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Mark Scheme (Results)
June 2010

GCE

GCE Physics (6PH01)

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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) <u>Horizontal force of hinge on table top</u>

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. '<u>resonance</u>'

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.

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.

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] ✓
[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. 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.

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	A	**(1)**
2	D	**(1)**
3	C	**(1)**
4	A	**(1)**
5	C	**(1)**
6	B	**(1)**
7	A	**(1)**
8	C	**(1)**
9	D	**(1)**
10	D	**(1)**

Question Number	Answer	Mark
11	Complete the diagram Before A = laminar flow – minimum of 2 continuous smooth lines roughly parallel to wing surface which don't cross After A = turbulent flow – lines crossing, eddies, sudden changes in direction, change in direction > 90°, lines disappearing and appearing	 **(1)** **(1)**
	Total for question 11	**2**

Question Number	Answer	Mark
12	Explain the difference between elastic deformation and plastic deformation QWC – spelling of technical terms must be correct and the answer must be organised in a logical sequence Elastic – returns to original shape when deforming force/stress removed /no permanent deformation Plastic – doesn't return to original shape when deforming force/stress removed / permanent deformation Suitable material or object named which undergoes elastic and plastic deformation, e.g. spring/wire/strawberry laces – do not accept rubber / elastic band but accept balloon Illustration comparing both types of deformation under different force / stress / strain / amount of deformation for material / object (independent of material mark)	 **(1)** **(1)** **(1)** **(1)**
	Total for question 12	**4**

Question Number	Answer	Mark
13(a) (i)	Show that the initial horizontal component of velocity for the drop is about 1 m s^{-1}. Shows a correct, relevant trigonometrical relationship Correct answer for horizontal component (1.2 (m s^{-1})) Example of calculation $v_h = v \cos\theta$ = 3.5 m s^{-1} x cos70° = 1.2 m s^{-1}	 **(1)** **(1)**
13(a)(ii)	Calculate the vertical distance to the insect if the shot is successful. Use of equation of motion suitable for time Calculates time (allow 1/3) Use of trigonometry or Pythagoras suitable to find vertical component of speed Use of equation of motion suitable to find distance Correct answer (0.55 m) If using $v^2 = u^2 + 2as$: Use of trigonometry or Pythagoras suitable to find vertical component of speed(1) Use of equation of motion suitable to find distance (1) Substitute $v = 0$ (1) Substitute g negative (1) Correct answer (1) Answers based on $mgh = 1/2\ mv^2$ coincidentally giving correct answer are not credited as $v^2 = u^2 + 2as$ unless conservation of energy fully described, i.e. ke at bottom using u = 3.5 m s^{-1} and ke at top due to only horizontal motion accounted for Example of calculation $t = s/v$ = 0.4 m / 1.2 m s^{-1} = 0.33 s $v_v = v \sin\theta$ = 3.5 m s^{-1} x sin 70° = 3.3 m s^{-1} $s = ut + 1/2\ at^2$ = 3.3 m s^{-1} x 0.33 s - 1/2 x 9.81 m s^{-2} x $(0.33\ s)^2$ = 0.55 m	 **(1)** **(1)** **(1)** **(1)** **(1)**
13(b)	Sketch the path of the water droplet Any section of an approximate parabolic path	 **(1)**
	Total for question 13	**8**

Question Number	Answer	Mark
14 (a)	Show that the upthrust is about 8 x 10^{-4} N Use of mass = density x volume Correct answer for upthrust (= 8.3 x 10^{-4} (N)) <u>Example of calculation</u> mass of liquid displaced = density x volume = 1300 kg m^{-3} x 6.5 x 10^{-8} m^3 = 8.45 x 10^{-5} kg upthrust = 8.45 x 10^{-5} kg x 9.81 m s^{-2} = 8.3 x 10^{-4} N	 **(1)** **(1)**
14 (b)	Show that the viscosity of the liquid is about 2 kg m^{-1} s^{-1} Correct summary of forces, e.g. V = W - U Use of $F = 6\pi\eta rv$ Correct answer for viscosity (1.8 (kg m^{-1} s^{-1})) <u>Example of calculation</u> Viscous drag = W – U = 4.8 x 10^{-3} N - 8.3 x 10^{-4} N = 3.97 x 10^{-3} N $F = 6\pi\eta rv$ η = 3.97 x 10^{-3} N / (6 x π x 4.6 x 10^{-2} m s^{-1} x 2.5 x 10^{-3} m) = 1.8 kg m^{-1} s^{-1} [Watch out for out of clip answers]	 **(1)** **(1)** **(1)**
14 (c)	State a relevant variable to control <u>Temperature</u>	 **(1)**
	Total for question 14	**6**

Question Number	Answer	Mark
15(a)	Explain the meaning of the terms: Ductile – can be made/drawn into wires / shows significant/large/lots of plastic deformation / large plastic region Brittle - shatters when subject to impact / sudden force fails/breaks/cracks with little or no plastic deformation / breaks just beyond elastic limit / breaks just beyond limit of proportionality / breaks under stress due to propagation of cracks	 **(1)** **(1)**
15(b)	Calculate the mass that would produce this load. Use of $W = mg$ Correct answer (3600 kg) <u>Example of calculation</u> $W = mg$ $m = 35\,000 \text{ N} / 9.81 \text{ N kg}^{-1}$ $= 3570 \text{ kg}$	 **(1)** **(1)**
	Total for question 15	**4**

Question Number	Answer	Mark
16(a)	Show that the acceleration is about 2 m s^{-2}. Use of equation of motion suitable to find acceleration Correct answer (1.5 (m s^{-2})) <u>Example of calculation</u> $s = ut + 1/2\ at^2$ a = 2 x 2 500 000 m / ((30 x 60)s)^2 = 1.54 m s^{-2}	 **(1)** **(1)**
16 (b)	Calculate the maximum speed. Use of equation of motion suitable to find maximum speed Correct answer (2700 m s^{-1}) <u>Example of calculation</u> $v = u + at$ = 0 + 1.5 m s^{-2} x (30 x 60)s = 1.5 m s^{-2} x (30 x 60)s = 2700 m s^{-1} (Use of 2 m s^{-2} → 3600 m s^{-1}, 1.54 m s^{-2} → 2772 m s^{-1}),	 **(1)** **(1)**
16 (c)	Calculate the force which must be applied to decelerate the train. Use of $F = ma$ Correct answer (680 000 N) <u>Example of calculation</u> $F = ma$ = 4.5 x 10^5 kg x 1.5 m s^{-2} = 675 000 N (Use of 2 m s^{-2} → 900 000 N, 1.54 m s^{-2} → 693 000 N)	 **(1)** **(1)**
	Total for question 16	**6**

Question Number	Answer	Mark
17(a)	Sketch a vector diagram Correct diagram – closed polygon, accept a triangle using the resultant of lift and weight, but arrows must follow correctly. Must show sequence of tip-to-tail arrowed vectors.	 **(1)**
17(b)	Find the tension in the string. Use of trigonometrical function for the horizontal angle (allow mark for vertical angle if correct and shown on dia) Correct answer for <u>horizontal</u> angle (32.8°) Use of Pythagoras or trigonometrical function for the tension Correct answer for tension magnitude (7.1 N) <u>Example of calculation</u> weight – lift = 3.86 N from horizontal, tan (angle) = 3.86 N/ 6.0 N angle = 32.8° $T^2 = F_h^2 + F_v^2$ $= (6.0\text{ N})^2 + (3.86\text{ N})^2$ $T = 7.1$ N	 **(1)** **(1)** **(1)** **(1)**
17(c) (i)	Calculate the work done by the girl. Use of $W = Fs$ Correct answer (150 J) <u>Example of calculation</u> $W = Fs = 6.0\text{ N} \times 25\text{ m}$ = 150 J	 **(1)** **(1)**
17(c) (ii)	Calculate rate at which work is done Finds time Correct rate (12 W) <u>Example of calculation</u> $t = s/v = 25\text{ m} / 2.0\text{ m s}^{-1} = 12.5\text{ s}$ $P = 150\text{ J} / 12.5\text{ s}$ = 12 W	 **(1)** **(1)**
	Total for question 17	**9**

Question Number	Answer	Mark
18 (a)	Explain this demonstration and the need for the precautions. QWC – spelling of technical terms must be correct and the answer must be organised in a logical sequence Max 4 from this part It will not strike the student's face / at most will just touch / returns to starting point The total energy of the pendulum is constant / energy is conserved It cannot move higher than its starting point … … because that would require extra gpe (consequent on previous mark) Mention specific energy transfer: gpe → ke / ke → gpe Energy dissipated against air resistance … … will stop it quite reaching its starting point (consequent on attempt at describing energy loss mechanism) Max 4 from this part Pushing does work on the ball / pushing provides extra energy If pushed, it can move higher (accept further) … will hit the student If the face moves (forward) the ball may reach it (before it is at its maximum height) OR if the face moves (back) the ball won't reach it	 **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **Max 6**
18 (b) (i)	Calculate the gravitational potential energy gained by the ball. Use of gpe = *mgh* Correct answer (100 J) <u>Example of calculation</u> gpe = *mgh* = 7 kg x 9.81 N kg^{-1} x 1.5 m = 103 J	 **(1)** **(1)**
18 (b) (ii)	Calculate the speed of the ball at the bottom of its swing Use of ke = 1/2 mv^2 Correct answer (5.4 m s^{-1}) <u>Example of calculation</u> 103 J = 1/2 mv^2 v = √(2 x 103 J / 7 kg) = 5.4 m s^{-1} (Use of 100 J → 5.3 m s^{-1})	 **(1)** **(1)**
	Total for question 18	**10**

Question Number	Answer	Mark
19 (a)	Explain whether the spring obeys Hooke's law. States: Straight line shown / constant gradient (So) extension or change in length proportional to force (accept Δx or Δl or e proportional to F) / k constant (Yes, because extension or change in length proportional to force gets 2)	 **(1)** **(1)**
19 (b)	Show that the stiffness of the spring is about 20 N m^{-1} Indication of use of (inverse) gradient, e.g. $k = F/\Delta x$ or with values obtainable from graph (accept extension/force for first mark) Substitution of values as force/extension Correct answer (16 (N m^{-1})) <u>Example of calculation</u> $k = F/\Delta x$ k = 1.6 N / (0.51 m – 0.41 m) k = 1.6 N / 0.1 m = 16 N m^{-1}	 **(1)** **(1)** **(1)**
19 (c) (i)	Calculate force on spring Use of $F = k\Delta x$ (must be extension, not length) Correct answer (5.1 N) [ecf] <u>Example of calculation</u> $F = k\Delta x$ = 16 N m^{-1} x (0.41 m – 0.09 m) = 5.1 N (Use of 20 N m^{-1} → 6.4 N)	 **(1)** **(1)**
19 (c) (ii)	Calculate energy stored Use of $E = ½ F\Delta x = = ½ k(\Delta x)^2$ Correct answer (0.82 J) <u>Example of calculation</u> $E = 1/2\ F\Delta x$ = 0.5 x 5.1 N x (0.41 m – 0.09 m) = 0.82 J	 **(1)** **(1)**

19 (d)	Explain effect on spring QWC – spelling of technical terms must be correct and the answer must be organised in a logical sequence Change in length greater / compression greater More force More elastic energy / more strain energy / more energy stored / more potential energy / greater ½ $k(\Delta x)^2$ / more work done (on spring) Greater acceleration (Therefore) more kinetic energy (and) greater speed	 **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **max 3**
	Total for question 19	**12**

Question Number	Answer	Mark
20 (a)	Use Newton's laws 1 and 3 to explain motion Uses N3 – force (backward) on air by balloon/car, (so/=) force (forward) on balloon/car by air Uses N1 – resultant force / forces unbalanced / force on balloon > drag, (so) there is an acceleration / moves from rest / <u>starts</u> moving Identifies the <u>use</u> of N1 or N3 (by name or description) correctly, linking it to the context	 **(1)** **(1)** **(1)**
20 (b) (i)	Show that maximum speed is between 100 and 150 cm s^{-1} Draw tangent on graph / state use gradient / show use of gradient Identify max speed between 1.2 and 1.4 s (from position of gradient or values used) Correct answer (120 (cm s^{-1})) <u>Example of calculation</u> v = 120 cm – 0 cm / 1.9 s – 0.9 s = 120 cm s^{-1} (allow answers which are in range 100 and 150 cm s^{-1} when rounded to 2 sf)	 **(1)** **(1)** **(1)**
20 (b) (ii)	Sketch graph Shows: Speed increasing from 0 and then decreases Max speed at correct time (accept between 1.0 and 1.5 s) OR correct magnitude (must be indicated) Speed decreasing to 0 at between 3.4 and 4.0 s	 **(1)** **(1)** **(1)**
	Total for question 20	**9**

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