Mark schemes

1 (a) K

1

(b) Decreases

1

(c) use a metre rule / 30 cm ruler to measure across 10 (projected) waves

accept any practical number of waves number for 10

1

and then divide by 10

1

(d) 1.2 cm = 0.012 m

1

18.5 × 0.012 = 0.22(2) (m / s)

1

*allow 0.22(2) with no working shown for **2** marks*

typical walking speed = 1.5m / s

accept any value e.g. in the range 0.7 to 2.0 m / s

1

so the water waves are slower (than a typical walking speed)

this cannot score on its own

1

[8]

2 (a) in a longitudinal wave the oscillations / vibrations are parallel to the direction of energy transfer.

accept wave travel for energy transfer throughout

1

in a transverse wave the oscillations / vibrations are perpendicular to the direction of energy transfer.

1

(b) accept any sensible suggestion eg a vibrating drum skin does not move the air away to create a vacuum (around the drum)

1

(c) **Level 3 (5–6 marks):**
A detailed explanation linking variations in current to the pressure variations of a sound wave, with a logical sequence.

Level 2 (3–4 marks):
A number of relevant points made, but not precisely. A link between the loudspeaker and a sound wave is made.

Level 1 (1–2 marks):
Some relevant points but fragmented with no logical structure.

0 marks:
No relevant content.

Indicative content

the current in the electrical circuit is varying

the current passes through the coil

the coil experiences a force (inwards or outwards)

reversing the current reverses the force

the size of the current affects the size of the force

the varying current causes the coil to vibrate

the (vibrating) coil causes the cone to vibrate

the vibrating cone causes the air molecules to move

the movement of the air molecules produces the pressure variations in the air needed for a sound wave

the air molecules bunch together forming compressions and spread apart forming rarefactions

6

[9]

3 (a) frequency

1

(b) echo(es)

1

(c) 340 (m/s)

*allow **1** mark for correct substitution ie 25 000 × 0.0136 provided no subsequent step*

or

*allow **1** mark for a correct calculation showing an incorrect value from conversion to hertz × 0.0136*

*an answer of 0.34 gains **1** mark*

2

(d) (a wave where the) oscillations are parallel to the direction of energy transfer

both marking points may appear as labels on a diagram

accept vibrations for oscillations
accept in same direction as for parallel to
allow direction of wave (motion) for direction of energy transfer

*allow **1** mark for a correct calculation showing an incorrect value from conversion to hertz × 0.0136*

1

causing (areas of) compression and rarefaction

accept correct description in terms of particles

mechanical wave is insufficient
needs a medium to travel through is insufficient

1

[6]

4

(a) X marked in the centre of the sign

Check position by eye

1

(b) concentrated

1

(c) 0.5 (s)

*allow **1** mark for correct substitution, ie*

$\frac{1}{2}$

provided no subsequent step

2

(d) make the cables longer

accept pendulum / sign for cables

1

[5]

5

(a) 20 000 Hz

1

(b) 400 (m)

*allow **1** mark for correct*
substitution ie 1600 × 0.25
provided no subsequent steps shown
*an answer of 200 (m) gains **1** mark*

2

(c) twice

1

(d) From pulse 1 to pulse 3 the distance (to the sea floor) decreased

accept the sea got shallower
or
the submarine went deeper for the distance decreased

1

then (after pulse 3) the distance (to the sea floor) increased

accept the sea got deeper
or
the submarine rose for the distance increased
*An answer of the distance decreased then increased gains **1** mark*

1

[6]

6 (a) ultrasound is not ionising

allow ultrasound does not harm the (unborn) baby

1

but X-rays are ionising

1

so X-rays increase the health risk to the (unborn) baby

accept specific examples of health risks, eg cancer, stunted growth, impaired brain function etc
X-rays are dangerous is insufficient

1

(b) ultrasound/waves are partially <u>reflected</u>

(when they meet a boundary) (between two different media / substances / tissues)

must be clear that not all of the wave is reflected

1

the time taken is measured (and is used to determine distances)

1

(c) 1600 (m/s)

*800 (m/s) gains **2** marks*

*160 000 (m/s) gains **2** marks*

*0.0016 (m/s) gains **2** marks*

*allow **2** marks for*

$$\frac{0.04}{25\times10^{-6}}$$

or

$$\frac{0.08}{50\times10^{-6}}$$

*80 000 (m/s) gains **1** mark*

*0.0008 (m/s) gains **1** mark*

*allow **1** mark for*

$$\frac{0.04}{25}$$

or

$$\frac{0.08}{50}$$

*allow **1** mark for evidence of doubling the distance or halving the time*

3

(d) (i) they are absorbed by bone

allow stopped for absorbed

X-rays are reflected negates this mark

1

they are transmitted by soft tissue

allow pass through for transmitted

allow flesh / muscle / fat

accept less (optically) dense material for soft tissue

1

(the transmitted) X-rays are detected

1

(ii) short

accept small

1

[12]

7 (a) high frequency sound (waves)

1

with a frequency above limit of human hearing
or with a frequency greater than 20 000 Hz

above limit of human hearing

***or** greater than 20 000 Hz gains maximum **1** mark*

1

(b) $5(.0) \times 10^{-4}$ (m)
or
0.0005 (m)

*$1500 = 3 \times 10^6$ λ gains **2** marks*
*answer of 500 gains **2** marks*
*1500 = 3.0 λ gains **1** mark*

3

(c) it will run off the surface of the skin
or
water is not a gel

accept water would evaporate

1

(d) The width of the coupling agent

1

The width of the water

1

(e) (i) A

1

(ii) E

1

(f) (i) **K**

reflection from skin

maximum 5 marks if no mention of reflection

1

very little reflection, so small peak

1

L

reflection from front of kidney

1

large amount of reflection, so large peak

1

M

reflection from back of kidney

1

smaller peak due to absorption of ultrasound in kidney
or
smaller peak as further from source
or
front of the kidney already reflected a lot, so there is now less to be reflected

reflection from a boundary gains 1 mark if no other mark given

1

(ii) 0.06 (m)
or
$6(.0) \times 10^{-2}$

*0.12 (m) gains **2** marks*

*distance = $1500 \times 8 \times 10^{-5} \times 0.5$ gains **2** marks*

*distance = $1500 \times 8 \times 10^{-5}$ gains **1** mark*

3

[19]

8 (a) (i) microwave

1

(ii) refraction

1

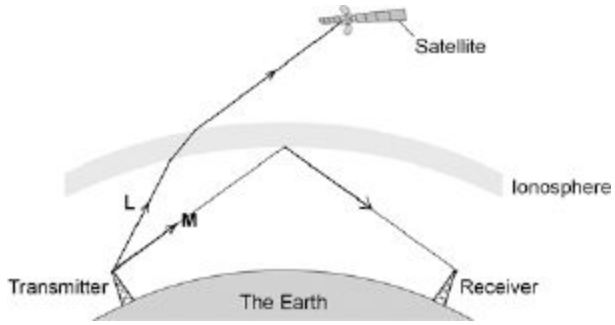
(b) (i) wave M continues as a straight line to the ionosphere and shown reflected

accept reflection at or within the ionosphere

1

correctly reflected wave shown as a straight line reaching the top of the receiver

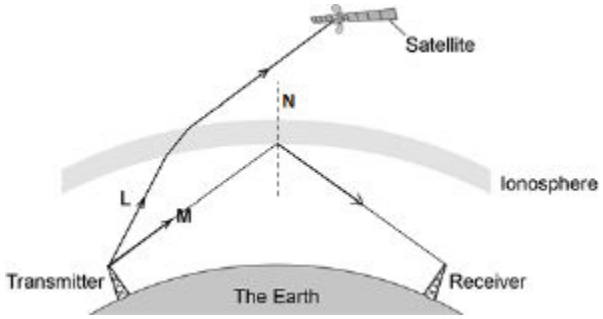
if more than 2 rays shown 1 mark maximum



ignore arrows

1

(ii) normal drawn at point where their **M** meets the ionosphere



1

(c) any **two** from:

- transverse
- same speed (through air)

  *accept speed of light **or** 3 × 10^8 m / s*
- can be reflected
- can be refracted
- can be diffracted
- can be absorbed
- transfer energy
- can travel through a vacuum

  *an answer travel at the same speed though a vacuum scores **2** marks*
- can be polarised
- show interference.

  travel in straight lines is insufficient

2

[7]

9 (a) 1.25

*accept 1.3 for **2** marks*

*allow **1** mark for correct substitution*

ie $\frac{1}{0.8}$

provided no subsequent step shown

2

(b) (i) increasing the length (of the pendulum) decreases the number of oscillations / swings made (in 20 seconds)

accept increasing the length (of the pendulum) increases the time (of 1 oscillation / swing)

accept increasing the length (of the pendulum) decreases the speed / frequency (of 1 oscillation / swing)

answers must refer to the effect of increasing / decreasing length

ignore references to time being proportional to length

1

changing the mass (of the pendulum bob) does not change the number of oscillations / swings made (in 20 seconds)

accept changing the mass does not change the time / speed / frequency / results

accept weight for mass

1

(ii) any **two** suitable improvements:

- measure (the number of swings) over a wider range of (pendulum) lengths
- measure (the number of swings) over a wider range of (bob) masses
- measure the number of swings made over a greater period of time
- repeat each measurement & calculate mean / average (number of oscillations in 20 seconds)

accept repeat measurements & discard anomalous measurements

repeat measurements is insufficient

- measure (the total number of swings &) the fraction of swings made
- start the swings at the same height.

use a computer / datalogger to make measurement (of number of oscillations) is insufficient

measuring time period is insufficient

using a stop clock with greater resolution is insufficient

2

[6]

10 (a) pitch

1

loudness

1

(b) (i) as length (of prongs) decreases frequency / pitch increases

accept converse

accept negative correlation

ignore inversely proportional

1

(ii) 8.3 (cm)

accept 8.3 ± 0.1 cm

1

(iii) (8.3 cm is) between 7.8 (cm) and 8.7 (cm)

*ecf from part **(ii)***

1

(so *f* must be) between 384 (Hz) and 480 (Hz)

1

410 (Hz) ≤ *f* ≤ 450 (Hz)

*if only the estimated frequency given, accept for **1** mark an answer within the range*

1

(c) (i) electronic

1

(ii) frequency is (very) high

accept frequency above

*20 000 (Hz) **or** audible range*

1

so tuning fork ***or*** length of prongs would be very small (1.2 mm)

1

(d) 285.7 (Hz)

accept any correct rounding 286, 290, 300

*allow **2** marks for 285*

*allow **2** marks for correct substitution 0.0035 = 1 / f*

*allow **1** mark for T = 0.0035 s*

*allow **1** mark for an answer of 2000*

3

[13]

11 (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* $0.7\dot{7}\dot{2}$

*allow **2** marks for an answer of 0.772*

*allow **1** mark for correct substitution ie 340 = 440 × λ*

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]

12 (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 × 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 × 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 <u>any</u> 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 <u>ionising</u>

  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]

13 (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) 7.5×10^{-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]

14 (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]

15 (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]

16 (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

(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]

17 (a) (i) wavelength

accept frequency

accept speed

1

(ii) amplitude

accept energy

height is insufficient

1

(iii) sound

1

(b) 0.12

*allow **1** mark for correct substitution, ie 8 × 0.015 provided no subsequent step shown*

2

metre per second **or** m/s **or** metre/second

*do **not** accept mps*
units must be consistent with numerical answers

1

[6]

18 (a) (i) bat(s)

1

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

appropriate number and unit both required

1

(b) (i) A, C, D

all three required and no other

1

(ii) D, E

both required and no other

1

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

accept there is no medium (for the sound to travel through)
*do **not** accept there is no air (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]

19 (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]

20 (a) (i) **J** and **L**

both required, either order

1

(ii) **K**

1

(iii) **L**

1

highest frequency

reason does not score if __L__ not chosen
accept most waves (on screen)
do __not__ accept frequency above 20 000(Hz)
do __not__ accept cannot hear it

1

(b) transmitter

detector

computer

all three in correct order

*allow **1** mark for one correct*

2

[6]

21 (a) (i) 3

1

(ii) 30 000 **or** 10 000 × their (a)(i) correctly calculated

1

(iii) any **two** from:

- frequency is above 20 000 (Hz)
  accept the frequency is 30 000
- frequency is above the upper limit of audible range
- upper limit of audible range equals <u>20 000</u> (Hz)
  ignore reference to lower limit
- it is ultrasound/ultrasonic

2

(b) (i) wave (partially) <u>reflected</u>

1

at crack to produce **A** and end of bolt to produce **B**

accept at both ends of the crack

1

(ii) 0.075 (m) allow **2** marks for time = 0.0000125

*allow **1** mark for time = 0.000025*

*answers 0.15 **or** 0.015 **or** 0.09 gain **2** marks*

*answers 0.18 **or** 0.03 gain **1** mark*

the unit is not required but if given must be consistent with numerical answer for the available marks

3

[9]

22 (a) letter C clearly marking a compression

accept C at any point in a compression

if more than one letter C marked
all must be correct

1

(b) (i) straight continuous line drawn from loudspeaker to metal to sound sensor

judge by eye

1

angle I = angle R

judge by eye

ignore any arrows on lines

1

(ii) less sound reflected

accept energy for sound

or

(some) sound passes through the glass

accept (some) sound absorbed by the glass

1

(iii) makes the sound louder

1

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

340

*allow **1** mark for correct substitution*
ie 850 × 0.4

provided no subsequent step shown

2

(c) echo

1

(d) (i) from 250 Hz to 750 Hz

1

(ii) curtains reduce (percentage of) sound reflected more (than carpet)

accept curtains absorb more sound (than carpet)

1

for all frequencies (shown)

accept for both marks an answer in terms of walls having a larger (surface) area to reflect sound and curtains reducing the amount of reflected sound more (than carpet)

*answers less noisy or walls / curtains have a larger area gain **1** mark only*

*do **not** accept curtains are cheaper*

1

[11]

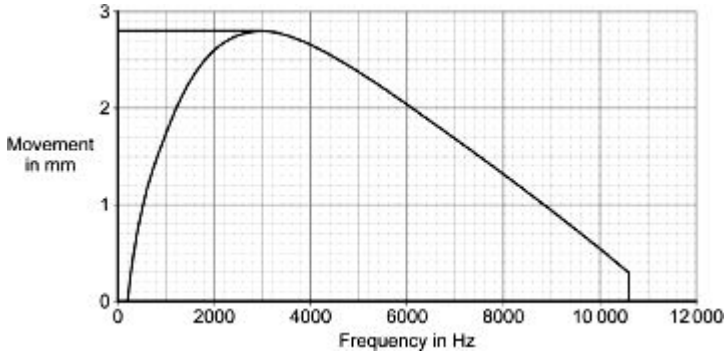
23 (a) 10 600 (Hz)

accept 10.6 kHz

1

(b) 3000 (Hz)

*allow **1** mark for a line drawn to show greatest movement*
(allow only if frequency is between 2800 and 3200)
accept other indication of correctly using the graph



2

(c) (No)

no marks for just the ticked box
reasons can score even if yes is ticked

(human hearing) range is 20 – 20 000 (Hz)

accept (most) people hear up to 20 000 (Hz) / 20 kHz

1

any **one** from:

- range on graph is within this range
- range on graph starts after 20 Hz
- range on graph is from to 200 – 10 600 (Hz)
- range on graph finishes before 20 000 Hz

1

(d) reliability

this answer only

1

(e) only 1 variable affects dependent variable / size of movement

accept 'results' for 'size of movement'

or

there is only one independent variable

fair test is insufficient

*do **not** accept to control the experiment*

or

to be able to compare (effect of different frequencies)

1

[7]

24 (a) vibrate

*allow move more (vigorously) but **not** just move*

1

dirt / muck / grit / rust / dust etc.

*do **not** accept bacteria*

1

(b) any **one** medical use eg

ignore incorrect biological detail

- scanning unborn babies
- destroying (kidney) stones

1

(c) (i) 2

1

(ii) C

1

[5]

25 (a) microphone

1

(c) (i) vertical line from any maxima or minima to axis

*do **not** penalise minor errors but*

*do **not** allow unless intention is clear*

1

(ii) loudness / volume / intensity / energy

*do **not** accept noise*

1

(c) 17

this answer only

1

(d) the greater the distance, the smaller the amplitude

accept volume / intensity / energy / loudness for amplitude

or

there is a (strong) negative correlation between distance and amplitude

or

there is an inverse square relationship between distance and amplitude

*do **not** accept distance and amplitude are inversely proportional*

1

(e) 20 Hz

either order

1

20,000 Hz

accept 20 kHz provided unit has been clearly changed

1

[7]

26 (a) sound / mechanical / longitudinal (wave)

1

any **one** from:

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

1

(b) **either**

particles / molecules / fluid vibrate(s) (1)

(and) knock particles of dirt off the jewellery (1)

or

by the process of cavitation (1)

accept 'formation and collapse of tiny bubbles'

which breaks up / releases dirt from the surface (1)

2

(c) ***either*** *both pro*
or *both con*
or *one of each*

either

two appropriate points gain **1** mark 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

[6]

27 (a) 20000

accept any unambiguous indication

1

(b) kilohertz

credit misspellings

credit '1000 hertz' or '1000 Hz'

accept 1000 oscillations/beats/waves <u>per second</u>

1

(c) (i) cleaning (e.g. something delicate such as a watch)

***or** quality control/flaw detection*

credit any appropriate extra Specification response
e.g. sonar

1

(ii) pre-natal (scanning)

*do **not** credit just 'scanning'/medical scanning/ scanning a baby*

credit any appropriate extra Specification response
e.g. destruction of (kidney) stones or cleaning teeth

1

(d) 8 (μs)

1

(e) distance (1)

between the <u>boundary</u> and the detector (1)

accept 'between the <u>boundary</u> and the source'

accept any correct use of speed = distance/time

2

(f) examples

publish/tell doctors/the public (1) ... their evidence/results/research/data (1)

carry out more research/tests (1) ... to make sure/check reliability (1)

allow a wide variety of appropriate responses
valid point (1) appropriate example/qualification/expansion/etc. (1)

allow just 'stop using them/ultrasonic waves' (1)

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

2

[9]

28 (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]

29 (a) (i) same frequency / period / pitch / wavelength

ignore references to amplitude

1

(ii) differences in waveform / shape / quality

accept the diagrams are not identical

1

(b) (i) 20 000 Hz / hertz

or 20 kHz / kilohertz

in both cases, if the ***symbol*** *rather than the name is used, it must be correct in every detail*

1

(ii) material(s) / substance(s) (through which sound travels)

1

(iii) is absorbed

accept (some) sound (energy) is transformed / transferred <u>as</u> heat / thermal energy

1

is transmitted

accept is refracted
accept changes speed
accept changes velocity

*do **not** accept is diffracted*
*do **not** accept is diffused*
*do **not** accept is dissipated*

1

[6]

30 (a) (i) 25 (%)

*do **not** accept ¼*

1

(ii) increases

1

(b) tick (✓) in top and bottom box

both required

1

(c) SHINY surfaces are good reflectors of infra-red radiation

accept white for shiny

or black surfaces are POOR reflectors of infra-red radiation

accept bad for poor
accept insertion of 'not' before 'good' in statement

or black surfaces are good EMITTERS of infra-red radiation

or black surfaces are good ABSORBERS of infra red radiation

1

[4]

31 (a) (mechanical) vibration(s)

***not** just 'particles knocking into each other'*
not reference to 'sound particles'

1

(b) K

1

(c) (i) reflected by the material from loudspeaker to microphone X

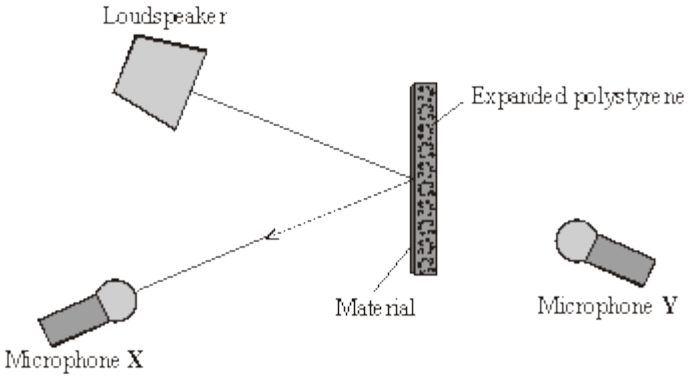
1

shown by straight lines with angle of incidence = angle of reflection (by eye) **and** at least one arrow in the correct direction

*do **not** credit if the direction is contradicted by any incorrect arrow / may be shown by waves / wavefronts in the direction of straight lines*

ignore any sound to Y or which 'misses' the material

example



1

(ii) any **one** from:

- so (the student) can compare results
- so only one (independent) variable
- to get reliable / accurate results
- because (the expanded) polystyrene absorbs some of the sound

*do **not** credit just 'so it's a fair test'*

1

(iii) **[A]** wood

1

[B] either 0.25 **or** 1/4 **or** 25 % **or** 15/60 **or** 1: 3

*do **not** credit 1 : 4*

1

(d) practical suggestion

1

appropriate reason / explanation

example *line / panel the walls with wood / plasterboard / increase the thickness of the plaster (on the walls) (1)*
(this) will absorb / reflect (back) (most / some of) the sound (1)

credit legal suggestions for attempting to limit the noise made by the neighbours
example *ask the neighbours to make less noise (1)*
by limiting the time(s) music played (1)

do ***not*** *credit reference to 'sound particles' for second mark*

1

[9]

32 (a) (i) **A**, **C** and **D**

any order but all three required and no others

1

(ii) **D** and **E**

either order but both required and no others

1

(b) (i) 20000 (Hz) to 20 (Hz)

accept '19980 (Hz)'

or vice-versa

1

(ii) frequency (of dog whistle) too high (for humans to hear) / frequency above 20000 Hz

accept 'it is ultrasound'

accept 'sound from the whistle is ultrasonic'

1

(c) (i) substance

1

reflection

correct order essential

1

(ii) detector

1

[7]

33 (a) any **two** points:

*do **not** credit features which are true of sound in general eg longitudinal waves*

- humans cannot hear ultrasound
- it has a very high frequency / pitch

  *do **not** credit just 'has a high frequency / pitch'*
- above the (upper) limit for humans / above 20 000 Hz

2

(b) (i) ultrasound / waves are reflected

...are bounced is insufficient, but
...echo is acceptable

1

Pulse **A** indicates / is the crack

Pulse **B** indicates / is the back (of the block or crack)

need to mention both A and B to get this mark

1

(ii) 90 (mm)

accept any answer in the range 88 – 92 (mm)

1

[5]

34 (i) (partly) reflected when they hit a (boundary between two) different media or substance or tissue

accept named substances

*do **not** accept bounce back*

1

time taken for reflected wave (to return) is used to produce the image

1

(ii) any **one** from:

cleaning a delicate mechanism / jewellery

*do **not** accept cleaning*

welding plastics

cutting textiles

mixing emulsion paints

sonar

motion sensors (in burglar alarms)

*do **not** accept burglar alarms*

removing dental plaque

industrial quality control

breaking up kidney stones

treating injuries

1

[3]

35 (a) sound with a frequency above audible

do not accept answer in terms of λ

do not accept sound which cannot be heard unless obvious from context

accept above 20 kHz

1

(b) (i) to show detail **or** to give a clear image/picture

*accept the generators **or** transducers can be small*

accept so the beam does not spread out/beam in focus

***not** 'good picture'*

1

(ii) (much) smaller wavelength

allow higher frequency/pitch

1

(iii) no damage to living cells (provided low power)

accept the converse

*accept no damage to baby **or** not dangerous to baby*

1

(iv) any **two** forms

sex

stage of development

or specific examples

abnormalities

general health

potential problems (at birth)

accept specific examples e.g. umbilical cord around neck

size of head

accept multiple births

2

[6]

36 (a) stop

accept any indication

cannot travel

2

(b) middle box ticked

accept a tick next to the statement even if not in the box
*do **not** accept two ticks*

1

(c) (i) B

highest frequency

accept most waves (in box)
accept 'squashed together'
*do **not** accept 'squashed'*
accept 'close (together)'
accept shortest wavelength

2

(ii) D

largest amplitude

*accept tallest **or** highest wave*
*do **not** accept biggest wave*
*do **not** accept 'high' wave*

2

[7]

37 (a) glass

1

air

must be in correct order

1

closer the particles faster the speed

answer must show a comparison

or

particles in glass closest in air furthest apart

accept the denser the material the faster the sound travels

or

sound travels faster in solids than gases

incorrect explanation negates credit

1

(b) (i) grasshopper

(ii) ultrasound

accept ultrasonic

1

(c) all of reflected pulse closer than given in original diagram

accept a cluster of pulses ignore a reflected pulse in original position any pulse drawn to right of original negates credit

1

reflected pulse smaller than emitted but greater than 1 square high

accept cluster of pulses provided one part fulfils height criteria

2

[7]

38 (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]

39 (a) vibrates (owtte)

for one mark

1

(b) (i) higher

for one mark

1

(ii) louder

for one mark

1

(c) (i) ultrasonic (ultrasound)

for one mark

1

(ii) different frequency / wavelength / pitch

gains 1 mark

but

high frequency / pitch, higher frequency /pitch (lower frequency / pitch *wrong*)

gains 2 marks

2

[6]

40 (a) 4

1

(b) 3

1

(c) 3

correct answer with no working = 2
allow 1 mark for f = number ÷ time
or correct working i.e., 12 ÷ 4
N.B. correct answer from incorrectly recalled relationship / substitution = 0

2

Hz / hertz

accept HZ, hz, hZ
allow waves / cycles per second
allow wps, w/s, cps, c/s

1

[5]

41 (a) Quality of written communication:
Correct use of 2 of the words, angle, critical, normal and reflection

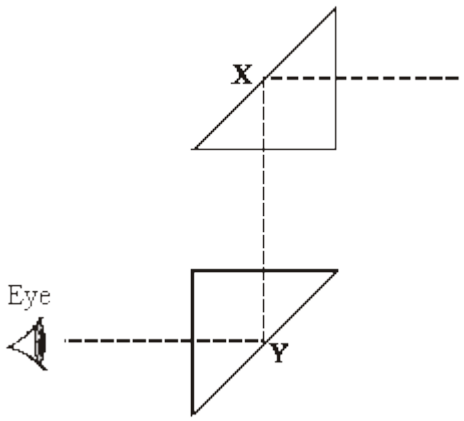
1

any **two** from

- light is reflected / bounces off
- if angle between ray and normal angle of incidence
- is greater than critical angle
- idea that no refraction bending if ray at 90°

2

(b)



*1 mark for reflection at **X** if ray would reach the lower prism*
*1 mark for subsequent reflection at **Y***
1 mark for subsequent ray emerging from prism in direction of front of eye
*accept dotted **or** dashed lines*
ignore any arrows

3

[6]

42 (a) (ultrasound) waves reflected

accept 'bounce off'

1

at boundary / from muscle

1

(b) (i) time

1

(ii) speed of (ultrasound) waves

1

[4]

43 (a) (i) cat

1

(ii) tuna

1

(b) (i) ultrasound

allow ultrasonic

1

(ii) cleaning / quality control / flaw detection / medical scanning / animal scaring / sonar

1

[4]

44 ***Quality of written communication***

correct use of **three** scientific terms from speed / velocity, reflection, density, time, boundary

1

any **three** from:

different tissues have different densities

ultrasound travels at different speeds / velocities in different tissues

reflection

accept bouncing back

from tissue boundaries

time taken to return

3

[4]

45 (a) changes the sound wave(s)

to a varying **or** changing (electric) potential difference **or** p.d. **or** voltage **or** current **or** to an irregular alternating current or a.c. **or** transfers sound energy to electrical energy (1) mark is vibrations **or** pulses **or** of sound **or** in air become electrical waves

do not credit just 'to electricity' ***or*** *'to a.c'*

2

(b) (i) decrease **or** reduce the amplitude

accept less amplitude nothing else added

1

(ii) increase the frequency **or** decrease wavelength

accept higher frequency nothing else added

1

[4]

46

- idea that (in words or on diagram)
- sound reflects / bounces off cliff
- returns the way it came / produces an echo

each for 1 mark

[2]

47 D

gains 1 mark

but E (D + E = 1)

gains 2 marks

[2]