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Mark Scheme - Results

Summer 2013

GCE Physics 6PH01

Paper 01R: 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 schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:

  i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
  ii) select and use a form and style of writing appropriate to purpose and to complex subject matter
  iii) organise information clearly and coherently, using specialist vocabulary when appropriate

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:
- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.
( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.
Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:
- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.
Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Question Number	Acceptable Answers	Reject	Mark
1	**D**		**1**

Question Number	Acceptable Answers	Reject	Mark
2	**C**		**1**

Question Number	Acceptable Answers	Reject	Mark
3	**A**		**1**

Question Number	Acceptable Answers	Reject	Mark
4	**C**		**1**

Question Number	Acceptable Answers	Reject	Mark
5	**D**		**1**

Question Number	Acceptable Answers	Reject	Mark
6	**A**		**1**

Question Number	Acceptable Answers	Reject	Mark
7	**C**		**1**

Question Number	Acceptable Answers	Reject	Mark
8	**B**		**1**

Question Number	Acceptable Answers	Reject	Mark
9	**C**		**1**

Question Number	Acceptable Answers	Reject	Mark
10	**C**		**1**

Question Number	Acceptable Answers	Mark
11(a)	Use of density $= \frac{\text{mass}}{\text{volume}}$ **(1)** Use of weight = *mg* **(1)** Weight = 0.49 (N) **(1)** <u>Example of calculation</u> Mass of water = 1000 kg m^{-3} × 0.010 m ×(5.0 ×10^{-3} m^2)= 0.050 kg Weight of water = 0.050 kg x 9.81 N kg^{-1} Weight = 0.49 (N)	**3**

Question Number	Acceptable Answers	Mark
11(b)	Weight of cork = 0.49 or 0.5 N (allow ecf) **(1)** <u>upthrust</u> = weight of displaced water **Or** <u>upthrust</u> = 0.49 N **Or** weight (of cork) = <u>upthrust</u> **(1)**	**2**
	Total for question 11	**5**

Question Number	Acceptable Answers	Mark
12 (a)(i)	**Hard** resistant to indentation/scratching **Or** surface is resistant to plastic deformation **(1)**	**1**

Question Number	Acceptable Answers	Mark
12 (a)(ii)	**Stiff** high Young's Modulus **Or** large force / load / stress for (small) extension / strain / deformation **Or** (large) force / load / stress for small extension / strain / deformation **(1)** (not "resistant to", "hard to bend")	**1**

Question Number	Acceptable Answers	Mark
12 (a)(iii)	**High tensile strength** withstand/bear/undergo a large stress/force (under tension) before breaking/fracture. **(1)**	**1**

Question Number	Acceptable Answers Reject	Mark
***12(b)**	(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate) (Large stretching) force/stress/tension applied **Or** wire is being stretched/taut **(1)** High elastic limit:(can be implied from the stem) Will not plastically /permanently deform **Or** will return to original length (when force removed) **Or** Low elastic limit: (must be stated) Will plastically/permanently deform **Or** will not return to original length (when force removed) **(1)** Idea that the pitch/frequency/tone/tune/sound/note will alter. **(1)**	**3**
	Total for Question 12	**6**

Question Number	Acceptable Answers	Mark
13(a)(i)	Measures the final interval = 2.2 cm **O**r measures the total distance = 14.6cm **(1)** Velocity = 1.1 (ms^{-1}) **(1)** (independent marks, even if MP1 not awarded, 2nd mark can be awarded if value rounds to 1.1(ms^{-1})) <u>Example of calculation</u> $\text{Velocity} = \frac{0.022\,\text{m}}{0.02\,\text{s}}$ or $\text{Velocity} = \frac{0.146\,\text{m} \times 2}{0.02\,\text{s} \times 13}$ Velocity = 1.1 m s^{-1}	**2**

Question Number	Acceptable Answers	Mark
13(a)(ii)	Use of $a = \frac{v-u}{t}$ or suitable equation of motion to calculate *a* **(1)** a = 4.2 or 4.3 m s^{-2} (allow full ecf for values substituted from (i)) **(1)** (in (i) and (ii) only penalise once for use of 14 gaps) <u>Example of calculation</u> Using $a = \frac{v-u}{t}$ $a = \frac{1.1\,\text{m s}^{-1} - 0}{13 \times 0.02\,\text{s}}$ a = 4.2 m s^{-2}	**2**

Question Number	Acceptable Answers	Mark
13(b)	No friction/drag between tape/trolley and timer. **Or** The computer does the calculation **Or** Student doesn't calculate velocity **(1)** (NOT precision, accuracy, plots graph automatically, reaction time, parallax, human error)	**1**
	Total for question 13	**5**

Question Number	Acceptable Answers	Mark
14(a)(i)	Energy = power × time **Or** power = $\frac{\text{energy}}{\text{time}}$ **Or** see 4.2 × 0.4 **(1)** Energy = 1.7 (J) **(1)** Example of calculation Energy = 4.2 W × 0.4 s Energy = 1.68 (J)	**2**

Question Number	Acceptable Answers	Mark
14(a)(ii)	Use of $E_k = ½ mv^2$ **(1)** v = 5.9 / 6.0 ms^{-1} (ecf) **(1)** Example of calculation $v = \sqrt{\frac{2 \times 1.68\,\text{J}}{0.095\,\text{kg}}}$ v = 5.9 m s^{-1}	**2**

Question Number	Acceptable Answers	Mark
14(a)(iii)	Energy is dissipated to heat **Or** work is done against friction **Or** not all the energy becomes kinetic energy **Or** air resistance on car **Or** friction between car/wheels/pin and track **Or** resistance in motor **(1)**	**1**

Question Number	Acceptable Answers	Mark
14(b)	No resultant force is acting on the car **(1)** (do not credit use of external force) (Car) continues moving: in a straight line **Or** in same direction **Or** with same velocity. **(1)**	**2**
	Total for question 14	**7**

Question Number	Acceptable Answers	Mark
15(a)	As the temperature increases the viscosity decreases **(1)** at a decreasing rate **Or** the rate of decrease is greater at lower temperatures **Or** exponentially **(1)** (do not accept quicker/slower in place of greater/smaller) (a statement that quantities are inversely proportional can score MP1 only)	**2**

Question Number	Acceptable Answers	Mark
15(b)(i)	F = N **Or** F = kg m s^{-2} **Or** Pa m^2, r = m and v = ms^{-1} seen **(1)** Pa = N m^{-2} clearly shown **(1)** <u>Example of calculation</u> $\eta = \frac{\text{N}}{\text{m} \times \text{m s}^{-1}} = \text{N m}^{-2}\ \text{s} = \text{Pa s}$	**2**

Question Number	Acceptable Answers	Mark
15(b)(ii)	Reading from graph of viscosity: 1.09 to 1.13 ($\times 10^{-3}$)(Pa s) **(1)** Use of $F = mg$ **and** $F = 6\pi r\eta v$ **Or** use of $mg = 6\pi r\eta v$ **(1)** v =3.7 to 3.8 (m s^{-1}) (must be at least 2 sig figs) **(1)** <u>Example of calculation</u> $v = \frac{4.0 \times 10^{-6}\ \text{kg} \times 9.81\ \text{N kg}^{-1}}{6 \times \pi \times 5.0 \times 10^{-4}\ \text{m} \times 1.11 \times 10^{-3}\ \text{Pa s}}$ v = 3.75 (m s^{-1})	**3**

Question Number	Acceptable Answers	Mark
***15(c)**	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)** **Max 3** Viscosity of biodiesel is high **Or** viscosity of biodiesel higher than diesel **Or** viscosity of biodiesel needs reducing **(1)** Freezing point of biodiesel is high **Or** freezing point of biodiesel is higher than diesel **(1)** Adding ethanol/blending reduces η/freezing point **Or** adding ethanol/blending makes η/freezing point closer to that for diesel **(1)** Ethanol/ alcohol alone has too low an energy content **(1)**	**3**
	Total for question 15	**10**

Question Number	Acceptable Answers	Mark
16(a)	Use of an equation of motion involving $a = g$ *or* $-g$ **(1)** $v = u + at$ with v or $u = 0$ and double t **Or** Use of $s = ut + \frac{1}{2} at^2$ with $s = 0$ **Or** Use of $a = \frac{v-u}{t}$ with $v = -u$ **Or** Find max $s = 0.40$ m then use $s = \frac{1}{2}(v + u)\,t$ and double t **(1)** (do not award MP2 if 8 m s^{-1} used) Time = 0.57 or 0.58(s) **(1)** (Do not award 3rd mark if negatives have been ignored.) Example of calculation: using $a = \frac{v-u}{t}$ $t = \frac{0 - 2.8\,\text{m s}^{-1}}{-9.81\,\text{m s}^{-2}} = 0.285\,\text{s}$ to reach top of jump $t = 0.57$ (s)	**3**

Question Number	Acceptable Answers	Mark
16(b)	Use of distance = 8 m s^{-1} × time (either their time or 0.6 s) **(1)** Distance = 4.6 m (ecf (a)) **(1)** (If show that value of 0.6 s used then $d = 4.8$ m) Example of calculation Distance = 8.0 m s^{-1} × 0.57 s Distance = 4.6 m	**2**

Question Number	Acceptable Answers	Mark
16(c)	Attempt to calculate total / extra time using correct equations with correct vertical values **(1)** t = 0.14 s or 1/7 s extra time for additional drop assuming u = 2.8 m s^{-1} t =0.43 s or 3/7 s time from calculation of maximum height using u = 0 t = 0.71 s or 5/7s time for whole trajectory using s = − 0.5 m **(1)** Distance = 8.0 m s^{-1} × time **(1)** Extra horizontal distance travelled = 1.1m to 1.2m **(1)** <u>Example of calculation</u> $v^2 = (2.8\ \text{m s}^{-1})^2 + (2 \times 9.81\ \text{m s}^{-2} \times 0.50\ \text{m})$ $v = 4.2\ \text{m s}^{-1}$ $t = \frac{4.2\,\text{m s}^{-1} - 2.8\,\text{m s}^{-1}}{9.81\,\text{m s}^{-2}}$ t = 0.14 s Distance = 8.0 m s^{-1} × 0.14 s Distance = 1.1 m	**4**
	Total for question 16	**9**

Question Number	Acceptable Answers	Mark
17(a)(i)	Use of $E_{grav} = mgh$ **(1)** $E_{grav} = 48 \times 10^3$ J **(1)** Example of calculation Work done = 810 kg × 9.81 N kg $^{-1}$ × 6.0 m Work done = 47 700 (J)	**2**

Question Number	Acceptable Answers	Mark
17(a)(ii)	(useful) energy transferred = 0.4 × total energy transferred **(1)** Use of work done against resistive forces of the ground = $F\Delta s$ **(1)** Force = 9.5 / 9.6 × 10^4 N (ecf) (ignore any −) **(1)** (It is possible to calculate v from K.E., then a and use $F = m\,a$) Example of calculation Useful energy transferred from driver = $\frac{40}{100}$ × 47 700 J = 19 100 J Resistive force = $\frac{19100\,\text{J}}{0.20\,\text{m}}$ = 9.6 × 10^4 N	**3**

Question Number	Acceptable Answers	Mark
17(b)(i)	Use of Stress = $\frac{\text{force}}{\text{area}}$ **Or** Use of Strain = $\frac{\text{extension}}{\text{original length}}$ **(1)** Correctly use $E = \frac{\text{stress}}{\text{strain}}$ with E = 120 (× 10^6) , F = 7(× 10^5), x = 0.4 correctly substituted **(1)** (Use of $E = (F \times x) / (A \times \Delta x)$ scores MP1 for quoting formula and MP2 for 'use of') Δx = 0.008(3) (m) **(1)** Example of calculation $\sigma = \frac{7.0\times10^5\,\text{N}}{\pi\times(0.30\text{m})^2} = 2.48\times10^6\,\text{Pa}$ $\varepsilon = \frac{\Delta x}{0.40\ \text{m}}$ $\Delta x = \frac{2.48\times10^6\,\text{Pa}\times0.40\text{m}}{120\times10^6\,\text{Pa}}$ Δx (compression) = 0.0083 (m)	**3**

Question Number	Acceptable Answers	Mark
17(b)(ii)	Use of $E_{el} = ½F\Delta x$ **(1)** Energy stored = 2.8×10^3 J or 2.9×10^3 J (ecf) **(1)** Example of calculation $E_{el} = ½ \times 7.0 \times 10^5$ N $\times$ 0.0083 m $E_{el} = 2.9 \times 10^3$ J	**2**

Question Number	Acceptable Answers	Mark
***17(b)(iii)1.**	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)** [Only apply if both 1. and 2. get full marks] Graph: Permanent/plastic compression/deformation **Or** does not return to its original length/shape **(1)** Effect: Becomes too thin **Or** will not compress **Or** no longer elastic **Or** becomes brittle **(1)**	**2**

Question Number	Acceptable Answers	Mark
***17(b)(iii)2.**	More work done in loading than unloading the wood **Or** more energy is absorbed/stored than released **Or** the area between the lines shows energy is dissipated **Or** the area while applying the force > the area while releasing **Or** (the area in) the hysteresis loop shows energy is dissipated **(1)** (these should be marked if written in 1. above)	**1**
	Total for question 17	**13**

Question Number	Acceptable Answers	Mark
18(a)	**Laminar**: Continuous lines, not crossing, below the wing, with at least 2 continuing beyond the wing **(1)** **Turbulent:** swirls, crossing lines, changes of direction greater than 90° **only** above the wing, not necessarily attached to the lines from the left **(1)**	**2**

Question Number	Acceptable Answers	Mark
18(b)(i)	The idea that a (component of) lift = weight **(1)** See L cos 20° or mg / cos 20° **(1)** L = 0.66 or 0.7 (N) **(1)** <u>Example of calculation</u> Vertical component of lift = weight $L\cos 20^{o} = 0.063 \text{ kg} \times 9.81 \text{ N kg}^{-1}$ L = 0.66 (N)	**3**

Question Number	Acceptable Answers	Mark
18(b)(ii)	Find the horizontal component of lift (drag) using trig or Pythagoras **(1)** (L sin 20°, W tan 20°, $\sqrt{L^2 - W^2}$) Use of $F = ma$ **(1)** Acceleration = (−) 3.6 to 3.7 m s^{-2} (ecf) **(1)** <u>Example of calculation</u> $L_{\text{horizontal}} = -L\sin 20^{\circ} = -0.66 \text{ N} \times \sin 20^{\circ} = -0.226$ (N) $\text{acceleration} = \frac{-0.226 \text{ N}}{0.063 \text{ kg}}$ acceleration = −3.57 m s^{-2}	**3**

Question Number	Acceptable Answers		Mark
18(c)(i)	Bird/leg exerts force/push (down) on ground	**(1)**	**4**
	N3 ground exerts a force (up) on bird	**(1)**	
	Force ≠ / > weight **Or** there is a resultant/unbalanced force	**(1)**	
	Due to N2 / N1 bird accelerates	**(1)**	

Question Number	Acceptable Answers		Mark
18(c)(ii)	Maximum force read from graph = 2.00 N to 2.10 N	**(1)**	**3**
	resultant force = $F - W$ (1.37 N to 1.43 N)	**(1)**	
	Answer = 23 m s^{-2}	**(1)**	
	Example of calculation Maximum force = 2.05 N 2.05 N – (0.063 kg x 9.81 m s^{-2}) = 0.063 kg × a a = 22.7 m s^{-2}		
	Total for question 18		**15**

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