Pearson Edexcel

Mark Scheme (Results)

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

Edexcel and BTEC Qualifications

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These instructions should be the first page of all mark schemes

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.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- Organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.
Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

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 $g = 10$ 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	**The only correct answer is A** B is not correct because this is not equivalent to a coulomb C is not correct because this is not equivalent to a coulomb D is not correct because this is not equivalent to a coulomb	**1**
2	**The only correct answer is C** A is not correct because this is the resistance if all the resistors were in parallel B is not correct because this is the resistance for a different arrangement of the resistors D is not correct because this is the resistance if all the resistors were in series	**1**
3	**The only correct answer is D** A is not correct because the oscillations may also be in the *y* direction B is not correct because this would describe the situation for a longitudinal wave C is not correct because this would describe the situation for a longitudinal wave	**1**
4	**The only correct answer is D** A is not correct because this is an incorrect expression B is not correct because this is an incorrect expression C is not correct because this is an incorrect expression	**1**
5	**The only correct answer is C** A is not correct because *n* is unchanged in a metal B is not correct because *q* is a constant D is not correct because *A* is unchanged	**1**
6	**The only correct answer is D** A is not correct because this shows that electrons behave as a wave B is not correct because this shows that electrons behave as a wave C is not correct because the atoms are not arranged in circles	**1**

7	**The only correct answer is A** B is not correct because *I* and *V* are directly proportional C is not correct because *I* and *V* are directly proportional D is not correct because *I* and *V* are directly proportional	**1**
8	**The only correct answer is A** B is not correct because this does not show reflection C is not correct because this does not show refraction D is not correct because this does not show superposition	**1**
9	**The only correct answer is B** A is not correct because amplitude will decrease C is not correct because velocity will decrease D is not correct because wavelength will decrease	**1**
10	**The only correct answer is D** A is not correct because this has the greatest input power for the same output B is not correct because this does not have the lowest input power C is not correct because this does not have the lowest input power	**1**

Question Number	Answer	Mark
11(a)	Use of $E = hf$ (1) Conversion between eV and J (1) Max E_k = 2.1×10^{-18} (J) (1) <u>Example of calculation:</u> $E = 6.63\times10^{-34}$ J s × 4.2 $\times10^{15}$ Hz = 2.79×10^{-18} J $\varphi =$ 4.1 eV × 1.6 $\times10^{-19}$ J eV^{-1} = 6.56 $\times10^{-19}$ J $E_k = 2.79\times10^{-18}$ J – 6.56 $\times10^{-19}$ J = 2.13×10^{-18} J	**3**
11(b)	Greater radiation flux **Or** Greater intensity (1) So more (UV) photons per unit time (1) Each photon interacts with one electron (1)	**3**
	Total for question 11	**6**

Question Number	Answer	Mark
12(a)	Use $R = \frac{\rho l}{A}$ (1) Use of thickness = $\frac{\text{area}}{\text{width}}$ (1) Thickness = 4.8×10^{-9} m (1) <u>Example of calculation</u> $A = \frac{2.5x10^{-5}\ \Omega\text{m x } 2.7 \text{ x } 10^{-2}\text{m}}{47000\ \Omega} = 1.4 \text{ x } 10^{-11}\ \text{m}^2$ Thickness = $\frac{1.4 \text{ x } 10^{-11}\ \text{m}^2}{3.0 \text{ x } 10^{-3}\ \text{m}} = 4.8 \text{ x } 10^{-9}$ m	**3**
12(b)	P.d is divided/shared (across the length of the track) **Or** this is a potential divider circuit (1) p.d. (across the buzzer) depends on the ratio of resistance (accept length for resistance) (1) Slider at C then V = 0 / minimum **and** when the slider is at A then V = e.m.f. / 9 (V) / maximum **Or** p.d. increases as slider moved from C to A (accept converse) (1)	**3**
	Total for question 12	**6**

Question Number	Answer		Mark
***13**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate)		
	There are discrete energy levels **Or** only specific energy levels are possible	(1)	
	Atoms/electrons (gain energy and) move to higher energy levels **Or** Atoms/electrons (gain energy and) get excited	(1)	
	Atoms/electrons then move to lower energy levels (accept ground state) and a photon is emitted **Or** Atoms/electrons are de-excited and a photon is emitted	(1)	
	The energy of a photon if proportional to its frequency (Accept $E = hf$ with E and f defined)	(1)	
	The energy of the photon is equal to the difference in energy levels	(1)	
	There are specific frequencies emitted because the energy differences are specific	(1)	**6**
	(accept answers in terms of wavelength)		
	Total for question 13		**6**

Question Number		Mark
14(a)	Light must reach a boundary travelling in a medium of higher refractive index towards one of lower refractive index **Or** light must reach a boundary at which velocity would increase in the second medium **Or** light travelling in more dense medium towards a less dense [rarer] medium (1) Angle of incidence must be greater than (or equal to) the <u>critical</u> angle (1)	**2**
14(b)	Use of ${}_1\mu_2 = \sin i / \sin r$ (1) **Either** Critical angle = 60(°) (1) The ray will not totally internally reflect as the angle of incidence is smaller than the critical angle (1) **Or** Refracted angle = 35(°) (1) The ray does not totally internally reflect as the ray has refracted into the liquid (1) <u>Example of calculation</u> $\frac{1}{1.15} = \frac{\sin i}{\sin 90} = 60.4^{o}$ So not TIR as this is more than 30°	**3**

14(c)	Clear link between a mass change and a change in refractive index e.g. A 1 gram change corresponds to (~)0.001 change in refractive index **Or** a calculation of gradient (1) Comment that (to two sig figs) the refractive index values do not change across the range of the graph **Or** Data used in the graph (for refractive index values) are given to more than two sig figs. (1)		**2**
	Total for question 14		**7**

Question Number	Answer	Mark
15(a)	(Two or more waves meet) travelling in opposite directions **Or** A wave and its reflected wave (1) and superpose / interfere (1) Creating points where the waves are in phase and points where they are in antiphase **Or** creating points of zero/min amplitude and points of maximum amplitude (1)	**3**
15(b)	The particles (of air) are stationary **Or** the particles have minimum/0 amplitude/displacement at a node (1) The particles (of air) oscillate/vibrate with maximum amplitude at an antinode (1) The particles move in a direction that is parallel to the direction of the (original) wave at an antinode (1)	**3**
15(c)	Measures distance across a minimum of 3 spaces (1) Scales x2 (1) Wavelength = 2 × distance between droplets (1) Use of $v = f\lambda$ (1) Frequency = 40000 - 44000 Hz (1) <u>Example of calculation</u> Distance across 6 spaces = 11.5 mm distance between droplets = 1.9 mm scaled distance between droplets = 2×1.9 =3.8 mm wavelength = 2×3.8 mm = 7.6 mm $320 = f \times 7.6 \times 10^{-3}$ f = 41700 Hz	**5**
	Total for question 15	**11**

Question Number	Answer	Mark
16(a)	When two or more waves meet [accept overlap/coincide] (1) The resultant <u>displacement</u> is the sum of the individual <u>displacements</u> (1)	**2**
16(b)	path <u>difference</u> is zero **Or** path lengths would be the same [accept travelled the same distance] (1) waves in phase **Or** phase difference = 0 / 2nπ **Or** both rays have undergone an odd number of phase changes **Or** both rays have undergone the same phase change (1) So constructive interference/superposition **Or** produces max amplitude (1)	**3**
16(c)	**Max 2** Path difference now half a wavelength (or 1.5 λ ; 2.5λ or $\left(n+\frac{1}{2}\right)\lambda$) (1) phase difference of 180^{o} /in antiphase (1) So destructive interference / superposition (1)	**2**
16(d)	The path difference must be half a wavelength **Or** $\frac{\lambda}{2} = 200$ nm **Or** height changes by ¼ wavelength **Or** $\frac{\lambda}{4} = 100$ nm (1) So wavelength is 400 nm (1)	**2**
	Total for question 16	**8**

Question Number	Answer		Mark
***17(a)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate)		
	(Ultrasound pulse) is reflected (from surface of baby)	(1)	
	Time taken *t* is measured	(1)	
	Depth = $\frac{1}{2}vt$	(1)	**3**
17(b)	Doppler effect	(1)	
	Ultrasound wave reflects (from moving blood)	(1)	
	Frequency/wavelength of wave changes	(1)	
	The greater the change in frequency/wavelength the greater the speed of the blood	(1)	**4**
(c)	X-rays have higher energy (than ultrasound) **Or** X-rays are more penetrating	(1)	
	X-rays are ionising	(1)	
	Causing damage/mutation of cells/DNA/tissue	(1)	**3**
	Total for question 17		**10**

Question Number	Answer	Mark
18(a)	Use of $V=IR$ (1) Recognises $V_R = (6.0-1.8) = 4.2$ V (1) Current = 19 (mA) (1) <u>Example of calculation</u> $4.2\text{ V} = I \times 220\ \Omega$ $I = 0.019$ A I = 19 (mA)	**3**
18(b)	Use of $P=IV$ with V=1.8 V **Or** $P = \frac{V^2}{R}$ with R = 95 Ω or 90 Ω **Or** $P = I^2R$ with R = 95 Ω or 90 Ω (1) P=0.034 to 0.038W (1) <u>Example of calculation</u> $P = 0.019\text{A} \times 1.8\text{V}$ $P = 0.034\text{W}$	**2**
18(c)	Use of radiation flux as power per unit area (1) Use of Energy = power × time (1) Use of Efficiency = $\frac{\text{useful energy out}}{\text{energy in}}$ (1) Use of 90% on energy transferred out of LED (1) Overall efficiency = 0.03 or 3% (1) <u>Example of calculation</u> $P = 680\text{ W m}^{-2} \times 0.21\text{m} \times 0.12\text{m}$ $P = 17.14\text{W}$ $W_{in} = 17.14\text{W} \times 5 \times 60\text{s}$ $W_{in} = 5141\text{J}$ $W_{out} = 0.034\text{W} \times 80 \times 60\text{s}$ $W_{out} = 163\text{J}$ $\text{Efficiency panel and battery} = \frac{163\text{J}}{5141\text{J}} = 0.0317$ $\text{Overall Efficiency} = 0.0317 \times 0.9 = 0.0285$	**5**

18(d)(i)	*eV* **Or** *qV*	(1)	**1**
18(d)(ii)	Calculates gradient of graph (using at least half the graph) See $E = hf$ and $E = VQ$ Uses h = gradient × e h = 6.4×10^{-34} to 7.2×10^{-34} J s <u>Example of calculation</u> Gradient = $\frac{2.7 - 1.5\text{ V}}{7.0\times10^{14}\text{ Hz - }4.1\times10^{14}\text{ Hz}} = 4.1\times10^{-15}\text{ V s}$ $h = 4.1\times10^{-15}\text{ V s}\times1.6\times10^{-19}\text{ C}$ $h = 6.6\times10^{-34}\text{ J s}$	(1) (1) (1) (1)	**4**
	Total for question 18		**15**

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