Mark Scheme (Results)

Summer 2015

Pearson Edexcel GCE in Physics (6PH02) 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.

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.

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] [Bald answer scores 0, reverse calculation 2/3]	✓	**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	B	**1**
2	C	**1**
3	B	**1**
4	D	**1**
5	D	**1**
6	C	**1**
7	C	**1**
8	D	**1**
9	A	**1**
10	B	**1**

Question Number	Answer	Mark
11(a)	Lowest / minimum frequency (of light / photons incident on a metal) that will cause electrons to be emitted (from surface) **Or** the frequency of (light / photons) that will cause electrons to be emitted (from the surface of a metal) with zero kinetic energy **(1)** (accept only just emitted)	**1**
11(b)	Conversion of eV to J **(1)** Use of $E = hf$ **(1)** $f = 5.5 \times 10^{14}$ Hz **(1)** <u>Example of calculation</u> $\varphi = (2.28 \text{ eV} \times 1.6 \times 10^{-19} \text{ C})$ $= 3.65 \times 10^{-19}$ J $f = 3.65 \times 10^{-19} \text{ J} / 6.63 \times 10^{-34} \text{ J s} = 5.50 \times 10^{14}$ Hz	**3**
	Total for Question 11	**4**

Question Number	Answer	Mark
12(a)	To be able to distinguish which reflection comes from which emission **Or** so one pulse returns before the next one is emitted **(1)**	**1**
12(b)	Use of $v = s/t$ **(1)** Correct use of factor of 2 (double distance or double time) **(1)** Pulse duration = 2.4×10^{-3} s (0.0024 s, 2.4 ms) **(1)** <u>Example of calculation</u> Time = $2 \times 0.4 \text{ m} \div 330 \text{ m s}^{-1}$ Pulse duration = 2.4×10^{-3} s	**3**
12(c)	(Ultrasound) <u>reflect</u>ed away from the sensor **Or** (Ultrasound) <u>reflect</u>ed towards the floor **(1)**	**1**
	Total for Question 12	**5**

Question Number	Answer		Mark
13(a)	Mean velocity of charge carriers	**(1)**	**1**
13(b)(i)	v for Y is twice v for X **Or** v for X is half v for Y $I = nqvA$ and n and q are constant **Or** v inversely proportional to A	**(1)** **(1)**	**2**
***13(b)(ii)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Resistance of Y is greater than the resistance of X (v greater for Y…) therefore electrons gain more ke between collisions (with lattice ions) **Or** therefore more frequent collisions (with lattice ions) **Or** therefore more energy lost per collision (with lattice ions) **Or** therefore more energy lost in a given time in collisions (with lattice ions) therefore greater pd required for a given current (MP2 and 3 accept reverse argument in terms of v for X)	 **(1)** **(1)** **(1)**	 **3**
	Total for Question 13		**6**

Question Number	Answer		Mark
14(a)	The (maximum) length is (directly) proportional to the area	**(1)**	**1**
14(b)(i)	Use of $\rho l/A = R$ $R = 1.34\ (\Omega)$ <u>Example of calculation</u> $R = 1.68 \times 10^{-8}\ \Omega\ \text{m} \times 80\ \text{m} \div 1.0 \times 10^{-6}\ \text{m}^2$ $R = 1.34\ \Omega$	**(1)** **(1)**	 **2**
14(b)(ii)	Use of $P = I^2R$ $P = 160$ W allow ecf from (i) <u>Example of calculation</u> $P = (11\ \text{A})^2 \times 1.34\ \Omega$ $P = 162$ W (157 W if they use 1.3 Ω)	**(1)** **(1)**	 **2**
14(b)(iii)	Use of $V = IR$ **Or** use of $P = VI$ **Or** use of $P = V^2/R$ $V = 15$ V allow ecf from (i) and/or (ii) <u>Example of calculation</u> $V = 11\ \text{A} \times 1.34\ \Omega = 14.7\ \text{V}$ (14.3 V if 1.3 Ω is used)	**(1)** **(1)**	 **2**
14(c)	To prevent (use of a cable with) resistance that is too large (Accept answers that refer to maintaining or not exceeding a resistance of about 1.3 Ω) Meaning more energy / power / p.d. available for the shredder	 **(1)** **(1)**	 **2**
	Total for Question 14		**9**

Question Number	Answer	Mark
15(a)	Variable resistor in series **(1)** Ammeter in series and voltmeter in parallel with cell **(1)** (If there are extra fixed resistances they can be ignored, as long as the terminal p.d. is being measured. Assume the ammeter has zero resistance, so its precise placement doesn't matter as long as it is in series)	**2**
15(b)	Best fit straight line drawn **(1)** Substitution of values from student's line for gradient using at least half current axis ($\Delta I \geq 80$ mA) **(1)** $\mathcal{E}$ **=** 3.9 V to 4.1 V **(1)** r = 1.6 Ω to 2.5 Ω **(1)** <u>Example of calculation</u> gradient = (3.7 V – 4.0 V) / 0.16 A = – 1.9 Ω	**4**
15(c)	Start y-axis at 3.0 V (accept reference to points from 3.0 to 3.75 V) **(1)** This will allow plots to be made more accurately **Or** This will allow intercept and change in V to be determined to more sf **Or** this will allow read-offs to be made with more precision **(1)** (Only award this mark if first mark awarded)	**2**
	Total for Question 15	**8**

Question Number	Answer		Mark
16(a)	Change in direction of wave (accept ray or any named wave) (do not accept bend) (Due to) change in (optical) density / speed / medium	 **(1)** **(1)**	**2**
16(b)	There is no change in direction for the light (passing between the water and the gel) **Or** There is no refraction (as the light passes between the water and the gel) (accept … within the beaker) The light must have the same/similar wave speed in the water and gel (accept same/similar density for water and gel)	**(1)** **(1)**	**2**
16(c)	(When light strikes a boundary with) angle of incidence greater than the critical angle **Or** When light within a denser medium strikes a boundary with a less dense medium All of the light is reflected **Or** none of the light is transmitted **Or** none of the light is refracted	**(1)** **(1)**	**2**
16(d)(i)	Use of $\mu = \sin i / \sin r$ $x = 41(°)$ <u>Example of calculation</u> $\sin x = \sin 60° / 1.33$ $x = 40.6°$	**(1)** **(1)**	**2**
16(d)(ii)	Use of $\mu = \sin i / \sin r$ with $i = 90°$ (accept stating $\sin c = 1 / \mu$) $c = 49(°)$ <u>Example of calculation</u> $\mu = \sin 90° / \sin c$ $\sin c = 1 / \mu = 1 / 1.33$ $c = 49°$	**(1)** **(1)**	**2**
16(d)(iii)	Angle in gel < critical angle **Or** angle y < critical angle **Or** (If angle x = angle y, then this corresponds to an) angle in air of 60° Not total internal reflection so some light reaches screen **Or** Light will be refracted/transmitted so some light reaches screen	**(1)** **(1)**	**2**
	Total for Question 16		**12**

Question Number	Answer	Mark
17(a)	Idea of two or more waves meeting **(1)** Displacement is sum of individual displacements **(1)**	**2**
17(b)	Electromagnetic waves are transverse, with oscillations ***perpendicular*** **(1)** to the direction of ***energy transfer*** **Or** ***wave travel*** **Or** ***propagation*** **(1)** When they pass through a polarising filter all the components of the oscillations perpendicular to the plane of polarisation are ***absorbed***. (accept ***blocked***) **Or** When they pass through a polarising filter all the components of the oscillations ***parallel*** to the plane of polarisation are ***transmitted***. **(1)** The oscillations of the polarised wave are all in the same plane which ***includes*** the direction of energy transfer. **Or** The oscillations of the polarised wave are all in the same ***direction*** which is perpendicular to the direction of energy transfer **(1)**	**4**
***17(c)(i)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate – e.g. if the term 'superimpose' is used this mark is not awarded) When in phase constructive interference/superposition occurs **(1)** **Or** when path difference is nλ constructive interference/superposition occurs When in antiphase destructive interference/superposition occurs **Or** when path difference is (n + ½) λ destructive interference/superposition occurs **(1)** Light band forms when in phase **Or** path difference is nλ **Or** constructive **Or** Dark band forms when in antiphase **Or** path difference is (n + ½) λ **Or** destructive **(1)**	**3**
17(c)(ii)	Oscillations of light from the two filters are perpendicular to each other **(1)** So there are no opposite components to cancel each other out **Or** so the waves do not interact/interfere **(1)** So zero amplitude not possible **(1)** **OR** (If the candidate assumes that it is a source of polarised light) One filter is parallel to the plane of polarisation of the light source, so light is transmitted but the other one absorbs light **(1)** So light now only reaches the screen from one filter, so there is no interference **(1)** So zero amplitude not possible **(1)**	**3**
	Total for Question 17	**12**

Question Number	Answer	Mark
18(a)	Use of $W = VIt$ **(1)** W = 69 000 (J) **(1)** Use of efficiency = (useful energy / total energy) (x 100%) **(1)** Efficiency = 0.42 (or 42%) **(1)** **Or** Use of $P = IV$ **(1)** Use of $P = W/t$ (to calculate rate of increase of internal energy of water) **(1)** Use of efficiency = (output power / input power) (x 100%) **(1)** Efficiency = 0.42 (or 42%) **(1)** <u>Example of calculation</u> W = 5.0 A × 230 V × 60 s = 69 000 J Efficiency = 29 000 J / 69 000 J = 0.42	**4**
18(b)	Human body contains water molecules **Or** body has same structure as food **(1)** So cells/tissues would gain internal energy **(1)** (Accept cells/tissues would be heated)	**2**
18(c) (i)	Waves spread out **(1)** After passing through a gap **Or** after passing around an obstacle **(1)**	**2**
18(c)(ii)	Use of $c = f\lambda$ with $c = 3.0 \times 10^8$ m s^{-1} **(1)** λ = 0.12 m **(1)** <u>Example of calculation</u> $\lambda = 3.0 \times 10^8$ m s^{-1} ÷ 2.5×10^9 Hz λ = 0.12 m	**2**
18(c)(iii)	Diameter = 2mm **(1)**	**1**
***18(c)(iv)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Diffraction greatest when wavelength is about the same as gap size **(1)** Diameter of holes much greater than wavelength of light **and** diameter of holes less than microwave wavelength **(1)** so no/little diffraction of light takes place **Or** so microwave radiation still diffracted through large angle but intensity is very small. **(1)** MP3 must follow on from relevant part of MP2	**3**
	Total for Question 18	**14**

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