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Mark Scheme
(FINAL)
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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] [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, 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) i	Why speed is unchanged Force/Weight [not acceleration] is perpendicular to velocity/motion/direction of travel/instantaneous displacement [not speed] OR no component of force/weight in direction of velocity etc No work is done OR No acceleration in the **direction of motion**	✓ ✓	**2**
(a) ii	Why it accelerates Direction (of motion) is changing Acceleration linked to a change in velocity	✓ ✓	**2**
(b)	Speed of satellite Use of $a = v^2/r$ [ignore km to m conversion here] [Substitution of a and r into a correct equation] Correct answer [3.8 to 4.0 x 10^3 m s^{-1}] Example calculation: $v = \sqrt{(2.7 \times 10^7 \text{ m} \times 0.56 \text{ m s}^{-2})}$ [Allow 1 mark for ω = 1.4 x 10^{-4} rad s^{-1}]	✓ ✓	**2**
			6

Question Number	Answer		Mark
2 (a) i	Demonstrating the stationary wave Move microphone between speaker and wall OR perpendicular to wall OR left to right OR towards the wall [could be shown by labelled arrow added to diagram] **Oscilloscope**/**trace** shows sequence of maxima and minima	✓ ✓	**2**
(a) ii	How nodes and antinodes are produced Superposition/combination/interference/overlapping/crossing of emitted/incident/initial and reflected waves [Not just waves in opposite directions interfering] Antinodes: waves (always) in phase OR reference to coincidence of two compressions/rarefactions/peaks/troughs /maxima/minima, hence constructive interference/reinforcement Nodes: waves (always) in antiphase/**exactly** out of phase OR compressions coincide with rarefactions etc, hence destructive interference / cancellation	✓ ✓ ✓	**3**
(a) iii	Measuring the speed of sound Measure separation between (adjacent) **nodes** / **antinodes** and double to get λ/this is ½λ [not between peaks and troughs] [At this stage allow words that mean nodes and antinodes like quiet and loud] Frequency known from/produced by signal generator OR measured on CRO / by digital frequency meter Detail on measurement of wavelength OR frequency e.g. measure several [if a number is specified then ≥3] node spacings and divide by the number [not one several times] OR measure several (≥3) periods on CRO and divide by the number OR adjust cro so only one full wave on screen Use v (allow c) = $f\lambda$	✓ ✓ ✓ ✓	**4**
(b) i	Application to concert hall Little or no sound /amplitude OR you may be sat at a node	✓	
(b) ii	Sensible reason Examples: Reflected wave not as strong as incident wave OR walls are covered to reduce reflections OR waves arrive from elsewhere [reflections/different speakers] OR such positions depend on wavelength / frequency	✓	**2**
			11

Question Number	Answer		Mark
3 (a) i	Amplitude and frequency 0.17 m [allow 0.17 to 0.18 m but not 0.19 m] 0.8(3) Hz or s^{-1} [not 0.84 or a fraction e.g. 5/6]	 ✓ ✓	 **2**
(a) ii	Maximum velocity Use of $v_{max} = 2\pi f x_0$ [ecf their x_o and f] Correct answer [0.89, 2 sig fig minimum, no u.e.] Example calculation: $v_{max} = 2\pi$ x 0.83 Hz x 0.17 m OR Use of maximum gradient of h versus t graph Answer to 2 sig fig minimum	 ✓ ✓ ✓ ✓	 **2**
(a) iii	Velocity-time graph Wave from origin [can be e.g. triangular], period 1.2 s [only check crossing points at 1.2 s and 2.4 s] Inverted sine wave with scale on velocity axis &initial peak value 0.9 m s^{-1} [ecf their v_{max}] [Ignore variation in peak value]	 ✓ ✓	 **2**

(b) i	Definition of SHM Acceleration / resultant force proportional to displacement OR Acceleration / resultant force proportional to distance from a fixed point [not just distance from equilibrium but 'distance from equilibrium position' is acceptable] OR a = (-) constant x x [with a and x defined] OR F = (-) constant x x [with F and x defined] Acceleration /resultant force directed towards the fixed point / in opposite direction (to displacement) OR negative sign in equation explained [e.g a and x in opposite directions]	✓ ✓	**2**
(b) ii	Verifying SHM Read off h value and use it to get displacement [only penalise the first mark if h used for displacement throughout] Plot acceleration-displacement graph OR calculate ratios eg $a \div x$ Straight line through the origin OR check ratios to see if constant Negative gradient / observe acceleration OR constant is negative and displacement have opposite signs OR Use $x = x_o\cos(2\pi ft)$ for a range of t OR Read off h and get x Use values of x_o and f from part (a) OR Use $a=-(2\pi f)^2x$ for range of x Add equilibrium value to x to get h OR Use value of f from part (a) If results agree with values of h (or a) from graph it is SHM	✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓	**4**
			12

Question Number	Answer		Mark
4	Identification of graphs C B E D	 ✓ ✓ ✓ ✓	 **4**
			4

Question Number	Answer		Mark
5(a)(i)	Line B Knot T at 2.4 m [±½ small square, no label needed]	 ✓	
(a) ii	Knots Q, R, S at 0.6, 1.2, 1.8 m [±½ small square, no labels needed] [ecf from wrong position of knot T i.e. Q at ¼T, R at ½T & R at ¾T]	✓	**2**
(b)	How model represents the Universe and its behaviour Knots/letters/points represent <u>galaxies</u> Reference to expansion of Universe / galaxies moving apart [NOT galaxies move away and stay same distance apart]	 ✓ ✓	**2**
(c)	How model illustrates Hubble's law Stating or showing velocities are different for 2 of the knots [Shown by either calculating speeds or comparing distances moved between diagrams A and B] Calculation of velocity for at least 2 of the knots [other than T] Use of their data to show speed (of knot) $\propto$ distance (from P) Examples: determine values of $v \div d$ [allow $v \div \Delta d$] sketch graph of v against d [allow v against Δd]	 ✓ ✓ ✓	**3**
(d)	Defects of the model Any 2 sensible points Examples: Galaxies are not evenly spaced Initial spacing of knots is not zero No force pulling galaxies/Universe apart Rate of expansion of Universe OR speed of galaxies increasing/ not constant [not speed decreasing] Relative sizes of knot and spacing are unrealistic Universe is 3 dimensional/galaxies are not in a straight line	 ✓✓	**2**
			9

Question Number	Answer		Mark
6(a)	Meaning of statement (5.89×10^{-19} J / work function) is the energy needed to remove an electron [allow electrons] from the (magnesium) surface/plate **Consequent mark** **Minimum** energy stated or indicated in some way [e.g. at least /or more]	✓ ✓	**2**
(b)(i)	Calculation of time Use of $P = IA$ Use of $E = Pt$ [use of $E = IAt$ scores both marks] Correct answer [210 (s), 2 sig fig minimum, no u.e.] [Reverse argument for calculation leading to either intensity, energy or area gets maximum 2 marks] Example calculation: $t = (5.89 \times 10^{-19}\ \text{J})/(0.035\ \text{W m}^{-2} \times 8 \times 10^{-20}\ \text{m}^2)$	✓ ✓ ✓	**3**
(b)(ii)	How wave-particle duality explains immediate photoemission QOWC Photon energy is hf / depends on frequency / depends on wavelength **One/Each** photon ejects **one/an** electron The (photo)electron is ejected **at once/immediately** [not just 'photoemission is immediate']	✓ ✓ ✓ ✓	**4**
			9

Question Number	Answer		Mark
7(a)(i)	Length of pendulum Substitution of l and g into a correct form of $T = 2\pi\sqrt{(l/g)}$ Correct answer [1 m (0.99 m to 1.01 m depending on value g used)] [note: need to check method as an incorrect rearrangement can also lead to a value of 1.01] Example calculation: $l = 9.81 \text{ m s}^{-2} \times (2.00 \text{ s}/2\pi)^2$	✓ ✓	**2**
(a)(ii)	Reason for variation in period ***l* varies** with temperature OR ***g* varies** from place to place/with altitude [ignore references to angle of swing as 'small amplitude' in stem]	✓	**1**
(a)(iii)	Mass-spring system Appropriate conclusion linked with relevant statement about what affects/doesn't affect either m or k Examples: No, mass/m doesn't change Yes, mass changes plus a valid reason No, spring constant/stiffness/k doesn't change Yes, spring constant/stiffness/k changes e.g. with temperature/age No, independent of g	✓	**1**
(b)(i)	Calculation of wavelength Correct answer [32.6 (mm), 3 sig fig minimum, no u.e.] Example calculation: $\lambda = (3.00 \times 10^8 \text{ m s-1})/(9.19 \times 10^9 \text{ Hz})$	✓	**1**
(b)(ii)	Part of spectrum Microwaves	✓	**1**
(b)(iii)	Energy level spacing Use of $\Delta E = hf$ or hc/λ [**If unexpected λ send response to review**] Dividing their ΔE by 1.6×10^{-19} Correct answer [3.8×10^{-5} (eV), no u.e.] Example calculation: $\Delta E = (6.63 \times 10^{-34} \text{ J s}) \times (9.19 \times 10^9 \text{ Hz})/(1.60 \times 10^{-19} \text{ J eV}^{-1})$	✓ ✓ ✓	**3**
			9
	Total for paper		**60**