named device which uses principle of light travelling in straight lines to work

examples
light (from a street lamp) strikes an object producing a shadow
laser light travelling through (fine) dust shows a straight beam
three pieces of card with central holes need to be lined up to be able to see through the third hole from the first
ray box type experiment using mirrors/prisms, etc
beams on paper or in smoke
torch beams through smoke
example devices:–
–pinhole camera (qualification may get second mark)
–periscope
–optical fibre
–reflection 'in a ***mirror***

2

[4]

9. **Quality of written communication**

*award for a sensible sequence of **two** points*

1

X-rays do not go through lead

accept lead protects them from the X-rays
accept not exposed to X-rays

1

lead stops / reduces risk of X-rays harming / damaging / killing (persons) cells

accept X-rays (may) cause cancer

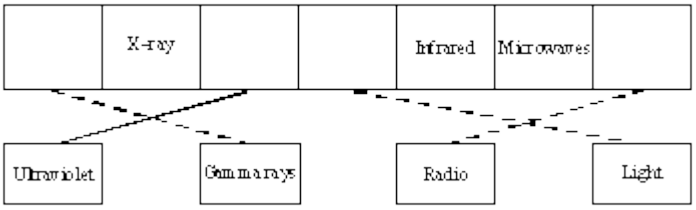
accept organs for cell
*do **not** accept references to electric shock*
*do **not** accept stops bones of people showing on X-ray*
answers involving the horse wearing an apron are incorrect

references to gamma rays are incorrect

1

[3]

10. (a) all **three** correct



***one** only correct, **1** mark only*

allow names in boxes

*there should be only **one** line from **or** to each box*

2

(b) the same as

1

(c) any **two** from:

- bones absorb X-rays
- so film not exposed
- X-rays pass through flesh or skin or
- body or tissue (to expose film)

allow X-rays cannot pass through bones

2

[5]

11. (a) radio – 1500
ultra violet 3×10^{-8}
visible – 5×10^{-7}
X-rays – 1×10^{-11}

4

(b) 1×10^{10}Hz 10^{10}HzOK

for 4 marks

else 1×10^{10}

for 3 marks

else 3×10^{8}/0.03

for 2 marks

else v = frequency × wavelength or $3 \times 10^{8} = 0.03$f
any answer with unit Hz scores 1, 2 or 3

for 1 mark

4

[8]

12. (a) number of complete vibrations per second

for 1 mark

1

(b) (i) correct trace (more waves), *ignore amplitude*

for 1 mark

1

(ii) correct trace (higher amplitude), *ignore frequency*

for 1 mark

1

(c) (i) higher

for 1 mark

1

(ii) quieter

for 1 mark

1

[5]