Mark Scheme (Results)

October 2020

Pearson Edexcel International Advanced Subsidiary/Advanced Level
In Physics (WPH012)
Paper 1: Waves and Electricity

Question Number	Answer	Mark
1	**C is the correct answer** as to calculate speed, the wavelength is determined from the displacement-distance graph and multiplied by the frequency which is determined from the displacement-time graph. A is not the correct answer as this can be determined from either graph B is not the correct answer as this can be determined from the displacement-time graph only D is not the correct answer as this can be determined from the displacement-distance graph only	**(1)**
2	**C is the correct answer** as a path difference of λ is equivalent to a phase difference of 360°, so $3\lambda/8$ is equivalent to 3/8ths of 360° which = 135° A is not the correct answer as 34° is 3/8ths of 90° B is not the correct answer as 68° is 3/8ths of 180° D is not the correct answer as 270° is 3/8ths of 720°	**(1)**
3	**D is the correct answer** as $n\lambda = d\sin\theta$ where $n = 1$ and $d = 1/300$. $\tan\theta =$ 0.40m / 2.00m. A is not the correct answer as the wavelength is not $300\sin\theta$ B is not the correct answer as the wavelength is not $300\sin\theta$ C is not the correct answer as θ is not $\sin^{-1}$ (0.40/2.00)	**(1)**
4	**B is the correct answer** as power is a derived quantity A is not the correct answer as current is a base quantity C is not the correct answer as the coulomb is a derived unit D is not the correct answer as the volt is a derived unit	**(1)**
5	**A is the correct answer** as a large change in density causes most of the ultrasound to reflect, so the ultrasound does not penetrate deeper into the body. B is not the correct answer as this does not affect whether ultrasound can enter the lungs C is not the correct answer as this does not affect whether ultrasound can enter the lungs D is not the correct answer as ultrasound is not considered to cause damage to the body.	**(1)**
6	**D is the correct answer** as it is the graph for a thermistor A is not the correct answer as it is not a graph for a diode B is not the correct answer as it is not a graph for a filament lamp C is not the correct answer as it is not a graph for a resistor	**(1)**
7	**A is the correct answer** as $\rho = VA / Il$, where $A = x^2$ and $l = x$ B is not the correct answer C is not the correct answer D is not the correct answer	**(1)**
8	**D is the correct answer** as only transverse waves can be polarised A is not the correct answer as only transverse waves can be polarised B is not the correct answer as only transverse waves can be polarised C is not the correct answer as only transverse waves can be polarised	**(1)**

9	**B is the correct answer** as $v \propto 1/A$ when I, n and q are the same. A is not the correct answer as both wires have the same charge carrier density as they are both made from copper. C is not the correct answer as both wires have the same current as they are in series D is not the correct answer as the length of the wire is not related to drift velocity	**(1)**
10	**D is the correct answer** as the sum of the e.m.f.s is equal to the sum of the p.d.s in the circuit. A is not the correct answer as if the resistance of the LDR halved the voltmeter reading would increase. B is not the correct answer as increasing the light intensity would increase the voltmeter reading (as the LDR would have a lower resistance) C is not the correct answer as increasing the light intensity would increase the voltmeter reading (as the LDR would have a lower resistance)	**(1)**

Question Number	Answer		Mark
11a	Use of $n_1\sin\theta_1 = n_2\sin\theta_2$ with both 1.33 and 1.52 seen angle of refraction = 37° **<u>Example of calculation</u>** $n_1\sin\theta_1 = n_2\sin\theta_2$ 1.33 sin (43°) = 1.52 sin r r = 36.6°	(1) (1)	**2**
11b	Use of sin $C = 1/n$ critical angle = 61° **OR** Use of sin C = 1 / 1.14 (if ratio calculated in (a)) critical angle = 61° (Allow an ecf of n_1/ n_2 ratio from (a)) **<u>Example of calculation</u>** sin $C = 1/n$ $C = \sin^{-1}$ (1.33/1.52) = 61.0°	(1) (1) (1) (1)	**2**
	Total for question 11		**4**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>12(a)</td><td>Uses ratio of resistances to p.d.s (1)
V = 1.2 V (1)

OR
Use of $R = V/I$ (1)
V = 1.2 V (1)

<u>Example of calculation</u>
$V = \left(\frac{55\ \text{k}\Omega}{12\ \text{k}\Omega + 55\ \text{k}\Omega}\right) \times 1.5\ \text{V} = 1.23\ \text{V}$</td><td>2</td></tr>
<tr><td>12(b)</td><td>1 mark for each correct reason (1)(1)
1 mark for each explanation (1)(1)

<table><tr><th>Reason</th><th>Explanation</th></tr><tr><td>Cell has (internal) resistance</td><td>Terminal/cell p.d. is lower
Or lost volts</td></tr><tr><td>Resistance in wires/connections</td><td>Wires/connections have p.d. across them too.</td></tr><tr><td>Voltmeter has a “low” resistance
Or voltmeter draws current</td><td>Resistance of parallel combination would be less than 55 kΩ (so p.d. would be lower)</td></tr></table></td><td>4</td></tr>
<tr><td></td><td>Total for question 12</td><td>6</td></tr>
</table>

Question Number	Answer	Mark
13a	Use of $v = f\lambda$ (1) $\lambda = 0.40$ (m) (1) Wave is suitable (1) **OR** Use of $v = f\lambda$ (1) $f = 850$ (Hz) / 0.85 (kHz) (1) Wave is suitable (1) **OR** Use of $v = f\lambda$ (1) $v = 340$ (m/s) (1) Wave is suitable (1) (MP3 by any method is dependent upon awarding both MP1 and MP2) **<u>Example of calculation</u>** $v = f\lambda$ 340 m s^{-1} = 850 Hz × λ $\lambda = 0.40$ m	**3**

***13b**

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.

IC points	IC mark	Max linkage mark	Max final mark
6	4	2	6
5	3	2	5
4	3	1	4
3	2	1	3
2	2	0	2
1	1	0	1
0	0	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

Indicative content

- Sound (from ANR) has to diffract to reach the furthest/right ear
- (Sound) cancelled when destructive interference takes place
- (Sound) louder when constructive interference takes place
- Destructive interference is where waves are in antiphase
- Constructive interference is where waves are in phase
- When distance between the ears is half a wavelength
  Or distance between the ears is approximately 20cm.

(For IC1, do not allow "noise from engine diffracts to reach the right ear")
(For IC2 to IC5, interference or superposition are accepted)
(For IC2 and IC3 accept correct reference to minimum/maximum amplitude)
(For IC4 and IC5, accept answers in terms of path difference. However, path difference must be in terms of λ and phase difference in terms of π or °)

Linkage mark 1 – needs at least 2 from IC1-IC3 to consider this.
Linkage mark 2 – needs at least 2 from IC4-IC6 to consider this.

6

	Total for question 13	**9**

Question Number	Answer		Mark
14a	Minimum energy required to release a(n) (photo)electron (from the surface of a metal)	(1)	**1**
14b	Use of $E = hf$	(1)	
	Use of $hf = \Phi + ½ mv^2_{max}$	(1)	
	$\Phi = 5.90 \times 10^{-19}$ (J) so metal is magnesium	(1)	**3**
	Example of calculation $E = hf = (6.63 \times 10^{-34}$ Js) $\times (6.32 \times 10^{15}$ Hz) $= 4.19 \times 10^{-18}$ J $hf - ½ mv^2_{max} = 4.19 \times 10^{-18}$ J $- 3.60 \times 10^{-18}$ J $= 5.90 \times 10^{-19}$ J so metal used is magnesium.		
14ci	Use of $I = P/A$	(1)	
	Use of $P = W/t$ with $W = 3.62 \times 10^{-19}$ (J)	(1)	
	$t = 118$ s	(1)	**3**
	Example of calculation $I = P/A$, $(38.0 \times 10^{-3}$ Wm$^{-2}) \times (8.10 \times 10^{-20}$ m$^2) = 3.08 \times 10^{-21}$ W. $t = W/P$, $(3.62 \times 10^{-19}$ J) / $(3.08 \times 10^{-21}$ W) = 118 seconds.		
14cii	One photon releases one electron	(1)	
	Photons transfer all of their energy to the electrons **Or** Photons are packets/quanta of energy	(1)	**2**
	Total for question 14		**9**

Question Number	Answer	Mark
15a	Substitutes values into $E = (\frac{e^2}{kh})^2 (\frac{m}{8})$ (1) Converts J into eV (1) 13.5eV or 13.6 eV (1) (MP3 is dependent upon correct working being shown) **Example of calculation** $E = = \frac{(1.60 \times 10^{-19}\text{C})^4 \ (9.11 \times 10^{-31}\text{ kg})}{(8.85 \times 10^{-12}\text{ Fm}^{-1})^2 \ (6.63 \times 10^{-34}\text{ Js})^2 \times 8}$ $E = 2.17 \times 10^{-18}$ J $(2.17 \times 10^{-18}$ J) / $(1.60 \times 10^{-19}$ J eV^{-1}) = 13.56eV	**3**
15b	Substitutes values into $r = \frac{h^2 k}{\pi m e^2}$ (1) $r = 5.3 \times 10^{-11}$ (m) (1) Use of $\lambda = h/p$ (1) $\lambda = 2.8 \times 10^{-14}$ (m) (for neutron) (1) neutron wavelength not similar to size of atom radius, so student is incorrect (1) (MP5 is dependent upon awarding all of MP1-4 and there needs to be some comparison of the two values) (allow MP1 and/or MP3 for candidates who substitute the incorrect mass into the equation e.g. mass of neutron where it should be mass of electron in MP1) **Example of calculation** $r = \frac{h^2 k}{\pi m e^2} = \frac{(6.63 \times 10{-}34\text{ Js})^2 (8.85 \times 10{-}12)}{\pi\ (9.11 \times 10{-}31\text{ kg})(1.60 \times 10{-}19\text{ C})^2}$ r = 5.31×10^{-11} m For neutron, $\lambda = h/p$ = $(6.63 \times 10^{-34}$ Js) / $(1.67 \times 10^{-27}$ kg) $(1.4 \times 10^7$ m s^{-1}) = 2.84×10^{-14} m	**5**
	Total for question 15	**8**

Question Number	Answer		Mark
16a	Idea that when waves rise from 900 m depth they speed up **Or** indication that speed at 700m is greater than at 900m	(1)	
	Curving is due to the change in speed being gradual **Or** not a sudden change in direction as there is no sudden change in speed.	(1)	
	Waves are refracted away from the normal	(1)	
	Angle of incidence reaches/exceeds the critical angle (at 700m) **Or** angle of refraction becomes 90° (at 700m)	(1)	
	(At 700 m, total internal) reflection takes place (allow TIR)	(1)	**5**
16b	Path in diagram B is a longer (distance) **Or** straight line path is a shorter (distance)	(1)	
	Sound waves travel faster on path in diagram B **Or** sound waves travel slower on straight line path **Or** sound waves travel faster at 700m than at 900m	(1)	**2**
16c	Any **two** from:		
	(Change in) temperature in the sea	(1)	
	(Change in) pressure in the sea	(1)	
	(Change in) density/salinity of the sea	(1)	**2**
	Total for question 16		**9**

Question Number	Answer		Mark
17a	(Two) waves travelling in opposite directions **Or** wave meeting its reflection	(1)	
	Nodes are points of zero/minimum amplitude **and** antinodes are points of maximum amplitude	(1)	
	Nodes linked to destructive interference **and** antinodes linked to constructive interference	(1)	**3**
17b	Equates $v = f\lambda$ and $v = \sqrt{(T/\mu)}$	(1)	
	Rearranges to give $f^2 = \frac{T}{\mu\lambda^2}$ **Or** $f^2 = \frac{T}{\mu(2L)^2}$	(1)	
	Replaces T with W in equation	(1)	
	Where μ and λ are constants **Or** where μ and L are constants	(1)	
	f^2 α W **Or** no "c" in "$y=mx+c$" **Or** y-intercept is 0 **Or** in the format $y = mx$	(1)	**5**
	(MP5 is dependent on some correct working leading to an equation) (Award MP4 if stated that $\frac{1}{\mu\lambda^2}$ = constant or equivalent in terms of l)		
17c	(Connect signal generator to) cathode ray oscilloscope **Or** record movement of the string with a video camera	(1)	
	(Measure time period T and) calculate $f = 1/T$	(1)	**2**
17d	Use of $v = \sqrt{(T/\mu)}$	(1)	
	Identifies that $\lambda = 2L$	(1)	
	$\mu = 4.3 \times 10^{-4}$ kg m^{-1}	(1)	**3**
	<u>Example of calculation</u> $f\lambda = \sqrt{(T/\mu)}$, 659 Hz × (2 × 0.328 m) = $\sqrt{(80.0\ \text{N} / \mu)}$, $\mu = 4.3 \times 10^{-4}$ kg m^{-1}		
	Total for question 17		**13**

Question Number	Answer		Mark
18a	Use of resistors in parallel formula	(1)	
	Resistance of parallel section of circuit calculated as 1.33Ω	(1)	
	Total circuit resistance = 2Ω + their parallel resistance **Or** Use of ratio of resistance:p.d.	(1)	
	Use of $I = V/R$ to calculate total circuit current (3A) **Or** Use of $I = V/R$ to calculate p.d. across resistor A (6V)	(1)	
	Use of $P = VI$, $P = V^2/R$ or $P = I^2R$	(1)	
	A = 18W, B = 2W, C = 2W, D = 8W	(1)	**6**
	<u>Example of calculation</u> $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ (for parallel combination) $\frac{1}{Rp} = \frac{1}{2} + \frac{1}{4}$ $R_p = 1.33\ \Omega$ Total resistance in circuit = (1.33 + 2.00) = 3.33 Ω $I = V/R$ (for whole circuit) = 10.0 V / 3.33 Ω = 3.00 A For resistor A, $P = I^2R = (3.00\ A)^2 \times 2.00\ \Omega = 18$ W Current through D = $\frac{2}{3}$ (3.00 A) = 2.00 A For D, $P = I^2R = (2.00\ A)^2 \times 2.00\ \Omega = 8$ W For B and C, $P = I^2R = (1.00\ A)^2 \times 2.00\ \Omega = 2$ W		
18b	(With resistor D removed there is) lower circuit current **Or** (with resistor D removed there is) lower p.d. across A	(1)	
	Seeing an appropriate power equation to support the conclusion that power would be less in A	(1)	**2**
18c	As p.d increases, current increases	(1)	
	(As current increases,) temperature increases (allow "heats up")	(1)	
	Atoms/ions/lattice have greater vibrations/KE	(1)	
	Increased rate of collisions between electrons and atoms/ions	(1)	**4**
	Total for question 18		**12**