Unit 2: Waves and Electricity - Mark scheme

Question number	Answer	Mark
1	**C**	**1**
2	**C**	**1**
3	**B**	**1**
4	**D**	**1**
5	**D**	**1**
6	**A**	**1**
7	**C**	**1**
8	**C**	**1**
9	**C**	**1**
10	**B**	**1**

Question number	Answer		Mark
11(a)	Wavelength is the distance between two adjacent points that are in phase	(1)	**1**
11(b)	• Use of $v = s/t$ • Calculate distance to aircraft when the return time is 0.75 μs (225 m) **Or** Calculate time for pulse to return when distance to aircraft is 60 km (2.3×10^{-4} s) **Or** Calculate total distance travelled by pulse when the return time is 1.5 μs (225 m) and compare to 60 km **Or** Calculate time for pulse to return when distance travelled is 60 km (2.0×10^{-4} s) and compare to 0.75 μs • Appropriate comment on suitability, e.g. detectable distance less than distance required, so suitable **Or** pulse shorter than time required to travel the distance, so suitable (Third mark is awarded only if second mark is awarded) <u>Example of calculation</u> $s = 3\times 10^{8}$ m s^{-1} $\times 1.5 \times 10^{-6}$ s s = 450 m One way = 225 m **Or** $t = 60000$ m$/3 \times 10^{8}$ m s^{-1} $t = 2.0 \times 10^{-4}$ s	(1) (1) (1)	**3**

Question number	Answer	Mark
11(c)	• Use of $I = \frac{P}{A}$ (1) • $P = 2.1$ kW (1) <u>Example of calculation</u> $P = 0.16 \text{kWm}^{-2} \times 13.2 \text{m}^2$	**2**
	Total for Question 11	**6**

Question number	Answer	Mark
12	This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning. Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning. The following table shows how the marks should be awarded for indicative content.	6

Number of indicative marking points seen in answer	Number of marks awarded for indicative marking points
6	4
5–4	3
3–2	2
1	1
0	0

The following table shows how the marks should be awarded for structure and lines of reasoning**.**

	Number of marks awarded for structure of answer and sustained line of reasoning
Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout	2
Answer is partially structured with some linkages and lines of reasoning	1
Answer has no linkages between points and is unstructured	0

Total marks awarded is the sum of marks for indicative content and the marks for structure and lines of reasoning

Indicative content

- (the atoms) of gases in the atmosphere contain electrons
- electrons absorb photons from the sunlight
- electron moves to higher energy level
- the energy levels (of electrons) are discrete
  Or only certain energy levels are possible
- The energy of the photon must be equal to the difference in energy levels
  Or $hf = E2 - E1$
- There are only a limited number of energy differences and only a corresponding number of black lines

	Total for Question 12	**6**

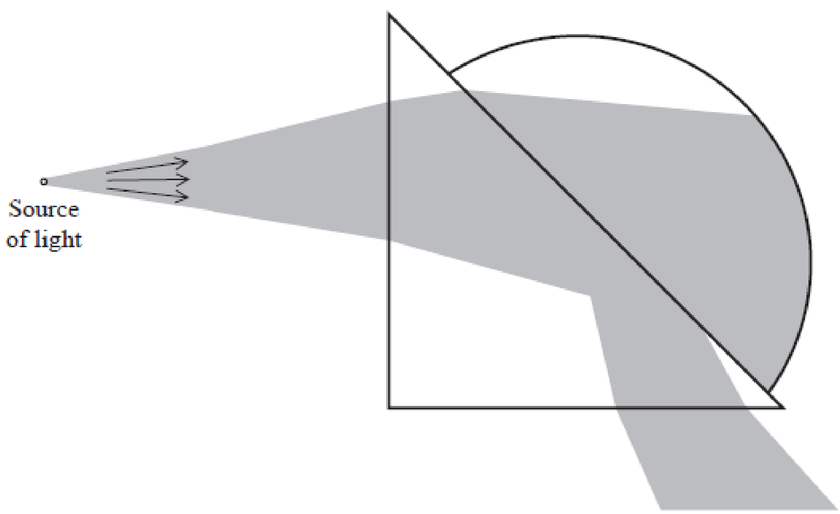
Question number	Answer	Mark
13(a)	• A wave on which there are points that always have maximum displacement and others that always have zero displacement **Or** A wave on which there are points that are nodes and antinodes (1)	1
13(b)(i)	• Quarter of a wavelength in length of air/pipe (1) • Use of $v = f\lambda$ (1) • Comparison with $y = mx$ (1) Example of calculation $v = f \times 4l$ $f = \frac{v}{4} \times \frac{1}{l}$	3
13(b)(ii)	• Determines gradient of graph (1) • $v = 330$ (m s^{-1}) (1) Example of calculation Gradient = $\frac{500s^{-1}}{6m^{-1}} = 83.3$ m s^{-1} $v = 4 \times 83.3 = 330$ m s^{-1}	2
13(b)(iii)	• Use of $v = f\lambda$ to determine λ (1) • Second standing wave: length = ¾ wavelength (1) • Corresponds to $1/l = 1.7$ (m^{-1}) as given on the graph so yes produced audible sound (1) Example of calculation $330 = 415\lambda$ $\lambda = 0.795$m $l = \frac{3}{4} \times 0.795$ $l = 0.6$m $\frac{1}{l} = 1.7\text{m}^{-1}$	3
	Total for Question 13	9

Question number	Answer	Mark
14(a)	• Light (photons) transfers energy to electrons (1) • Greater number of conduction electrons so less resistance (1)	2
14(b)(i)	• Amount of energy supplied (by the cell) per unit charge (1)	1
14(b)(ii)	• Use of $V = IR$ to calculate current (1) • Subtraction of p.d. from e.m.f. (1) • $r = 6500\ \Omega$ (1) <u>Example of calculation</u> $I = \dfrac{0.47}{6100} = 7.7\times10^{-5}$ A $r = \dfrac{0.97-0.47}{7.7\times10^{-5}} = 6500\ \Omega$	3
14(b)(iii)	• Use of $P = VI$ **Or** $P = V^2/R$ (1) • $P = 3.6 \times 10^{-5}$W (1) <u>Example of calculation</u> $P = 7.7\times10^{-5}\ \text{A}\times0.47\text{V} = 3.6 \times 10^{-5}$W	2
	Total for Question 14	**8**

Question number	Answer	Mark
15(a)(i)	• A minimum is produced (1) • Waves arrive 180° out of phase (1)	2
15(a)(ii)	• If this path difference = half a wavelength then a maximum would occur, as the overall path difference = one wavelength (1) • So the light from the planet produces a maximum and the light from the star produces a minimum (1)	2
15(b)	• IR radiation has a longer wavelength than visible light (1) In a laboratory the setup can be made to have a path difference that matches half the wavelength of IR used **Or** the actual path difference with visible light would be extremely small (1)	2
	Total for Question 15	**6**

Question number	Answer		Mark
16(a)	• Uses graph to find ρ = 240 Wm • Use of $R = \frac{\rho l}{A}$ • R = 21 kΩ <u>Example of calculation:</u> $R = \frac{240\text{Wm} \times 5.0 \times 10^{-2}\text{m}}{5.8 \times 10^{-4}\text{m}^2}$ = 20.7 kΩ	(1) (1) (1)	3
16(b)(i)	• Use of $I = V/R$ • Output p.d. = 0.70 V <u>Example of calculation:</u> $V = \frac{21}{21+129} \times 5 = 0.70$ V	(1) (1)	2
16(b)(ii)	**Either** • As soil dries resistivity of soil increases • As soil dries R_{probe} increases (above 21k) • So as soil dries the p.d. becomes greater than 0.7 V • Incorrect information as this system will switch off water as soil gets drier **Or** • As soil gets wetter resistivity decreases • As soil has moisture more than 0.14 R_{probe} decreases (below 21 k) • As it gets wetter p.d. decreases below 0.7 V • Incorrect information as this system will switch on water as soil gets wetter	(1) (1) (1) (1) (1) (1) (1) (1)	4
16(c)	• Negative coefficient: resistance decreases as temperature increases • Resistance decreases means output p.d. decreases • So sensor could switch on coolers **Or** open windows **Or** turn off heaters when temperature above a certain value	(1) (1) (1)	3
	Total for Question 16		**12**

Question number	Answer		Mark
17(a)	• Photons of ultraviolet light • Results in electrons being emitted from <u>surface</u> of zinc • So electroscope loses charge and leaf falls	(1) (1) (1)	3
17(b)	• Use of $\phi = hf$ • Use of $c = f\lambda$ • $\lambda = 2.9 \times 10^{-7}$ m <u>Example of calculation</u> $4.3 \times 1.6 \times 10^{-19}\text{ J} = 6.63 \times 10^{-34}\text{ J s} \times f$ $f = 1.04 \times 10^{15}$ Hz $3.00 \times 10^{8}\text{ m s}^{-1} = 1.04 \times 10^{15}\text{ Hz} \times \lambda$ $\lambda = 2.9 \times 10^{-7}$ m	(1) (1) (1)	3
17(c)	• Wave energy depends on intensity • Energy is spread over the whole wave • The wave model suggests that if exposed for long enough electrons would eventually be released but this does not happen.	(1) (1) (1)	3
	Total for Question 17		**9**

Question number	Answer		Mark
18(a)	• Use of $n = \frac{c}{v}$ • $v = 1.97 \times 10^8$ m s^{-1} <u>Example of calculation</u> $1.52 = \frac{3.00 \times 10^8}{v}$ $v = 1.97 \times 10^8$ m s^{-1}	(1) (1)	2
18(b)	• At the first surface the beam refracts towards the normal • At the second surface some of the beam is incident at an angle greater than c – this light internally reflects • Some of the light is less than c this refracts out of the prism • At the bottom surface the light refracts out of the prism	(1) (1) (1) (1)	4
18(c)(i)	• Use of $n_1 \sin\theta_1 = n_2 \sin\theta_2$ • $C = 58.8°$ <u>Example of calculation</u> $1.52 \times \sin C = 1.30 \times \sin 90^0$ $C = 58.8°$	(1) (1)	2
18(c)(ii)	• The beam has a larger angle of deviation when it is refracted into the air than when it is refracted into the fruit juice • Very small proportion of beam reflecting at second surface • Some refraction shown on leaving bottom surface <u>Example of diagram</u>  	(1) (1) (1)	3

Question number	Answer	Mark
18(c)(iii)	• If refractive index greater then critical angle greater (1) • So less of beam reflected at second surface (1) • Hence the illumination of the scale is over a shorter length (1) (MP3 dependent on MP2)	**3**
	Total for Question 18	**14**