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Mark Scheme Final Version
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GCE

GCE Physics (6734/01)

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These instructions should be the first page of all mark schemes

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.

Question Number	Answer	Mark
1(a)	Calculation of angular speed Use of $\omega = 2\pi/T$ (1) 7.27×10^{-5} [2 sig fig minimum] (1)	2
	$2\pi/(24\text{ h} \times 3600\text{ s h}^{-1})$ $= 7.27 \times 10^{-5}\text{ rad s}^{-1}$	
(b) (i)	Calculation of acceleration Use of $a = r\omega^2$ OR $v = r\omega$ and $a = v^2/r$ (1) 0.034/031 m s^{-2} (1)	2
	$(6400 \times 10^3\text{ m})(7.27 \times 10^{-5}\text{ rad s}^{-1})^2$ $= 0.034\text{ m s}^{-2}$	
(ii)	Direction of acceleration Arrow to the left (1) [No label needed on arrow. If more than one arrow shown, no mark unless correct arrow labelled acceleration]	1
(iii)	Free-body diagram Arrow to left labelled Weight/*W*/*mg*/pull of Earth/gravitational force (1) Arrow to right labelled Normal reaction/*N*/ *R*/push of Earth (OR ground)/(normal)contact force (1) [Don't accept "gravity" as label] [More than two forces max 1] [Diagram correct except rotated gets 1 out of 2]	2
(iv)	How the acceleration is produced *N* is less than *W* (1) Resultant (OR net OR unbalanced) force towards centre (1) [Accept downward / centripetal for towards the centre, but not as an alternative to "resultant"]	2
	Total	9

Question Number	Answer	Mark
2(a)	Experiment Scheme for timing methods: QOWC (1) Use $f = 1/T$ OR f = (number of cycles/time taken) (1) Apparatus (1) Principle of method (1) One precaution for accuracy (1) Examples for last three marks: Stopclock / stopwatch (1) Measure time taken for a number of cycles (1) Repeat timings and average / use Σn at least 20 / use fiducial mark / ensure vertical oscillations / not exceeding elastic limit (1) **Or** Motion (OR position) sensor and datalogger (OR computer) (1) Read time for one (or more) cycles from displacement-time graph (1) Read time for several cycles / ensure vertical oscillations (1) **Or** Light gate and datalogger (OR computer) (1) Computer measures time interval between beam interruptions (1) Use narrow light beam / position gate so beam cut at equilibrium position / ensure vertical oscillations (1) **Or** Video Camera (1) Read time for one (or more) cycles from video (1) Read time for several cycles / ensure vertical oscillations (1) [Mark other reasonable techniques on the same principles]	**Max 4**
	Scheme for strobe method: QOWC (1) Use stroboscope [Accept strobe] (1) Adjust frequency until mass appears at rest (1) Find highest frequency at which this happens (1) Repeat and average / ensure vertical oscillations (1)	**Max 4**
	Scheme for use of T m/k) / T e/g QOWC (1) Calculate T from measured (OR known) m and k using T m/k) (1) or calculate T from measured e known g using T e/g (1) Use $f = 1/T$ (1) [e is the extension of the spring produced by weight of mass m]	**Max 2**
	[Do not give any credit for experiments to measure the resonant frequency of the system]	

2 (b) (i)	Graph Axis labels and single peak (1) Rounded top and concave sides (1) f_0 marked on the frequency axis at, or just to right of, peak. [Amplitude at f_0 should be at least 75% of maximum amplitude] (1) [A sharp kink loses mark 2 only] [Graphs with multiple peaks lose marks 1 and 2; f_0 marked correctly on lowest frequency peak for mark 3] [Ignore whether or not curve goes to origin]	3
(ii)	Name of phenomenon Resonance (1) [Mark this independent of whether graph is correct Do not accept "resonant frequency"]	1
(iii)	Footbridge application People walking / wind / earthquake can cause vibration / act as a driver / apply regular impulses (1) If resonance occurs OR if frequency equals / is close to f_0 we may get large / dangerous / violent oscillations OR large energy transfer OR damage to bridge (1)	2
	Total	**10**

Question Number	Answer	Mark
3(a) (i)	<u>How we know the speed is constant</u> Crest spacing constant / circular crests Or wavelength constant / equal wavelength (1) [Accept wavefront for crests] [Don't accept wave]	1
(ii)	<u>Calculation of speed</u> λ is 10 mm (1) [Allow 9 to 11] Use of $v = f\lambda$ (1) 0.40 m s^{-1} (1) [Allow 0.36 to 0.44 Allow last two marks for correct calculation from wrong wavelength]	3
	(40 Hz)(10 x 10^{-3} m) = 0.40 m s^{-1}	
(b)	<u>Line X</u> 1st constructive interference line below PQ, labelled X (1) [Accept straight line Ignore other lines provided correct one is clearly labelled X]	1
(c) (i)	<u>Superposition along PQ</u>	
	Constructive interference / reinforcement / waves of larger amplitude / larger crests and troughs (1) Crests from S_1 and S_2 coincide / waves are in phase / zero phase difference / zero path difference (1) Amplitude is the sum of the individual amplitudes (OR twice the amplitude of the separate waves) (1)	3
(ii)	<u>Table</u> A constructive (1) B destructive (1)	2
	Total	**10**

Question Number	Answer	Mark
4(a)	Amplitude	
(i)	Amplitude remains constant (1)	1
(ii)	Amplitude decreases then increases (1) Amplitude is zero at node (OR half way between X and Y) (1)	2
(b)	Phase difference	
(i)	Phase difference increases / is proportional to distance XP (1)	1
(ii)	Up to node phase difference is zero / in phase (1) Beyond the node phase difference is π / 180^0 / half a cycle / in antiphase (1) [Do not allow completely out of phase]	2
	Total	**6**

Question Number	Answer	Mark
5(a)	Part of spectrum Light / Visible / red (1)	1
	Calculation of work function Use of $\varphi = hc/\lambda$ (1) 3.06×10^{-19} [2 sig fig minimum] (1)	2
	$(6.63 \times 10^{-34}$ J s$)(3.00 \times 10^{8}$ m s$^{-1})/(6.5 \times 10^{-7}$ m) $= 3.06 \times 10^{-19}$ J	
(b) (i)	Meaning of stopping potential Minimum potential difference between C and A / across the photocell (1) Which reduces current to zero OR stops electrons reaching A / crossing the gap / crossing photocell (1)	2
(ii)	Why the graphs are parallel Correct rearrangement giving $V_s = hf/e - \varphi/e$ (1) Gradient is h/e which is constant / same for each metal (1) [Second mark can be awarded without the first if no rearrangement is given, or if rearranged formula is wrong but does represent a linear graph with gradient h/e]	2
	Total	7

Question Number	Answer	Mark
6(a)(i)	Name of effect Diffraction/interference/superposition (1)	**1**
(ii)	How the experiment shows the properties Behaves as a wave when diffracted / interfere / superpose (1) Behaves as a particle when accelerated / when electric field exerts force on it / Thermionic emission (1) [Don't accept general particle properties, e.g. has charge, has mass. Answer must refer to behaviour in this experiment]	**2**
(b) (i)	Why the wavelength is suitable It is of the same order as the atomic spacing / lattice spacing (1) Which is necessary for (observing) diffraction (1)	**2**
(ii)	Calculation of momentum Use of $\lambda = h/p$ (1) 3.32×10^{-23} kg m s^{-1} [3 sig fig minimum] (1)	**2**
	$(6.63 \times 10^{-34}$ J s$)/(2.0 \times 10^{-11}$ m) $= 3.32 \times 10^{-23}$ kg m s^{-1}	
(iii)	Showing KE is 4 keV	
	Use of $p = mv$ (1) Use of $E_k = mv^2/2$ (1) (Use of $E_k = p^2/2m$ earns both marks) Use of 1.6×10^{-19} (1) 3.7 to 3.8 (keV) [minimum 2 sig fig] (1)	**4**
	$v = (3.32 \times 10^{-23}$ kg m s$^{-1})/(9.11 \times 10^{-31}$ kg) $= 3.64 \times 10^{7}$ KE = $(9.11 \times 10^{-31}$ kg$)(3.64 \times 10^{7}$ m s$^{-1})^2/$ $2(1.6 \times 10^{-19}$ J eV$^{-1})$ $= 3.77 \times 10^{3}$ eV	
(iv)	Accelerating p.d. 4000 V or their answer from previous part (1)	**1**
	Total	**12**

Question Number	Answer	Mark
7 (a)	Calculation of recession speed $\Delta\lambda = 684 - 656$ (1) Use of $v/c = \Delta\lambda/\lambda$ (1) 1.28×10^7 m s^{-1} (1) [Substituting 684 for λ, leading to 1.23×10^7, loses last two marks]	3
	$(3.00 \times 10^8$ m s$^{-1})(28 \times 10^{-9}$ m)/$(656 \times 10^{-9}$ m) $= 1.28 \times 10^7$ m s^{-1}	
(b)	Calculation of wavelength received from Y By Hubble's law / $v = Hd$ / v proportional to d, as d is doubled, v is doubled (1) $\Delta\lambda = 56$ / is doubled (1) 712 nm (1) [Bald answer of 712 nm, with no working or explanation, gets 2 marks only] [If candidate gets part (a) wrong, accept EITHER 56, 712 for the last two marks (if they have avoided reusing the formula or made the same mistake again) OR ecf (if they have repeated the calculation but avoided the original mistake)]	3
	Total	**6**
	Total for paper	**60**