Pearson

Mark Scheme (Results)

January 2018

Pearson Edexcel
International Adavanced Subsidiary Level
in Physics (WPH01)
Paper 01 Physics on the Go

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January 2018
Publications Code WPH01_01_1801_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.

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. '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 × 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.

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

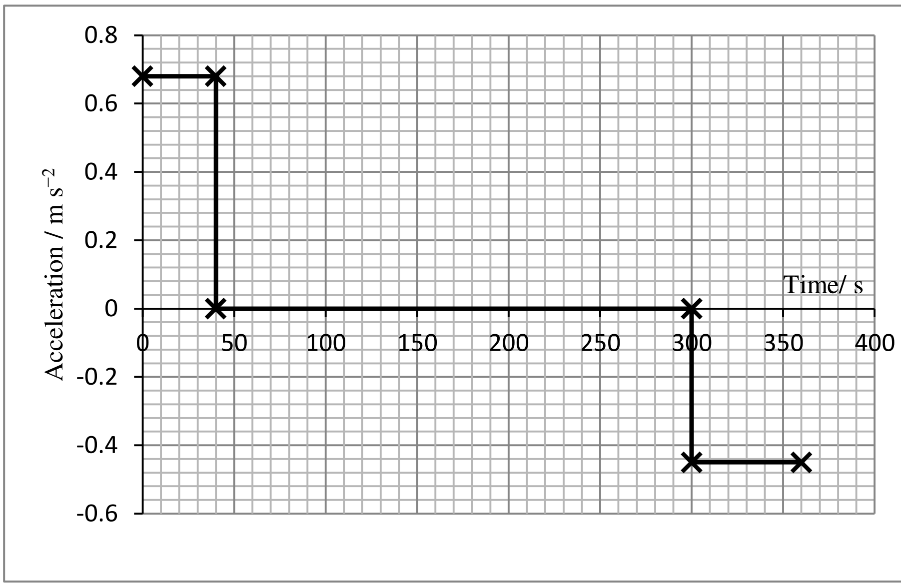
Question Number	Answer	Mark
1	**1. The only correct answer is D** ***A kg m s***$^{-2}$ *is not correct because it is equivalent to the newton* ***B kg m***^{2} ***s***$^{-2}$ *is not correct because it is equivalent to the joule* ***C kg m s***$^{-3}$ *is not correct because it is equivalent to newtons per second*	**(1)**
2	**2. The only correct answer is C** ***A*** *is not correct as ductile behaviour is only exhibited under a tensile force and not a compressive force* ***B*** *is not correct as hardness is a measure of a material's resistance to being scratched* ***D*** *is not correct because a stiff material would not exhibit as much compression under a compressive force*	**(1)**
3	**3. The only incorrect answer is D** ***A*** *is a correct statement as temperature is a scalar quantity* ***B*** *is a correct statement as time is a scalar quantity* ***C*** *is a correct statement as velocity is a vector quantity*	**(1)**
4	**4. The only correct answer is C** ***A*** *is not correct as* $u\cos\theta$*, the horizontal and not the vertical component of the initial velocity was used in the equation* $a = \frac{v-u}{t}$ ***B*** *is not correct as* $u\cos\theta$*, the horizontal and not the vertical component of the initial velocity was used in the equation* $a = \frac{v-u}{t}$ *and the negative sign implies that u and a are in the same, and not opposite directions.* ***D*** *is not correct as the negative sign implies that u and a are in the same, and not opposite directions.*	**(1)**
5	**5. The only correct answer is A** ***B*** *is not correct as this is describing turbulent and not laminar flow* ***C*** *is no correct as the velocity is lower at the edges of a pipe due to frictional forces* ***D*** *is not correct as the velocity differs between adjacent layers.*	**(1)**

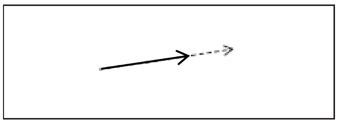
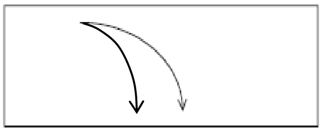
6	**6. The only correct answer is C** ***A*** *is not correct as the diameter, and not the radius, was substituted into the equation for the cross-sectional area of the cylinder.* ***B*** *is not correct as the '2' was not squared when the diameter /2 was substituted for the radius into the equation for the cross-sectional area of the cylinder.* ***D*** *is not correct as an incorrect equation for the cross-sectional area of the cylinder was used.*	**(1)**
7	**7. The only correct answer is B** ***A*** *Is not correct as the box is accelerating to the right so F cannot be in the same direction as the acceleration* ***C*** *Is not correct as the box is accelerating to the right so F cannot be in the same direction as the acceleration and the weight, mg is not a horizontal force.* ***D*** *is not correct as the equation for the resultant horizontal force should not include the weight, mg, a vertical force.*	**(1)**
8	**8. The only correct answer is B** ***A*** *is not correct because a larger diameter wire would produce a smaller stress, a smaller strain and hence a smaller extension.* ***C*** *is not correct because a larger diameter wire would produce a smaller stress, a smaller strain and hence a smaller extension. For the same strain, a shorter wire would also produce a smaller extension.* ***D*** *is not correct because, for the same strain, a shorter wire would produce a smaller extension.*	**(1)**
9	**9. The only correct answer is C** ***A*** *is incorrect because the percentage uncertainty should only be quoted to the same number of sf as the absolute uncertainty i.e. 1 sf* ***B*** *is incorrect because this is 2 times the correct percentage uncertainty and it has been quoted to 2 sf* ***D*** *is incorrect because this is 2 times the correct percentage uncertainty*	**(1)**
10	**10. The only correct answer is B** ***A*** *is incorrect as* E_{grav} *is a maximum on release and not 0.* ***C*** *is incorrect as* E_{grav} *is a maximum on release and the shape of the graph is incorrect.* ***D*** *is incorrect as this is the graph for* E_{grav} *against vertical distance and not displacement.*	**(1)**
	Total marks for multiple choice questions	**10**

Question Number	Answer	Mark
11(a)	The difficulty/resistance (of a material) to scratching/indentation/denting **Or** the resistance of a surface to plastic deformation **Or** the ability to withstand scratching/indentation/denting (1) Do not accept a description of 'hard' e.g. difficult to scratch or resistant to scratching etc.	**1**
11(b)(i)	(The hardness of the pencil is) greater/equal to (the hardness of) the paint/surface **Or** the pencil is harder than the paint/surface (1)	**1**
11(b)(ii)	**Max 2** The pencils used by different manufacturers may not be the same (1) The pencil ('lead') may be at a different sharpness/area (at the tip) (1) (Cart may be pushed with) different force/velocity/speed (1) There are only certain hardness pencils available **Or** this will not give you (an exact) value for the hardness (1) Thickness of paint varies **Or** paint not smooth/even (1) The pencil may be at a different angle (1)	**2**
	Total for question 11	**4**

Question Number	Answer	Mark
12(a)	W_{slope} = W sin 3.0° **Or** $h = s$ sin 3.0° **Or** v = 2.5 sin 3.0° (1) Use of $W = mg$ (allow use of $E_{grav} = mg\Delta h$) (1) Use of power = work done/time taken (Allow use of power = E_{grav}/time) (1) Power = 103 W (1) <u>Example of calculation</u> W = 80.0 kg × g × sin 3.0° = 41.1 N In 1 second, the distance travelled is 2.5 m ΔW = 41.1 N × 2.5 m = 102.8 J Power = $\frac{102.3\ \text{J}}{1\ \text{s}}$ = 102.8 W	**4**
12(b)	An athlete running on a treadmill will have no/less air resistance **Or** there is no wind acting on the runner **Or** the surface of the treadmill is softer/springier/elastic **Or** there is less impact force on the runner (1)	**1**
	Total for question 12	**5**

Question Number	Answer		Mark
13(a)	(Rate of flow =) $\frac{\text{volume (of oil)}}{\text{time}}$ (described or as a formula) Unit conversion e.g. volume ×10^{-6} or see volume = 1.5 ×10^{-4} (m^3)	(1) (1)	**2**
13(b)(i)	**Either** Plot a graph of mass against time Calculate/determine the gradient (conditional on MP1) (Rate of flow =) gradient ÷ density **Or** Use $\rho = m/V$ to obtain the volume **Or** see $V = m/\rho$ Plot graph of volume against time Calculate/determine the gradient (and the gradient = rate of flow) (conditional on MP2) (Accept graphs plotted other way round with correct explanation of how to obtain the rate of flow)	(1) (1) (1) (1) (1) (1)	**3**
13(b)(ii)	**Advantage**: Greater accuracy/precision/reliability **Or** the graphical method would show if/how the rate varies **Or** anomalies could be identified (and removed) **Disadvantage**: Taking readings every 2 s **Or** it is difficult to read the clock and balance simultaneously **Or** comparison of reaction time to 2 s	(1) (1)	**2**
13(c)	The greater the temperature of the oil the lower its viscosity (accept the viscosity is inversely proportional to the temperature) The greater the temperature, the greater the rate of flow Accept converse	(1) (1)	**2**
	Total for question 13		**9**

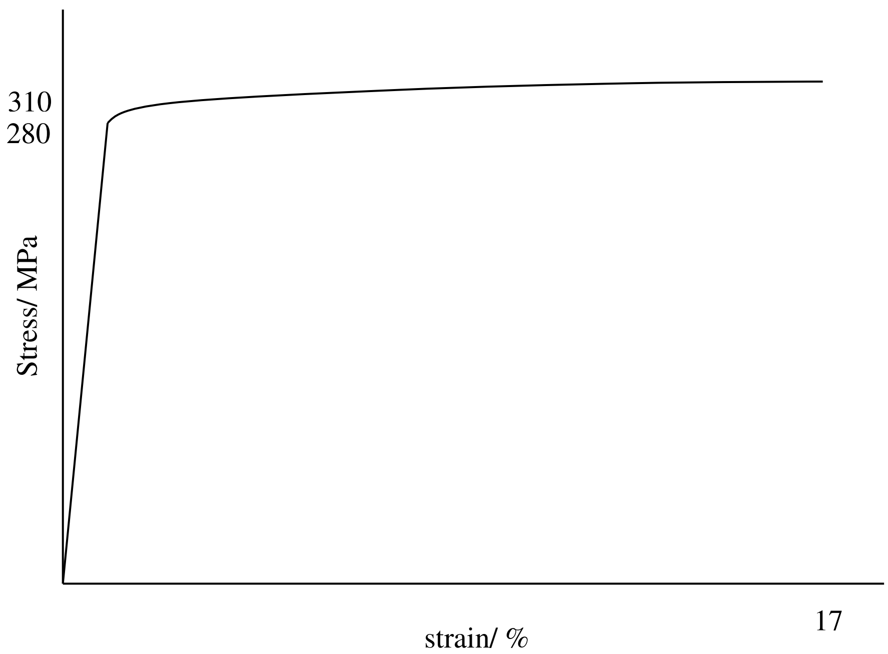
Question Number	Answer		Mark
14(a)	Acceleration axis scaled, using at least half of grid (Minimum of two values both above and below 0, scale must be linear, no false origin, negative on negative acceleration axis, no scales in 3,7 etc.)	(1)	
	Constant acceleration drawn onto graph between 0s and 40 s	(1)	
	0 acceleration between 40 s and 300 s and vertical solid/dashed lines at 40 s and 300 s	(1)	
	Final negative constant acceleration drawn onto graph between 300 s and 360 s	(1)	
	Use of $a = \frac{v - u}{t}$	(1)	
	Acceleration plotted at 40 s = 0.68 (m s^{-2}) **and** acceleration plotted at 360 s = −0.45 (m s^{-2})	(1)	**6**
	Example of calculation $a = \frac{27\ \text{m s}^{-1} - 0\ \text{m s}^{-1}}{40\ \text{s}} = 0.675\ \text{m s}^{-2}$ $a = \frac{0\ \text{m s}^{-1} - 27\ \text{m s}^{-1}}{60\ \text{s}} = -0.45\ \text{m s}^{-2}$ 		

14(b)(i)	**Either** It's a straight line (1) As no horizontal forces are acting (1) **Or** The path shown is caused by the resultant/sum/addition/combination of two velocities/displacements (1) The velocity/displacement in the direction of the train and the velocity/displacement in the direction of the throw (1)	**2**
14(b)(ii)	The vertical velocity is increasing **Or** there is a vertical acceleration/force (1) The horizontal velocity is constant **Or** there is no horizontal acceleration/force (1)	**2**
14(b)(iii)	Figure 2: straight line in the same direction but shorter than the original line (1) Figure 3: shallower curve under the drawn curve (1) [be generous as to the exact shape of the curve]  Figure 2  Figure 3	**2**
	Total for question 14	**12**

Question Number	Answer	Mark
15(a)(i)	Use of $v^2 = u^2 + 2as$ with $u = 0$ **Or** use of $t = s$/average velocity and $v = u + at$ with $u = 0$ (1) The final velocity in m s^{-1} **Or** distance in km (1) $a = 2.8 \times 10^5$ m s^{-2} **Or** 280 km s^{-2} (1) <u>Example of calculation</u> $(11 \times 10^3 \text{ m s}^{-1})^2 = 0^2 + (2 \times a \times 220 \text{ m})$ $a = 275\,000$ m s^{-2}	**3**
15(a)(ii)	Use of $E_k = ½ mv^2$ with $m = 1500$ kg (1) Correct use of 50% e.g. $(2 \times E_k)$ or $(0.5 \times 3 \times 10^6)$ (1) Use of mass of fuel = kinetic energy/energy per kg of fuel (1) Mass of fuel required = 6.1×10^4 kg (1) <u>Example of calculation</u> $E_k = ½ \times 1500 \text{ kg} \times (11 \times 10^3 \text{ m s}^{-1})^2 = 9.075 \times 10^{10}$ J Energy to be supplied by fuel = $2 \times 9.075 \times 10^{10}$ J = 1.815×10^{11} J Mass of fuel required = 1.815×10^{11} J/3×10^6J kg^{-1}= 6.05×10^4 kg	**4**
***15(b)**	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)** <u>Gas</u> is ejected forwards (1) By N3, there is a backward/opposite force/push (on the capsule). (1) There is a (backwards) resultant force (on the capsule) (1) By N1/N2, there is an acceleration (1) Force/acceleration is in opposite direction to motion, so a deceleration **Or** force/acceleration is in opposite direction to motion, so negative acceleration (1) (accept upwards and downwards for forwards and backwards)	**5**
	Total for question 13	**12**

Question Number	Answer		Mark
16(a)	Use of $F = k\Delta x$ $\Delta x = 0.049$ (m) <u>Example of calculation</u> $0.88\ \text{N} = 18\ \text{N m}^{-1} \times \Delta x$ $\Delta x = 0.0489$ m	(1) (1)	**2**
16(b)(i)	Upthrust increases **Or** upthrust is no longer negligible **Or** there is upthrust in water Weight = tension + upthrust The tension (in the spring) decreases so the extension/Δx decreases (allow converse explanation for lower in air and all symbols other than Δx must be defined)	(1) (1) (1)	**3**
16(b)(ii)	**Either** Use of $W = mg$ **and** $\rho = m/V$ **Or** see Upthrust = ρVg **Or** see $U = 0.334$ N Tension = $0.88 - U$ Use of $y = 0.050 - \Delta x$ (allow use of (0.05 – y) for Δx in Hooke's law equation) $y = 0.020$ m (0.018 m to 0.020 m) <u>Example of calculation</u> $U = 1.0 \times 10^{3}\ \text{kg m}^{-3} \times 3.4 \times 10^{-5}\ \text{m}^{3} \times 9.81\ \text{N kg}^{-1}$ $U = 0.334$ N $18\ \text{N m}^{-1} \times \Delta x = 0.88\ \text{N} - 0.334\ \text{N}$ $\Delta x = 0.0303$ m $y = 0.050\ \text{m} - 0.0303\ \text{m} = 0.0197$ m	(1) (1) (1) (1)	**4**
***16(c)**	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)** The density of oil is less (than the density of water) The upthrust is lower (do not award if a greater density in oil described) The tension/force in the spring is greater	(1) (1) (1)	**3**
	Total for question 16		**12**

Question Number	Answer		Mark
17(a)(i)	Resolve horizontally **Or** see (horizontal component =) $F\sin\theta$	(1)	
	$F_1\sin\theta = F_2\sin\theta$ **Or** accept a clear and complete explanation	(1)	**2**
17(a)(ii)	See (vertical component =) $F_1\cos 10$ **Or** see (vertical component =) $F_2\cos 10$ **Or** see (vertical component =) $F\cos 10$	(1) (1)	
	Use of $\Sigma F = 0$ (for the vertical) **Or** $2F\cos10 = 325$	(1)	**3**
	$F_1 = 170$ N		
	<u>Example of calculation</u> $F_1\cos10 + F_2\cos10 - (650\text{ N} \div 2) = 0$ As $F_1 = F_2$ $2F\cos10 = 325$ N $F_1 = 165$ N		
17(b)	**Max 3**		
	Frictional force = $F_{body} \times \sin\theta$ **Or** frictional force = $R\tan\theta$	(1)	
	θ increases and tan/sin θ increases	(1)	
	F_{body} increases **Or** the horizontal component of the force (of the body on the crutch) increases	(1)	
	frictional force increases	(1)	
	friction is greater than the maximum frictional force, the crutch will slide/move **Or** the horizontal component of the force (of the body on the crutch) is greater than the (maximum) frictional force and the crutch will slip/move	(1)	**3**

17(c)(i)	The extension divided by the original length **Or** the percentage increase in the original length **Or** the ratio of the extension to the original length (1) will be 17 % on breaking (1) (MP2 conditional on MP1)	**2**
17(c)(ii)	Use of $E = \sigma/\varepsilon$ (1) ε = 0.43 (%) **Or** 4.3×10^{-3} (1) <u>Example of calculation</u> $65 \times 10^{9}\ \text{Pa} = \frac{280 \times 10^{6}\ \text{Pa}}{\varepsilon}$ $\varepsilon = 4.3\times 10^{-3} = 0.431\ \%$	**2**
17(c)(iii)	Yield point at approximate end of linear region with 280 (MPa) labelled on stress axes (1) Strain at fracture at 17 % (marked on strain axis) (1) UTS at 310 (MPa) (marked on stress axis) (1) Sudden change in strain beyond their yield point and then curved graph until fracture. (It does not have to curve down towards fracture) (1) 	**4**
	Total for question 17	**16**

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