Mark Scheme (Results)

June 2017

Pearson Edexcel
GCE Advanced Subsidiary 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] ✓ **1**
[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.

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.

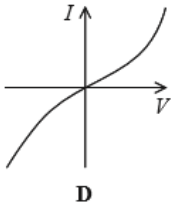
6.2 Sometimes a separate mark will be given for units or for each axis if the units are complex. This will be indicated on the mark scheme.

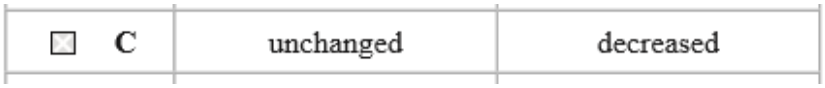
6.3 A mark given for choosing a scale requires that the chosen scale allows all points to be plotted, spreads plotted points over more than half of each axis and is not an awkward scale e.g. multiples of 3, 7 etc.

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.

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	**D current** this is an SI base quantity	**1**
	Incorrect Answers: A- this is an SI unit B- this is not an SI base quantity C- this is an SI unit	
2	**C** $\frac{VIt}{mgh}$ using efficiency $= \frac{\text{power output}}{\text{power input}}$	**1**
	Incorrect Answers: A-this is input power / output energy B- this is output energy / input power D- this is input power / output power	
3	**D**  **D** Temperature increases as the current/p.d increases, and an increase in temperature leads to an increase in resistance so rate of increase in current decreases	**1**
	Incorrect Answers: A- I-V characteristics for an ohmic resistor B- I-V characteristics for a diode C- shows resistance increasing as pd increases	
4	**D visible line spectra**	**1**
	Incorrect Answers: A- waves only B- waves only C- waves only	
5	**A** $\frac{It}{e}$ total charge (It) / charge on an electron	**1**
	Incorrect Answers: B- incorrect arrangement of $Q=It$ C- has the division the wrong way round D- incorrect arrangement of $Q=It$ and has the division the wrong way round	
6	**B charge carrier density and potential difference** same material so the charge carrier density is the same and as they are in parallel the p.d. will be the same.	**1**
	Incorrect Answers: A- current will be different in the parallel wires as they have different cross-sectional areas and therefore different resistances C- pd will be the same but current will be different in the parallel wires as they have different cross-sectional areas and therefore different resistances D- As the wires have different cross-sectional areas they have different resistances	

7	**A energy of photoelectron** this gives the kinetic energy of an electron after emission	**1**
	Incorrect Answers: B- hf is the energy of photon C- ionisation is the emission of an electron from an atom whilst the photoelectric effect is the emission of an electron from a metal D- Ø is the work function of the metal	
8	**C number of conduction electrons is unchanged and resistance decreased** 	**1**
	Incorrect Answers: A- the number of conduction electrons does not change with temperature in a metal B- the number of conduction electrons does not change with temperature in a metal and resistance does not increase with temperature D- resistance does not increase with temperature	
9	**A** The emission of radiation occurs with a decrease in energy. Using $E = \frac{hc}{\lambda}$ the shortest wavelength results from the largest energy change	**1**
	Incorrect Answers: B- largest magnitude for the change in energy but this represents an increase in energy which will not result in the emission of radiation. C- this is not the greatest energy change represented in the diagram D- this is not the greatest energy change represented in the diagram and represents an increase in energy which will not result in the emission of radiation.	
10	**B At a rarefaction the particles are at minimum displacement from equilibrium**	**1**
	Incorrect Answers: A- this is true C- this is true D- this is true	

Question Number	Answer	Mark
11(a)	Two waves travelling in opposite directions **Or** wave meeting its reflection **(1)** Interfere/superpose **(1)**	**2**
11(b)	**Either** (stationary wave on string) causes (surrounding) air molecules/particles to vibrate / oscillate **(1)** Setting up a (longitudinal) progressive wave **(1)** **Or** Energy transferred from string to (surrounding) air **(1)** Causing air molecules/ particles to vibrate / oscillate **(1)**	**2**
	Total for question 11	**4**

Question Number	Answer	Mark
12(a)	Use of $V=IR$ **(1)** V=9.5 V **(1)** Example of calculation $V = (19 \times 10^{-3})\ \text{A} \times 500\ \Omega\ = 9.5\ \text{V}$	**2**
12(b)	**Either** **(1)** Calculates pd across parallel combination using their answer from (a) (2.5 V) Use of $V=IR$ with their value for V and R=300 Ω to find the current in 300 Ω **(1)** resistance **(1)** Use of $I = I_1 + I_2$ to calculate current in R R=234 Ω **Or** Use of $V=IR$ to find total resistance of circuit (630 Ω) Resistance of parallel combination = 630 Ω – 500 Ω = 130 Ω Use of resistors in parallel combination R=234 Ω Example of calculation $R = \frac{12\ \text{V} - 9.5\ \text{V}}{19 \times 10^{-3}\ \text{A} - 8.3 \times 10^{-3}\ \text{A}} = 234\ \Omega$	**4**
	Total for question 12	**6**

Question Number	Answer	Mark
13(a)	Identifies diffraction **(1)** Low frequencies have greater/substantial/more diffraction (than high frequencies) **(1)**	**2**
13(b)	Use of $v = f\lambda$ with $\lambda = 1.2$ m **(1)** $f = 280$ Hz **(1)** Example of Calculation $f = \frac{340\ \text{m s}^{-1}}{1.2\ \text{m}} = 283$ Hz	**2**
	Total for question 13	**4**

Question Number	Answer		Mark
14(a)(i)	Attempts to draw line of best fit to y-axis $\mathcal{E}$ = 6.1 – 6.3 V	**(1)** **(1)**	**2**
14(a)(ii)	Attempts to find gradient **Or** use of $E=V+Ir$ using their E and corresponding values of V and I from their graph r = 1.5 Ω to 1.6 Ω	 **(1)** **(1)**	**2**
14(b)	**Either** Show that with $R=0$ then Ɛ = Ir A small r would result in a large current **Or** If there is a short circuit Limit current in external circuit	**(1)** **(1)** **(1)** **(1)**	**2**
	Total for question 14		**6**

Question Number	Answer		Mark
15(a)	<u>Effect of stretching wire</u> Refers to $R = \rho l/A$ Increasing length leads to increase in resistance Thinner wire has smaller CSA which leads to increase in resistance [last two points may be combined to give single statement, can score both marks]	**(1)** **(1)** **(1)**	**3**
15(b)	Use of $R = \rho l/A$ × 8 R = 0.28 (Ω) [Omitting x8 gives R = 0.035 Ω scores 1] <u>Example of calculation</u> $R = (9.9 \times 10^{-8}\ \Omega\ m) \times (8 \times 0.03\ m) \div 8.5 \times 10^{-8}\ m^2$ $R = 0.2795\ \Omega$	**(1)** **(1)** **(1)**	**3**
15(c)(i)	Attempts to substitute for $A = V/l$ in $R = \rho l/A$ See $R = \rho l^2/V$	**(1)** **(1)**	**2**
15(c)(ii)	**Either** Any attempt to relate original resistance of gauge to 3.0^2 (possibly × 8, cm or m) Relates this to resistance associated with increase in length Change in resistance = $4.0 \times 10^{-3}\ \Omega$ **Or** Uses $V=lA$ to find new area Use of $R = \rho l/A$ with new length to find new R Change in resistance = $4.0 \times 10^{-3}\ \Omega$ [if candidate assumes A constant and finds new R and ΔR scores 1 mark] <u>Example of Calculation</u> $R = \frac{(3.02\times10^{-2}\ m)^2}{(3.00\times10^{-2}\ m)^2} \times 0.28\ \Omega = 0.284\ (\Omega)$ $\Delta R = 0.284\ \Omega - 0.280\ \Omega = 4.0 \times 10^{-3}\ \Omega$	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**3**
15(d)	Each section of wire increases in length **Or** there is a longer total length **Or** there is a long wire in the small space (Small change in length of gauge) leads to <u>larger change</u> in resistance (If no other marks awarded "less chance of wire breaking as force is shared across the sections" can score 1 mark)	**(1)** **(1)**	**2**
	Total for question 15		**13**

Question Number	Answer	Mark
16(a)	Use of $v = \frac{s}{t}$ **(1)** Correct use of factor of 2 **(1)** Distance from bat =2.6 m **(1)** <u>Example of calculation</u> $s = 340\ (\text{m s}^{-1}) \times \frac{15 \times 10^{-3}(\text{s})}{2} = 2.55\ \text{m}$	**3**
16(b)(i)	Moving away because (observed) wavelength is greater **Or** Moving away because (observed) frequency is lower **(1)**	**1**
16(b)(ii)	Use of $v = 170\left(\frac{\Delta\lambda}{\lambda}\right)$ **(1)** $v = 1.57\ \text{m s}^{-1}$ **(1)** <u>Example of calculation</u> $v = 170\ \text{m s}^{-1}\left(\frac{(5.45-5.40)\times10^{-3}\text{m}}{5.40\times10^{-3}\ \text{m}}\right)$=1.57 m s^{-1} [Answer to be given in 3 sig figs. Answer of 1.6 m s^{-1} scores 1] [Division by 5.45×10^{-3} m gives 1.56 m s^{-1} scores 1]	**2**
16(b)(iii)	Appreciation that the moth may be moving at an angle to the displacement from the bat **Or** Calculation assumes moth is moving along a direct straight line (to/from moth). **Or** Doppler only detects a change in wavelength in a direct straight line (to/from bat) **Or** (This is a relative speed to the speed of the bat so) actual speed is relative speed plus speed of bat **(1)**	**1**
	Total for question 16	**7**

Question Number	Answer		Mark
***17(a)**	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)** Place polarising filter over crystal and rotate	**(1)**	
	(components of) light polarised parallel to (the plane of polarisation of) filter can pass through **Or** (components of) light polarised perpendicularly to (the plane of polarisation of) filter are absorbed	**(1)**	
	One image will disappear at orientations of 0 and180° **and** the other will disappear at 90° and 270° (reference to both images at more than one orientation)	**(1)**	**3**
17(b)(i)	Use of $_1\mu_2 = \frac{\sin i}{\sin r}$ $\mu = 1.6$	**(1)** **(1)**	
	<u>Example of Calculation</u> $\mu = \frac{\sin 32}{\sin 19} = 1.63$		**2**
17(b)(ii)	Refers to $_1\mu_2 = \frac{v_1}{v_2}$ **or** speed (through the crystal) is inversely proportional to the refractive index	**(1)**	
	First ray has greater speed (in crystal) **or** second ray has lower speed (dependent mark)	**(1)**	**2**
	Total for question 17		**7**

Question Number	Answer		Mark
18(a)	When two (or more) waves meet / combine / collide	**(1)**	
	Displacement of resultant wave is equal to the sum of the individual displacements	**(1)**	**2**
***18(b)**	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)**		
	Generated wave and noise have same/similar frequency and amplitude	**(1)**	
	And in antiphase	**(1)**	
	(Causing) destructive interference/superposition **or** resultant amplitude is 0	**(1)**	**3**
18(c)(i)	Speech contains a wider range of frequencies (at high intensity) **Or** aircraft noise contains a smaller range of frequencies (at a high intensity)	**(1)**	
	Intensity / amplitude from the aircraft is more constant **Or** Intensity of speech is more variable	**(1)**	
	A wave produced by the headphones may cause constructive interference with some frequencies **Or** More difficult to produce a wave that will cancel a large range of frequencies **Or** Difficulty in sampling rate being fast enough to keep up with the changes in speech	**(1)**	**3**
18(c)(ii)	Resultant wave has 0/minimum amplitude (so not heard by ear) **Or** Volume of (useful) sound can be turned down so headphones can be beneficial	**(1)**	**1**
	Total for question 18		**9**

Question Number	Answer	Mark
***19(a)**	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)** Reference to electromagnetic radiation **and** a metal surface **(1)** The idea of a one-to-one interaction between one photon and one electron **(1)** Energy (of photon) proportional to frequency **Or** reference to E=hf **(1)** If frequency of the radiation is above threshold frequency then electrons gain enough energy to be released **Or** If energy (of photon) is greater than the work function electrons are released from the surface **(1)**	**4**
19(b)(i)	The greater the intensity the greater the number incident photons per unit time **(1)** (So) the number of electrons released (per unit time) is greater **(1)** (Since current is rate of transfer of charge) the current is greater **(1)** (MP3 dependent on MP1)	**3**
19(b)(ii)	Use of $P = VI$ **(1)** Recall that radiation flux = $\frac{\text{Power}}{\text{Area}}$ **(1)** $F = 450$ (W m^{-2}) **(1)** Example of calculation $F = \frac{3\text{ (V)} \times 0.61\text{ (A)}}{4.1 \times 10^{-3}\text{ (m}^2\text{)}} = 446$ (W m^{-2})	**3**
19(b)(iii)	Use of $E = hf$ **(1)** Conversion between eV and J **(1)** **Either** $E = 0.911$ eV **(1)** caesium not suitable since this is less than 4.32 (eV) **(1)** **Or** f_0 (caesium) = 1.04×10^{15} Hz **(1)** caesium not suitable since its threshold frequency is greater than 2.2×10^{14} Hz **(1)** Example of calculation $E = 6.63 \times 10^{-34}\text{(J s)} \times 2.2 \times 10^{14}\text{(s}^{-1}\text{)} = 1.46 \times 10^{-19}$ J $E = \frac{1.46 \times 10^{-19}\text{ (J)}}{1.6 \times 10^{-19}\text{(C)}}$ eV $E = 0.911$ eV	**4**
	Total for question 19	**14**

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