

Mark schemes

- 1.** (a) C 1
- (b) radio waves have a longer wavelength than ultraviolet 1
- (c) (risk of) skin cancer
cancer is insufficient
or
(prematurely) ageing skin
skin damage is insufficient
ignore kills skin cells 1
- (d) risk is higher (for X-ray of uds than X-ray of chest) 1
- by a factor of 50
- or**
- risk calculated for each type of X-ray
chest X-ray = 1:200 000 (1)
uds = 1:4000 (1) 1
- [5]
- 2.** (a) sound 1
- (b) (visible) light 1
- (c) cooking food 1
- (d) 1.2 gigahertz 1
- (e) $300\,000 \times 1000 = 300\,000\,000$ m/s 1
- (f) wave speed = frequency \times wavelength
allow $v = f\lambda$ 1

- (g) $300\,000\,000 = 1\,200\,000\,000 \times \lambda$
an answer of 0.25 scores 3 marks

1

$$\lambda = \frac{300\,000\,000}{1\,200\,000\,000}$$

allow ecf from (e)

1

$$\lambda = 0.25 \text{ (m)}$$

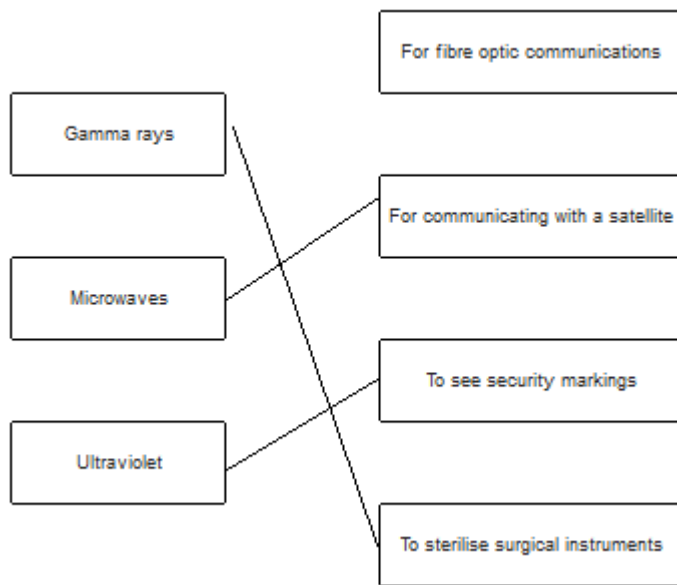
1

[10]

- 3.** (a) radio

1

- (b)



award 1 mark for each correct line
if more than one line is drawn from any em wave then none of those lines gain credit

3

- (c) ionising

1

[5]

4.	<p>(a) any one from:</p> <ul style="list-style-type: none"> • (visible) light • UV / ultra violet • X-ray • gamma / γ-ray 	1
	<p>(b) less than</p> <p style="padding-left: 40px;">less than</p> <p style="padding-left: 40px;">the same as</p>	1 1 1
		[4]
5.	<p>(a) use of infrared: remote controls fibre optic (communications)</p> <p>use of microwaves: mobile/cell phones <i>accept mobiles</i> <i>accept phone signals</i> satellite (communications/TV) wi-fi Bluetooth</p>	1
	<p>(b) any two from</p> <ul style="list-style-type: none"> • same speed <li style="padding-left: 20px;">or <li style="padding-left: 20px;">travel at the speed of light (in a vacuum) • transverse <li style="padding-left: 40px;"><i>accept a full description of a transverse wave</i> • transfer energy (from one place to another) • can be reflected • can be refracted • can be diffracted • can be absorbed / transmitted • can travel through a vacuum/space • can be polarised <li style="padding-left: 40px;"><i>travels in straight lines is insufficient</i> 	1
		[4]
6.	<p>(a) electromagnetic <i>accept e.m.</i></p>	1

- (b) (i) 2.2 (arbitrary units)
allow an answer between 2.1 and 2.3 1
- (ii) the thicker the tissue the lower the intensity
accept more intensity is needed to pass through thicker tissue 1
- the relationship is not linear
accept the line is not straight
allow for 1 mark
it still goes through with thicker tissue
or
intensity does not reach zero
or
at 5 cm X rays still pass through 1
- (iii) Both variables are continuous 1
- (c) (they are) absorbed
accept (they are) stopped 1
- (d) With a charge-coupled device (CCD). 1
- (e) (i) X-rays are ionising 1
- (ii) stand behind a (protective) screen
accept leave the room
accept wear a lead apron 1

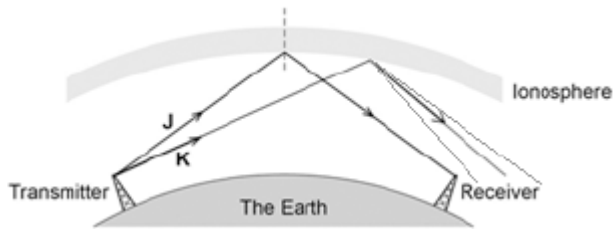
[9]

7.

- (a) (i) reflection of wave **K** at or within the ionosphere
allow dashed lines

1

angle $i = \text{angle } r$
'judge by eye'



tolerance for the reflected ray is between the first e and last r
ignore arrows

a reflected ray to the receiver doesn't score 2nd mark

additional rays shown don't score 2nd mark

1

- (ii) normal

1

- (b) (i) microwave

1

- (ii) refraction

1

- (c) All electromagnetic waves are transverse.

1

All electromagnetic waves have the same speed in a vacuum.

1

[7]

8.

- (a) 20,000

accept 20 kilo

or

20 k

or *20 001*

1

an atom

1

- (b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer in the Marking Guidance and apply a 'best-fit' approach to the marking.

0 marks

no relevant content

Level 1 (1–2 marks)

At least one relevant statement is given for either type of wave

Level 2 (3–4 marks)

either

a use, risk and precaution is given for one type of wave

or

A medical use is given for both types of wave

plus

a risk or precaution for one type of wave

Level 3 (5–6 marks)

At least one medical use is given for both types of wave linked to the risks and any precautions necessary

Examples of the points made in the response

Medical use of X-rays

Any one from:

- Detecting bone fractures
- Detecting dental problems
- Killing cancer cells
- CT scanning.

*Ignore details about how X-rays / ultrasound work
accept any specific use of X-rays, eg*

- *detecting heart / lung disorders (with chest X-rays)*
- *mammograms / breast cancer detection*
- *detecting stones / bowel disease (with abdominal X-rays)*

Risks with X-rays

X-rays pose a risk / danger / hazard

accept are harmful

X-rays cause ionisation / damage to cells

or

mutate cells / cause mutations / increase chances of mutations

or

turn cells cancerous / produce abnormal growths / produce rapidly growing cells

or

kill cells

accept a description of what ionising is

instead of cell, any of these words can be used: DNA / genes / chromosomes / nucleus

accept (may) cause cancer

Operator precautions with X-rays

The X-ray operator should go behind a (metal / glass) screen / leave the room when making an X-ray / wear a lead lined apron

accept appropriate precautions for the patient e.g. limit the total exposure / dose (in one year)

wear a radiation badge is insufficient

Medical use of ultrasound

Any one from:

- Pre-natal scanning
- Imaging (a named body part).
- removal / destruction of kidney / gall stones
- removing plaque from teeth

cleaning teeth is insufficient

- *accept examples of repair, eg alleviating bruising, repair scar damage, ligament / tendon damage, joint inflammation.*

accept physiotherapy

accept curing prostate cancer or killing prostate cancer cells

Risks with ultrasound

Ultrasound poses no risk / danger / hazard (to the user / patient)

accept ultrasound is safer than using X-rays

Ultrasound is not ionising

or

Ultrasound does not damage (human) cells

Precautions with ultrasound

The operator needs to take no precautions when making an ultrasound scan

this can be assumed if it is stated that ultrasound is harmless or it is safer than using x-rays or it is non-ionising

6

[8]

9.

(a) (i) frequency

1

wavelength

1

(ii) 10^{-15} to 10^4

1

(b) 2.0×10^5

*correct substitution of
 $3.0 \times 10^8 / 1500$ gains 1 mark*

2

Hz

1

(c) (i) (skin) burns

1

(ii) skin cancer / blindness

1

(d) (i) any **one** from:

- (detecting) bone fractures
- (detecting) dental problems
- treating cancer

1

(ii) any **one** from:

- affect photographic film
- absorbed by bone
- transmitted by soft tissue
- kill (cancer) cells

answer must link to answer given in (d)(i)

1

(iii) $9 / 36 = 0.25$
 $0.5 / 2 = 0.25$
 $4 / 16 = 0.25$

accept:

$$36 / 9 = 4$$

$$2 / 0.5 = 4$$

$$16 / 4 = 4$$

2

conclusion based on calculation

two calculations correct with a valid conclusion scores 2 marks

one correct calculation of k scores 1 mark

1

[13]