Pearson Edexcel

Mark Scheme (Results)

October 2018

Pearson Edexcel International Advanced Subsidiary Level
In Physics (WPH01)
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.

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.

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 $g = 10\ m\ s^{-2}$ **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	**The only correct answer is C** A is not correct because the unit of gravitational field strength is N kg^{-1} B is not correct because the unit of gravitational potential energy is J or Kg m^2 s^{-2} D is not correct because the unit for work done is J or Kg m^2 s^{-2}	**1**
2	**The only correct answer is B** A is not correct because displacement, Δs is vector and not scalar C is not correct because work done, ΔW is scalar and not vector and displacement, Δs is vector and not scalar D is not correct because work done, ΔW is scalar and not vector	**1**
3	**The only correct answer is C** A is not correct because 4 cm is the additional extension when a load of 2.5 N is added B is not correct because 8 cm is the additional extension when a load of 5.0 N is added D is not correct because 16 cm is the total extension when a load of 10.0 N is added and not the additional extension x.	**1**
4	**The only correct answer is A** B is not correct because Vernier calipers do not produce sufficient resolution when measuring the diameter of a wire C is not correct although a micrometer has been used as Vernier calipers do not produce sufficient resolution when measuring the diameter of a wire and a metre rule has not been included to measure the length D is not correct because Vernier calipers do not produce sufficient resolution when measuring the diameter of a wire and a metre rule has not been included to measure the length	**1**
5	**The only correct answer is A** B is not correct because R is not perpendicular to F and T C is not correct because T is too short so $T \neq (F + \text{component of } W)$ D is not correct because R is not perpendicular to F and T and T is too short	**1**

6	**The only correct answer is C** At terminal velocity, frictional force $F = 6\pi r\eta v$ so $F \propto r$. A volume 8 times greater will have a radius $\sqrt[3]{8}$ = 2 times greater. Therefore, F is 2 times greater (2F) A is not correct because 512 is 8 cubed and not the cube root of 8 B is not correct because the volume has increased by a factor of 8 and it is the increase in radius and not volume that is directly proportional to the frictional force. D is not correct because a sphere of volume 8V will not have the same frictional force as a sphere of volume V.	1
7	**The only correct answer is B** A is not correct because the viscosity η increases as the liquid cools C is not correct because the terminal velocity decreases not increases D is not correct because the terminal velocity decreases not increases and the viscosity η increases as the liquid cools	1
8	**The only correct answer is B** $s = 0 + \frac{1}{2} at^2$ so $s = \frac{1}{2} \times 9.81 \times 1.6^2 = 12.56$ s A is not correct because $s = 0 + \frac{1}{2} at$ was used to determine s C is not correct because $s = 0 + at$ was used to determine s D is not correct because $s = 0 + at^2$ was used to determine s	1
9	**The only correct answer is D** A is not correct because the ball starts from rest and this graph starts with a non-zero velocity B is not correct because the ball starts from rest and this graph starts with a non-zero velocity C is not correct although it starts with a zero value for velocity, the ball rebounded with a greater velocity than the velocity with which it hit the ground	1
10	**The only correct answer is B** A is not correct because the liquid with a lower viscosity will flow at a greater speed C is not correct because the liquid with a lower viscosity will flow at a greater speed D is not correct because a faster fluid will transfer a greater volume of liquid per second and not a smaller volume	1

Question Number	Answer	Mark
11(a)(i)	The (gravitational) force per unit mass (exerted on an object) **Or** the (gravitational) force per kg (exerted on an object) **(1)** (allow weight for gravitational force)	**1**
11(a)(ii)	A point at/through which (all) the weight of an object can be assumed to act **Or** the point at which (all) the weight is centred upon **Or** the point that can be used to represent the (whole) weight **(1)** (Allow gravitational force for weight)	**1**
11(b)	In free-fall, resultant force = mg (assuming there is no air resistance) **(1)** $mg = ma$ with cancellation of mass leading to $a = g$ **(1)** **Or** Resultant force on 1 kg = 1 kg × 9.81 N kg^{-1} = 9.81 N **(1)** 9.81 N = 1 kg × a so a = 9.81 m s^{-2} **(1)**	**2**
	Total for question 11	**4**

Question Number	Answer	Mark
12	**Max 4 from any 2 correct pairs** Reason: Reaction time for stop watch **Or** no reaction time for electronic timing system **(1)** Explanation: Reaction time is large compared to the time to be measured **(1)** Reason: resolution (of the timer) is smaller **(1)** Explanation: smaller percentage/% uncertainty (in t). **(1)** Reason: timer started after ball released **Or** ball released with a force **(1)** Explanation: Initial velocity not zero **Or** measured time would be lower **(1)** MP3, allow precision for resolution. MP2 and MP4 must be comparative.	**4**
	Total for question 12	**4**

Question Number	Answer	Mark
13(a)	Distance $P = D - h$ **(1)** Distance $Q = D$ **(1)**	**2**
***13(b)**	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)** **Max 5** A statement or description of tension = weight – upthrust (+ drag) **(1)** (Initially) tension constant as upthrust is constant **Or** (Initially) the graph is flat as upthrust is constant in water **(1)** The speed is slow/constant in water so friction is constant/negligible **(1)** As the cylinder moves through the surface of the water the volume/weight/mass of displaced water decreases **(1)** The tension increases because the upthrust decreases **Or** the tension increases as the upthrust is proportional to submerged volume **(1)** (Once above the water the) tension greater/constant as tension = weight **Or** (Once above the water the) tension greater/constant as upthrust is negligible/small **(1)** Accept symbols for tension, weight and upthrust but symbols must be defined if QWC awarded	**5**
	Total for question 13	**7**

Question Number	Answer		Mark
14(a)	The hot gases exert an upwards force on the spacecraft	**(1)**	
	There is now a resultant (upwards) force (on the spacecraft) **Or** this force is now greater than the weight	**(1)**	**2**
14(b)	**Either** Use of $W = mg$	**(1)**	
	Resultant force = $R - W$	**(1)**	
	Use of $\Sigma F = ma$ with m = 81 kg	**(1)**	
	a = 36 m s^{-2}	**(1)**	
	Or Use of $\Sigma F = ma$ to obtain apparent acceleration of crew member	**(1)**	
	Acceleration of spacecraft = Apparent acceleration – acceleration due to gravity of crew member	**(1)**	
	Use of above expression	**(1)**	
	a = 36 m s^{-2}	**(1)**	**4**
	<u>Example of calculation</u> Weight of crew member = 81 kg × 9.81 N kg^{-1} = 794.6 N Resultant force = 3700 N – 794.6 N = 2905.4 N 2905.4 N= 81 kg × a a = 35.9 m s^{-2}		
14(c)	This reduces the <u>mass/weight</u> of the spacecraft	**(1)**	
	Acceleration will increase **Or** less energy/fuel/thrust/force is needed	**(1)**	**2**
14(d)	The parachute has a large/increased cross-sectional area	**(1)**	
	Air resistance or drag force (greatly) increases	**(1)**	
	Resultant force now upwards **Or** resultant force is opposite to direction of motion	**(1)**	**3**
	Total for question 14		**11**

<table>
<tr><th>Question Number</th><th>Answer</th><th></th><th>Mark</th></tr>
<tr><td>15(a)(i)</td><td>(As horizontal dances are equal then) horizontal velocity of A = horizontal velocity of B

Resolve horizontally e.g. see horizontal velocity of A = $u_A \cos\theta$ and horizontal velocity of B = $u_B \cos 45$

$u_A \cos\theta = u_B \cos 45$

(MP3 dependent on MP1 or MP2)

<u>Example of calculation</u>
Horizontal velocity of A = $u_A \cos\theta$
Horizontal velocity of B = $u_B \cos 45$
$u_A \cos\theta = u_B \cos 45$
$u_A \cos\theta = 0.707 u_B$
$u_A = \frac{0.707 u_B}{\cos\theta}$</td><td>(1)

(1)

(1)</td><td>3</td></tr>
<tr><td>15(a)(ii)</td><td>Either
(component of velocity method)
θ must be greater than 45° (for the paths shown)
Or A is launched at a greater angle than B (to the horizontal)

Comparison of initial horizontal components to lead to $u_A > u_B$
e.g.
$\cos\theta < 0.707$ Or $\cos\theta < \cos 45$ Or $\frac{0.707}{\cos\theta} > 1$ leading to i.e. $u_A > u_B$

Or

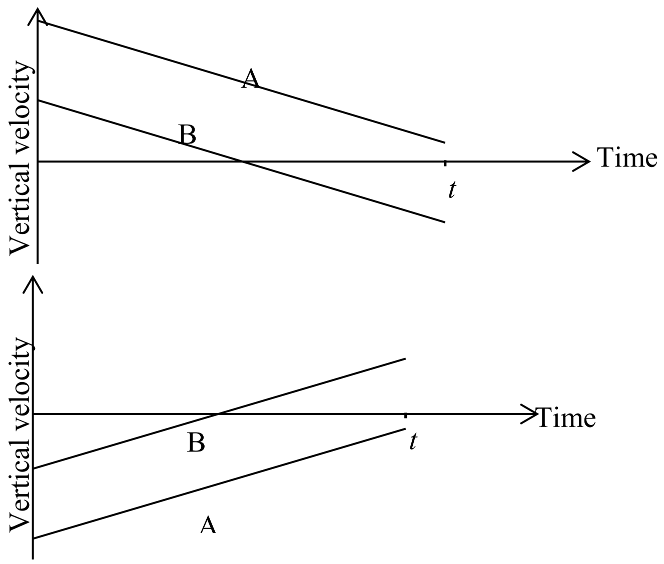
(range method)
The maximum range of a projectile is at 45°

To have a greater range at a greater launch angle, then the initial velocity must be greater</td><td>(1)

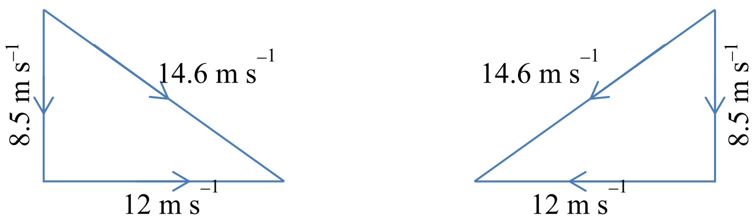
(1)

(1)

(1)</td><td>2</td></tr>
</table>

15(b)	Line for A: downward straight diagonal line, ending above 0 (at time *t*) (1) Line for B: downward straight diagonal line crossing the time axis (1) Lines parallel (between 0 and *t*/2) (1) Line B passes through (*t*/2, 0) with *t*/2 labelled on time axis (1) (MP4 conditional on MP3) (Accept graphs where the positive direction is taken to be downwards, Only one line needs to be labelled. Max 3 for both lines unlabelled) 	**4**
	Total for question 15	**9**

Question Number	Answer		Mark
*16 (a)	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)**		
	Either		
	At terminal/constant velocity the resultant force is zero (stated or implied) **Or** at terminal/constant velocity weight = drag	**(1)**	
	$\frac{4}{3}\pi r^3 \rho g = 6\pi r \eta v$	**(1)**	
	So (terminal) velocity is proportional to the radius squared	**(1)**	
	Larger droplets have a greater terminal/average velocity (so will reach the ground first)	**(1)**	
	Or		
	At terminal/constant velocity the resultant force is zero (stated or implied) **Or** at terminal/constant velocity weight = drag	**(1)**	
	Larger droplets require greater air resistance before reaching terminal velocity **Or** larger droplets require a greater air resistance to equal a greater weight **Or** as the radius increases, weight increases more rapidly than drag (at a given speed)	**(1)**	
	Drag increases with velocity	**(1)**	
	Larger droplets have a greater terminal/average velocity (so will reach the ground first)	**(1)**	**4**

16(b)(i)	Velocity of rain drawn to scale as a vertical line and labelled (vertical velocity, (velocity of) rain, 8.5 (m s^{-1}), scaled length) **and** Velocity of wind drawn as a horizontal line to scale and labelled (horizontal velocity, (velocity of) wind, 12(.0) (m s^{-1}), scaled length) **(1)** Resultant correctly drawn with a consistent set of arrows on the three vectors **(1)** Scale of 1 m s^{-1} to 1 cm used **(1)** (Only award all three marks if a ruler has been used for all the sides)		**3**
16(b)(ii)	Magnitude of resultant velocity of rain = 15 m s^{-1} **(1)** Direction of resultant velocity of rain = 35.0 ° to 36.0 ° to the horizontal **Or** 54.0 ° to 55.0 ° to the vertical **(1)** (Accept answers written onto the diagram in (b)(i) and answers obtained by calculation e.g. Pythagoras, do not accept direction referring to compass points) Examples of calculation  		**2**
	Total for question 16		**9**

Question Number	Answer		Mark
17(a)(i)	Use of area = πr^2 **Or** area = $\frac{\pi d^2}{4}$ Use of $\sigma = F/A$ **and** $\varepsilon = \Delta x/x$ **Or** see $E = \frac{Fx}{A\Delta x}$ Use of $E = \sigma/\varepsilon$ **Or** use of $E = \frac{Fx}{A\Delta x}$ Δx = 7.8 (mm) <u>Example of calculation</u> Cross sectional area = $\frac{\pi}{4} \times (3.3 \times 10^{-4})^2 = 8.55 \times 10^{-8}$ m^2 σ = 190 N ÷ 8.55 × 10^{-8} m^2 = 2.22 ×10^9 Pa $\varepsilon = \Delta x/0.60$ m 170×10^9 Pa = $\frac{2.22 \times 10^9 \text{ Pa} \times 0.60 \text{ m}}{\Delta x}$ $\Delta x = 7.84 \times 10^{-3}$ m = 7.84 mm	**(1)** **(1)** **(1)** **(1)**	**4**
17(a)(ii)	Use of $\Delta x/\pi d$ Number of turns = 0.3 turns (0.28 with show that value and ecf from (a)(i) for Δx) <u>Example of calculation</u> Number of turns = $\frac{7.8}{\pi \times 9.2}$ = 0.27 turns	**(1)** **(1)**	**2**
17(b)(i)	Maximum stress/force for which the material will return to its original length (when the applied force is removed)	**(1)**	**1**
17(b)(ii)	Large stress/force/tension applied (with a high elastic limit) the wire will not permanently/plastically deform **Or** (with a high elastic limit) the wire will return to the original length (when the applied force is removed) So the guitar does not go out of tune **Or** to produce the same frequency/note/sound each time a string is plucked **Or** extra stress/force/tension produced by plucking could produce more plastic deformation	**(1)** **(1)** **(1)**	**3**
	Total for question 17		**10**

Question Number	Answer		Mark
18(a)	(As the pole bends) kinetic energy is transferred to elastic potential energy (As the pole straightens) elastic potential energy transferred to gravitational potential energy (and kinetic energy) Greater heights can be reached as the EPE stored in the pole is greater than in the legs when jumping **Or** more of initial KE transferred to GPE in pole vaulting than in a jump **Or** the pole is more efficient at converting (horizontal) KE into (vertical) GPE than the legs alone ('potential' only needs to be included once for epe and once for or gpe. Allow E_k,KE, E_{grav}, GPE, E_{el}, EPE, elastic strain energy)	**(1)** **(1)** **(1)**	**3**
18(b)(i)	Use of $E_k = ½ mv^2$ Use of $\Delta E_k = E_{k2} - E_{k1}$ Use of $\Delta E_{grav} = \Delta E_k$ $\Delta h = 4.4$ m (MP1 may be awarded for use of Δv for v. Use of $v^2 = u^2 + 2as$ scores 0) <u>Example of calculation</u> $mg\Delta h = ½ m(9.4 \text{ m s}^{-1})^2 - ½ m(1.1 \text{ m s}^{-1})^2$ $\Delta h = 4.44$ m	**(1)** **(1)** **(1)** **(1)**	**4**
18(b)(ii)	Use of $F = k\Delta x$ Use of $E_{el} = ½ F\Delta x$ Use of $E_k = ½ mv^2$ Use of $\frac{E_{el}}{E_k}$ Maximum proportion of initial kinetic energy = 0.54 (or 54 %) <u>Example of calculation</u> $F = 850 \text{ N m}^{-1} \times 2.1 \text{ m} = 1785 \text{ N}$ $E_{el} = ½ \times 1785 \text{ N} \times 2.1 \text{ m} = 1874.3 \text{ J}$ $E_k = ½ \times 78 \text{ kg} \times (9.4 \text{ m s}^{-1})^2 = 3446.0 \text{ J}$ $\frac{E_{el}}{E_k} = \frac{1874.3 \text{ J}}{3446.0 \text{ J}} = 0.54$	**(1)** **(1)** **(1)** **(1)** **(1)**	**5**

<table>
<tr><td>18(c)</td><td>Property 1
Explanation 1
Property 2
Explanation 2

(Award MP1/2 and MP3/4 to two pairs of properties and corresponding explanations from the table that give the highest total number of marks)

<table>
<tr><td>Property</td><td>Explanation</td></tr>
<tr><td>Strong or high UTS (accept tensile strength for UTS)</td><td>So it does not break/fail/snap under large forces/stresses</td></tr>
<tr><td>Low density</td><td>Low mass and E_k of the pole lost on contact is low Or low mass so pole easier to hold horizontally</td></tr>
<tr><td>High elastic limit</td><td>So pole does not bend permanently</td></tr>
<tr><td>Low elastic modulus (k) or Young modulus</td><td>So pole can bend (to store energy)</td></tr>
</table></td><td>(1)
(1)
(1)
(1)</td><td>4</td></tr>
<tr><td></td><td>Total for question 18</td><td></td><td>16</td></tr>
</table>

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