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Mark Scheme (Results)

Summer 2012

GCE Physics (6PH01) Paper 01
Physics on the go

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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 mean that the final calculation mark will not be awarded.
   - 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, for example in a spreadsheet.
   - 2.4 The same missing or incorrect unit will not be penalised more than once within one question (one clip in epen).
   - 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 The use of g = 10 m s^{-2} or 10 N kg^{-1} instead of 9.81 m s^{-2} or 9.81 N kg^{-1} will be penalised by one mark (but not more than once per clip). Accept 9.8 m s^{-2} or 9.8 N kg^{-1}

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 $L \times W \times H$ ✓

Substitution into density equation with a volume and density ✓

Correct answer [49.4 (N)] to at least 3 sig fig. [No ue] ✓
[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:

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

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

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

$= 49.4 \text{ N}$

5. Quality of Written Communication
   - 5.1 Indicated by QWC in mark scheme. QWC – Work must be clear and organised in a logical manner using technical wording where appropriate.
   - 5.2 Usually it is part of a max mark, the final mark not being awarded unless the QWC condition has been satisfied.

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.

For a line mark there must be a thin continuous line which is the best-fit line for the candidate's results.

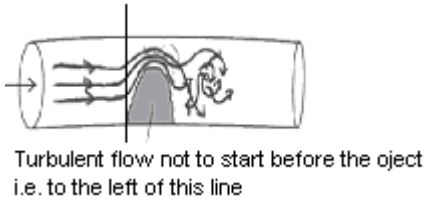
Question Number	Answer	Mark
1	B	**1**
2	B	**1**
3	C	**1**
4	D	**1**
5	B	**1**
6	C	**1**
7	D	**1**
8	A	**1**
9	C	**1**
10	C	**1**

Question Number	Answer	Mark
11*	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Plastic: doesn't return to original shape **OR** stays stretched **OR** permanently deformed **OR** stays bent **(1)** … when force/stress removed **(1)** This is <u>brittle</u> behaviour **(1)** Breaks/fails/cracks/snaps with little/no plastic deformation **OR** breaks under stress due to propagation of cracks **OR** breaks just beyond elastic limit / limit of proportionality **(1)**	**4**
	Total for question 11	**4**

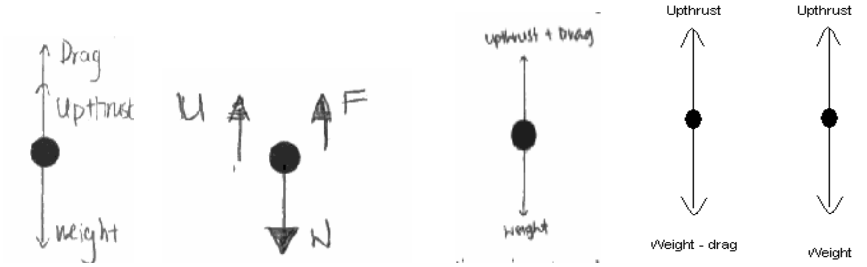
Question Number	Answer	Mark
12	Newton's 3rd law: The minimum: Every action has an equal and opposite reaction **OR** More detail: An object A exerts a force on object B then object B exerts an equal and opposite force on object A **(1)** • Forces act on different bodies **OR** forces act on the road and the tyre **(1)** • Forces act in <u>opposite directions</u> **OR** (directions of the) forces are backwards and forwards **(1)** • Forces have same magnitude/size **OR** both forces are 300 N **(1)** • Forces are of same kind **OR** forces are both are (frictional) contact forces/friction **(1)**	**5**
	Total for question 12	**5**

Question Number	Answer		Mark
13	See: W = mg **OR** newton unit of force **OR** newton unit of weight W = 0.98 N or W = 0.1 (kg) x 9.81 (N kg^{-1}) = 1 N See: W = Fs **OR** gpe = Wh **OR** gpe = mgh **OR** joule unit of energy Gpe = 0.98 J See: P = W/t or variation **OR** watt unit of power P = 0.98 W	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**6**
	Total for question 13		**6**

Question Number	Answer		Mark
14 (a)	Line not straight **OR** gradient not constant Force not proportional to extension **OR** to obey Hooke's Law, force should be proportional to extension	**(1)** **(1)**	**2**
14 (b)	Use of area under graph Work done = 2.5 J <u>Example of calculation</u> 0.5 x 15 x 0.33 = 2.48 J **OR** 1255 squares × 2 ×10^{-3} J = 2.51 J	**(1)** **(1)**	**2**
14 (c)	Elastic (tries to) return to a smaller/original length (So) will be in <u>tension</u> **OR** applies <u>force /pull</u>	**(1)** **(1)**	**2**
14 (d)	Work done stretching the elastic greater **OR** area under stretching>area under releasing **OR** the area between the two lines represents the energy (So) energy must be dissipated (in process) **OR** energy transferred as heat **OR** energy transferred to internal energy	**(1)** **(1)**	**2**
	Total for question 14		**8**

Question Number	Answer		Mark
15(a)(i)	**Laminar:** at least 2 roughly parallel lines before object **Turbulent:** lines crossing or showing change in direction of greater than 90^{o}. (**Max 1** mark if the laminar flow not shown leading into the turbulent flow.)  2 marks  1 mark only	**(1)** **(1)**	**2**
15(a)(ii)	**Laminar flow:** No abrupt change in velocity of flow **OR** no abrupt change in speed or direction of flow (must mention both speed **and** direction) **OR** velocity at a point is constant **OR** flows in layers/flowlines/streamlines **OR** layers do not mix/cross **OR** layers are parallel **Turbulent flow:** Mixing of layers/flowlines/streamlines **OR** crossing of layers etc. **OR** contains eddies **OR** contains vortices/whirlpools **OR** abrupt/random changes in speed or direction	**(1)** **(1)**	**2**
15(b)(i)	Greater velocity with lower viscosity	**(1)**	**1**
15(b)(ii)	Lower viscosity So faster flow **OR** greater velocity	**(1)** **(1)**	**2**
	Total for question 15		**7**

Question Number	Answer		Mark
16(a)(i)	Use of $v = s/t$ Velocity = 2.1 (m s^{-1}) (No ue) Example of calculation $v = \frac{1.83\ m}{0.88\ s}$ = 2.14 m s^{-1}	**(1)** **(1)**	**2**
16(a)(ii)	Use of appropriate equation(s) to calculate velocity Velocity = 4.3 (m s^{-1}) (No ue) (if $v = 0$ and $g = -9.81$ have not been used only award the first mark) Example of calculation $v = u + at$ $0 = u + (-9.81\ ms^{-2}) \times 0.44\ s$ $u = 9.81\ m\ s^{-2} \times 0.44\ s$ = 4.3 m s^{-1} **OR** $s = ut + \frac{1}{2}at^2$ $0 = (u \times 0.88\ s) + (\frac{1}{2} \times (-9.81\ ms^{-2}) \times (0.88\ s)^2)$ u = 4.3 m s^{-1}	**(1)** **(1)**	**2**
16(a)(iii)	Correct use of Pythagoras/trig function to find the velocity. Magnitude = 4.8 m s^{-1} Correct use of trig function Angle = 64º (ecf from parts (i) and (ii)) Example of calculation velocity^2 = (2.1 m s^{-1})^2 + (4.3 m s^{-1})^2 velocity = 4.8 m s^{-1} tan of angle = $\frac{4.3\ m\ s^{-1}}{2.1\ m\ s^{-1}}$ angle = 63.9º	**(1)** **(1)** **(1)** **(1)**	**4**
16(b)(i)	Air resistance has not been taken into account **OR** air resistance acts on the rocket **OR** friction of the rocket on the stand has not been taken into account **OR** energy dissipated/transferred due to air resistance (just 'air resistance' does not gain credit)	**(1)**	**1**
16(b)(ii)	**Max 2** Can watch again Can slow down /watch frame by frame/stop at maximum height Too fast for humans to see Does not involve reaction time Can zoom in (to see height reached)	**(1)** **(1)** **(1)** **(1)** **(1)**	**2**
	Total for question 16		**11**

Question Number	Answer	Mark
17(a)(i)	Upthrust/*U* Weight/*W*/*mg*/gravitational force/force due to gravity (Viscous) drag/fluid resistance/friction/*F*/*D*/*V* (3 correct = 2 marks, 2 correct = 1 mark. All arrows must touch the dot and straight, vertical lines required, no curving around dot, arrows can be of any length)  2 marks 0 marks 2 marks 2 marks 1 mark	2
17(a)(ii)*	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Initially viscous drag = 0 **OR** viscous drag is very small **OR** resultant force is downwards **OR** $W > U$ **OR** $W > U + D$ (1) Viscous drag increases (1) (Until) forces balanced **OR** resultant/net force zero **OR** forces in equilibrium (1) (Therefore) no <u>acceleration</u> (1) (To gain all 4 marks, any letters used to indicate forces must be defined in either parts (a)(i) or (a)(ii)).	4
17(a)(iii)	$W = U + D$ (allow ecf from diagram in part (a)(i)) (1)	1

Question Number	Answer		Mark
17(b)(i)	Use of mass = density × volume Upthrust = 2.1×10^{-5} (N) Example of calculation Mass = 1.0×10^{3} kg $m^{-3} \times 2.1 \times 10^{-9}$ m^{3} = 2.1×10^{-6} kg Upthrust = 2.1×10^{-6} kg × 9.81 N kg^{-1} = 2.1×10^{-5} N	**(1)** **(1)**	**2**
17(b)(ii)	State or use viscous drag = W – U ($F = 3.6 \times 10^{-5}$ N) Use of $F = 6\pi\eta rv$ Speed = 2.0 m s^{-1} (ecf from (b)(i)) Example of calculation $F = 5.7 \times 10^{-5}$ N – 2.1×10^{-5} N = 3.6×10^{-5} N $v = \frac{3.6 \times 10^{-5}\ \text{N}}{6\pi\eta r}$ $= \frac{3.6 \times 10^{-5}\ \text{N}}{6 \times \pi \times 1.2 \times 10^{-3}\ \text{Pa s} \times 8 \times 10^{-4}\ \text{m}}$ = 2.0 m s^{-1}	**(1)** **(1)** **(1)**	**3**
17(c)	larger particles have higher terminal/maximum/average velocity **OR** smaller particles reach terminal velocity quicker **MAX 2** Viscous drag varies in proportion to radius (or area in proportion to radius squared) but weight varies in proportion to radius cubed (terminal) velocity proportional to radius squared	**(1)** **(1)** **(1)** **(1)**	**3**
	Total for question 17		**15**

Question Number	Answer		Mark
18(a)	Use of $F = kx$ $k = 32$ (N m^{-1}) Example of calculation $k = \frac{3.9\text{ N}}{0.122\text{ m}} = 32.0$ N m^{-1}	**(1)** **(1)**	**2**
18(b)(i)	Use of $F = kx$ **OR** $F = ma$ $F = 4.1$ (N) (ecf) Example of calculation $F = 31.97$ N m^{-1} × 0.127 m $F = 4.06$ N OR $F = 0.4$ kg x (9.81 m s^{-2} +0.4 m s^{-2}) $F = 4.08$ N	**(1)** **(1)**	**2**
18(b)(ii)	**Max 2** Can be answered using a description: Resultant force = force of spring on mass - weight Substitution of resultant force into $F = ma$ **OR** Could be answered using a calculation e.g. $F = 4.06$ N – 3.9 N $a = \frac{0.16\text{ N}}{0.4\text{ m s}^{-2}}$ **OR** clear substitution of any force into this equation.	**(1)** **(1)** **(1)** **(1)**	**2**
18(b)(iii)	Use of $v = u + at$ $v = 0.8$ m s^{-1} (allow ecf) Example of calculation $v = 0 + (0.4 \text{ x } 2) = 0.8$ m s^{-1}	**(1)** **(1)**	**2**
18(b)(iv)	Graph correct shape i.e. 1 region of acceleration, 1 region of deceleration Constant velocity between	**(1)** **(1)**	**2**
18(b)(v)	Use of area under graph to find distance **OR** use of appropriate equations of motion Distance = 4.0 m (correct answer only) Example of calculation Area = (½ × 2 s × 0.8 m s^{-1}) + (3 s × 0.8 m s^{-1}) + (½ × 2 s × 0.8 m s^{-1}) Area = 4.0 m	 **(1)** **(1)**	**2**
18(b)(vi)	Spring extended beyond static extension **OR** extension increased at start (So) resultant force upwards	**(1)** **(1)**	**2**
	Total for question 18		**14**

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