Mark Scheme (Results)

January 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.

Mark scheme notes

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:

(iii) 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.]	✓	**1**

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

1. Mark scheme format

1.1 You will not see 'wtte' (words to that effect). Alternative correct wording should be credited in every answer unless the ms has specified specific words that must be present. Such words will be indicated by underlining e.g. 'resonance'

1.2 Bold lower case will be used for emphasis.

1.3 Round brackets ( ) indicate words that are not essential e.g. "(hence) distance is increased".

1.4 Square brackets [ ] indicate advice to examiners or examples e.g. [Do not accept gravity] [ecf].

2. Unit error penalties

2.1 A separate mark is not usually given for a unit but a missing or incorrect unit will normally mean that the final calculation mark will not be awarded.

2.2 Incorrect use of case e.g. 'Watt' or 'w' will **not** be penalised.

2.3 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, for example in a spreadsheet.

2.4 The same missing or incorrect unit will not be penalised more than once within one question (one clip in epen).

2.5 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.

2.6 The mark scheme will indicate if no unit error penalty is to be applied by means of [no ue].

3. Significant figures

3.1 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.

3.2 The use of g = 10 m s^{-2} or 10 N kg^{-1} instead of 9.81 m s^{-2} or 9.81 N kg^{-1} will be penalised by one mark (but not more than once per clip). Accept 9.8 m s^{-2} or 9.8 N kg^{-1}

4. Calculations

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

4.2 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.

4.3 **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.

4.4 **recall** of the correct formula will be awarded when the formula is seen or implied by substitution.

4.5 The mark scheme will show a correctly worked answer for illustration only.

4.6 Example of mark scheme for a calculation:

'Show that' calculation of weight

Use of L × W × H ✓

Substitution into density equation with a volume and density ✓

Correct answer [49.4 (N)] to at least 3 sig fig. [No ue] ✓
[If 5040 g rounded to 5000 g or 5 kg, do not give 3rd mark; if conversion to kg is omitted and then answer fudged, do not give 3rd mark] **3**
[Bald answer scores 0, reverse calculation 2/3]

Example of answer:

80 cm × 50 cm × 1.8 cm = 7200 cm^3

7200 cm^3 × 0.70 g cm^{-3} = 5040 g

5040 × 10^{-3} kg × 9.81 N/kg

= 49.4 N

5. Quality of Written Communication

5.1 Indicated by QoWC in mark scheme. QWC – Work must be clear and organised in a logical manner using technical wording where appropriate.

5.2 Usually it is part of a max mark, the final mark not being awarded unless the QoWC condition has been satisfied.

6. Graphs

6.1 A mark given for axes requires both axes to be labelled with quantities and units, and drawn the correct way round.

6.2 Sometimes a separate mark will be given for units or for each axis if the units are complex. This will be indicated on the mark scheme.

6.3 A mark given for choosing a scale requires that the chosen scale allows all points to be plotted, spreads plotted points over more than half of each axis and is not an awkward scale e.g. multiples of 3, 7 etc.

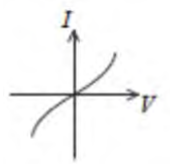
6.4 Points should be plotted to within 1 mm.

- Check the two points furthest from the best line. If both OK award mark.
- If either is 2 mm out do not award mark.
- If both are 1 mm out do not award mark.
- If either is 1 mm out then check another two and award mark if both of these OK, otherwise no mark.

6.5 For a line mark there must be a thin continuous line which is the best-fit line for the candidate's results.

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

Question Number	Answer		Mark
11 (a) (i)	Use of power = radiation flux × area Use of efficiency = useful output / total input Output power = 1460 (W) (Reverse show that from 1500 W gives 607 W m^{-2} scores max 2) <u>Example of calculation</u> Power = 590 W m^{-2} × 9.5 m^2 = 5600 W Useful output = 5600 × 26% = 1457 W	(1) (1) (1)	**3**
11 (a) (ii)	Use of power = current × p.d. Current = 91 (A) (allow ecf for power) (Use of 590 W m^{-2} gives 93.8 A) <u>Example of calculation</u> Current = 2 × 1460 W ÷ 32 V = 91.25 A	(1) (1)	**2**
11 (b)(i)	Use of charge = current × time Time = 2000 s **Or** 33 minutes **Or** 0.55 hours (allow ecf for current) (Accept Time = 4000 s **Or** 66 minutes **Or** 1.1 hours (allow ecf for current)) <u>Example of calculation</u> Time = 180 000 C ÷ 90.6 A = 1987 s	(1) (1)	**2**
11 (b)(ii)	Valid physics suggestion, for example: Indication that the radiation flux may decrease, Some of the current is drawn for the components of the orbiter, Heating effect of current increases resistance and decreases current, Because current is maximum **and** $t = Q/I$		**1**
	Total for question 11		**8**

Question Number	Answer	Mark
12 (a)	Correct curve in the positive quadrant (1) Symmetrical about origin (1) e.g.  	**2**
***12 (b**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) (Increased p.d.) causes more energy transfer to lattice ions/atoms (1) More charge carriers released/available (1) $I=nAvq$, so relative increase in I (1) Reference to $R=V/I$ to justify decrease in R (1)	**4**
	Total for question 12	**6**

Question Number	Answer		Mark
13 (a)	<u>Photon(s)</u> absorbed **Or** <u>photon(s)</u> transfers energy to an electron and a (photo)<u>electron(s)</u> is emitted	(1) (1)	 **2**
13 (b)(i)	Use of φ = y intercept $\varphi = 6.0 \times 10^{-19}$ J (range 6.0×10^{-19} J to 6.2×10^{-19} J) Use of $hf_0 = \varphi$ $h = 5.8 \times 10^{-34}$ J s **Or** h = gradient $h = 5.9 \times 10^{-34}$ J s (range 5.7×10^{-34} J s to 6.1×10^{-34} J s) $hf_0 = \varphi$ $\varphi = 6.0 \times 10^{-19}$ J **Or** h = gradient $h = 5.9 \times 10^{-34}$ J s (range 5.7×10^{-34} J s to 6.1×10^{-34} J s) Use of φ = y intercept $\varphi = 6.0 \times 10^{-19}$ J (range 6.0×10^{-19} J to 6.2×10^{-19} J) (treat simultaneous equations as gradient) <u>Example of calculation</u> $\varphi = 6.0 \times 10^{-19}$ J When = 0, $hf_0 = \varphi$ so $h = \varphi / f_0$ $h = 6.0 \times 10^{-19}$ J / 10.4×10^{14} Hz $= 5.8 \times 10^{-34}$ J s	(1) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	 **4**
13 (b)(ii)	(on this graph) there is no (electron) emission below a certain frequency **Or** with waves (electron) emission could happen at any frequency (because) with waves (electron) energy should be able to increase over time	 (1) (1)	 **2**
	Total for question 13		**8**

Question Number	Answer		Mark
14(a)	a discrete/specific/allowed energy of an <u>electron</u>	(1)	**1**
14(b)(i)	An electron/atom gains energy and is excited **Or** An electron/atom gains energy and moves to a higher level The electron/atom (subsequently) falls to a lower level emitting energy in the form of a <u>photon</u>	(1) (1)	**2**
14(b) (ii)	use of $E = hf$ use of $\div 1.6 \times 10^{-19}$ J eV^{-1} add calculated E to -5.14 eV (no ue) add level -3.03 eV above -5.14 eV and label <u>Example of calculation</u> $E = 6.63 \times 10^{-34}$ J s $\times 5.1 \times 10^{14}$ Hz $= 3.38 \times 10^{-19}$ J $= 3.38 \times 10^{-19}$ J $\div 1.6 \times 10^{-19}$ J eV^{-1} = 2.11 eV E level = -5.14 eV + 2.11 eV = -3.03 eV	(1) (1) (1) (1)	**4**
14(c)	Different elements have different <u>differences</u> in energy levels so photons/light of different energies/frequencies/wavelength are emitted	(1) (1)	**2**
	Total for question 14		**9**

Question Number	Answer	Mark
15(a)	Time for return trip divided by 2 (1) Multiply by speed of light (accept *c* or value) (1)	**2**
15(b) (i)	Use of $s = vt$ with speed of light (1) Pulse length = 0.06 m or 6 cm (1) <u>Example of calculation</u> $s = 3.0 \times 10^{8}\ \text{m s}^{-1} \times 2.0 \times 10^{-10}\ \text{s}$ = 0.060 m or 6.0 cm	**2**
15(b) (ii)	Distance is to the nearest km but pulse length is to the nearest mm, so acceptable (accept pulse length to nearest cm) (1) Not acceptable because 6.0 cm pulse is longer than 3.8 cm, **Or** The distance is calculated from a difference over 40 years, so it is over a metre, so it is acceptable compared to 6.0 cm (1)	**2**
15(b) (iii)	So they can tell which received pulse matches which sent pulse (1) (Ignore: 'so one pulse is received before the next is sent') (Accept so they can identify the start of a pulse or reference to another feature or the pulse profile)	**1**
15 (c) (i)	Use of $P = E/t$ (1) Power = 1.2×10^{9} W (1) <u>Example of calculation</u> $P = 115 \times 10^{-3}\ \text{J} / 100 \times 10^{-12}\ \text{s}$ $= 1.15 \times 10^{9}$ W	**2**
15(c) (ii)	Diffraction would cause the beam to spread out **and** weaken the signal further (1) The aperture is much larger than the wavelength (1) So diffraction is minimised/zero (1)	**3**
	Total for question 15	**12**

Question Number	Answer		Mark
16 (a) (i)	For low resistance the parallel arrangement has a higher current **Or** For high resistance the series arrangement has a higher current High resistance is equivalent to fresh water, so series is used for fresh water **Or** Low resistance is equivalent to salt water, so parallel is used for salt water	 (1) (1)	 **2**
16 (a) (ii)	Use of e.m.f. = sum of p.d.s Use of $V = IR$ (accept use of $\mathcal{E} = V + Ir$ for MP1 & 2) $r = 0.48\ \Omega$ <u>Example of calculation</u> $6.9\text{ V} = 3.3\text{ V} + (1.5\text{ A} \times r)$ $r = 2.4\ \Omega / 5 = 0.48\ \Omega$	(1) (1) (1)	 **3**
16 (a) (iii)	(if the ammeter has resistance) there will be a p.d. across it So the voltmeter will no longer be measuring terminal p.d. **Or** the voltmeter will be measuring a reduced value **Or** the voltmeter will measure terminal p.d. minus p.d. across ammeter (Accept converse arguments based on negligible resistance of ammeter)	(1) (1)	 **2**
16 (b)	Use of $R = \rho l/A$ Correct sides used for area $\rho = 13\ \Omega\text{ m}$ (Accept 1300 Ω cm) <u>Example of calculation</u> $1200\ \Omega = \rho \times 0.135\text{ m} / (0.030\text{ m} \times 0.050\text{ m})$ $\rho = 13.3\ \Omega\text{ m}$	(1) (1) (1)	 **3**
16 (c)	Use of $E = VIt$ $E = 11\text{ J}$ <u>Example of calculation</u> $E = 45\text{ V} \times 0.12\text{ A} \times 5 \times 10^{-3}\text{ s} \times 400$ $= 10.8\text{ J}$	(1) (1)	 **2**
	Total for question 16		**12**

Question Number	Answer	Mark
17(a)	Use of Video/camera/phone (accept ‘record’) (1) With scale added (1) Recording can be replayed **Or** image looked at frame by frame (1) Stopwatch has reaction time **Or** reaction time error eliminated with video (1)	**4**
17(b)	Coherent means the sources have a constant phase relationship/difference (1) The rods have the same frequency (1)	**2**
***17(c) (i)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Superposition takes place **Or** interference takes place between waves from the two sources (1) If the path difference is nλ, they are in phase **Or** If the path difference is (n + ½) λ, they are in antiphase (1) If the path difference is nλ constructive interference occurs **Or** If they are in phase constructive interference occurs (1) If the path difference is (n + ½) λ destructive interference occurs **Or** If they are in antiphase destructive interference occurs (1) Correct conditions related to maximum or minimum <u>amplitude</u> (1) (accept zero amplitude)	**5**
17(c) (ii)	Measure length of at least 4 waves (1) Wavelength = 1.25 cm (accept 1.2 to 1.3 cm) (1) Use of $v = f\lambda$ (1) f = 20 Hz (accept 19.4 to 21.0 Hz) (1) <u>Example of calculation</u> f = 25.2 cm s^{-1}/ 1.25 cm = 20.2 Hz	**4**
	Total for question 17	**15**

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