Mark Scheme (Results)

June 2019

Pearson Edexcel International Advanced Subsidiary Level
In Physics (WPH01)
Paper 01 Physics on the Go

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These instructions should be the first page of all mark schemes

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 $g = 10 \text{ m s}^{-2}$ **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	The only correct answer is **B** The units for viscosity are Pa s which are kg m^{-1} s^{-1} in SI base units. Pa s = N m^{-2} s = kg m s^{-2} m^{-2} s = kg m^{-1} s^{-1} A is not correct because kg m^{-1} s^{-3} is not a correct unit for viscosity in SI base units C is not correct because kg m s^{-3} is not a correct unit for viscosity in SI base units D is not correct because kg m s^{-1} is not a correct unit for viscosity in SI base units	(1)
2	The only correct answer is **A** 40 N increases the length by 2 cm. 10 N would increase the length by 0.5 cm 60 N would increase the length by 3 cm Original length = 9 cm – 3 cm = 6 cm B is incorrect (see above) C is incorrect (see above) D is incorrect (see above)	(1)
3	The only correct answer is **C** A is not correct as a brittle object shows no plastic deformation B is not correct as the force being applied to shape the clay is compressive and not tensile D The strength of the clay depends on the maximum stress before fracture. This is not a property that will affect the clay at the low applied stress needed for shaping the clay	(1)
4	The only correct answer is **C** The total extension produced is now doubled. E = ½ kΔx so energy α extension. Double the extension results in double the energy being stored. A is incorrect as the energy is doubled. This would be the energy stored if the extension were to be halved B is incorrect as the energy is doubled and does not stay the same D is incorrect as the energy is doubled. This would be the energy stored if the extension were to be quadrupled i.e. by 4 springs end to end.	(1)
5	The only correct answer is **D** A is not correct as work and time are both scalar quantities B is not correct as work and time are both scalar quantities C is not correct as work and time are both scalar quantities	(1)
6	**The only correct answer is B** power =$\frac{total\ work\ done}{time}$ power = $\frac{\boldsymbol{force \times total\ distance}}{\boldsymbol{time}} = \frac{\mathbf{150\ \times 2.1 \times 36}}{\mathbf{122}}$ **A** is not the correct answer because the substitution into $\frac{force \times total\ distance}{time}$ is incorrect **C** is not the correct answer because the substitution into $\frac{force \times total\ distance}{time}$ is incorrect **D** is not the correct answer because the substitution into $\frac{force \times total\ distance}{time}$ is incorrect	(1)

7	The only correct answer is **C** The directions of two component vectors should always lead from the tail of the arrow of the original force to the top of the arrow of the original force. A The component arrows point away from each other rather than from the tail to the top of the original arrow B the component arrows point from the top of the original arrow to the tail D The component arrows point away from each other rather than from the tail to the top of the original arrow	(1)
8	The only correct answer is **B** The direction of the force is in the direction of the motion of the train, but the passenger falls backwards A The passenger falls backwards and not forwards C The force on the passenger is forwards, in the direction of motion of the train, and the passenger falls backwards and not forwards D The force on the passenger is forwards, in the direction of motion of the train	(1)
9	The only correct answer is **C** The total force acting in the vertical and in the horizontal direction must be 0. The horizontal component of the force of the hinge on the shelf must cancel out the weight and the vertical component must cancel out the tension (force of wire on shelf). A is not the correct diagram B is not the correct diagram D is not the correct diagram	(1)
10	The only correct answer is **C** The velocity is increasing (gradient increasing) leading to a constant velocity i.e. constant gradient A is incorrect as the graph is for an object moving at a constant velocity followed by a period of deceleration until it becomes stationary B is incorrect as the graph is for an object moving at a constant velocity and is then stationary. D is incorrect as the velocity is constant at all times	(1)

Question Number	Answer	Mark
11(a)(i)	Undergoes little/no plastic deformation before breaking **Or** breaks just after limit of proportionality **Or** breaks just after elastic limit **Or** shatters under impact (force) (1)	**1**
11a(ii)	Resistant to scratching/ denting/ indentation **Or** the <u>surface</u> is resistant to <u>plastic</u> deformation **Or** can withstand scratching/ denting/ indentation (1)	**1**
11a(iii)	Takes a large <u>stress</u> to break it (1)	**1**
11(b)	As the temperature increases, the viscosity decreases **Or** temperature is inversely proportional to viscosity (1) So the glass will flow **Or** the glass is no longer brittle **Or** the glass will now deform plastically **Or** the glass becomes ductile/ malleable (1)	**2**
	Total for question 11	**5**

Question Number	Answer	Mark
***12**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) **Max 6** This is describing Newtons first law (not third law) (1) (treat references to N2 as neutral) Newton's third law describes a pair of equal and opposite forces **Or** correct explanation of N3 e.g. if body A exerts a force on body B, body B exerts an equal and opposite force on body A (1) N3 forces act on different bodies **Or** *F* and *P* acting on the same **book/object/body** (1) N3 forces are the same **type/nature** of force (1) *F* and *P* are friction and contact/reaction forces (1) The book doesn't have to be moving for a third law pair to exist (1) When a force/pull/push is applied to the book – the book applies an (equal and) opposite force to whatever is pushing it (1) The force of friction from the table on the book (to the right) has a force of friction from the book on the table (to the left) (1) (Ignore references to other N3 pairs within system)	**6**
	Total for question 12	**6**

Question Number	Answer	Mark
13(a)	Initial velocity = 12 m s^{-1} **and** comes to rest at 6 s (1) Uniformly accelerates/decelerates **Or** velocity decreases/changes at a constant rate (1) with a value –2 m s^{-2} (1) (minus not required if stated that is a deceleration) <u>Example of calculation</u> $a = \frac{v-u}{t}$ $a = \frac{0 - 12 \text{ m s}^{-1}}{2 \text{ s}}$ $a = -2 \text{ m s}^{-2}$	**3**
13(b)	Use of $s = ut + \frac{1}{2}at^2$ for X (1) Use of $s = ut + \frac{1}{2}at^2$ for Y (1) Equates their expressions for *s* for X and Y (1) Time = 4.0 s (allow e.c.f from 13(a)) (1) **Alternative method:** Uses area under graph = displacement [over any time] (1) Uses trapezium area rule or triangle to determine area (1) Displacement at overtake = 32 m (1) Time at overtake = 4.0 s (1) (accept trial and error method with *t* = 0, *t* = 1 etc. to determine time where distances are the same) <u>Example of calculation</u> $s = (12 \text{ m s}^{-1})t - \frac{1}{2}(2 \text{ m s}^{-2})t^2$ $s = \frac{1}{2}(4 \text{ m s}^{-2})t^2$ $12t - \frac{1}{2}2t^2 = \frac{1}{2}4t^2$ $12 = 3t$ $t = 4.0\text{s}$	**4**

***13(c)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) **Max 4** The time between frames in a video is known **Or** each frame = 1/25 s **Or** playback video for stated/small time (1) Ensure that there is a length measure within the footage (to scale off distances) **Or** markers placed on road/track a known/fixed/ stated distance apart (1) Measure distance moved over a short/stated/corresponding time **Or** measure the distance moved over a number of frames (1) Velocity = distance divided by corresponding time interval (1) Frames known from the start to give the time to plot against the (instantaneous) velocity (1)	**4**
	Total for question 13	**11**

Question Number	Answer		Mark
14(a)	Value of density that rounds to 788 kg m^{-3} from graph Use of mass of liquid displaced = density × volume Use of upthrust = *mg* Weight = 0.014 N (MP4 conditional on MP1) <u>Example of calculation</u> $\text{mass of liquid displaced} = 788\,\text{kg m}^{-3} \times 1.77\times10^{-6}\,\text{m}^3$ $\text{upthrust} = 1.395\times10^{-3}\,\text{kg}\times 9.81\,\text{N kg}^{-1}$ $\text{weight} = 0.0137\,\text{N}$	(1) (1) (1) (1)	**4**
14(b)(i)	(As temperature increases) density (of liquid) decreases Upthrust would decrease **Or** weight of displaced fluid decreases (As weight of sphere constant) the resultant force is (now) downwards **Or** (as weight of sphere constant) weight is (now) greater than upthrust (treat references to viscosity, drag etc. as neutral)	(1) (1) (1)	**3**
14(b)(ii)	Upthrust/*U* marked upwards Weight/*W*/*mg or* marked downwards Friction/*F*/Drag/*D* marked upwards (3 marks may only be awarded if all 3 forces are to scale i.e. $W = U + D$, −1 for additional arrows, each force much touch dot to be credited)	(1) (1) (1)	**3**
	Total for question 14		**10**

Question Number	Answer		Mark
15(a)	Use of $s = ut + \frac{1}{2}at^2$ (award MP1 for use of the equation with 0.910 m, 0.400 m, 0.910 – 0.400 m but not 11.9 m) $u = 0$ Use of velocity = distance/time Horizontal component velocity = 28 (m s^{-1}) <u>Example of calculation</u> $0.910\ \text{m} = \frac{1}{2} 9.81\ \text{ms}^{-2} t^2$ $t = 0.431\text{s}$ $v = \frac{11.9\ \text{m}}{0.431\ \text{s}}$ $v = 27.6\ \text{m s}^{-1}$	(1) (1) (1) (1)	**4**
15(b)	Calculates vertical height of flight Use of equation(s) of motion to determine u e.g. $v^2 = u^2 + 2as$ (accept use of $s = vt - ½ at^2$) Vertical initial velocity = 3.2 (m s^{-1}) <u>Example of calculation</u> $s = 0.910\ \text{m} - 0.400\ \text{m} = 0.510\ \text{m}$ $0 = u^2 + (2 \times -9.81\ \text{m s}^{-2} \times 0.510\ \text{m})$ $u = 3.16\ \text{m s}^{-1}$	(1) (1) (1)	**3**
15(c)	Uses Pythagoras with two previous velocity values **Or** correct use of trig with calculated angle Velocity = 28 m s^{-1} Correct use of trig to determine angle Angle = 6.5° (e.c.f from (a) and (b))(using show that values 30.1 m s^{-1} and 5.7°) <u>Example of calculation</u> $\text{initial velocity}^2 = 3.16^2 + 27.6^2$ $\text{initial velocity} = 27.8\ \text{m s}^{-1}$ $\text{Angle} = \tan^{-1}\frac{3.16}{27.6}$ $\text{Angle} = 6.5^{\circ}$	 (1) (1) (1) (1)	**4**
	Total for question 15		**11**

Question Number	Answer		Mark
16(a)	**6 Max**		
	Identifies limit of proportionality P (at end of straight line)	(1)	
	Up to the limit of proportionality (P) the wire obeys Hooke's law **Or** Up to P, the forces is proportional to the extension **Or** initially the wire obeys Hooke's law	(1)	
	Identifies an elastic limit E (between end of linear region and region with constant gradient)	(1)	
	Up to E wire will return to its original shape if force removed	(1)	
	Beyond E, the wire will not return to its original shape if force removed	(1)	
	Wire shows ductile behaviour	(1)	
	Identify a yield point and explain that beyond this there is extensive plastic deformation with little increase in force e.g. there will be a large increase in length/extension for no/little increase in force	(1)	**(6)**

16(b)	Resolves correctly through 70° (1) Use of factor of 2 (1) Use of stress = $\frac{\text{force}}{\text{area}}$ (1) Use YM = stress/strain (1) Use of strain = extension/length (1) extension = 2.6 $\times 10^{-4}$ m **and** comparison with 1mm (1) (unit required for MP6) (See $E = \frac{Fl}{A\Delta x}$, scores MP3 &4 and use of $E = \frac{Fl}{A\Delta x}$ scores MP3,4 & 5) <u>Example of calculation</u> $\text{weight on one end of wire} = \frac{10.8\text{ N}}{2} = 5.4\text{ N}$ $\text{tension} = \frac{5.4\text{ N}}{\cos 7\,0} = 15.8\text{ N}$ $\text{stress} = \frac{15.8\text{ N}}{3.3 \times 10^{-7}} = 4.8 \times 10^{7}\text{Pa}$ $\text{strain} = \frac{4.8 \times 10^{7}\text{Pa}}{1.3 \times 10^{11}\text{Pa}} = 3.7 \times 10^{-4}$ $\text{extension} = 3.7 \times 10^{-4} \times 0.70\text{m} = 2.6 \times 10^{-4}\text{m}$	**(6)**
	Total for question 16	**12**

Question Number	Answer		Mark
17(a)	Attempts to determine area under graph (accept triangle approximation or use of average force × distance) Work done = 0.84 J (allow 0.8 J to 0.9 J) Example of calculation $\text{area of equivalent rectangle} = 3\,\text{N} \times 0.28\,\text{m} = 0.84\,\text{J}$	(1) (1)	**2**
17(b)	Use of $\Delta E_{grav} = mg\Delta h$ Calculates Δh using trig e.g. see 1.2sin7 or 0.15 ΔE_{grav} = 0.22 – 0.23 J Example of calculation $\Delta \text{E}_{\text{grav}} = 0.153\,\text{kg} \times 9.81\,\text{ms}^{-2} \times 1.2\sin 7\,\text{m} = 0.22\,\text{J}$	(1) (1) (1)	**3**
17(c)	**Max 4** Some of the work done was not transferred to energy stored in spring Some of the energy stored in spring not transferred to (E_k) to ΔE_{grav} Due to resistive forces (dependent on MP1 or MP2) Work done is done against resistive forces Energy transferred to thermal/internal energy **Or** (E_{el}) is dissipated as heat **Or** Energy transferred to thermal energy (ignore references to sound energy, do not accept lost for transfer)	(1) (1) (1) (1) (1)	**4**
17(d)(i)	Use of $E_{\text{k}} = \frac{1}{2}mv^2$ Max E_{k} = 0.13 J Example of calculation $E_{\text{k}} = \frac{1}{2} \times 0.153\text{ kg} \times (1.3\text{ ms}^{-1})^2 = 0.13\text{ J}$	(1) (1)	**2**

17(d)(ii)	**Max 4** Initially force from spring giving car acceleration **Or** initially the force from the spring is the resultant force so max acceleration (1) Accelerating/resultant force = driving force from spring – friction (1) Driving force decreases, so acceleration decreases **Or** resultant force decreased so acceleration decreases (1) Acceleration is zero when frictional force equals the driving force (1) Decelerates when frictional/resistive forces greater than driving force (accept decelerates when driving force 0) (1) (MP2/3/4/5 accept spring/accelerating/forward force for driving force)	**4**
	Total for question 17	**15**