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Mark Scheme (Results)

October 2016

Pearson Edexcel
International Advanced Level
in Physics (WPH02) Paper 01
Physics at Work

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Physics Specific Marking Guidance

Underlying principle

The mark scheme will clearly indicate the concept that is being rewarded, backed up by
examples. It is not a set of model answers.

For example:

Horizontal force of hinge on table top

66.3 (N) or 66 (N) **and** correct indication of direction [no ue]

[Some examples of direction: acting from right (to left) / to the left / West / opposite direction to horizontal. May show direction by arrow. Do not accept a minus sign in front of number as direction.]

This has a clear statement of the principle for awarding the mark, supported by some
examples illustrating acceptable boundaries.

Mark scheme format

- Bold lower case will be used for emphasis.
- Round brackets ( ) indicate words that are not essential e.g. "(hence) distance is increased".
- Square brackets [ ] indicate advice to examiners or examples e.g. [Do not accept gravity] [ecf].

Unit error penalties

- A separate mark is not usually given for a unit but a missing or incorrect unit will normally cause the final calculation mark to be lost.
- Incorrect use of case e.g. 'Watt' or 'w' will not be penalised.
- There will be no unit penalty applied in 'show that' questions or in any other question
where the units to be used have been given.
- The same missing or incorrect unit will not be penalised more than once within one
question but may be penalised again in another question.
- Occasionally, it may be decided not to penalise a missing or incorrect unit e.g. the candidate may be calculating the gradient of a graph, resulting in a unit that is not one
that should be known and is complex.
- The mark scheme will indicate if no unit error penalty is to be applied by means of [no
ue].

Significant figures

- Use of an inappropriate number of significant figures in the theory papers will normally
only be penalised in 'show that' questions where use of too few significant figures has
resulted in the candidate not demonstrating the validity of the given answer.
- Use of an inappropriate number of significant figures will normally be penalised in the
practical examinations or coursework.
- Using $g = 10 \text{ m s}^{-2}$ **will** be penalised.

Calculations

- Bald (i.e. no working shown) correct answers score full marks unless in a 'show that'
question.

- Rounding errors will not be penalised.
- If a ‘show that’ question is worth 2 marks then both marks will be available for a reverse working; if it is worth 3 marks then only 2 will be available.
- use of the formula means that the candidate demonstrates substitution of physically
correct values, although there may be conversion errors e.g. power of 10 error.
- recall of the correct formula will be awarded when the formula is seen or implied by
substitution.
- The mark scheme will show a correctly worked answer for illustration only.

Question Number	Answer	Mark
1	D Voltmeters are always connected in parallel and have a very high resistance	**1**
	Incorrect Answers: A – Both statements are incorrect; voltmeters are connected in parallel with a high resistance B – One incorrect statement; voltmeters are connected in parallel C – One incorrect statement; the voltmeter's resistance is very high	
2	B Using $I = nAvq$ with n,q and I constant gives $v \propto \frac{1}{A}$	**1**
	Incorrect Answers: A - This is the wrong ratio C - This has the correct numbers but wrong ratio D - This has the wrong ratio	
3	C Equates to a quarter of a wavelength path difference with $\frac{\lambda}{4} = 6$ cm. Option C is the only one with a difference of 6 cm from 24 cm.	**1**
	Incorrect Answers: A – The distance is not a difference of 6cm from 24cm B - The distance is not a difference of 6cm from 24cm D - The distance is not a difference of 6cm from 24cm	
4	C Resistance increases proportionally with temperature and resistance is not 0 at 0 °C.	**1**
	Incorrect Answers: A – Resistance is decreasing with temperature; it should increase proportionally B – Resistance remains constant with temperature; it should increase proportionally D – Resistance is 0 at 0°C; this is incorrect	
5	C Using $V = \frac{W}{Q}$ rearranges to $Q = \frac{W}{V}$ so $\mathrm{C} = \frac{\mathrm{J}}{\mathrm{V}}$.	**1**
	Incorrect Answers: A – This is volts B – This is an incorrect rearranging of $Q=It$ D – This is ampere	
6	A Waves travel more slowly in shallow water shown by the waves bunching up. Frequency does not change.	**1**
	Incorrect Answers: B- They do not travel more quickly; the wave speed decreases C- They do not have a lower frequency; frequency remains constant D- They do not have a higher frequency; frequency remains constant	

7	B Half a wavelength between a compression and rarefaction so half a time Period.	**1**
	Incorrect Answers: A – Δt must be half the period T C – Δt must be half the period T D – Δt must be half the period T	
8	A Doppler Effect so observed frequency is less than emitted frequency when source is moving away. Observed amplitude decreases as distance increases.	**1**
	Incorrect Answers: B – This contains one incorrect statement; frequency should decrease C- This contains one incorrect statement; amplitude should decrease D – Both statements are inccorect; amplitude and frequency both decrease	
9	A The only correct statement is diffraction can be used to demonstrate the wave property of electrons	**1**
	Incorrect Answers: B – It is not correct that diffraction only occurs when the size of the gap is equal to wavelength C – It is not correct that microwaves show more significant diffractions around hills than radio waves D – It is not correct that sound waves cannot be diffracted	
10	D emf is determined from the y-axis and the magnitude of r is determined directly from the gradient	**1**
	Incorrect Answers: A – Both statements are incorrect B – The statement regarding r is incorrect; r is determined by magnitude of the gradient C – The statement regarding e.m.f is incorrect; e.m.f is determined by the y-intercept	

Question Number	Answer	Mark
11	Use of $R = \frac{\rho l}{A}$ (1) Use of $A = \pi r^2$ (1) $l = 0.51$ m (1) Example of calculation $A = \pi \times \left(\frac{0.23 \times 10^{-3}\text{ m}}{2}\right)^2 = 4.15 \times 10^{-8}\text{ m}^2$ $l = \frac{6.0\ \Omega \times 4.2 \times 10^{-8}\text{ m}^2}{4.9 \times 10^{-7}\ \Omega\text{m}} = 0.51\text{ m}$	**3**
	Total for question 11	**3**

Question Number	Answer	Mark
12(a)	**Either** Oscillations/vibrations are in single/one plane (not just "a") (1) Which includes direction of energy transfer **Or** which includes direction of propagation (of wave) (1) **Or** Oscillations/vibrations are in single/one direction (not just "a") (1) Which is perpendicular to direction of energy transfer **Or** Which is perpendicular to direction of propagation (of the wave) (1)	**2**
12(b)	The light from the screen is polarised (may be stated anywhere) (1) In landscape the (polarised) light from the screen has the same orientation as the sunglasses **Or** Screen looks bright when light is parallel to filter (do not credit if "the screen is parallel to light") (1) As it is rotated from landscape to portrait the magnitude of the <u>component</u> of the light parallel to the (plane of polarisation of) the sunglasses decreases (1) In portrait mode the (polarised) light from the screen is perpendicular to the sunglasses **Or** Screen looks dark when light is perpendicular to filter (1)	**4**
	Total for question 12	**6**

Question Number	Answer	Mark
***13**	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)** Electrons/atoms exist in discrete/fixed/certain energy levels (1) (Do not accept particle) Electron/atom gains (sufficient) energy to move up energy levels **Or** energy gained to raise electron/atom above ground state (1) An (excited) electron (is unstable and) falls back down emitting a photon (Do not accept an electron emitting photons) (1) With a wavelength/frequency corresponding to the difference in the energy levels **Or** reference to $E=hf$ **or** $E \propto f$ (1) So only certain wavelengths / frequencies are emitted (1)	**5**
	Total for question 13	**5**

Question Number	Answer	Mark
14(a)	Refers to E=hf / Energy of photon proportional to frequency (1) (When frequency greater than f_0) the energy of the <u>photon</u> exceeds the work function (for zinc) (1) Electron is emitted/released (from the plate/metal/surface leaving the plate positively charged) (1) (MP3 dependent on MP2) (no mention of photons or quanta of energy gains 0)	**3**
14(b)	One photon interacts with one electron (1) Increasing the intensity increases the number of photons <u>per second</u> (releasing more photoelectrons) (1)	**2**
14(c)	(UV) absorbed by cells in skin **Or** (UV) causes damage to cells **Or** (UV) damages eyes/retina **Or** causes cataracts (1)	**1**
	Total for question 14	**6**

Question Number	Answer		Mark
15(a)	**Either** Use of $V = IR$ Recognises that current divides 2:1 $R_X = 20\ \Omega$ **and** $R_Y = 10\ \Omega$ **Or** Use of $V = IR$ (to find total resistance) Use of $\frac{1}{R_T} = \frac{1}{R_x} + \frac{1}{R_y}$ **and** $R_x = 2R_y$ $R_X = 20\ \Omega$ **and** $R_Y = 10\ \Omega$ <u>Example of calculation</u> $R_X = \frac{6\ V}{0.9\ A/3} = 20\ \Omega$ $R_Y = \frac{20\ \Omega}{2} = 10\ \Omega$	 (1) (1) (1) (1) (1) (1)	3
15(b)	Use of $V = IR$ with $R = R_X + R_Y$ allow ecf from (a) I = 0.20 A <u>Example of calculation</u> $I = \frac{6\ V}{(20+10)\Omega} = 0.20$ A	(1) (1)	2
15(c)	**Either** Reference to $P = \frac{V^2}{R}$ recognising V is constant So greater R gives lower P and bulb is less bright **Or** Reference to $P = VI$ recognising V is constant So I is smaller through greater R so lower P and less bright **Or** Reference to $P = I^2R$ recognising that I is greater in Y So greater power in Y as I^2 increase has a greater effect than R increase (Accept converse arguments with respect to Y being brighter) (Accept answers in respect of energy W=VIt, W=$\frac{V^2}{R}t$ or $W = I^2Rt$) (Accept correct calculations of power with conclusion) (No reference to power or energy gains 0)	 (1) (1) (1) (1) (1) (1)	2
	Total for question 15		**7**

Question Number	Answer		Mark
16(a)	Use of $E = hf$ **and** $c = f\lambda$ **Or** $E = \frac{hc}{\lambda}$ Converts eV to J λ = 5.7×10^{-7}m <u>Example of Calculation</u> λ = $\frac{6.63\times10^{-34}\ \text{Js} \times 3.0\times10^{8}\ \text{m s}^{-1}}{2.2\ \text{eV} \times 1.6\times10^{-19}\ \text{C}} = 5.65 \times 10^{-7}$m	(1) (1) (1)	**3**
16(b)	Use of $F = \frac{P}{A}$ and $E = Pt$ to calculate energy from Sun (135 kJ or 37 Wh) Multiply energy/power of Sun by 25 % Use of $P = \frac{E}{t}$ with P=1.5 (W) $t = 6.2$ (hours) <u>Example of Calculation</u> $E = 1300\ \text{W m}^2 \times 0.25 \times 3.6\ \times 10^{-3}\ \text{m}^2 \times 8\ \text{h} = 9.36$ (Wh) $t = \frac{9.36\ \text{Wh}}{1.5\ \text{W}} = 6.2$ (hours)	(1) (1) (1) (1)	**4**
	Total for question 16		**7**

Question Number	Answer		Mark
17(a)(i)	Use of $v = \frac{s}{t}$ with $t = (3.5 \rightarrow 4.0) \times 0.02 \times 10^{-3}$s Correct use of factor of 2 $s = 0.06$ m <u>Example of Calculation</u> $s = 1500 \text{ m s}^{-1} \times 0.5 \times 4.0 \times 0.02 \times 10^{-3} \text{ s} = 0.06 \text{ m}$	(1) (1) (1)	**3**
17(a)(ii)	(The second pulse) has travelled a greater distance (so greater reduction in energy) **Or** energy absorbed as pulse travels through heart (assume they are referring to second pulse unless they say otherwise) Reduction in energy due to reflection	(1) (1)	**2**
17(b)	Frequency of emitted **and** received pulses **Or** the change in frequency	(1)	**1**
	Total for question 17		**6**

Question Number	Answer		Mark
18(a)	For <u>total internal reflection</u> to occur	(1)	**1**
18(b)	Use of $_1\mu_2 = \frac{\sin i}{\sin r}$ with $r = 90°$ Use of $\theta = 90° - c$ $\theta = 8°$ <u>Example of Calculation</u> $c = \sin^{-1} 0.99 = 81.9°$ $\theta = 90° - 82° = 8°$	(1) (1) (1)	**3**
18(c)	Laser emits a smaller range of wavelengths **Or** LED emits a wider range of wavelengths (Not laser has a shorter wavelength) The idea that the pulses in the LED will arrive at different times **Or** for laser any time/speed differences are small/negligible **Or** the range of speeds is greater in the LED Output signal more dispersed spread out with LED **Or** sharper signal achieved with laser	(1) (1) (1)	**3**
	Total for question 18		**7**

Question Number	Answer	Mark
19(a)	Oscillations/vibrations of (air) particles/molecules/atoms (1) Oscillations/vibrations/displacement parallel to direction of propagation **Or** Oscillations/vibrations/displacement parallel to direction of energy transfer (1) (Producing) compressions and rarefactions **Or** regions of high and low pressure **Or** it is a longitudinal wave (1)	**3**
***19(b)(i)**	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)** **Max 4** Waves (from the two prongs) are superposing/interfering (If clearly writing about standing waves do not award this mark) (1) Prongs are coherent sources (1) Constructive interference where waves meet in phase, **Or** constructive interference where path difference nλ (1) Destructive interference where waves meet in antiphase (not out of phase) **Or** destructive interference where path difference (n+$\frac{1}{2}$)λ (1) Constructive interference produces maximum amplitude **Or** destructive interference produces minimum amplitude (1)	**4**
19(b)(ii)	Wavefronts/waves further apart **Or** greater distance between constructive / destructive interference (1)	**1**
19(c)(i)	Use of $v = f\lambda$ (1) Use of $\lambda = 4l$ (1) $f = 259$ Hz (1) Example of Calculation $f = \frac{330 \text{ m s}^{-1}}{4 \times 3.18 \times 10^{-1} \text{ m}} = 259 \text{ Hz}$	**3**
19(c)(ii)	Length measured too small (due to added distance between end of tube and antinode) **Or** reference to end correction **Or** Temperature of air lower than expected causing *v* to be higher (1) (do not accept an incorrect measurement of length)	**1**
	Total for question 19	**12**

Question Number	Answer	Mark
20(a)(i)	**Either** Resistance of leads is much smaller than the resistance of thermistor (accept resistance of leads is too/very small) **Or** does a %U calculation (1) Error is negligible **Or** Error can be ignored/neglected **Or** Error is more significant for smaller values of resistance **Or** Error is small compared to the resistance of the thermistor (1) **Or** error is a systematic error (1) 1.8 Ω removed from each reading (1)	**2**
20(a)(ii)	**Max 2** Synchronous readings taken **Or** both readings can be taken at the same time (1) More readings can be obtained in a given time **Or** the rate of readings can be greater (1) Avoids parallax errors Precision of thermometer +/- 1 degree and precision of sensor 0.1 degree) (1) (Do not accept plots a graph, more precise, repeating, reaction time, reduces human error) (1)	**2**
20(b)(i)	Resistance decreases as temp increases (1) (An increase in temp) increases the number of charge carriers **Or** (An increase in temp) increases the number of (free) electrons (1) Reference to $I=nAvq$ linking n increase to I increase **Or** the idea of the effect of the charge carrier increase being greater than the effect of collisions from increased lattice vibrations (1)	**3**
20(b)(ii)	**Either** Uses graph to find resistance of thermistor at 24 ℃ (540 – 550 (Ω)) (1) Recognises V_T =12 – 4.5 (V) (1) Uses $V_T=IR$ using (1) R = 324 - 330 Ω (1) **Or** Uses graph to find resistance of thermistor at 24 ℃ (540 – 550 (Ω)) Recognises V_T =12 – 4.5 (V) (1) Uses $\frac{V_T}{V} = \frac{R_T}{R}$ (1) R =324 - 330 Ω (1) (1) (Accept use of potential divider equation) <u>Example of Calculation</u> $R = \frac{550\ \Omega \times 4.5\ \text{V}}{7.5\ \text{V}}$	**4**
	Total for question 20	**11**

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