

**M1.** (a) any **two** from:

- (sound with frequency) above 20 000 hertz / 20 kHz
- frequencies above (human) audible range
- (sound) cannot be heard by humans

2

(b) **either**

two appropriate points gain **1** mark each

*either both pro / con or one of each*

**or** one appropriate point (and) appropriate qualification / amplification

*examples*

*other mammals (sufficiently) similar to humans (1)*

*so results appropriate (1)*

*unethical to experiment on humans (1)*

*so it is better to experiment on mice (1)*

*knowledge / techniques will benefit humans (1)*

*and also other animals (1)*

*experiments were justified because ultrasound has proved useful (1)*

2

(c) examples

*allow a wide variety of appropriate responses*

publish / tell doctors / the public (1)

...their evidence / results / research / data (1)

*valid point (1)*

*appropriate example / qualification / expansion / etc (1)*

carry out more research / tests (1)

...to make sure / check reliability (1)

*allow just 'stop using them / ultrasonic waves' for 1 mark only*

*allow using them (only) for industrial purposes for 1 mark only*

2

[6]

- M2.** (a) (i) 440 (sound) waves produced in one second  
*accept vibrations / oscillations for waves* 1
- (ii) 0.773 (metres)  
*allow 2 marks for an answer that rounds to 0.773*  
*allow 2 marks for an answer of 0.772*  
*allow 2 marks for an answer of 0.772*  
*allow 1 mark for correct substitution ie  $340 = 440 \times \lambda$*  3
- (b) (sound is) louder  
*do not accept the converse* 1
- as amplitude is larger  
*waves are taller is insufficient* 1
- higher pitch / frequency 1
- as more waves are seen  
*reference to wavelengths alone is insufficient*  
*waves are closer together is insufficient* 1

[8]

- M3.** (a) 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 to the information in the [Marking guidance](#), and apply a 'best-fit' approach to the marking.

**0 marks**

No relevant / correct content.

**Level 1 (1-2 marks)**

There is a basic description of either wave **OR** What happens to either wave when they enter the body. However there is little other detail.

**Level 2 (3-4 marks)**

There is either: A clear description of BOTH waves **OR** A clear description as to what happens to BOTH waves inside the body **OR** A clear description of ONE of the waves with clear detail as to what happens to either wave inside the body.

**Level 3 (5-6 marks)**

There is a detailed description of BOTH of the waves **AND** A detailed description as to what happens to EITHER wave inside the body.

**Examples of the points made in the response:**

**Description of an X-ray**

- X-rays are electromagnetic waves / part of the electromagnetic spectrum  
*do **not** allow a description of a property – eg X-rays travel*
- X-rays are (very) high frequency (waves)  
*through a vacuum / at the speed of light*
- X-rays are (very) high energy (waves)
- X-rays have a (very) short wavelength
- Wavelength (of X-rays) is of a similar size to (the diameter of) an atom
- X-rays are a transverse wave  
*correct description acceptable – oscillations / vibrations are perpendicular (at 90°) to direction of energy transfer*
- X-rays are ionising radiation

**Description of ultrasound**

- ultrasound has a frequency above 20 000 (hertz)
- or**
- ultra sound is above 20 000 hertz
- ultrasound is above / beyond the human (upper) limit (of hearing)  
*accept ultrasound cannot be heard by humans*
  - ultrasound is a longitudinal wave  
*correct description acceptable – oscillations / vibrations (of particles) are parallel (in same direction) to direction of energy transfer*

**Statement(s) as to what happens to X-rays inside the human body:**

- X-rays are absorbed by bone
- X-rays travel through / are transmitted by tissue / skin

**Statement as to what happens to ultrasound inside body:**

- ultrasound is (partially) reflected at / when it meets a boundary between two different media
- travel at different speeds through different media

6

- (b) (because the X-rays) are ionising  
*accept a description of what ionising is*

1

(they will) damage cells

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

**or**

mutate cells / cause mutations / increase chances of mutations

**or**

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

*do **not** accept they can be dangerous (to human health)  
do **not** accept damage to soft tissue*

**or**

kill cells

1

(c) any **one** from:

- removal / destruction of kidney / gall stones
- repair of damaged tissue / muscle  
*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*
- removing plaque from teeth  
*cleaning teeth is insufficient*

1

[9]

- M4.** (a) (i) perpendicular  
*accept correct description 1* 1
- (ii) light off – no / slow rotation 1
- light on – fast(er) rotation  
*accept starts rotating*  
*ignore references to energy transfers* 1
- (b) one ray drawn from wrist watch and reflected by mirror  
*accept solid or dashed lines* 1
- two rays drawn from wrist watch and reflected by mirror with  $i = r$  for both rays  
*judge angles by eye* 1
- one ray traced back behind mirror  
*accept solid or dashed lines* 1
- image in correct position  
*judged by eye*  
*accept image marked where two reflected rays traced back cross behind the mirror* 1
- (c) cannot be formed on a screen  
*accept image formed behind the mirror*
- or**
- rays of light seem to come from it but do not pass through it 1

[8]

M5.(a) the oscillation / vibration (causing the wave)  
*a movement causes the wave is insufficient* 1

for a transverse wave is perpendicular to the direction of energy transfer  
*accept direction of wave travel* 1

and for a longitudinal wave is parallel to the direction of energy transfer  
*accept direction of wave travel*  
*if no marks awarded allow 1 mark for correctly linking*  
*perpendicular with transverse and parallel with longitudinal*  
*the marks may be scored by the drawing of two correctly*  
*labelled diagrams* 1

(b) for radio waves:  
*accept converse for each mark*  
are transverse 1

travel at speed of light / higher speed 1

have greater frequencies 1

can travel through vacuum  
*accept sound waves are not electromagnetic for 1 mark* 1

[7]

M6.(a) (i) 20

1

20 000

*either order*

*accept ringed answers in box*

1

(ii) (frequency) above human range  
*accept pitch for frequency*

**or**

(frequency) above 20 000 (Hz)

*do **not** accept outside human range*

*allow ecf from incorrect value in (a)(i)*

1

(iii) any **one** from:

- pre-natal scanning  
*accept any other appropriate scanning use*  
*do **not** accept pregnancy testing*
- removal / destruction of kidney / gall stones
- repair of damaged tissue / muscle  
*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*
- removing plaque from teeth  
*cleaning teeth is insufficient*

1

(b)  $7.5 \times 10^{-4}$  (m)

*$1.5 \times 10^3 = 2.0 \times 10^6 \times \lambda$  gains 1 mark*

2

(c) for reflected waves

*must be clear whether referring to emitted or detected / reflected waves*



*if not specified assume it refers to reflected wave*

any **two** from:

- frequency decreased
- wavelength increased
- intensity has decreased  
*allow amplitude / energy has decreased*  
*allow the beam is weaker*

2

[8]

**M7.**

(a) (sound waves) which have a frequency higher than the upper limit of hearing for humans

**or**

a (sound) wave (of frequency) above 20 000 Hz

*sound waves that cannot be heard is insufficient*

*a wave of frequency 20 000 Hz is insufficient*

1

(b) 640

*an answer of 1280 gains 2 marks*

*allow 2 marks for the correct substitution*

*ie  $1600 \times 0.40$  provided no subsequent step*

*allow 2 marks for the substitution  $\frac{1600 \times 0.80}{2}$*

*provided no subsequent step*

*allow 1 mark for the substitution  $1600 \times 0.80$  provided no subsequent step*

*allow 1 mark for the identification that time (boat to bed) is 0.4*

3

(c) any **one** from:

- pre-natal scanning / imaging
- imaging of a named organ (that is not surrounded by bone), eg stomach, bladder, testicles

*accept heart*

*do **not** allow brain **or** lungs (either of these negates a correct answer)*

- Doppler scanning blood flow

1

(d) advantage

any **one** from:

- (images are) high quality or detailed or high resolution  
*clearer / better image is sufficient*
- (scan) produces a slice through the body
- image can be viewed from any direction  
*allow images are (always) 3D / 360°*
- an image can be made of any part (inside the body)  
*allow whole body can be scanned*
- easier to diagnose **or** see a problem (on the image)

1

disadvantage

any **one** from:

- (the X-rays used **or** scans) are ionising  
*allow a description of what ionising is*
- mutate cells **or** cause mutations **or** increase chances of mutations  
*allow for cells:*

- DNA / genes / chromosomes / nucleus / tissue*
- turn cells cancerous **or** produce abnormal growths **or** produce rapidly growing cells
  - kill cells
  - *damage cells is insufficient*
  - shielding is needed
  - *can be dangerous (to human health) unqualified, is insufficient*

1

[7]