Mark Scheme (Results)

Summer 2016

Pearson Edexcel AS
in Physics (6PH01) Paper 01
Physics on the Go

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications are awarded by Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk. Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

Summer 2016
Publications Code 46646_MS*

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.

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.

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. '<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 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:

<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

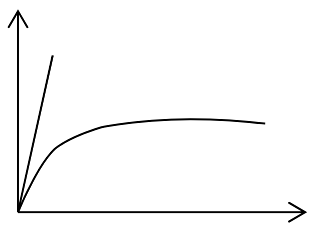
5. Quality of Written Communication
    5.1 Indicated by QoWC in mark scheme. QWC – Work must be clear and organised in a logical manner using technical wording where appropriate.
    5.2 Usually it is part of a max mark, the final mark not being awarded unless the QoWC condition has been satisfied.

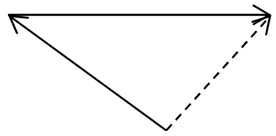
6. Graphs
    6.1 A mark given for axes requires both axes to be labelled with quantities and units, and drawn the correct way round.
    6.2 Sometimes a separate mark will be given for units or for each axis if the units are complex. This will be indicated on the mark scheme.
    6.3 A mark given for 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.
    6.5 For a line mark there must be a thin continuous line which is the best-fit line for the candidate's results.

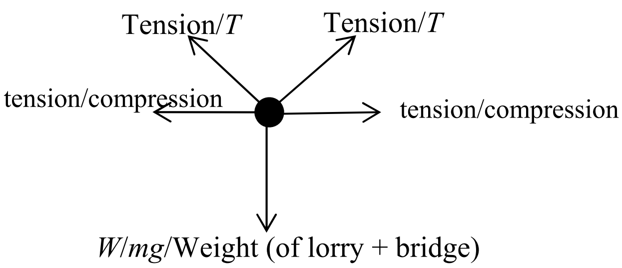
Question Number	Answer	Mark
1	B	**1**
2	C	**1**
3	D	**1**
4	D	**1**
5	A	**1**
6	B	**1**
7	C	**1**
8	D	**1**
9	B	**1**
10	A	**1**

Question Number	Answer	Mark
***11**	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)** (When submerged) there is an upthrust acting on the ball **Or** there is a force equal to the weight of water displaced **Or** the ball is less dense than water **(1)** upthrust > weight of the ball (+ drag) **(1)** Creates an upwards acceleration **Or** there is an upwards resultant force **(1)**	**3**
	Total for Question 11	**3**

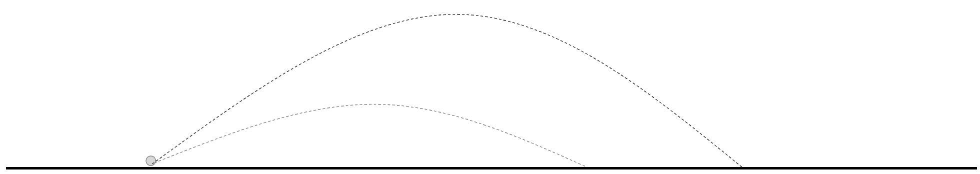
Question Number	Answer	Mark
12(a)	Correct conversion of lb to kg **(1)** Use of $W = mg$ with $g/6$ **(1)** $W_{moon} = 26$ N **(1)** <u>Example of calculation</u> 35 lb = 35 lb × 0.45 = 15.75 kg $g_{moon} = 9.81\text{N kg}^{-1}/6 = 1.635 \text{ N kg}^{-1}$ $W_{moon} = 15.75 \text{ kg} \times 1.635 \text{ N kg}^{-1}$ $W_{moon} = 25.8$ N	**3**
12(b)	Divide by six **(1)**	**1**
12(c)	Spring used on Earth has to be stiffer **Or** have a greater spring/stiffness constant **(1)** (Accept converse for the spring on the moon) To give the same extension for (the same mass) **(1)**	**2**
	Total for Question 12	**6**

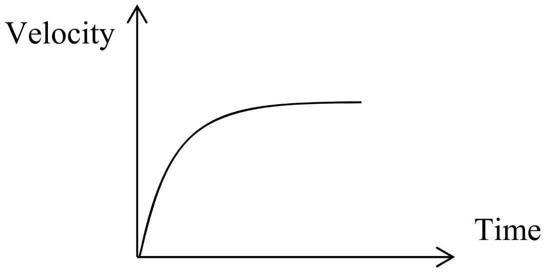
Question Number	Answer	Mark
***13(a)**	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)** **The following regions may be described or referred to using labels on the graph** **Initial straight line:** Obeys Hooke's law **Or** stress proportional to strain **Or** elastic behaviour **Or** it will return to original shape when (applied) force removed (1) **Non-linear region:** the wire deforms plastically **Or** the material will not return to its original shape when the (applied) force is removed (1) **Large (flat) region:** shows the material is ductile **Or** there will be a large extension/strain for little/no applied stress (1)	**3**
13(b)	Calculate the gradient (1) Of the initial linear region of the graph **Or** up to the limit of proportionality (1)	**2**
13(c)	Straight line from the origin (1) (allow a small amount of curving before fracture and there is no minimum length of the line) Line to be steeper than initial part of the other graph (1) <u>Example of graph</u> 	**2**
	Total for Question 13	**7**

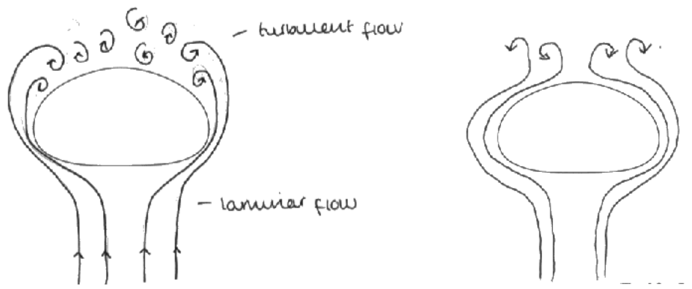
Question Number	Answer	Mark
14(a)	Construction of a vector triangle or parallelogram (labels not required but arrows must be included and in the correct direction) **(1)** Magnitude = 13 N to 14 N **(1)** Direction to 16 N force = 47 ° to 48° **(1)** <u>Example of diagram</u> 	**3**
14(b)(i)	(A quantity with both) magnitude/size **and** direction **(1)**	**1**
14(b)(ii)	**Any 2 from** Displacement Velocity Acceleration Momentum **(1)** (Do not award this mark if additional quantities that are not vector are also given or for any examples of forces e.g. upthrust or weight)	**1**
	Total for Question 14	**5**

Question Number	Answer	Mark
15(a)	Both upward tensions labelled **(1)** Weight labelled **(1)** (allow 2 separate arrows for the weight of the bridge and the lorry) Tension **and/or** compression labels for the horizontal force **(1)** (-1 for any additional forces and all lines must touch the dot) 	**3**
15(b)	(Diagonal) beams create a upward/vertical force **(1)** The idea that the beams support/distribute/share the weight **Or** to prevent the bridge from sagging **Or** to reduce the tension/compression in the horizontal section of the bridge **(1)**	**2**
	Total for Question 15	**5**

Question Number	Answer	Mark
16(a)	<u>Resistance</u> (of a fluid) to flow **(1)**	**1**
16(b)(i)	<u>Rate of flow</u> is inversely proportional to the viscosity **Or** <u>rate of flow</u> decreases with increasing viscosity (and vice versa) **(1)** The time to empty the cup is proportional to the viscosity **Or** the time to empty the cup is inversely proportional to the flow rate **Or** the time to empty the cup decreases as viscosity decreases **Or** the time to empty the cup decreases as the flow rate increases **(1)** (Accept converse explanation in terms of time increasing for MP2)	**2**
16(b)(ii)	The temperature was greater on the first day **Or** the temperature was lower (on the second day) **Or** the paint/room was colder (on the second day) **Or** the time is greater when the temperature is lower **Or** the time is lower when the temperature is greater **(1)**	**1**
16(c)	Error 1 **(1)** Correct outcome from error 1 **(1)** Error 2 **(1)** Correct outcome from error 2 **(1)** (Do not credit descriptions of changing temperature) <u>Examples of answer</u> Reaction time Measured time greater than actual time Initial paint level in cup could be higher/lower than the level Time would be greater /less Hole/opening becomes blocked Time to drain would be greater Paint left in cup after pouring **Or** paint spilt Reduces time to drain	**4**
	Total for Question 16	**8**

Question Number	Answer	Mark
17(a)(i)	Use of trig to find the vertical **Or** horizontal component of the initial velocity **(1)** Use of suitable equations of motion to calculate total time of flight of the ball **(1)** Use of $v = s/t$ **(1)** Total horizontal distance travelled = 98 m to 101 m **(1)** <u>Example of calculation</u> u_v = 35 m s^{-1}sin26° = 15.3 m s^{-1} $t_{½} = \frac{0 - 15.3\text{ m s}^{-1}}{-9.81\text{ m s}^{-2}}$ = 1.56 s t_{total}= 3.12 s s = 35 m s^{-1}cos26° × 3.12 s = 98.1 m	4
17(a)(ii)	Trajectory with a greater max height **and** a greater range **(1)** <u>Example of diagram</u> 	1
17(b)	**Air resistance:** Decreases the time (of flight) **Or** increases the deceleration of the golf ball as it rises **Or** decreases the horizontal velocity **Or** unbalanced force acting horizontally **(1)** Decreases (horizontal) distance travelled **(1)** **Upwards force:** Increases the time of flight **Or** decreases the deceleration of the golf ball as it rises **(1)** Increases (horizontal) distance travelled **(1)**	4
	Total for Question 17	**9**

Question Number	Answer	Mark
18(a)(i)	Initially: constant acceleration **(1)** Decreasing acceleration followed by constant velocity **(1)** <u>Example of graph</u> 	**2**
18(a)(ii)	Drag increases with speed (this may be implied following a description of acceleration) **(1)** When drag = weight (− upthrust) **(1)** No resultant force **Or** there is no (further) acceleration **Or** the forces are in equilibrium **(1)**	**3**
18(a)(iii)	Density of air is negligible compared to density of water **Or** mass/weight of air displaced is negligible/tiny compared to the mass/weight of the raindrop **Or** the upthrust is negligible/tiny compared to the mass/weight of the raindrop **(1)**	**1**
18(b)(i)	Use of $v = s/t$ **(1)** $v = 7.1\ \mathrm{m\ s^{-1}}$ **(1)** <u>Example of calculation</u> $v = \frac{1100\ \mathrm{m}}{2.6\ \mathrm{min} \times 60}$ $v = 7.05\ \mathrm{m\ s^{-1}}$	**2**
18(b)(ii)	See or use of $\rho V g = 6\pi r \eta v$ **(1)** See $V = \frac{4}{3}\pi r^3$ **and** values substituted into above equation **(1)** $r = 2.4 \times 10^{-4}$ m (ecf from part (b)(i) for terminal velocity) **(1)** <u>Example of calculation</u> Weight of raindrop $= \frac{4}{3} \times \pi \times r^3 \times 1.0 \times 10^3\ \mathrm{kg\ m^{-3}} \times 9.81\ \mathrm{N\ kg^{-1}}$ Drag force $= 6 \times \pi \times r \times 1.8 \times 10^{-5}\ \mathrm{Pa\ s} \times v$ $\frac{4}{3}\pi \times r^3 \times 1.0 \times 10^3\ \mathrm{kg\ m^{-3}} \times 9.81\ \mathrm{N\ kg^{-1}} = 6 \times \pi \times r \times 1.8 \times 10^{-5}\ \mathrm{Pa\ s} \times 7.1\ \mathrm{m\ s^{-1}}$ $r^2 = \frac{9 \times 1.8 \times 10^{-5}\ \mathrm{Pa\ s} \times 7.1\ \mathrm{m\ s^{-1}}}{2 \times 1.0 \times 10^3\ \mathrm{kg\ m^{-3}} \times 9.81\ \mathrm{N\ kg^{-1}}} = 1.04 \times 10^{-7}$ $r = 2.42 \times 10^{-4}$ m	**3**

18(c)	Laminar air flow around main body of rain drop **(1)** (minimum of 2 lines either side) Some turbulence at the top of the rain drop **(1)** (must not start below the top 1/3rd of the rain drop) (1 mark max for correct drawing of laminar and turbulent flow around the rain drop but upside down. Labels and arrows not required) <u>Example of diagram</u> 	**2**
	Total for Question 18	**13**

Question Number	Answer	Mark
19(a)	Use of spring constant = gradient **Or** use of $F = k\Delta x$ using a pair of values from the graph **(1)** Spring constant = (3.5 to 3.6) × 10^4 N m^{-1} **(1)** <u>Example of calculation</u> Gradient = $\frac{3.6 \times 10^3 \text{ N}}{10.2 \times 10^{-2} \text{ m}}$ Spring constant = 3 5300 N m^{-1}	**2**
19(b)(i)	Use of $E = ½ F\triangle x$ **Or** use of work done = area under graph **(1)** Using the correct region of the graph (trapezium under graph from 3 to 9 cm) **(1)** Work done by the child on the spring = 126 -128 (J) **(1)** <u>Example of calculation</u> Work done in compressing spring = (½ × (3.2× 10^3 N) × (9 × 10^{-2} m)) - (½ × (1.05 × 10^3 N) × (3 × 10^{-2} m)) Work done by the child on the spring = 128 J	**3**
19(b)(ii)	Elastic potential energy to kinetic energy **(1)** and gravitational potential energy **(1)** (accept EPE, E_{el}, GPE, E_{grav}, KE, E_k) (only penalise once the omission of potential from gravitational or elastic potential energy)	**2**
19(b)(iii)	Use of $E_{grav} = mgh$ **(1)** Use of work done by child on spring = $E_{grav} + E_k$ **(1)** Use of $E_k = ½ mv^2$ **(1)** v = 2.5 m s^{-1} (ecf from part (b)(i)) **(1)** <u>Example of calculation</u> E_{grav} = 35 kg × 9.81 N kg^{-1} × 0.06 m = 20.60 J E_k = 128 J – 20.60 J = 106.4 J $v = \sqrt{\frac{2 \times 106.4 \text{ J}}{35 \text{ kg}}}$ v = 2.48 m s^{-1}	**4**
***19(c)**	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)** (The pogo-stick pushes down on the ground and) by N3 the ground exerts an upwards force on the pogo-stick **(1)** Upwards force on pogo-stick > weight of pogo-stick **Or** there is an unbalanced upwards force on the pogo-stick **(1)** Due to N1/ N2 the pogo-stick accelerates (upwards) **(1)**	**3**
	Total for Question 19	**14**

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London WC2R 0RL