Mark Scheme (FINAL Standardisation)

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GCE

GCE Physics (6731/01)

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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] [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. ‘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:

<u>'Show that' calculation of weight</u>

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.

6731 Unit Test PHY1

Question Number	Answer	Mark
1	Complete the table	
	<table><tr><th>Source</th><th>Absorber</th><th>Effect on count rate</th><th>Radiations emitted</th><th></th></tr><tr><td>A</td><td></td><td></td><td>Beta</td><td>(1)</td></tr><tr><td>B</td><td></td><td>Eg reduced[allow ‘slightly reduced’, ‘significantly reduced’ etc] (Reduced to) background (Reduced to) background</td><td></td><td>(1)</td></tr><tr><td>C</td><td></td><td></td><td>Alpha, beta and gamma</td><td>(1)</td></tr><tr><td>D</td><td></td><td>(Reduced to) background (Reduced to) background (Reduced to) background</td><td></td><td>(1)</td></tr></table>	**(4)**
	[do not allow ‘stopped’ for ‘reduced to background’]	
	Total	**4**

Question Number	Answer	Mark
2 (a)	<u>Determine the acceleration of free fall</u> Attempt to measure the gradient of the vertical motion graph or use of appropriate equation(s) of motion [Allow this mark even when the gradient is taken over a small range] **(1)** Answer [Allow answers in the range (9.6 – 10.0) m s^{-2}. **This mark is consequent on the first mark being obtained ie no bald answer**] **(1)** Eg gradient = $\frac{59\text{ m s}^{-1}}{6\text{ s}}$ = 9.83 m s^{-2}	**(2)**
(b)	<u>Height above point A</u> Attempt to measure area under vertical motion graph or use of appropriate equation of motion taking values from the graph [for equations involving 'g' they must use their value from part (i)] **(1)** Answer [For area under graph method only accept 177 m. For use of equation methods accept values in the range (172 – 180) m and for these methods this mark is consequent on the first mark being obtained] **(1)** Eg Area under graph = $\frac{6\text{ s x }59\text{ m s}^{-1}}{2}$ = 177 m	**(2)**
(c)	<u>Distance from A</u> Time at which condition described occurs ie 4.9 s [do not accept 5 s for this mark] **(1)** Attempt to measure area under horizontal motion graph or use of $s = ut$ [For their time and allow 50 m s^{-1}] **(1)** Answer [240 m. Only give this mark if 48 m s^{-1} and 4.9 s have been used. However, a bald answer 240 m must be given 3 marks] **(1)** Eg Time = 4.9 s Area under graph for this time or ut = 48 ms^{-1} x 4.9 s = 235.2 m	**(3)**
	Total	**7**

Question Number	Answer	Mark
3 (a)(i)	<u>The height from the ground</u> **Either** Deducts 2.4 s from 3.8 s / 1.4s seen **(1)** Selects $s = (ut) + \frac{1}{2}at^2$ or 2 appropriate equations. **(1)** Subtracts value obtained for second mark from 28 m / value for distance fallen seen [9.6(1) m, 9.8 m if 10 m s^{-2} is used] **(1)** Answer [18 m] **(1)** Eg t = 3.8 s -2.4 s = 1.4 s $s = (ut) + \frac{1}{2}at^2$ $= \frac{1}{2}$ x 9.81 m s^{-2} x $(1.4\ s)^2$ = 9.6(1) m [9.8 m if g = 10 m s^{-2} used] height = 28 m – 9.6(1) m = 18 (.39 m) [18(.2) if g = 10 m s^{-2} used] **Or** Use of equation to calculate initial velocity at point of release / 23.5 m s^{-1} seen [allow this mark even if the candidate confuses *v* and *u* and uses positive '*g*' value in their calculation] **(1)** Selects $s = (ut) + \frac{1}{2}at^2$ or 2 appropriate equations. **(1)** Uses minus *g* and correctly applies values to *v* and *u* throughout **(1)** Answer [Allow answers in the range (18 – 19) m] **(1)** Eg *V = u + at*	**(4)**

	• $0 = u - 9.81\ \text{m s}^{-2} \times 2.4\ s$ • $u = 23.5(4)\ \text{m s}^{-1}$ • $s = ut + \frac{1}{2}at^2$ • $= 23.54\ \text{m s}^{-1} \times 3.8\ \text{s} - \frac{1}{2}\, 9.81\ \text{m s}^{-2} \times 3.8^2\ \text{s}^2$ • $= 18.4(7)$ m	
• **(a)(ii)**	• <u>Assumption made</u> • • That ball falls with constant acceleration / that ball's acceleration is 9.8(1) m s^{-2} [or 10 m s^{-2}] / that (air) resistance (force) is negligible / time at zero velocity is negligible / the ball is caught close to the Earth('s surface) [Do not accept 'force of gravity acts downwards' or 'no force'. Accept 'no friction' or 'no resistance' • Where a mixture of wrong and right answers are given do not award mark eg 'no resultant force acts, no air resistance'] **(1)** •	• • • • **(1)**
• **(b)**	• <u>Why force is reduced</u> • QWOC **(1)** • **Either** • (To catch ball) velocity of ball has to be reduced (to zero) or change in velocity is the same or the relative velocity between the ball and hand is reduced **(1)** • (By moving his hand as described) time to do this is lengthened **or** acceleration is reduced[Phrases such as 'the change is slower' are fine for this mark] **(1)** • [Be generous in allowing these two marks above. If these points are made in addition to others which are inaccurate or contradictory, in general, award the marks eg many candidates are writing that the impulse is reduced, but in addition make other perfectly correct statements] • Therefore **force applied by the hand or the force applied to the ball** is reduced **(1)** • By Newton's third law / an equal but opposite (reduced) force is **applied by the ball or is applied to the hand** **(1)** • [It is essential that the link to N3 is made for this mark. An answer which only states 'the force applied by the ball to the hand is reduced' simply repeats what is already in the stem of the question] • **Or** • (To catch ball) momentum of the ball has to be reduced (to zero) or impulse is the same or momentum change is the same **(1)** • (By moving his hand as described) time to do this is lengthened[Phrases such as 'the change is slower' are fine for this mark] **(1)** • [For 'rate of change of momentum is reduced' give both these marks] • [See advice above] • Therefore **force applied by the hand or the force applied to the ball** is reduced **(1)**	• **(5)**

	By Newton's third law / an equal but opposite (reduced) force is **applied by the ball or is applied to the hand** **(1)** [See advice above] **Or** (To catch ball) kinetic energy has to be reduced (to zero) **(1)** (By moving his hand as described) means that the work required to do this takes place over a longer distance **(1)** [See advice above] Therefore **force applied by the hand or the force applied to the ball** is reduced **(1)** By Newton's third law / an equal but opposite (reduced) force is **applied by the ball or is applied to the hand** **(1)** [See advice above]	
	Total	**10**

Question Number	Answer	Mark
4(a)	<u>Show weight is ~ 0.3 N</u> Use of $\pi r^2 t$ to find volume or 3.5(3) (x 10^{-6} m^3) seen **(1)** [Award this mark even when the diameter value is use for the radius] Appropriate values substituted into density equation **(1)** Answer [0.31 N. No ue but must have 2 d.p. Accept values in range 0.305 N – 0.314N. Because this is a 'show that' question this mark must only be given if it is clear that the candidate has used g to get the weight. A bald answer gets no marks here] **(1)** Eg volume = $\frac{\pi \text{ x } (30 \text{ x } 10^{-3} \text{ m})^2}{4}$ x 5 x 10^{-3} m = 3.53 x 10^{-6} m^3 Mass = 3.53 x 10^{-6} m^3 x 8900 kg m^{-3} = 3.14 x 10^{-2} kg Weight = 3.14 x 10^{-2} kg x 9.81 N kg^{-1} = 0.308 N	**(3)**
(b) (i)	<u>State Newton's first law</u> A body[allow 'it'] will remain at rest or will move with uniform speed in a straight line / uniform velocity / zero acceleration **(1)**	

	• [Do not allow 'uniform motion'] • unless acted upon by a resultant / unbalanced force or if forces are balanced **(1)**	• **(2)**
• **(ii)**	• <u>Label magnitude of forces</u> • • *P* = *Q* = 0.3 N / their value [must have both marked] **(1)** • *X* = *Y* = 0.6 N / 2 x their value [must have both marked] **(1)** • [Item 4a is shown for answers where 'their value' needs to be checked]	• • • **(2)**
• **(iii)**	• <u>Describe Newton third law force</u> • • Magnitude = 0.3 N / their value [accept 'same size as Q'] **(1)** • Direction = Upwards[Allow arrow pointing upwards or states 'opposite direction to Q' Do not allow arrow pointing sideways] **(1)** • Type = Gravitational [not 'reaction force'] **(1)** • Object = Earth [Do not accept ground or Earth's surface] **(1)** •	• • • • • • **(4)**
•	• **Total**	• **11**

Question Number	Answer	Mark
5(a)	Principle of moments For equilibrium / balance **(1)** Sum of the moments clockwise = the sum of the moments anticlockwise or sum of the moments about a point is zero. **(1)** [Sum or equivalent eg total/net/resultant, **not all**, must be seen at least once]	**(2)**
(b) (i)	Upward force on rod L Moments equation with **correct** values **(1)** Answer [18 N.] **(1)** Eg F x 120 (x 10^{-3} m) = 27 N x 80 (x 10^{-3} m) F = 18 N	**(2)**
(ii)	Weight of lid Use of 120 (x 10^{-3} m) in determining the moment of the lid or for correct anticlockwise moment ie 18 N[their value] x 20 (x 10^{-3} m) **(1)** Answer [3.0 N. Ecf their value of force from b(i)] **(1)** [Do not penalise same ue more than once per question] Eg 18 N x 20 (x 10^{-3} m) = W x 120 (x 10^{-3} m) W = 3 N	**(2)**
(iii)	Resultant normal contact force Size [15 N. Ecf their values from bi and bii] **(1)** Direction [Downwards. Or arrow pointing down, but not sideways]**(1)** Eg downward force = upward force R + 3 N = 18 N 0r 3 N = 18 N + R R = 15 N or R = -15 N ie both results indicate downwards	**(2)**
	Total	**8**

Question Number	Answer	Mark
6(a)	<u>Principle of conservation of energy</u> Either Energy can neither be created or destroyed **(2)** Or Energy cannot be created / destroyed / is not lost / is not gained or **total** energy is constant **(1)** (merely) transformed / changed / transferred / converted from one form to another or in a closed / isolated system **(1)** [Simple statement 'energy is conserved' gets no marks. $\Delta Q = \Delta U + \Delta W$, with terms defined acceptable for first mark]	**(2)**
(b) (i)	<u>Loss in gravitational p.e</u> Use of $\Delta gpe = mg\Delta h$ [Allow their value for height e.g. 9 m and 9 cos30 m] **(1)** Correct height value used ie 4.5 m / 9 m sin 30 seen **(1)** [Candidates may measure the height of P(and scale their measurement) rather than use 9 m sin 30 - the angle 30^{o} is accurately drawn on the diagram] Answer [290 J] **(1)** Eg Δgpe = 6.5 kg x 9.81 m s^{-2} x 9 m sin30 = 286.9 J	**(3)**
(ii)	<u>Kinetic energy of box</u> Use of $ke = \frac{1}{2}mv^2$ **(1)** Answer [220 J] **(1)** [Do not penalise same ue more than once per question] [Eg E_K = 0.5 x 6.5 kg x 8.2 m s^{-1} x 8.2 m s^{-1} = 218.5 J	**(2)**
(iii)	<u>How principle of conservation of energy applies</u> Some of the gpe or difference in gpe lost and ke gained or calculated difference eg (290 J – 220 J =) 70 J is transferred[allow phrases such as 'lost as'] to thermal[allow 'heat'] / internal energy (and sound) **(1)** [For this mark they must refer to 'gpe', or 'gravitational (potential) energy' ie not just 'some energy is transferred'. Allow also 'potential energy'.] (Doing work) overcoming the resistive / frictional forces (so	**(2)**

	total energy remains the same) [Allow simple statements such as ‘due to friction’ or ‘caused by friction’ but not ‘lost to friction’ for this mark] **(1)** • [If candidates use the work done equation to calculate the average frictional force allow this for second mark eg 70 J = $F\Delta x$] •	
•	• **Total**	• **9**

Question Number	Answer	Mark
7 (a)	<u>Complete atomic equation</u> ${}^{131}_{54}$Xe **(1)** ${}^{0}_{-1}$e [accept ${}^{0}_{-1}\beta$, ${}^{0}_{-1}\beta^-$, ${}^{0}_{-1}$beta. Allow numbers on right-hand side of symbol. Do not allow B or b. Ignore additional emissions other than alpha.] **(1)**	**(2)**
(b)	<u>Meaning of decay constant</u> Fraction of nuclei that decay every second or the probability that a nucleus will decay in one second or $\lambda = \frac{A}{N}$ provided all symbols are defined ie λ = decay constant, A = activity, N = number of undecayed nuclei.[accept for N 'number of atoms' and therefore also accept 'activity per atom'. We are being generous] or $\frac{0.693}{\lambda} = T_{1/2}$ with symbols defined. **(1)**	**(1)**
(c)	<u>Show half life is ~ 8 days</u> Use of $\frac{0.693}{\lambda} = T_{1/2}$ **(1)** Answer [8.1 days. At least 1 d.p. required, no ue.] **(1)** [Reverse arguments can score full marks] Eg $T_{1/2} = \frac{0.69}{9.9 \times 10^{-7}\ \text{s}^{-1}}$ (= 7 x 10^5 s) $= 7 \times 10^5\ \text{s} \times \frac{1}{3600\ \text{s} \times 24\ \text{h}}$ = 8.07 days	**(2)**
(d) (i)	<u>Calculate the number of atoms</u> Use of $A = \lambda N$ **(1)** Answer [2.2 x 10^{12} (atoms)] **(1)** Eg $N = \frac{2.2 \times 10^6\ \text{Bq}}{9.9 \times 10^{-7}\ \text{s}^{-1}}$ = 2.2(2) x 10^{12} atoms	**(2)**
(ii)	<u>Hence calculate mass of iodine</u> Divides number of atoms obtained for d(i) by 6 x 10^{23} and multiplies by 131 (g) or calculates atoms per gram and divides this into number of atoms obtained in d(i) **(1)** Answer [4.8 x 10^{-10} g or 4.8 x 10^{-13} kg. Ecf their value from d(i)] **(1)**	**(2)**

(e)	<u>Why nuclear structure is unaffected</u> Gamma radiation is (pure) energy / electromagnetic radiation / is a wave / consists of photons **(1)** (As such) it has no (charge or rest) mass or contains no particles[Candidates often name some eg 'contains no protons and neutrons' – allow this] or nucleus has dropped to lower energy state [Do not allow 'virtually no mass'. Accept 'not a particle'] **(1)**	**(2)**
	Total	**11**