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Mark Scheme (Results)

January 2013

GCE 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.

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. ‘<u>resonance</u>’

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	B	**1**
3	D	**1**
4	D	**1**
5	A	**1**
6	C	**1**
7	B	**1**
8	C	**1**
9	D	**1**
10	A	**1**

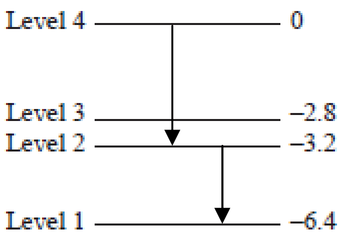
Question Number	Answer		Mark
11	Identifies (electron) <u>diffraction</u> (Electron) has wave properties/behaviour (Electron) has wavelength similar to atomic size/spacing (do not accept defraction for 1st mark)	**(1)** **(1)** **(1)**	 **3**
	Total for question 11		**3**

Question Number	Answer		Mark
12	(As temperature of thermistor increases) its resistance decreases (do not credit the converse) (Large) increase in: *n* **Or** electrons (per unit volume) **Or** charge carriers (per unit volume) **Any One from (conditional on mark 2 and not awarded if there are contradictory statements about any of these quantities)** (slight) decrease in *v* / velocity / drift velocity *A* and *Q* remain constant Reference to $R = V/I$	**(1)** **(1)** **(1)**	 **3**
	Total for question 12		**3**

Question Number	Answer		Mark
13(a)	Diode / LED (Any type of recognised diode scores the mark but if diode is included in a list of other components the mark cannot be gained.)	**(1)**	**1**
13(b)	Infinite / infinity / ∞ **Or** Very high **Or** very large	**(1)**	**1**
13(c)	Use of $R=V/I$ Correct value of R for their current in range 0.40 A to 0.43 A (Any valid pair of values for first mark. Use of tangent or gradient scores no marks) Example of calculation R= 0.70 V / 0.41 A R= 1.7 Ω	**(1)** **(1)**	**2**
13(d)	**Any One from, e.g.** To protect components / circuits Rectification Restricts current / flow (of charge) to one direction AC to DC Produce DC supply Power indicator light Light source, e.g. Christmas tree light, torch Regulate voltage (Accept any reasonable practical use for diode or LED)	**(1)**	**1**
	Total for question 13		**5**

Question Number	Answer		Mark
14(a)	The (minimum) energy required to remove one/an electron from the surface of the metal (must refer to surface)	**(1)**	**1**
***14(b)**	(QWC- Work must be clear and organised in a logical manner using technical wording where appropriate.) • Increasing the intensity (of light) increases the number of electrons emitted(per sec) **Or** number of electrons emitted(per sec) depends on the intensity (of light) • One photon releases one electron • Intensity determines number of photons **OR** • Increasing the intensity (of light) does not increase the energy/speed of the electrons • One photon releases one electron • Energy of photon determined by/depends on frequency (not intensity) **Or** $E = hf$ **OR** • Below a certain frequency / threshold frequency no electrons emitted **Or** above a certain wavelength no electrons emitted • Energy of photons increases with / depends on frequency **Or** $E = hf$ • Each photon needs a minimum amount of energy / work function **Or** One photon releases one electron **OR** • Electron emission starts at once (even for low intensity) • One photon releases one electron • Wave theory would allow energy to build up **OR** • Increasing the frequency (of light) increases the energy/speed of the electrons **Or** Increasing the frequency (of light) increases the stopping potential • Energy of photon determined by/depends on frequency **Or** $E = hf$ • One photon releases one electron **Or** Wave theory would allow energy to build up (Max one mark for a 2nd or 3rd point if no correct observation given)	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**3**
	Total for question 14		**4**

Question Number	Answer		Mark
15(a)(i)	4.0 Ω	**(1)**	**1**
15(a)(ii)	Use of $V=IR$ I = 0.75 A (ecf) <u>Example of calculation</u> I= 3 V / 4 Ω I= 0.75 A	**(1)** **(1)**	 **2**
15(a)(iii)	Use of $P = I^2R$ **or** $P = VI$ **or** $P=V^2/R$ Power = 2.0 W (ecf) <u>Example of calculation</u> P = (0.75 A)^2 x 3.6 Ω P= 2.0 W	**(1)** **(1)**	 **2**
15(b)	Total resistance (of circuit) will increase Current will decrease Reference to $P = I^2R$ to explain power decreasing **Or** $P = VI$ to explain power decreasing **Or** Lost volts increases **Or** Ir increases V across element decreases Reference to $P = VI$ to explain power decreasing **Or** $P=V^2/R$ to explain power decreasing	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**3**
	Total for question 15		**8**

Question Number	Answer		Mark
16(a)	A statement which implies only certain energy levels are allowed e.g. Allowed/possible energy of atoms/electrons Discrete energy of an atom/electron	**(1)**	**1**
16(b)	Identifies correct pairs of levels, 4 and 2 **AND** levels 2 and 1 Two arrows both showing correct direction [irrespective of identified levels] 	**(1)** **(1)**	**2**
16(c)	**Max 3** Atom/electron gains energy and moves to a higher level **Or** atom/electron becomes excited atom/electron has discrete energies **Or** atom/electron can only move between fixed levels **Or** only certain energy changes are possible atom/electron falls to a lower level By emitting energy in the form of photons **Or** reducing their energy by emitting photons Photons have a specific energy/frequency **Or** reference to $E = hf$ **Or** photon energy $= E_2 - E_1$	**(1)** **(1)** **(1)** **(1)** **(1)**	**3**
16(d)	Use of $E = hf$ with any of the possible energy differences Identifies ΔE as (±) 0.4 (× 10^{-19} J) $f = 6.0 \times 10^{13}$ Hz <u>Example of calculation</u> Smallest energy difference is 0.4×10^{-19} J $f = 0.4 \times 10^{-19}$ J / 6.63×10^{-34} Js $f = 6.03 \times 10^{13}$ Hz	**(1)** **(1)** **(1)**	**3**
16(e)	Divides an energy by 1.6×10^{-19} Energy = 4.0 (eV) (no ue) <u>Example of calculation</u> Energy = 6.4×10^{-19} J /1.6×10^{-19} C Energy = 4.0 eV	**(1)** **(1)**	**2**
	Total for question 16		**11**

Question Number	Answer		Mark
17(a)	Resistivity is a property of a material **Or** is constant for a material Resistance is a property of a wire/component/object **Or** Resistance depends on dimensions of a wire/component/object	**(1)** **(1)**	 **2**
***17(b)**	*Circuit diagram* Wire and a power supply (accept resistor symbol for wire) Ammeter in series and voltmeter in parallel with wire (an Ohmmeter across a wire with no supply scores 2 marks, an Ohmmeter across a wire with a supply scores 0 marks.) (QWC- Work must be clear and organised in a logical manner using technical wording where appropriate.) *Quantities measured* Current and potential difference **Or** resistance (consistent with diagram) Length of wire Diameter/thickness of wire (not area or radius) *Graph* Graph of R against l **Or** graph of V against l (for constant I) **Or** Graph of R against l/A **Or** Graph of RA against l (this mark is only awarded for a graph including different values of length) *Determination of resistivity* Determine the gradient of a relevant graph (allow for a graph of V against I) $A = \pi d^2/4$ **Or** $A = \pi r^2$ Correct processing to find ρ consistent with the graph (if no gradient, award final mark for statement that $\rho = RA/l$, ρ must be the subject)	 **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	 **9**
	Total for question 17		**11**

Question Number	Answer		Mark
18(a)	(sound waves travel as) longitudinal waves **Or** (Air molecules) vibrate parallel to direction of travel of wave (sound waves travel as) a series of compressions **and** rarefactions **Or** (sound waves travel as) areas of high and low pressure The idea that these vibrations create a pressure/force/stress/strain on the film **Or** The idea that these compressions/rarefactions create a pressure/force/stress/strain on the film This pressure/force/stress/strain generates a potential difference (accept idea that vibration/pressure/force/stress/strain causes redistribution of charge within crystal)	**(1)** **(1)** **(1)** **(1)**	**4**
18(b)	Thin film is flexible / lightweight The idea that there is not much energy in sound Large area gathers more sound (energy) **Or** Large area generates more power/current/pd	**(1)** **(1)** **(1)**	**3**
18(c)	Use of $P=E/t$ with any time, energy in J or kJ Conversion of kJ→J **and** correct time in s (36000 s) P =0.56 W (accept J s^{-1}) <u>Example of calculation</u> Power = 20000 J / 10 × 3600 s Power = 0.56 W	**(1)** **(1)** **(1)**	**3**
18(d)	**ONE** *Disadvantage* Expensive, Not washable Only works with (loud) noise Long time to charge a phone Low output power **ONE** *Advantage* Free source of energy Lower/zero running cost Portable Can be used when away from mains electricity [Credit should be given for any reasonable correct physics point but not for generalised comments such as ‘good for the planet’ ‘environmentally friendly’]	**(1)** **(1)**	**2**
	Total for question 18		**12**

Question Number	Answer		Mark
***19(a)**	(QWC- Work must be clear and organised in a logical manner using technical wording where appropriate.) • Two waves travelling in opposite directions **Or** a wave meets its reflection • Superposition occurs (do not credit superimposition) **Or** reference to both constructive and destructive interference • Producing points where the waves are in phase and points where they are in antiphase **OR** producing points of zero amplitude and points of maximum amplitude **OR** Nodes and antinodes produced	**(1)** **(1)** **(1)**	**3**
19(b)	Use of $v = f\lambda$ (ignore powers of 10 errors) λ = 1.2 m **Or** 120 cm f = 275 Hz (accept 275 s^{-1}) Example of calculation λ = 1.2 m f = 330 m s^{-1} / 1.2 m f = 275 Hz	**(1)** **(1)** **(1)**	**3**
19(c)	Remove: the frequencies with the highest amplitude **Or** the frequencies which are loudest **Or** frequencies f_2 and f_3 Reduces volume/loudness/sound/amplitude of vuvuzela (compared to commentator) (If all the frequencies removed) the speech of commentator would be affected **Or** (If all the frequencies removed) vuvuzela not heard at all (Do not award third mark if it is suggested that **all** sound is removed)	**(1)** **(1)** **(1)**	**3**
19(d)(i)	Antiphase: one wave 180°/ π /half a cycle out of phase with another wave (ignore references to wavelength – correct or incorrect; 'out of phase' not sufficient) Destructive interference is when two waves cancel each other out / produce zero amplitude/intensity The waves have the same frequency **Or** The waves have the same amplitude	**(1)** **(1)** **(1)**	**3**
19(d)(ii)	It would not work because: all of the sound would be cancelled **Or** amplitude of noise not constant (accept frequency not constant; accept (too) many frequencies)	**(1)**	**1**
	Total for question 19		**13**

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