Mark Scheme (Standardisation)
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GCE

GCE Physics (6734/01)

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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] ✓ **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 but may be penalised again in another 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.
3.2 Use of an inappropriate number of significant figures will normally be penalised in the practical examinations or coursework.
3.3 Using g = 10 m s^{-2} will **not** be penalised.

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] ✓
[Allow 50.4(N) for answer if 10 N/kg used for g.]
[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, placed as first mark.
5.2 Usually it is part of a max mark.
5.3 In SHAP marks for this are allocated in coursework only but this does not negate the need for candidates to express themselves clearly, using appropriate physics terms. Likewise in the Edexcel A papers.

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.

6734 Unit Test PHY 4

Question Number	Answer	Mark
1 (a) **(i)** **(ii)** **(iii)**	What happens to the property Increases **(1)** Decreases **(1)** Decreases **(1)**	**(3)**
(b)	Property which increases at larger wavelengths Diffraction / Fringe width/spacing (in 2-slit interference) / Period / Wavelength shift in Doppler effect **(1)**	**(1)**
(c)	Effect of wavelength on particle behaviour Short(er) wavelengths are (more) particle-like **(1)** [Or converse statement about larg(er) wavelengths] [Ignore references to energy momentum, photoelectric emission unless linked particle-like behaviour]	**(1)**
	Total	**5**

Question Number	Answer	Mark
2 (a)	Calculation of wavelength Use of $\lambda = vT$ or $f = 1/T$ and $v = f\lambda$ **(1)** Correct answer [1.81, 3 sig fig minimum, no u.e.] **(1)** [Allow 1.82] Example calculation: $\lambda = vT = 1.51 \text{ m s}^{-1} \times 1.20 \text{ s} = 1.812$ (m)	**(2)**
(b)	Graph for leaf X 2 cycles of a sinusoidal wave of period 1.2 s **(1)** [Zero crossings to be consistent to nearest half square] Cosine graph, with scale on displacement axis and amplitude 0.08 m **(1)**	**(2)**
(c)	Graph for leaf Y Sinusoidal graph lagging 0.3 s behind the graph drawn for X [check peaks only] **(2)** [Allow **1** mark if Y graph leads X graph by 0.3 s] [Ignore zero crossings and displacement scale; accept zero displacement up to t = 0.3 s]	**(2)**
	Total	**6**

Question Number	Answer	Mark
3 (a)	<u>Calculation of power output</u> Use of $P = IA$ [Can omit efficiency here] **(1)** Correct answer [7.2×10^3 , 2 sig fig minimum, no u.e.] **(1)** Example calculation: $P_{elec} = 0.19 \times 1400 \text{ W m}^{-2} \times 27 \text{ m}^2 = 7182$ (W)	**(2)**
(b) (i)	<u>Power output in Mars orbit</u> Use of $P_{Mars}/P_{Earth} = (r_{Earth}/r_{Mars})^2$ or equivalent formula for I **(2)** OR Use of P (or I) = k/r^2 for Earth, to give k **(1)** Use formula again, knowing k, for Mars **(1)** OR Use of $P = 4\pi r^2 I$ to give P_{Sun} [3.96×10^{26} W] **(1)** Use formula again, knowing P, for Mars **(1)** Correct answer [3.1 kW, or 3.0 kW if 7 kW used] **(1)** Example calculation: $P_{elec} = 7182 \text{ W} \times (1.5 \times 10^{11} \text{ m} / 2.3 \times 10^{11} \text{ m})^2 = 3055$ W	**(3)**
(ii)	<u>Assumption</u> EITHER Intensity obeys inverse square law OR (space is a vacuum) / contains very few atoms **(1)** No radiation (OR light OR energy) absorbed **(1)** OR Sun-to-satellite distance = Sun-to-planet distance **(1)** Satellite orbit radius << Sun-to-planet distance **(1)** [Ignore reference to light from other stars and blocking of light by other bodies and changes in efficiency or anything already referred to in question e.g. arrays perpendicular to rays, Sun radiates uniformly in all directions]	**(2)**
	Total	**7**

Question Number	Answer	Mark
4(a)	<u>Description of force R</u> <u>Normal</u> reaction / <u>normal</u> contact **(1)** Car/wheels/tyres Ground/road/Earth/earth **(1)** [Both answers needed for mark]	**(2)**
(b)(i)	<u>Acceleration and proof of formula</u> v^2/r OR $\omega^2 r$ OR <u>resultant</u> force/m OR $(R\text{-}mg)/m$ **(1)** Upwards / towards O / towards the centre / centripetal **(1)**	
(ii)	Resultant (OR unbalanced OR net OR accelerating) force = $R - mg$ OR = mv^2/r **(1)** <u>Hence</u> $R - mg = mv^2/r$ **(1)**	**(4)**
(c) (i)	<u>Gradient</u> Use of gradient = $\Delta R/\Delta v^2$ **(1)** Correct answer [in the range 12.7 to 14.8 (N s^2 m^{-2})] **(1)** [Accept 0.0127 to 0.0148 (kN s^2 m^{-2}) i.e. mark numerical value only and ignore units] [Note that ΔR = 18 – 12 (scales misread) leading to a gradient of 15 will score first mark only as value is outside range] Example calculation: gradient = $(16.5 - 11.0) \times 10^3$ N/(400 m^2 s^{-2}) = 13.75 (N s^2 m^{-2} or kg m^{-1})	**(2)**
(ii)	<u>Calculation of r</u> Use of gradient = m/r **(1)** (OR Use of $R = mv^2/r + mg$ with coordinates from graph) Correct answer [74 to 88 m] **(1)** [Allow ecf from incorrect gradient, BUT if they didn't convert kN to N in gradient calculation they must do so here to earn both marks] Example calculation: r = gradient/m = (1120 kg)/(13.75 kg m^{-1}) = 81.45 m	**(2)**
	Total	**(10)**

Question Number	Answer	Mark
5(a)(i)	<u>Acceleration-time graph</u> Inverted version of displacement graph **(1)**	**(1)**
(ii)	<u>Formula</u> $(2\pi f)^2 x_0 m$ OR $4\pi^2 f^2\ x_0 m$ **(1)** [Ignore leading negative but must be x_0 and not just x]	**(1)**
(b)(i)	<u>Where soil is most likely to break free</u> Q/at ends with a valid reason **(1)** Possible reasons: Acceleration is greater (Resultant) force (needed) is greater Soil keeps moving whilst root (or plant) turns round	**(1)**
(ii)	<u>More effective strategy</u> Double f because acceleration (or force) is increased more/greater **(1)** Quantitative statement **(1)** Possible statements: Force (or acceleration) is proportional to x_0 but to f squared Doubling x_0 doubles force (or acceleration) but doubling f quadruples it States equation and points out that f is squared	**(2)**
	Total	**5**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>6(a)</td><td>
<u>Explanation of observations</u>

QOWC (1)

Slits act as coherent sources (1)

<table>
<tr><td>At maximum
Or At O / P</td><td>waves in phase</td><td>constructive interference
Or reinforcement</td><td>(1)</td></tr>
<tr><td>At minimum</td><td>waves in antiphase
Or exactly out of phase</td><td>destructive interference
Or cancellation</td><td>(1)</td></tr>
<tr><td>Or</td><td>(1)</td><td>(1)</td><td></td></tr>
</table>
[Can score marks either horizontally or vertically but not both]

At maximum, path difference = $n\lambda$ (1)
(Or At O, path difference = 0 Or At 1st maximum/P, path difference = λ)

At minimum, path difference = $(n + ½)\lambda$ (1)
(Or At 1st minimum, path difference = ½ λ)
</td><td>(Max 5)</td></tr>
<tr><td>(b) (i)</td><td>
<u>Wavelength calculation from formula</u>

Correct answer [3.4 cm] (1)

Example calculation:
$\lambda = xs/D$ = (4.1 cm)(8.2 cm)/(10.0 cm) = 3.36 cm
</td><td>(1)</td></tr>
<tr><td>(ii)</td><td>
<u>Correct wavelength calculation</u>

Use of Pythagoras for S_2P (1)

Use of $\lambda = S_2P - S_1P$ (1)

Correct answer [2.9 cm] (1)
[Bald answer of 3 cm scores 0/3 while bald answer of 2.9 cm scores 3/3]

Example calculation:
$S_2P = \sqrt{((10.0\text{ cm})^2 + (8.2\text{ cm})^2)}$
= 12.93 cm
λ = 12.9 cm – 10.0 cm
= 2.9 cm
</td><td>(3)</td></tr>
<tr><td>(iii)</td><td>
<u>Condition for formula to be valid</u>

$s << D$ OR $s >> \lambda$ (1)
[if in words then need idea of ‘much less than’ or ‘much greater than’]
[Ignore any stated values]
</td><td>(1)</td></tr>
<tr><td></td><td>Total</td><td>10</td></tr>
</table>

Question Number	Answer	Mark
7 (a)	Why the equation is true hf is the energy of a photon **(1)** φ is the minimum energy to remove the electron / the energy to remove a surface electron **(1)** Difference is E_{max} by conservation of energy **(1)**	**(3)**
(b)	Measuring E_{max} Circuit to apply a reverse p.d. (anode negative) **(1)** P.d variable from zero **(1)** [Accept potential divider or d.c. supply with arrow through it or labelled variable d.c. supply, but not series rheostat] Ammeter and voltmeter suitably positioned **(1)** [Allow A, mA, μA, nA, pA but not I or M] [Don't worry if ammeter is placed so its reading includes voltmeter current] Increase V until I falls to zero / vary V until I just falls to zero **(1)** Record voltmeter reading **(1)** Multiply stopping potential (Or V_S) by e **(1)** (Or Stopping potential (Or V_S) gives E_{max} in eV) [if stating qV_S then must equate q to e]	**(Max 5)**
(c)	Calculation of f Use of $E_{max} = hf - \varphi$ **(1)** Correct answer [8.4×10^{14} Hz or s^{-1}] **(1)** Example calculation: $f = (E_{max} + \varphi)/h = (2.0 \times 10^{-19} + 3.6 \times 10^{-19})$ J/(6.63×10^{-34} J s) $= 8.45 \times 10^{14}$ Hz	**(2)**
	Total	**10**

Question Number	Answer	Mark
8 (a)	How wavelength depends on galaxy distance (Observed) wavelength increases as distance increases **(1)** Wavelength change (OR redshift) is proportional to distance (to galaxy) **(1)** [Allow $\Delta\lambda \propto d$ without symbols defined]	**(2)**
(b) (i)	Why expansion rate is expected to decrease with time Gravitational attraction slows down the galaxies / **(1)** KE converted to GPE so galaxies slow down [Accept force or pull of gravity, but not just "gravity"]	**(1)**
(ii)	Open and closed universes Open: graph A, keeps on expanding **(1)** Closed: graph B, eventually (stops expanding and) contracts **(1)** [Ignore references to Big Crunch] [Maximum of 1 if graphs A and B not referred to]	**(2)**
(iii)	Condition to be satisfied (Average mass-energy) density is below critical/threshold value **(1)** [Or converse statement if it is clear that candidate is stating condition for graph B to be followed]	**(1)**
(c)	Sketch graph Single line rising from origin, whose gradient initially decreases (but not to zero), then starts to increase **(1)**	**(1)**
	Total	**7**
	Total for paper	**60**