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Mark Scheme (Results)
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GCE

GCE Physics (6731/01)

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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] [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:

'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:

$80 \text{ cm} \times 50 \text{ cm} \times 1.8 \text{ cm} = 7200 \text{ cm}^3$

$7200 \text{ cm}^3 \times 0.70 \text{ g cm}^{-3} = 5040 \text{ g}$

$5040 \times 10^{-3} \text{ kg} \times 9.81 \text{ N/kg}$

$= 49.4 \text{ N}$

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

1. How A and B change

Force B

For ticking ‘no change’ in all 4 boxes ✓

Force A

4 ticks right	✓✓✓	✓
3 ticks right	✓✓	✓
2 ticks right	✓	✓

increases	no change	decreases
✓		
	✓	
		✓
	✓	

4

2 a Path of coin

Curved line that must begin to 'fall' towards the ground immediately ✓

1

bi Show that..

Selects $s = (ut +)\frac{1}{2}at^2$ or selects two relevant equations ✓

Substitution of physically correct values into equation or **both** equations. ✓

Answer [0.37 s - 0.38 s] ✓

[Allow use of $g = 10$ m s^{-2}. Must give answer to at least 2 sig. fig., bald answer scores 0. No ue.]

3

eg $0.7 \text{ m} = \frac{1}{2}(9.81 \text{ m s}^{-2})t^2$

$t = 0.38$ s

bii Horizontal distance [ecf their value of t]

Use of $v = \frac{d}{t}$ with correct value of time. [$s = \frac{v+u}{2}t$ is sometimes used. In this case v and u must be given as 1.5 m s^{-1} and t must be correct. Also $s = ut + 0.5at^2$ OK if 'a' is set = 0.] ✓

Answer [0.55 m – 0.60 m] ✓

2

eg $d = 1.5 \text{ (m s}^{-1}) \times 0.38 \text{ (s)}$

$= 0.57$ m

c A coin of greater mass?

QWOC ✓

It will follow the same path [accept 'similar path', do not accept 'same distance'] ✓

All objects have the same acceleration of free fall / gravity or acceleration of free fall / gravity is independent of mass / it will take the same time to fall (to the floor) ✓

Horizontal motion / velocity is unaffected by any force or (gravitational) force (acting on coin) has no horizontal component or horizontal motion/velocity is the same/constant. ✓

4

10

3.

a Meaning of 0.8 s

Reaction time (of cyclist and car driver) ✓

[Accept descriptions of reaction time eg 'time it takes both to take in that the lights have changed to green'. Accept response time] **1**

bi Same speed time

Answer [6.8 s - 6.9 s] [Accept any value in the range] ✓

1

bii How much further ahead?

Either

For measuring area under car graph at 6.8 s ✓

eg $\frac{6\text{ s} \times 9\text{ m s}^{-1}}{2} = 27\text{ m}$ [27.5 m if 6.9 s used]

For measuring area under cyclist graph at 6.8 s ✓

eg $\frac{2\text{ s} \times 9\text{ m s}^{-1}}{2} + 4\text{ s} \times 9\text{ m s}^{-1} = 45\text{ m}$ [45.9 m if 6.9 s used]

[For candidates who read the velocity 9 m s^{-1} as 8.5 m s^{-1} but otherwise do their calculation(s) correctly give 2/3]

[Allow one mark to candidates who attempt to measure an appropriate area]

Answer [(45 m – 27 m =) 18 m] ✓

Or

For recognising the area enclosed by cyclist and car graphs as the difference in distance travelled ✓

Using values from the graph to determine this area ✓

Answer [(45 m − 27 m =) 18 m] ✓

eg distance = $\frac{1}{2} \times (6.8 - 2.8)\text{ s} \times 9\text{ m s}^{-1}$

= 18 m **3**

c Relationship between average velocities

They are the same ✓

1

6

4 a Calculate the weight

Use of L x W x H ✓

Substitution into density equation with a volume and density ✓

Answer [466 N or 475 N] ✓

[466(.17) N or 475 N if 10 N kg^{-1} is used. At least 3 sig fig required, no ue. It must be clear that either 9.8(1) N kg^{-1} or 10 N kg^{-1} has been used. Bald answer scores 0] **3**

eg 0.6 m × 0.6 m × 0.04 m = 0.0144 m^3

0.0144 m^3 × 3300 kg m^{-3} = 47.52 kg

47.52 kg × 9.81 kg m^{-3} = 466 N

bi Position of centre of gravity

Position should be seen to have been found by drawing eg intersection of diagonals between opposite corners ✓ **1**

bii Force applied

Use of principle of moments ✓

Answer [230 N – 235 N] ✓ **2**

eg F × 0.6 m = 470 N × 0.3 m [Allow use of d and 2d or equivalent]

F = 235 N

c Why it becomes easier

(Because perpendicular) distance from weight (direction) to pivot reduces/(component of) weight perpendicular to the slab reduces ✓

The moment of the weight (about AB) reduces (as slab is raised) **or** clockwise moment reduces ✓

(Since perpendicular) distance from (applied) force (direction) to pivot remains constant ✓

(Hence applied) force (can be) reduced (to overcome smaller weight moment) or anticlockwise / (applied) force moment is reduced ✓

[Candidates should refer to **weight** or **force** to obtain each of these marks. References to mass and centre of gravity alone are insufficient.] **Max 3**

Or

Initially the height of the centre of gravity (of the slab) increases more or initially the gpe of the slab increases more ✓

For a given / the same distance/angle moved by the slab ✓

This means more work is done by the (applied) force (lifting the weight of the slab) ✓

(Hence applied) force reduces (as the slab is raised to the vertical) ✓ **Max 3**

9

5 a Momentum at impact

$p = mv$ seen or used ✓

Answer [11 kg m s^{-1}] ✓

2

eg momentum = 0.42 kg × 27 m s^{-1}

= 11.34 kg m s^{-1}

b Momentum at release

Minus ✓

8.4 kg m s^{-1} ✓

2

ci Average force(ecf momenta values)

Use of $F = \frac{\Delta p}{\Delta t}$ ie for using a momentum value divided by 0.22 ✓

Adding momentum values ✓

Answer [88.0 N - 89.8 N] ✓

$$F = \frac{-8.4\ \text{kg m s}^{-1} - 11.3\ \text{kg m s}^{-1}}{0.22\ \text{s}}$$

$F =$ (−) 89.5 N

Or

Use of $F = ma$ ✓

Adding velocities to calculate acceleration ✓

Answer [88.0 N – 89.8 N] ✓

Eg acceleration = $\frac{-20\,\text{m s}^{-1} - 27\,\text{m s}^{-1}}{0.22\,\text{s}}$ (= − 213.6 m s^{-2})

Force = 0.42 kg × −213.6 m s^{-2} = (−)89.7(2) N

3

cii Direction of force on diagram

Right to left ✓

[Accept arrow drawn anywhere on the diagram. Label not required] **1**

d Difference and similarity

Difference: opposite direction / acts on different object ✓

Similarity: same type of force / same size / acts along same line / act for same time / same **size** impulse ✓

['Magnitude' and 'size' on their own is sufficient. 'They are equal' is OK. Accept; they are both contact forces; they are both electrostatic forces]

2

10

6 a E_K of helium nucleus

Use of $E_K = \frac{1}{2}mv^2$ ✓

Answer [3.1×10^{-15} J. No ue. Min 2 sig fig required] ✓

2

eg $E_K = \frac{1}{2} \times 6.65 \times 10^{-27}$ kg $\times$ (9.65×10^5 m s^{-1})^2

$= 3.096 \times 10^{-15}$ J

bi Loss of E_K of proton [ecf their value for E_K of helium nucleus]

3×10^{-15} J or 3.1×10^{-15} J ✓

1

bii Speed of proton after collision

[ecf their value for loss of E_K of proton, **but not if they have given it as zero**]

Calculation of initial E_k of proton ✓

Subtraction of 3.1×10^{-15} J [= 1.7×10^{-15} J] ✓

Answer [$(1.40 – 1.50) \times 10^6$ m s^{-1}] ✓

eg $E_K = \frac{1}{2}$ 1.67×10^{-27} kg x $(2.4 \times 10^6$ m s$^{-1})^2$ $(= 4.8 \times 10^{-15}$ J)

E_K after collision = 4.8×10^{-15} J - 3.1×10^{-15} J ($=1.7 \times 10^{-15}$ J)

$$v = \left(\frac{1.7 \times 10^{-15}\ \text{J}}{0.5 \times 1.67 \times 10^{-27}\ \text{kg}}\right)^{0.5} = 1.43 \times 10^6\ \text{m s}^{-1}$$

Or

Use of the principle of conservation of momentum. ✓

Correct expression for the total momentum after the collision ✓

Answer [$(1.40 – 1.50) \times 10^6$ m s^{-1}] ✓

Eg 1.67×10^{-27} kg x 2.4×10^6 m s^{-1}

$= 6.65 \times 10^{-27}$ kg $\times$ $(9.65 \times 10^5$ m s$^{-1})$ + 1.67×10^{-27} kg $\times$ V

V = -1.44×10^6 m s^{-1}

[For both these solutions allow the second marking point to candidates who incorrectly write:
the mass of the proton as 1.6×10^{-27} kg or 1.7×10^{-27} kg,
or the mass of the helium as 6.6×10^{-27} kg or 6.7×10^{-27} kg
or the velocity as 9.6×10^5 m s^{-1} or 9.7×10^5 m s^{-1}]

3

c Other factor conserved

Momentum / mass / charge / total energy ✓

1

7

7 Deductions

ai The atom is mainly empty space
[The atom must be referred to. The words 'empty' and 'space' must be qualified eg 'there is a large amount of space in the atom' is not sufficient] ✓

aii Within the atom there is an area / the nucleus which is positive / charged or more massive than the alpha particle ✓
[If they choose to describe only the mass it must be a comparison ie 'the nucleus is (much) more massive than the alpha'. 'The atom has a dense centre,' 'the nucleus has a large mass' are both insufficient.]

2

b Explain
(Deflection could have been) repulsion from positive nucleus ✓
(Deflection could have been) attraction towards negative nucleus ✓
[The words repulsion and attraction can be described eg 'α deflected away from positive nucleus', 'α is deflected towards a negative nucleus'] [Diagrams showing the path of an alpha deflected by both a negatively and a positively charged nucleus would get both marks]

2

c Value of *n*
(4 – 6) ✓
[Allow minus values]

1

5

8a Meaning of 'random'

Impossible to predict which atom/nucleus (in a given sample) will decay (at any given moment)/ unable to predict when a given atom will decay ✓

[Mention of atom(s), or nucleus, or nuclei is essential because the word 'random' is to be described in context. Do not accept for atom or nucleus; substance; material; particle; molecule; sample.] **1**

b Nuclear equation

$^{241}_{95}Am \rightarrow {}^{237}_{93}Np + {}^{4}_{2}He$

$^{4}_{2}He$ or $^{4}_{2}\alpha$ ✓

$^{241}_{95}Am$ / $^{237}_{93}Np$ / both proton numbers correct / both mass numbers correct ✓

Entirely correct equation ✓

3

c Absorbtion experiment

Diagram [must include the source, detector and an indication of where the absorber is placed (maybe written in their account rather than on the diagram) – none of these need to be labelled] ✓

(Record) background count ✓

Source – detector distance must be close / less than or equal to 2 cm ✓

Insert eg paper between source and detector = no change in count rate or increase (by a small amount) the separation of the detector and source = no change in count rate (therefore no α present) ✓

Insert aluminium/brass (a few mm thick) or lead (≈ 2mm thick) / concrete ✓

Count reduced to background (therefore no gamma present)

[Do not give this mark if only paper or card or plastic is used as the absorber. Accept '0' in place of 'reduced to background' if candidate has deducted background from their measurements.] ✓

Max 5

9