Electromagnetic Waves

Mark Scheme 1

Level	GCSE (9-1)
Subject	Combined Science: Trilogy - Physics
Exam Board	AQA
Topic	6.6 Waves
Sub-Topic	Electromagnetic Waves
Difficulty Level	Silver Level
Booklet	Mark Scheme 1

Time Allowed: **60 minutes**

Score: **/59**

Percentage: **/100**

Grade Boundaries:

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

- light waves are transverse whereas sound waves are longitudinal
- light waves travel faster than sound waves
- light waves have a higher frequency than sound waves
- light waves have a shorter wavelength than sound waves
- light waves have oscillations perpendicular (to the direction of energy transfer) whereas sound waves are parallel (to the direction of energy transfer)

4

(b) the baby can be seen in the dark

1

(c) wave speed = frequency × wavelength

accept $v = f \lambda$

1

(d) $3 \times 10^8 = f \times 0.125$

1

$f = 3 \times 10^8 / 0.125$

1

$f = 2.4 \times 10^9$ (Hz)

allow 2.4×10^9 *with no working for* ***3*** *marks*

1

[9]

M2.(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]

M3. (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 $\frac{300\,000\,000}{20}$

*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]

M4. (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]

M5. (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]

M6. (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]

M7. (i) X-rays or gamma rays

for 1 mark

1

(ii) passes through flesh;
stopped by bone/absorbed

for 1 mark each

2

[3]

M8. (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]

M9. (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]

M10. (i) absorbed by water / water heated

1

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

1

(ii) 300 000 000 / 3×10^8

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]