Mark schemes

(a) B

must be in correct order

A

D

1

(b) (i) mass increases as refractive index increases

accept weight / density increases as refractive index increases

(ii) thinner

accept thin

heavier

accept heavy

(iii) maximum one advantage and one disadvantage of each design

water-filled
advantages:
• lenses are light
• wide range of focal length
• allows fine adjustment
• allows lenses to be altered independently.

disadvantages:
• unattractive
• lens might burst
• lens might leak
• uncomfortable.

sliding lenses
advantages:
• hard-wearing
• look like conventional glasses
• easy to adjust
• allows lenses to be altered independently.

disadvantages:
• heavy
• might slide out of position
• might get dirt between the lenses.
(c) any two from:
the image is
• blurred
• coloured
• inverted
• diminished.
accept not focussed

(a) high frequency sound (waves)
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

(b) \[5.0 \times 10^{-4} \text{ (m)}\]
or
\[0.0005 \text{ (m)}\]
\[1500 = 3 \times 10^6 \lambda \text{ gains 2 marks}\]
answer of 500 gains 2 marks
\[1500 = 3.0 \lambda \text{ gains 1 mark}\]

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

(d) The width of the coupling agent
The width of the water

(e) (i) A
(ii) E
(f) (i) \( K \)
reflection from skin

*maximum 5 marks if no mention of reflection*

very little reflection, so small peak

\( L \)
reflection from front of kidney

large amount of reflection, so large peak

\( M \)
reflection from back of kidney

smaller peak due to absorption of ultrasound in kidney

\textbf{or}

smaller peak as further from source

\textbf{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*

(ii) 0.06 (m)

or

\( 6(0.0) \times 10^{-2} \)

\( 0.12 \text{ (m)} \) 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]
(a) (i) reflection of wave K at or within the ionosphere

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 2nd mark
additional rays shown don’t score 2nd mark

(ii) normal

(b) (i) microwave

(ii) refraction

(c) All electromagnetic waves are transverse.

All electromagnetic waves have the same speed in a vacuum.

(a) (i) microwave

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

\textit{accept reflection at or within the ionosphere}

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

\textit{if more than 2 rays shown 1 mark maximum}

(ii) normal drawn at point where their \textbf{M} meets the ionosphere

(c) any \textbf{two} from:

- transverse
- same speed (through air)

\textit{accept speed of light or} \(3 \times 10^8 \text{ m/s}\)

- can be reflected
- can be refracted
- can be diffracted
- can be absorbed
- transfer energy
- can travel through a vacuum

\textit{an answer travel at the same speed though a vacuum scores 2 marks}

- can be polarised
- show interference.

\textit{travel in straight lines is insufficient}
(a) (i) Ray box

Normal

Glass block

(ii) 1 degree

(iii) 1.6

*allow 1 mark for correct substitution, ie 0.80 / 0.5 provided no subsequent step shown*

*working showing 1.59(9.....) scores zero*

(b) 2nd diagram ticked

(c) (i) any one correct description:

- upright
- virtual
- diminished.

*treat multiple words as a list*

(ii) 0.25

*allow 1 mark for correct substitution, ie 1 / 4 or 5 / 20 provided no subsequent step shown*

*ignore any unit*

(iii) Correcting short sight

[9]
6  (a)  1.25

accept 1.3 for 2 marks
allow 1 mark for correct substitution

\[ \frac{1}{0.8} \]

provided no subsequent step shown

(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

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

(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

7  (a)  20,000

accept 20 kilo

or

20 k

or 20 001

1
an atom

(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

8 (a) (i) line drawn at 90 degrees to the normal:

ignore (partial) reflection of the ray

(ii) 1.5

award both marks for an answer that rounds to 1.5
award 1 mark for correct substitution ie 1 / sin 41
or 1 / 0.656059

(b) 26

award 3 marks for an answer that rounds to 26
award 2 marks for

1.3 = 0.573576
or
r = sin⁻¹(0.573576) / 1.3

award 1 mark for correct substitution.ie 1.3 = sin 35
or
sin 35° shown correctly, ie 0.573576, or used correctly in the calculation
an answer of 0.44 scores 2 marks
an answer of 26.9 scores 0

9 (a) refraction
(b) towards the normal

(c) (i) convex
(ii) principal focus
    *accept focal point*

(d) parallel on left
refracted towards the normal at first surface
refraction away from normal at second surface
passes through or heads towards principal focus

(e) refractive index
    *accept material from which it is made*
(radius of) curvature (of the sides)
    *accept shape / radius*
    *do not accept power of lens*
    *ignore thickness / length*

(a) (i) frequency
wavelength
(ii) $10^{-15}$ to $10^4$

(b) $2.0 \times 10^5$
    *correct substitution of*
    $3.0 \times 10^8 / 1500$ gains 1 mark
Hz

(c) (i) (skin) burns
(ii) skin cancer / blindness
(d)  (i) any one from:
   • (detecting) bone fractures
   • (detecting) dental problems
   • treating cancer

(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)

(iii) \[
\begin{align*}
9 / 36 &= 0.25 \\
0.5 / 2 &= 0.25 \\
4 / 16 &= 0.25 \\
\end{align*}
\]

accept:
\[
\begin{align*}
36 / 9 &= 4 \\
2 / 0.5 &= 4 \\
16 / 4 &= 4 \\
\end{align*}
\]

conclusion based on calculation

\textit{two calculations correct with a valid conclusion scores 2 marks}

\textit{one correct calculation of k scores 1 mark}

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