GCSE Physics

Electromagnetic Radiation

Mark Scheme

Time available: 75 minutes
Marks available: 65 marks

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 × 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]

3.   (a)   radio

        1

(b)

Gamma rays

Microwaves

Ultraviolet

For fibre optic communications

For communicating with a satellite

To see security markings

To sterilise surgical instruments
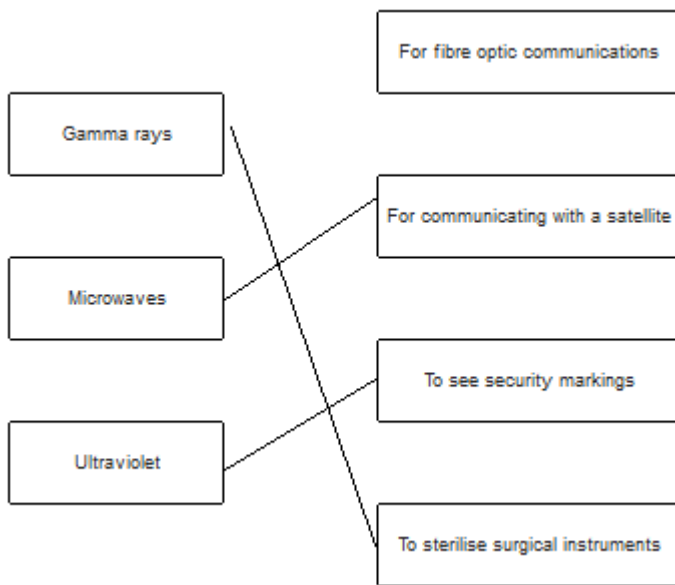
    *award **1** mark for each correct line*

    if more than one line is drawn from any em wave then none of those lines gain credit

        3

(c)   ionising

        1

        [5]

4. (a)   any **one** from:

- (visible) light
- UV / ultra violet
- X-ray
- gamma / γ-ray

1

(b)   less than

1

less than

1

the same as

1

[4]

5. (a)   **use of infrared:**
remote controls
fibre optic (communications)

1

use of microwaves:
mobile/cell phones

accept mobiles

accept phone signals
satellite (communications/TV)
wi-fi
Bluetooth

1

(b)   any **two** from
- same speed
  or
  travel at the speed of light (in a vacuum)
- transverse
  accept a full description of a transverse wave
- 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
  travels in straight lines is insufficient

2

[4]

6. (a)   electromagnetic

accept e.m.

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
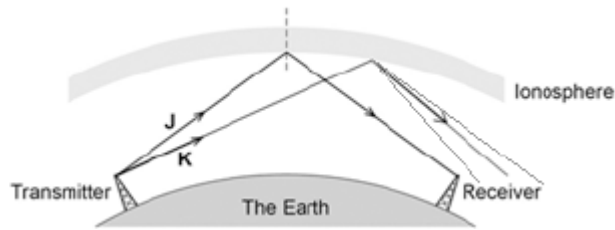
        accept wear a lead apron

                                          1

                                              [9]

7. (a) (i) reflection of wave **K** at or within the ionosphere

allow dashed lines

1

angle i = 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 2 nd mark

additional rays shown don't score 2 nd 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*

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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]