**Mark schemes**

Q1.

(a) converging (lens)

accept ‘convex (lens)’

accept biconvex

1

(b) (principal) foci

accept ‘focus’ / ‘focuses’ / ‘focis’

focal point(s)

1

(c) (i) formed where (real) rays (of light) intersect / meet / cross

accept rays (of light) pass through the image

accept ‘image is on the opposite side (of the lens to the object)’

accept (construction) lines cross over

a response relating to a screen or similar is neutral

lines are solid and not dotted is neutral

1

(ii) inverted

accept any unambiguous correct indication

1

(d) (i) smooth curve which matches the points

judge by eye but do not accept point to point by ruler or otherwise

1

(ii) continuous

1

(iii) as distance increases, magnification decreases

accept negative correlation

a statement ‘inversely proportional’ is incorrect and limits maximum mark for this part question to 1

1

further detail eg magnification falls steeply between 40 and 50 cm

or

magnification begins to level out after / at 70 cm

1

[8]

Q2.

(a) (i) (concave) mirror / reflector

do not allow convex mirror / reflector

1

(ii) refraction

1

(b) (i) converging

1

(ii) 4

allow 1 mark for correct substitution

ie 20 / 5 or 4 / 1

ignore any units

2

[5]

Q3.

(a) 85

1

(b) (i) thickness (of glass)

accept how thick the glass is

do not accept light intensity

1

(ii) transmits less infra red

accept radiation / or heat for infra red

accept transmits less energy (at all wavelengths)

accept (glass B) absorbs more infra red

accept infra red is the same as heat

ignore reference to visible light

1

infra red has a heating effect

or

infra red warms the room

ignore references to conservatory

keeping cool

1

[4]

Q4.

(a) (i) microwaves

1

(ii) can pass through the ionosphere

accept travels in a straight line

accept atmosphere for ionosphere

do not accept air for ionosphere

1

(b) higher the frequency, further the wave travels

(into the atmosphere before reflection)

1

(c) 15 000

allow 1 mark for correct transformation and substitution

ie

an answer of 15 000 000 only gains 1 mark

allow both marks for an answer of 15 MHz (unit must be changed)

an answer of 15 gains no credit

2

[5]

Q5.

(a) (i) bat(s)

1

(ii) elephant(s)

1

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

appropriate number and unit both required

1

(b) (i) B

1

(ii) F

1

[5]

Q6.

(a) (i) answer in the range 3.0 ↔ 3.1 inclusive

accept for 1

3.6 ÷ 1.2 or 3.7 ÷ 1.2

or 36 ÷ 12 or 37 ÷ 12

or 18 ÷ 6 or 18.5 ÷ 6

or 10.2 ÷ 3.4 or 102 ÷ 34

or answer in the range but with a unit eg 3 cm

2

(ii) (principal) focus / focal (point(s)) / foci / focus

accept ‘focusses’

accept focals

do not accept focal length

1

(iii) at the intersection of virtual / imaginary rays

or ‘where virtual / imaginary rays cross’

or the rays of (real) light do not cross

or the image on the same side (of the lens) as the object

or the image is drawn as a dotted line

or the image is upright

do not accept ‘cannot be put on a screen’

do not accept any response which refers to reflected rays

1

(b) (i) another correct observation about relationship between values of d (1)

(but) not the same relationship between corresponding

values for magnification (1)

example

15 is three times bigger than 5 but

2.0 is not three times bigger than 1.2

2

(ii) when the distance / d increases the magnification increases

or the converse

accept ‘there is a (strong) positive correlation’

do not accept any response in terms of proportion / inverse proportion

1

(iii) (student has) no evidence (outside this range)

accept data / results / facts for ‘evidence’

1

[8]

Q7.

(a) (i) infra red (rays)

accept IR

or

radio (waves)

do not accept heat waves

do not accept TV waves

1

(ii) radio (waves)

this answer only

1

(b) frequency

1

(c) (i) answer should be in terms of establishing if harmful or not

 harmful ie trying to clear up any uncertainty

do not accept answers that assume it is harmful

eg Wi-Fi systems will make you ill

need to know if it is harmful / makes you ill

accept idea that safety issue may worry people

accept idea that (more) research may reassure people

accept idea of finding out (the truth)

1

(ii) an opinion

1

[5]

Q8.

(a) (i) any two from:

• travel at the same speed (through a vacuum)

accept travel at the speed of light

accept air for vacuum

• can travel through a vacuum / space

do not accept air for vacuum

• transfer energy

• can be reflected

• can be refracted

• can be diffracted

• can be absorbed

• can be transmitted

• transverse

accept any other property common to electromagnetic waves

accept travel at the same speed through a vacuum for both marks

do not accept both radiated from the Sun

2

(ii) infra red

both required for the mark

radio(waves)

accept IR for infra red

1

(b) 2 400 000 000

correct transformation and substitution gains 1 mark

ie or

an answer of 24 000 000 gains 1 mark

either 2 400 000 kHz

or 2 400 MHz scores 3 marks but the symbol only scores the 3rd mark if it is correct in every detail

2

hertz

accept Hz

do not accept hz

1

(c) (i) presented (scientific) evidence / data

do an experiment / investigation is insufficient

1

(ii) to find out if there is a hazard (or not)

accept to find out if it is safe

accept not enough evidence to make a decision

not enough evidence is insufficient

1

[8]

Q9.

(a) any two for 1 mark each

deduct (1) from the first two marks if a ruler has not been used but the intention is clear

ray from the object's arrowhead

• through centre of lens

• parallel to the axis then, when it reaches the lens, through F on the right

• through F on the left then, when it reaches the lens parallel to the axis

example of a 4 mark response

if more than two construction lines have been drawn all must be correct to gain 2 marks

construction lines drawn as dashed lines do not score credit

2

image shown as vertical line from axis to where their rays intersect

image need not be marked with an arrowhead but, if it is, it must be correct

1

ray direction shown

only one correct direction

arrow needed but there must not be any contradiction

1

(b) any two from:

• inverted

accept ‘upside down’

• magnified

accept ‘bigger’

• real

accept ‘not virtual / not imaginary’

one correct feature gains 1 mark

ignore any reference to position

an incorrect feature negates a correct response

2

[6]

Q10.

(i) X-rays

infra red (rays)

radio (waves)

all three in correct order

allow 1 mark for 1 correct

2

(ii) to kill cancer cells

1

(iii) energy

1

[4]

Q11.

(a) (i) shorter than

1

(ii) increase slightly

1

(b) (i) go up in the same ratio

or (directly) proportional or as speed (of the tennis ball) increases so does the

(difference in) frequency

accept as one goes up, so does the other

accept positive correlation

1

(ii) 20 (m/s)

allow 1 mark for showing correct method on graph

(ie horizontal or vertical line anywhere on graph)

if indicated by a cross, must be ± half square of correct value)

2

(iii) frequency and speed are both continuous variables

1

[6]

Q12.

(a) (i) radio(waves)

1

(ii) energy

correct answer only

1

(b) (i) 0.0125 (m)

allow 1 mark for correct transformation and substitution

2

(ii) make it hot(ter)

do not accept cook it

accept (air) particles inside ball will move faster

accept water in the ball gets hotter

1

[5]

Q13.

(a) C (only)

1

(b) A (only)

1

[2]

Q14.

(a) reflection at the mirror of ray from tip of real puppy’s ear to real puppy’s eye (1)

may be drawn freehand

 accurate (1)

ruler must have been used and the reflected ray is an extension of the straight line from point virtual ear however the virtual part of the line need not be shown

 arrow to show correct direction (1)

only one arrow needs to be shown but there must be no contradiction

example of (3) mark response

3

(b) flat

accept ‘it’s not curved/bent’

accept ‘it’s straight’

1

[4]

Q15.

(a) (i) compare (the health of) mobile phone users with non-mobile

phone users

must be an implied comparison between users and non-users

any idea of doing an experiment negates the mark

1

(ii) increase the sample size

accept use more people

accept have a large sample size

repeat the research / test is neutral

1

(iii) ethical

1

(b) (i) so the phones can be compared (fairly)

a fair test is insufficient

accept different tests (may) give different results

do not accept to make the results reliable, unless qualified

eg all variables are controlled

do not accept bias unless qualified

1

(ii) yes all are below the legal limit / 2 (W/kg)

 or no and any one from:

• even absorbing a small amount of energy may be harmful

accept microwaves for energy

accept emits energy absorbed by head / other parts of body

• no proof that small amounts of energy are not harmful

accept because the SAR value is not 0 (W/kg)

1

(c) any one from:

• to get an independent opinion

• company scientists may be biased

accept company scientists may manipulate results

1

[6]

Q16.

(a) (i) plane

accept any unambiguous indication

1

(ii) inverted

1

 virtual

accept any unambiguous indication

1

(b) reflection takes place at the surface of the pond and angle of incidence

= angle of reflection

as judged by eye

1

 reflected ray is a straight line to frog’s eye through the air

1

 correct direction arrow either from insect or to frog’s eye

only one arrow essential but

do not accept if either arrow contradicted example of a fully correct response

1

[6]

Q17.

(a) the normal

1

(b) v

1

(c) any one from:

• light has moved from glass to air / from air to glass

accept light has changed medium

• speed of light has changed

beware of contradictions for this marking point eg light has moved from glass to air and slowed down gets zero

• angle of incidence is less than the critical angle

or (angle) i < (angle) c or (angle) y is less than the critical angle

• change in density (of medium)

eg glass is more (optically) dense than air

1

(d) (i) ratio of v to y does not give the same answer (in every case)

 or value of v doubles value of y does not double

1

 or increments for v are the same but increments for y are not the same

allow for 1 mark a calculation but no conclusion

eg 30 → 60 19 → 35 (38)

1

(ii) as (angle) v increases, angle y increases

accept as the angle of incidence increases, the angle of refraction increases

or there is a (strong) positive(non-linear) relationship between the variables

or ratio of sines is constant

do not accept angle y is not directly proportional to angle v

1

(iii) no evidence outside this range

OWTTE

 or when angle y is greater than the critical angle total internal

reflection occurs

1

[7]

Q18.

(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]

Q19.

(a) C or 0.18 mm

1

(b) 0.6 m

allow 1 mark for correct transformation and substitution

allow 1 mark for changing frequency to Hz

answer 600 gains 1 mark

2

(c) creates an alternating current

accept ‘ac’ for alternating current

accept alternating voltage

1

 with the same frequency as the radio wave

accept signal for radio wave

 or it gets hotter

1

(d) X-rays cannot penetrate the atmosphere

accept atmosphere stops X-rays

do not accept atmosphere in the way

 or X-rays are absorbed (by the atmosphere)

before reaching Earth

ignore explanations

1

[6]

Q20.

(a) converging

 or convex

1

(b) (principal) focus

 or focal point

1

(c) either (×)1.5 or (×)1½ or 150%

unambiguous evidence of appropriate measurements for 1 mark only eg 4 and 6 or 8 and 12 or 0.8 and 1.2

2

(d) real rays cross to form it / formed at the intersection of real rays

accept ‘image on the opposite side of the lens to the object’

accept ‘can be put onto a screen’

1

[5]

Q21.

(a) (i) (angle of) refraction

take care not to credit ‘angle of reflection’

1

(ii) normal

do not credit ‘horizontal’

1

(b) either

 (photographic) film

 or CCD(s) (charge-coupled device(s)) / CMOS(s) (sensor(s)) / (active) pixel sensor(s)

accept ‘LDR(s)’ / ‘light dependent resistor(s)’

not lux meter

do not accept light sensor(s)

1

(c) (i) converging

or ‘convex’

1

(ii) either

 (0).35

 or (0).4(1...)

do not give any credit for an answer greater than 1

or

7 ÷ 20 for 1 mark

or

clear evidence that appropriate measuring / counting, has been made for 1 mark

2

(d) otherwise it will have no effect on the light detector

 or otherwise no (real) light will fall on the light detector

or ‘a virtual / imaginary image will have no effect on the light detector’

allow error carried forwards for ‘light detector’

allow so it can be formed on the film

1

[7]

Q22.

(a) B

1

(b) G

1

(c) D

1

(d) A

1

[4]

Q23.

(a) (i) microwave

1

(b) (i) identical

1

(ii) • increased risk of cancerous growth (between ear and brain)

1

• complaints of headaches and tiredness

1

(iii) any two from:

• tests in a laboratory did not give effects of tiredness or headaches

• waves not strong enough to cause long term heat damage to cells

• evidence to link mobile phones and ill health is not reliable

2

[6]

Q24.

(i) all electromagnetic waves travel at the same speed through a vacuum, (so

assume same speed in air)

accept ‘all parts of spectrum’ for electromagnetic waves

1

(ii) 1500 (m)

allow 1 mark for correct transformation and substitution

allow 1 mark for using 200 000 Hz

answers 1 500 000 = 1 mark

2

(iii) line drawn at correct position

anywhere between 1000 and next section (10 000)

accept their value for (a)(ii) drawn in

the correct position

1

[4]

Q25.

(a) stars / galaxies / sources emit all / different types of electromagnetic waves /

radiation

accept two or more named electromagnetic waves

accept answers in terms of frequencies / wavelengths

1

(b) (i) wavelength (of light) increases

accept frequency decreases

or

light moves to red end of spectrum

accept redder but do not accept red alone

1

(ii) it is the star (detected) furthest from the

Earth

accept galaxy for stars

or

it is moving away the fastest

ignore reference to universe expanding

1

(c) (i) all matter compressed to / starts at / comes from a single point

do not accept increasing gravitational pull

accept everything / the universe for all matter

1

 (massive) explosion sends matter outwards

accept explosion causes universe to expand

ignore explosion creates the universe or further reference to star / Earth formation

1

(ii) check validity / reliability of the evidence

or

 change the theory to match the new evidence

accept comparison of new and old evidence

1

[6]

Q26.

(a) 400 000 000

or

correct equivalent

allow 1 mark for correct transformation and substitution (of 75)

answer 4 000 000 gains 1 mark only

2

(b) (i)

any mention of alpha, beta, gamma waves scores 0 marks

 emit / uses / transmit / receive microwaves

accept radiation for microwaves throughout

ignore radio waves

1

 some microwave / energy absorbed by / enters the body

ecf for their given electromagnetic wave

do not accept goes through the body

1

 raises temperature of (body) cells / tissue / water

accept reference to water molecules vibrating faster

accept it could cause mutation / harm / kill cells

do not accept answers in terms of ionisation

ignore references to cancer

1

(ii) any two from:

• research (may be) biased

or may have been misled in the past

accept not independent

or may be lying

• some research suggests a link

• long-term effect not proven / studied

accept not studied for long enough

• residents may not have seen the research

2

[7]

Q27.

(i) B

1

(ii) A

1

[2]

Q28.

(a) (i) point where the rays cross

do not credit if ambiguous

1

(ii) converging (lens)

do not accept convex

1

(b) (i) point where the rays appear to diverge from

this should appear to be within 10mm in front of the back of the arrows on the approximate centre line

need not be accurately constructed using a ruler

1

(ii) diverging (lens)

do not accept concave

1

(c) converging

1

film

1

smaller than

nearer to

accept any clear indication of the response e.g. ticking, ringing, writing in after a mistake

1

(d) (i) (image) bigger than object enlarge

accept just 'made bigger'

1

(ii) it / real image can be put on a screen or real image on the opposite side

of the lens to the object

accept 'not an imaginary or virtual image'

assume 'it' refers to a real image

do not credit 'it can be seen'

1

(e) either (the converging lens is) thick in the middle thin(ner) at the edge

1

thickest in the middle gains 2 marks

1

 or (both) sides bend outwards (1) in the middle (1)

convex gains 2 marks

suitable diagrams gains 2 marks

 or one side bends in the middle (1) more than the other side bends inwards

(in the middle) (1)

1

[12]

Q29.

silver is a (good) reflector of heat

(radiation) or

silver reflects the heat (radiation)

fact

heat = infra red

ignore references to light

accept shiny for silver

good radiator negates the mark

ignore references to good conductor

do not accept bounce back

1

 less heat is lost through the board or more heat is retained by the shirt

explanation

accept both sides of shirt heated

reflects heat back up gets 1 mark only

ignore mention of friction

1

[2]

Q30.

(a) (i) converging / convex / biconvex

1

(ii) focal (points) or foci

accept focuses or focus (point)

1

(iii) (principal) axis

1

(iv)

all lines drawn with a ruler for full marks

no ruler, penalise 1 mark from first four

last mark can still be awarded

double refraction drawn could get 4 out of 5 marks

ray that continues from the top of the object through L

to the eye

1

horizontal ray from the top of the object, refracted by the lens

and continued through F on the r.h.s. to the eye

1

back projections of these rays (shown as dotted lines)

1

image 25 mm high at 61 mm left of L

(tolerance 1 mm ± vertically, 2 mm ± horizontally)

1

at least one arrow shown on real ray and towards the eye

but do not credit if contradicted by other arrow(s)

1

(v) formed where imaginary rays intersect / cross or not formed by real rays

accept (virtual image) is imaginary

accept cannot be put on screen

do not credit just ‘… is not real’

1

(b) (the image) needs to fall on film / sensors / LDRs / CCDs

accept just ‘charged couples’

do not credit ‘… solar cells’

do not accept virtual image cannot be stored

1

 either to cause a (chemical) reaction or to be digitalised

for credit response must be appropriate to camera type

1

object (should be) on the far side of F / the focus (from the lens)

or … more than the focal length (away from the lens)

allow ‘beyond the focus’

 or object should be more than twice the distance / 2F (from the lens) (2 marks)

or … more than twice the focal length (away from the lens)

(2 marks)

1

[12]

Q31.

Quality of written communication

award for a sensible sequence of two points

1

X-rays do not go through lead

accept lead protects them from the X-rays

accept not exposed to X-rays

1

 lead stops / reduces risk of X-rays harming / damaging / killing (persons) cells

accept X-rays (may) cause cancer

accept organs for cell

do not accept references to electric shock

do not accept stops bones of people showing on X-ray

answers involving the horse wearing an apron are incorrect

references to gamma rays are incorrect

1

[3]

Q32.

 (a) (i) rays continued to meet on the right hand side of the lens and beyond

must be straight lines from the right hand side of the lens

ignore details through the lens

allow if no arrows

1

meet exactly on the axis

negate mark if contradictory arrow(s) added

do not need to go beyond the focus for this mark

1

(ii) (principal) focus

or focal (point)

1

(iii) converging

or convex

1

(b) (i) A

1

(ii) rays seem to come from this point

or words to this effect

or shows this on the diagram

1

(iii) diverging

or concave

1

(c) film

accept any unambiguous method of showing the correct response

1

smaller than

1

further away from

1

(d) any three from:

• real image can be put on a screen

allow film

• virtual image cannot be put on a screen / film

• virtual image is imaginary

• real image is formed where (real) rays cross / converge

allow real image has light travelling through it

• virtual image is where virtual / imaginary rays (seem to) come from

or virtual image is where rays seem to come from

• virtual image formed where virtual rays intersect / cross

3

[13]

Q33.

(a) (i) L

1

(ii) N

1

(c) the answer should be in the form:

not inside the eye

 either for both marks an arrangement which could demonstrate visibly

light travels in straight lines

full credit should be given for answer presented as a diagram

 and

an explanation of how it shows the straightness

or for one mark

 named device which uses principle of light travelling in straight lines to work

examples

light (from a street lamp) strikes an object producing a shadow

laser light travelling through (fine) dust shows a straight beam

three pieces of card with central holes need to be lined up to be able to see through the third hole from the first

ray box type experiment using mirrors/prisms, etc

beams on paper or in smoke

torch beams through smoke

example devices:–

–pinhole camera (qualification may get second mark)

–periscope

–optical fibre

–reflection ‘in a mirror

2

[4]

Q34.

(i) speed = frequency × wavelength

accept the equation rearranged

accept v or s = f × λ

do not allow w for wavelength

do not accept

unless subsequent calculation correct

1

(ii) 330 (m)

allow 1 mark for

λ =

or 300 000 000 = 909 000 × λ

or answer of 330000(m) or 330033(m)

2

[3]

Q35.

(a) all three correct

one only correct, 1 mark only

allow names in boxes

there should be only one line from or to each box

2

(b) the same as

1

(c) any two from:

• bones absorb X-rays

• so film not exposed

• X-rays pass through flesh or skin or

• body or tissue (to expose film)

allow X-rays cannot pass through bones

2

[5]

Q36.

(a) (i) 3

1

(ii) 1

accept a definition of frequency ignore units

1

(iii) hertz

1

(b) straight line in correct direction

judge by eye (from ‘a’ of waves to ‘s’ of across) ignore arrow

accept equal angles shown on waves

1

 (c) (i) gets smaller

1

(ii) kinetic

accept movement

1

(iii) renewable

1

[7]

Q37.

(i) wave speed = frequency × wavelength

accept correct transformation

accept v = f × λ

accept s for speed

accept m/s = Hz x m

accept if subsequent use of is correct

1

(ii) 500 000 000

credit for 1 mark correct transformation in words or numbers or correct substitution

2

 Hertz

3 marks for 500 000k Hz or 500 MHz

numerical answer and unit must be consistent for full credit

1

[4]

Q38.

(i) 0.5

1

(ii) wave speed = frequency wavelength

accept v = f × λ

accept s for v

accept m/s = Hz m

accept

providing subsequent method correct

1

(iii) 15.2 km

both numerical answer and unit are required for both marks

numerical answer and unit must be consistent

allow 1 mark for 15.2 with incorrect or no unit

allow 2 marks for an answer of 1.52 km if the answer to (b)(i) was given as 5

r 1 mark for correct transformation

or 1 mark for correct use of speed = distance/time

unit on its own gains no credit

2

[4]

Q39.

(i) X-rays or gamma rays

for 1 mark

1

(ii) passes through flesh;

stopped by bone/absorbed

for 1 mark each

2

[3]

Q40.

(a) Reflection correct

Normal incidence correct in and out

Correct refraction in

Parallel ray out

each for 1 mark

4

(b) (i) Each ray correctly refracted in

1 + 1 = 2

7

(ii) Wavefronts perp sides

Wavefronts closer

(Cannot score wavefront marks if refracted rays clearly wrong)

(iii) Speed reduces

Starting at B

Then D

each for 1 mark

(c) TIR correct

gets 2 marks

Else rough reflection

gets 1 mark

2

[13]

Q41.

(a) (i) Image distance increases

Image size increases

Remains inverted

Remains real

for 1 mark each

2

(ii) Image distance decreases

Image size decreases

Becomes upright

Becomes virtual

for 1 mark each

2

(b) Move lens with respect to film

Closer for distant objects

Further for near objects

for 1 mark each

3

[7]

Q42.

(a) (i) Ignore arrows on rays

perpendicular rays goes straight in and out

other ray refracts towards normal (not along)

emerges parallel incident ray (by sight) if refraction correct (ignore reflections)

for 1 mark each

3

(ii) emergent angle marked Y if emerges parallel to right of normal

for 1 mark

1

(b) straight ray to water surface refracts/bends

straight to eye/towards surface on right image correctly shown

or states the same mark prose only of diagram incomplete

any 3 for 1 mark each

3

[7]

Q43.

Eye – Diminished/smaller than object

Nearer the lens than object or on the retina

for 1 mark each

2

 Projector – real

Further from lens than object

for 1 mark each

2

 Camera – real

Smaller (than object)

for 1 mark each

2

[6]

Q44.

(a) radio – 1500

ultra violet 3 × 10–8

visible – 5 × 10–7

X-rays – 1 × 10–11

4

(b) 1 × 1010Hz 1010HzOK

for 4 marks

 else 1 × 1010

for 3 marks

 else 3 × 108/0.03

for 2 marks

 else v = frequency × wavelength or 3 × 108 = 0.03f

any answer with unit Hz scores 1, 2 or 3

for 1 mark

4

[8]

Q45.

(a) one mark for each ray correctly drawn straight to glass then bent towards pupil

accept both rays hitting any part of eye

judge straightness by eye

accept dotted or dashed lines

ignore any arrows

N.B. the rays must reach the eye

2

(b) speed

1

refraction

1

transverse

1

[5]

Q46.

(a) any two successive peaks labelled W

accept any 2 points on same part of adjacent waves

correct by eye

1

 half ‘height’ of wave labelled A

correct by eye

N.B. at least one of the answers must be labelled

1

(b) 0.2

correct answer with no working = 2

allow 1 mark for s = f x w or correct working i.e., 2 × 0.1

N.B. correct answer from incorrectly recalled relationship = 0

2

 m/s (unit)

independent mark do not allow mps or mHz

1

[5]

Q47.

(ultrasonic) waves or vibrations or oscillations in fluid

N.B. must mention fluid or liquid

or water

1

 idea of shaking dirt particles off watch

allow cavitation / implosion of small bubbles

1

[2]

Q48.

(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]

Q49.

(i) absorbed by water / water heated

1

 hot water heats (rest of) food / idea of particle vibration

1

(ii) 300 000 000 / 3 × 108

correct answer with no working = 2

allow 1 mark for s = f x w or correct working i.e., 10000 (000000) × 0.03

N.B. correct answer from incorrectly

recalled relationship / substitution = 0

2

[4]

Q50.

(a) D

1

(b) C

1

(c) B

1

[3]

Q51.

(a) first reflection vertically down to the

fourth hatch line or just to the left of

it reaching mirror (must come from

incident ray given)

1

 second reflection back parallel to incident ray must be linked to first part of ray

1

 appropriate arrow on a part of the ray (may be given if lines wrong)

(must come from source of light)

maximum of one mark to be lost for poor diagrams not using a ruler for straight lines

first time you come across wavy line, it is penalised

1

(b) ray in block bent downwards, not beyond the normal

do not credit if exactly on normal

1

emergent ray parallel to incident ray

do not credit a continuation of the line straight through the block these are independent

1

[5]

Q52.

(a) (i) more turns or waves per second

accept spinning or turning or faster

1

(ii) less time spent cutting field lines

accept shorter time in field or when the frequency increases (the wavelength decreases)

1

(iii) more energy given

accept more KE put in

accept a higher voltage produced

do not credit more power

1

(b) more coils

1

more powerful magnets

accept put in better bearings

do not credit reduce friction or add soft iron core

1

[5]

Q53.

(a) amplitude marked as approximately half a wave height

great precision is not required

1

 wavelength marked as a trough to trough distance or a peak to peak

distance

accept an equivalent repeat distance anywhere on the wave

1

(b) the number of waves each second

accept cycles per second accept 25 waves pass each second

1

(c) any pair from

microwave cooking or communication or mobile phone

radio communication or entertainment

infra-red cooking or heating or remote control or security or night sights or thermal imaging

accept sensible specific uses

2

[5]

Q54.

(i) (incident) ray along the normal

or (incident) ray at 90° (to the surface)

1

(ii) (A) total internal reflection

all three words required do not credit total internal refraction

1

(B) EITHER

angle of incidence is greater than the critical angle

or angle of incidence is greater than 42°

2

 OR

angle of incidence is 45°

1

[4]

Q55.

(i) (wave) speed = frequency × wavelength

or any correctly transposed version

accept v = f × λ

or transposed version

accept m/s = 1 / s × m

or transposed version

or

but only if subsequently used correctly

1

(i) 325

1

 metres per second

or m / s or 0.325 km/s for 2 marks

1

[3]

Q56.

makes things look bigger/clearer/nearer M used for small objects;

or to see things better T used for distant objects

 magnifies or makes it bigger

 ‘it’ = image of object; bigger for M;

inverted/upsidedown/ other way up smaller for T

any seven for 1 mark each

[7]

Q57.

idea that X-rays cause mutations

gains 1 mark

 but X-rays can cause/increase chance of mutations

gains 2 marks

 mutations usually harmful/produce abnormal growth

serious effect on growing foetus/rapidly growing cells

each for 1 mark

[4]

Q58.

(a) gamma rays above x-rays

for 1 mark

(b) upper radio wave boundary correct (10-1m) (± 1mm)

for 1 mark

(c) visible radiation/light

• within the middle third of a wavelength band

• in the correct wavelength range (10-6 – 10-7m)

each for 1 mark

(d) ultraviolet between \*visible radiation and X-rays

for 1 mark

(e) microwaves above \*radio waves and below \*infra red

(\*not necessarily immediately)

for 1 mark

(f) between 108Hz + 107Hz and nearer to 108Hz than to 107Hz

gains 1 mark

[7]

Q59.

(a) line (from fish) to complete ray to eye

[mark awarded even if begins outside the box]

[credit only if fish shown to left of normal]

• fish within the region shown or X or start of ray

(i. e. not necessarily directly below x) each for 1 mark

2

(b) bent/refracted/deviated/speeded up

for 1 mark

1

[3]

Q60.

• Q is louder

• Q is higher (pitch/note but not frequency)

[if loudness and pitch both mentioned but direction wrong / absent credit 1 mark]

• louder because bigger amplitude/height

• higher pitch because higher frequency/shorter wavelength/waves closer together

• factor of 2 mentioned w.r.t either

(NB converse answer for P)

each • for 1 mark

[5]