Mark Scheme (Results)

Summer 2013

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.

Physics Specific Marking Guidance

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:
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.]
This has a clear statement of the principle for awarding the mark, supported by some examples illustrating acceptable boundaries.

Mark scheme format

- Bold lower case will be used for emphasis.
- Round brackets ( ) indicate words that are not essential e.g. "(hence) distance is increased".
- Square brackets [ ] indicate advice to examiners or examples e.g. [Do not accept gravity] [ecf].

Unit error penalties

- 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.
- Incorrect use of case e.g. 'Watt' or 'w' will not be penalised.
- 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.
- The same missing or incorrect unit will not be penalised more than once within one question but may be penalised again in another question.
- 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.
- The mark scheme will indicate if no unit error penalty is to be applied by means of [no ue].

Significant figures

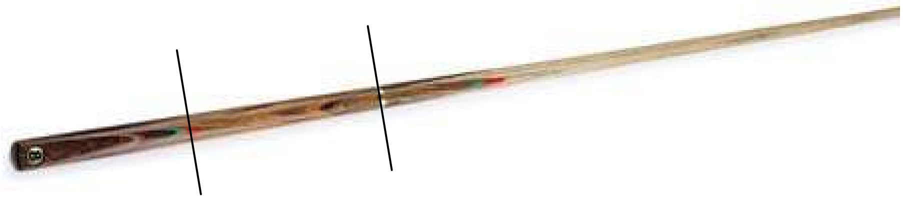
- Use of an inappropriate number of significant figures in the theory papers will normally only be penalised in 'show that' questions where use of too few significant figures has resulted in the candidate not demonstrating the validity of the given answer.
- Use of an inappropriate number of significant figures will normally be penalised in the practical examinations or coursework.
- Using $g = 10 \text{ m s}^{-2}$ **will** be penalised.

Calculations

- Bald (i.e. no working shown) correct answers score full marks unless in a 'show that' question.
- Rounding errors will not be penalised.
- 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.
- 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.
- recall of the correct formula will be awarded when the formula is seen or implied by substitution.
- The mark scheme will show a correctly worked answer for illustration only.

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

Question Number		Mark
11	$\text{Pa} = \text{N m}^{--2}$ (1) $\text{N} = \text{kg m s}^{-2}$ (1) ($\text{Pa} = \text{kg m s}^{-2}\,\text{m}^{-2}$ scores both marks) (The use of fractions rather than indices can still score both marking points)	**2**
	Total for question 11	**2**

Question Number		Mark
12 (a)	A point/position at which all the weight (of an object can be assumed to) act **Or** the point/position at which all the weight is centred upon **Or** the point/position that can be used to represent the whole weight (1)	**1**
12 (b)(i)	Correct position marked (1)  Looking at the words below the cue it must be between the 'm' of mark and the 'o'of the first 'of'. An arrow close to the cue in range is acceptable	**1**
12(b)(ii)	A simple method described to see if it will balance on a pivot (1)	**1**
	Total for question 12	**3**

Question Number			Mark
13 (a)	Calculation leading to $v = 18.1$ (m s^{-1}) (A reverse argument gives 64.8 (km h^{-1}) and scores the mark) Example of calculation $v = 65\,000$ m / 60 × 60 s = 18.06 m s^{-1}	(1)	**1**
13 (b)(i)	Use of distance = speed × time (see the calculation or use of 3 km) Use of emission = distance × reading from graph Use of difference between emissions at different speeds for 1 or 3 cars (This mark may still be awarded if the difference is between a 5 m s^{-1} for 10 minutes journey and an 18 m s^{-1} for 10 minutes journey) CO_2 emission = 0.72 kg (allow range 0.63 kg to 0.81 kg)	(1) (1) (1) (1)	**4**

Journey	CO_2 emission	Range	Marks
1 car 1 km	0.08 kg	0.07 to 0.09	**1** (MP3)
3 cars 1 km	0.24 kg	0.21 to 0.27	**1** (MP3)
1 car 3 km	0.24 kg	0.21 to 0.27	**3** (MP1,2,&3)
1 car travelling for 10 minutes at 5 m s^{-1} and 18 m s^{-1}	(-) 1.164 kg	1.02 to 1.31	**3** (MP1,2,&3)
3 cars travelling for 10 minutes at 5 m s^{-1} and 18 m s^{-1}	(-) 3.49 kg	3.06 to 3.93	**3** (MP1,2 &3)

<u>Example of calculation</u>

Distance = 5 m s^{-1} × 10 × 60 s = 3000 m = 3 km

3 × 3 km × (0.26 kg km^{-1} – 0.18 kg km^{-1}) = 0.72 kg

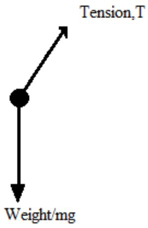
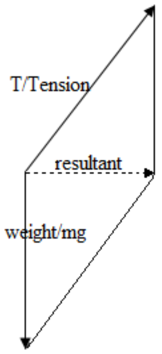
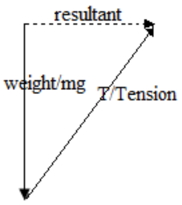
Question Number			Mark
13 (b)(ii)	Quantitative comparison of values 0.72 kg and 0.54 kg to indicate that the cyclist causes more CO_2 emissions **Or** qualitative statement e.g. more carbon dioxide emitted when he cycles candidates answer must be consistent with their value from part (i)	(1)	**1**
	Total for question 13		**6**

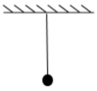
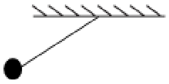
Question Number		Mark
14 (a)	Use of suitable equation(s) of motion to find distance (1) Height = 7.4 (m) (1) (accept 9.8(1)/6 or 1.635 for acceleration but do not accept g/6 as a substitution if final answer is wrong and looking to award MP1 only) (a reverse argument leading to $t = 2.9$ s can score both marks) Example of calculation $s = ½\, at^2$ $s = ½ \text{ x } (9.81 \text{ m s}^{-2} / 6) \text{ x } (3 \text{ s})^2$ $s = 7.4$ m	**2**
14 (b)(i)	Use of trig function appropriate to calculate vertical component of velocity **Or** 10.1 (m s^{-1}) seen (1) Use of suitable equation(s) of motion to find time (1) $t = 12.4$ (s) (1) (if v and u not consistent with sign of g max 2 marks. Calculation can be done for total time of 12.3 s with either total displacement =0 or u=-v) Example of calculation $u = 18 \text{ m s}^{-1} \text{ x } \sin 34^{\circ} = 10.1 \text{ m s}^{-1}$ $v = u + at$ $0 = 10.1 \text{ m s}^{-1} - (9.81 \text{ m s}^{-2} / 6) \text{ x } t$ $t = 6.2$ s to max height time of flight = 12.4 s	**3**
14 (b) (ii)	Use of trig function appropriate to calculate horizontal component of velocity **Or** 14.9 (m s^{-1}) seen **Or** Use of Pythagoras (1) Use of suitable equation(s) of motion to find distance (1) Distance = 185 (m) (ecf time value from part (i)) (1) Example of calculation $v = 18 \text{ m s}^{-1} \times \cos 34^{\circ} = 14.9 \text{ m s}^{-1}$ $s = vt = 14.9 \text{ m s}^{-1} \times 12.4 \text{ s}$ $s = 185.0$ m	**3**

***14 (c)**	*lower gravitational field strength*: lower acceleration (1) the idea of an increased time of flight (1) (do not accept slower in place of lower) *lack of atmosphere:* no work done against friction **Or** no slowing/deceleration due to friction (1) (accept air resistance or drag for friction)	**3**
	Total for question 14	**11**

Question Number		Mark
15(a)	(The line) AB (extended)does not pass through the origin /initially **Or** the graph is curved as it passes through the origin **Or** the graph (before A) is not a straight line through the origin. (1) The device does not obey Hooke’s law (conditional mark) (1)	**2**
15(b) (i)	Reference to finding area (1) **Detail** count squares **OR** approximate the shape of the graph to a triangle **Or** reference to using a trapezium(could be described as rectangles and triangles) (1)	**2**
15 (b) (ii)	Identifies that force is the problem. (1) Explains why force used is an overestimate e.g. maximum force has been used (each time) **Or** average force was not used (each time) **Or** the force is changing (continuously) **Or** should have used the trapezium rule **Or** area of rectangle has been used (1)	**2**
15(c)	Use of 25% of 540 kJ i.e. find the energy to be used (1) Use of $\frac{\text{total available energy (either 540 000 J or 135 000 J)}}{\text{energy per stretch or energy per unit time}}$ (1) Time = 612 min (1) Example of calculation 540 000 J x 25% = 135 000 J 135 000 J / 14.7 J = 9184 stretches 9184 / 15 stretches per minute = 612 minutes (36 720 s **Or** 10.2 h)	**3**
15(d)	smaller extension **Or** will not stretch as much (1) less work with reference to either same force applied **Or** to work done being force x extension (1) (Do not accept displacement or distance in place of extension for MP1or MP2)	**2**
	Total for question 15	**11**

Question Number		Mark
16(a) (i)	Use of equation of motion suitable for a, e.g. $v = u + at$ (1) $a = 16.3\ \text{m s}^{-2}$ (2.1 ×10^{5} km h^{-2} or 58.7 km h^{-1} s^{-1}) (1) Example of calculation $a = \frac{37.5\ \text{m s}^{-1} - 0}{2.3\ \text{s}}$ $a = 16.3\ \text{m s}^{-2}$	**2**
16(a) (ii)	Use of $E_k = ½\ mv^2$ (1) Use of $P = E/t$ (1) Power = $3.1×10^6$ W (1) **Or** Use of $F = ma$ (must be a from (i)) **and** Use of equation to find distance **and** use of work done = Fd (1) Use of $P = E/t$ (1) Power = $3.1 × 10^6$ W (1) (distance = 43 m) Examples of calculations $E_k = ½ × 10\ 000\ \text{kg} × (37.5\ \text{m s}^{-1})^2 = 7.03 ×10^6\ \text{J}$ Power = $7.03 × 10^6$ J / 2.3 s = $3.1 × 10^6$ W	**3**
16(a) (iii)	Energy transferred by heating **Or** energy transferred due to friction **Or** work done against friction **Or** idea that more energy required (due to energy transfer) due to friction. (1) (do not accept 'lost' but accept air resistance as an alternative to friction)	**1**
***16(b)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) larger force is needed **Or** the (same) force is insufficient (1) need same acceleration/ (max) velocity **OR** acceleration/(max) velocity is too small (1) more energy needed (to reach top) **Or** insufficient energy (to reach top) (1)	**3**
16 (c)	Viscosity of oil decreases (with increasing temperature) **Or** the (warm) oil is less viscous (1) (accept a reverse argument e.g. when cold oil is more viscous) Lower frictional/resistive force **Or** less viscous drag (1)	**2**
	Total for question 16	**11**

Question Number		Mark
17(a)(i)	Weight (1) (accept *W* or mg or gravitational pull/force) ('gravity' doesn't get the mark) Tension (1) (accept *T*) (Both arrows and labels required for each marking point)  (Arrows must touch mass for marks; ignore any arrows, for correct or incorrect forces, not touching (Minus one from maximum possible mark for each additional force (e.g. resultant, pull) or other arrow (e.g. speed or motion) touching mass)	**2**
17(a) (ii)	A triangle or parallelogram with W and T in correct position for vector addition with correct labels and directions. (1) Triangle or parallelogram completed correctly with resultant in correct directions. (1) (Can score 2 marks even if the resultant is not horizontal) e.g. (scores 2 marks)  	**2**

17(a) (iii)	$ma/mg = \tan\theta$ **OR** $T\cos\theta = mg$ **and** $T\sin\theta = ma$ (1) (seen or substituted into) $a = 1.2\ (\text{m s}^{-2})$ (1) Example of calculation $a = \tan 7^\circ \text{ x } g = \tan 7^\circ \text{ x } 9.81\ \text{m s}^{-2}$ $= 1.2\ \text{m s}^{-2}$	**2**
17(b)(i)	Straight down (by eye) (1) 	**1**
17(b) (ii)	To left, angle between string and roof to be less than 83º but not horizontal (1) 	**1**
17(b) (iii)	To right, at any angle except horizontal (1) 	**1**
17 (c)	Always has weight **Or** gravitational force **Or** force due to gravity (1) so tension needs a vertical component (1) **Or** Use of the equation $ma/mg = \tan\theta$ (1) Leading to the idea of infinite value of $\tan\theta$ requiring infinite acceleration (1)	**2**
17 (d)	Any correct physics answer that uses the concept of the independence of motion at right angles (1) e.g. (to detect movement) in the x,y,z directions/planes/axes **Or** up-down, left-right and forwards-backwards	**1**
	Total for question 17	**12**

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Question Number		Mark
18(a)	Graph does not have a zero gradient **Or** Graph does not shows constant velocity **Or** the velocity is constantly changing **Or** Graph always shows an acceleration (or deceleration) **Or** Graph not horizontal/ flat **Or** Graph not parallel to the time/x-axis **(1)** (Accept 'line/gradient/tangent' in place of 'graph')	**1**
18(b) (i)	Use of gradient of tangent **(1)** *a* = 6.5 to 7.4 (m s^{-2}) (conditional mark) **(1)** (Check graph to make sure that the values have been read accurately from the graph, misreading from the graph will only score 1 mark even if the answer falls in the above range) <u>Example of calculation</u> Acceleration = $\frac{8.0\text{ m} - 1.2\text{ m}}{1.0\text{ s}}$ Acceleration = 6.8 m s^{-2}	**2**
18(b)(ii)	Use of $F = ma$ **(1)** F = 0.016 to 0.018(N) (ecf acceleration from (b)(i)) **(1)** <u>Example of calculation</u> $F = 6.9\text{ m s}^{-2} \times 0.0024\text{ kg}$ = 0.017 N	**2**
18 (b) (iii)	Use of W = mg **(1)** Drag = 0.006 to 0.008(N) (ecf) **(1)** <u>Example of calculation</u> $W = 0.0024\text{ kg} \times 9.81\text{ N kg}^{-1} = 0.0235\text{ N}$ 0.017 = 0.0235 – drag Drag = 0.0065 N	**2**
18 (b) (iv)	Use of Stokes' law equation with velocity either 5.2 m s^{-1} or 6.6 m s^{-1} **(1)** $F = 3.5 \times 10^{-5}$ (N) or 4.5×10^{-5} (N) (no unit error) **(1)** <u>Example of calculation</u> $F = 6\pi\eta rv$ $= 6\pi \times 1.8 \times 10^{-5} \times 2 \times 10^{-2} \times 5.2\text{ m s}^{-1}$ $= 3.5 \times 10^{-5}$ N	**2**

18 (c)(i)	Correctly identifies a region of laminar flow and region of turbulent flow **(1)**	**1**
18 (c)(ii)	the idea that there is turbulent flow **Or** ball is moving fast **Or** this is a large sphere **Or** Statement about Stokes law force for laminar flow only **Or** Stoke's law assumes that the ball is moving slowly (which this is not) **Or** Stoke's law is for a small sphere (and the hollow ball is large) **(1)** **Or** A large amount of eddies increases the drag	**1**
18 (d)	**Max 3** Falls with constant acceleration **(1)** At about 0.8 s: the ball bounces **Or** the ball changes direction **(1)** Speed of ball after the bounce is less than the speed before the bounce **(1)** Max height reached at about 1.3 s. **(1)** Accelerations are the same before and after the bounce **(1)**	**3**
	Total for question 18	**14**

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