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Mark Scheme (Results)
June 2010

GCE

GCE Physics (6PH02/01)

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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 cause the final calculation mark to be lost.
   - 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.
   - 2.4 The same missing or incorrect unit will not be penalised more than once within one question.
   - 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.

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.

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	A	(1)
2	D	(1)
3	C	(1)
4	B	(1)
5	D	(1)
6	B	(1)
7	A	(1)
8	C	(1)
9	C	(1)
10	C	(1)

Question Number	Answer	Mark
11	See $c = 3 \times 10^8$ (m s^{-1}) converts MHz to Hz $\lambda = 3.13$ m <u>Example of calculation</u> $\lambda =$ (3×10^8 m s^{-1}) / 95.8×10^6 Hz $\lambda = 3.13$ m	(1) (1) (1)
	Total for question 11	3

Question Number	Answer	Mark
12(a)	Resistivity is a constant for the material / metal OR resistivity depends on / is a property of the material / metal Resistance depends on (resistivity and) length / area /dimensions OR $R = \rho l/A$ with terms defined (do not credit rearranged equation)	(1) (1)
12(b)	Correct substitution into the $R = \rho l/A$ formula $R = 0.0085\ \Omega$ [ue applies. Common error is to rearrange eqn and confuse R and ρ gives answer 3.4×10^{-14} scores zero] <u>Example of calculation</u> $R = (1.7 \times 10^{-8}\ \Omega$ m $\times$ 0.5 m) / 1×10^{-6} m^2 $R = 0.0085\ \Omega$	(1) (1)
12	Total for question 12	4

Question Number	Answer	Mark
13(a)(i)	Resistance at 20 °C = 1250 - 1300 (Ω)	(1)
13(a)(ii)	Converts kΩ → Ω [look for 1000 (Ω)] Use of potential divider formula OR use of 2300 (Ω) to find current Reading on voltmeter = 2.6 – 2.7 V (ecf value from (a)(i)) <u>Example of calculation</u> V = (1000 Ω ÷ 2300 Ω) × 6 V V = 2.6 V	(1) (1) (1)
13(b)	(decreasing temp causes) resistance of <u>thermistor</u> to increase Voltmeter reading decreases Candidates who think resistance will decrease leading to voltmeter increase can get 2nd mark.	(1) (1)
	Total for question 13	6

Question Number	Answer	Mark
14	QWC – spelling of technical terms must be correct and the answer must be organised in a logical sequence Identifies two rays of light Two rays have same frequency/come from same source/are coherent Path difference (between the two reflected rays) They superpose (when they meet) /constructive and destructive interference occur If they meet in phase/nλ /λ path difference, constructive interference/ bright fringe If they meet in antiphase / (n+ ½)λ / ½ λ path difference, destructive interference/dark fringe	 (1) (1) (1) (1) (1) (1) (max 5)
	Total for question 14	5

Question Number	Answer	Mark
15(a)	Volt is a Joule coulomb $^{-1}$ or V = J C^{-1} or $V = W/Q$ (not rearranged) Amp is a Coulomb sec^{-1} or A = C s^{-1} or $I = Q/t$ (not rearranged) Show units/symbols cancelling and equating to a watt. This mark can only be given if both the other marks scored. Method must be clear, do not allow 'let t = 1'.	(1) (1) (1)
15(b)(i)	Use of energy = power × time Energy = 2.9 × 10^5 J Example of calculation E = 700 × 7 × 60 E = 294 000 J	(1) (1)
15(b)(ii)	QWC – spelling of technical terms must be correct and the answer must be organised in a logical sequence See internal resistance / r Current will be less Less energy/power is lost in internal resistance OR wasted energy/power is reduced OR reduced lost volts OR it is more efficient	 (1) (1) (1)
	Total for question 15	8

Question Number	Answer	Mark
16(a)	n = sin 48 / sin 30 n = 1.5 (common answer will be 1.49) (n = 0.67 scores 1 mark for idea of ratio of sin of angles)	(1) (1)
16(b)(i)	QWC – spelling of technical terms must be correct and the answer must be organised in a logical sequence As x increases, y increases OR At a certain angle / critical angle, y = 90° / the light travels along the boundary (do not allow reflects at 90°) For angles greater than the critical angle (in glass) total internal reflection occurs (do not accept TIR)	 (1) (1) (1)
16(b)(ii)	Use of sin c = 1/n c = 42° ecf n from (a) unless n= 0.67 which scores 0 here	(1) (1)
	Total for question 16	7

Question Number	Answer	Mark
17(a)	Photon energy is too small / less than work function (do not credit the frequency is less than the threshold frequency or electrons have not been given enough energy)	(1)
17(b)	Method 1: Use of intercept x-axis Use of $E = hf$ with $f = 10 \times 10^{14}$ Hz Divide by 1.6×10^{-19} to convert to eV (this mark can be scored even if wrong frequency used) $\Phi = 4.1$ (eV) Unit given on paper so no ue and ignore reference to J OR Method 2:Use of Photoelectric Equation Use of $hf = \Phi + E_{max}$ with any pair of values Divide by 1.6×10^{-19} to convert to eV $\Phi = 4.1 - 4.5$ (eV) Unit given on paper so no ue and ignore reference to J	(1) (1) (1) (1) (1) (1) (max 3)
17(c)	Gradient of graph is Planck's constant/e (accept just Planck's constant)	(1)
17(d)	Graph parallel to original graph cutting X axis with a value less than 10	(1) (1)
	Total for question 17	7

Question Number	Answer	Mark
18(a)	There must be a circuit with a power supply and a labelled wire/identifiable ends of a wire/wavy line/resistor/lamp in order to score any marks ANY TWO Ammeter symbol in series with wire (not in the middle of) Voltmeter symbol in parallel with wire Variable power supply/variable resistor	 (1) (1) (1) (max 2)
18(b)	Use of $P = VI$ Rate of work = 4.5 W / J s^{-1}	(1) (1)
18(c)(i)	Correct use of $I = nqvA$ with e = 1.6×10^{-19} C $v = 3.0 \times 10^{-5}$ ms^{-1} <u>Example of calculation</u> $v = 1.5/ (1.0 \times 10^{29} \times 1 .6 \times 10^{-19} \times 3.1 \times 10^{-6}$ $v = 3.02 \times 10^{-5}$ ms^{-1}	(1) (1)
18(c)(ii)	Increased lattice/ions/atoms vibrations (causing) resistance to increase OR increased electron collisions with ions/atoms (This leads to a) reduction in the drift velocity / v	(1) (1) (1)
	Total for question 18	9

Question Number	Answer	Mark
19(a)(i)	$v = f\lambda$ (words or symbols not numbers) length of string = $\lambda/2$ OR wavelength = 2 x length OR node to node = $\lambda/2$	(1) (1)
19(a)(ii)	$\pi d^2/4$ OR $\pi(D3/2)^2$ OR π(D3/2)^2 (this mark is lost if there is a *length / A3) (ignore powers of ten)	(1)
19(a)(iii)	E4*density OR E4*7800 (ignore powers of ten) OR volume of 1 metre length x density	(1)
19(a)(iv)	5.12 (spreadsheet answers must be correct to same number dec places so do not accept 5.116 or 5.11) (correct answer on spreadsheet scores mark irrespective of what's written on next page)	(1)
19(a)(v)	See $T = v^2 \mu$ OR $\sqrt{T} = v\sqrt{\mu}$ (not just quoting given equation) T = 82 (N) (do not penalise dec places twice, 82.1 could score both marks if more than 3 dec places given in (iv)) (correct answer on spreadsheet scores both marks)	(1) (1)
19(b)	Plot a graph of $v \rightarrow \sqrt{T}$, $v^2 \rightarrow T$, $f \rightarrow \sqrt{T}$, or $f^2 \rightarrow T$ Graph should be a straight line through the origin Statement of what gradient equals (consistent with what has been plotted) (For this experiment μ is a constant. A graph using a variable μ can score max 1 mark for the correct gradient)	(1) (1) (1)
	Total for question 19	10

Question Number	Answer	Mark
20(a)	Wavelength of microwaves < wavelength radiowaves OR statement that wavelength of radiowaves is larger (need some comparison and do not credit frequency) Less / no diffraction OR beam spreads out less	 (1) (1)
20(b)(i)	Frequency (of reflected wave) would be higher	(1)
20(b)(ii)	There is a link between frequency (change) and speed(ing) (Car is speeding) when frequency (change) exceeds some limit (answers may be given in terms of wavelength)	(1) (1)
20(c)(i)	Use of intensity × area × 0.08 energy/sec = 6 J or J s^{-1} or W <u>Example of calculation</u> Energy per second = 500 W m^{-2} × 0.5 m × 0.3 m × 0.08 = 6 J	(1) (1) (1)
20(c)(ii)	Use of $E = Pt$ with any relevant time e.g. 8 hours, 480 min or 28800s t = 28800 s Number of flashes = 1700 Ecf answer to (c)(i) [Take their answer to (c)(i) and multiply by 288 to check their answer for full marks] <u>Example of calculation</u> Number of flashes = (6 × 8 × 3600)/100 =1728	(1) (1) (1)
	Total for question 20	11

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