Mark Scheme (Results)

January 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 A This is because the horizontal component of the acceleration = 6 cos 30°	**1**
2	The only correct answer is D A is not correct because this area represents the energy stored. B is not correct because this area represents the work done. C is not correct because the graph is only a straight line up to the limit of proportionality.	**1**
3	The only correct answer is C A in not correct because even though marble is brittle that is not the reason for its use. B is not correct because a ductile material would deform permanently. D is not correct because a malleable material would deform permanently.	**1**
4	The only correct answer is C The equation used is $s = ut + ½at^2$ with u = +20 m s^{-1} and a = −9.81 m s^{-2} A is not correct because a is positive B is not correct because u is negative and a is positive D is not correct because u is negative.	**1**
5	The only correct answer is C This is because density is a scalar and velocity is a vector.	**1**
6	The only correct answer is D A is not correct because Newton's laws do not concern energy. B is not correct because these equations do not concern energy. C is not correct because the force and distance moved are not given.	**1**
7	The only correct answer is D A is not correct because it represents the difference between the forces. B is not correct because it represents the difference between the forces. C is not correct because it represents the force required to give equilibrium.	**1**
8	The only correct answer is B This is because the unit of stiffness is N m^{-1} and N = kg m s^{-2} so stiffness is kg m s^{-2} m^{-1} = kg s^{-2}	**1**
9	The only correct answer is C A is not correct because the two horizontal forces represent the forces on the wall and the ground, not on the ladder. B is not correct because the weight is missing. D is not correct because the force of the wall is in the wrong direction.	**1**
10	The only correct answer is D A is not correct because the particle is moving at a constant velocity. B is not correct because the particle is moving. C is not correct because at terminal velocity the resultant force on the particle is zero.	**1**

Question Number	Answer	Mark
11(a)	"Smooth"/initially have <u>laminar</u> flow (1) Then 1 MAX from No abrupt change in direction/speed of flow **Or** flows in layers/flow-lines/streamlines **Or** no mixing/crossing of layers **Or** layers remain parallel **Or** velocity/speed at a point remains constant (1) Churned/later have <u>turbulent</u> flow (1) Then 1 MAX from Abrupt changes in direction/speed of flow (must be after the blades) **Or** Eddies **Or** Mixing/crossing of layers **Or** velocity/speed at a point changes (1) (MP2 and MP4 must be for different properties) (Allow correct sketches for MP2 and MP4) (If laminar and turbulent are incorrectly applied, e.g. reversed, MP2 and MP4 can still be given for a correct description of the flow before and after the blades)	**4**
11(b)	Kinetic energy is transferred to thermal/internal energy. (1) (This mark is lost if gravitational/potential/electrical energy is mentioned) (Allow K.E., E_k for kinetic energy) (Ignore any reference to sound) Kinetic energy is reduced/less/decreases because/so speed is reduced. **OR** (This is due to) kinetic energy of eddies **OR** (This is due to) friction within the liquid/sewage **OR** (This is due to) friction with the blades (1)	**2**
	Total for question 11	**6**

Question Number	Answer	Mark
***12**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Child (X) exerts a force (to the right) on the ball (1) Due to N3 the ball exerts a (opposite) force on the child/boat (1) (To award MP2, cause and effect must be correct) There is a resultant/unbalanced/net force on the child/boat (1) Due to N1/N2 the child/boat will accelerate (1) When child (Y) catches the ball there will be a force on the child/boat to the right (1) The child/boat will decelerate (1) (For MP2 and MP4, ignore general statements of Newton's laws. They must be applied to the boat/child/ball) (Ignore anything about the reason for there being no movement initially. Ignore any discussion of the motion while the ball is in the air. Ignore any attempt to explain why the speed drops to zero at the end)	**6**
	Total for question 12	**6**

Question Number	Answer		Mark
13a	<u>horizontal component</u> (of velocity/u) uses cos40° **Or** <u>Horizontal velocity/u</u> uses cos40°	(1)	
	State and use speed = $\frac{\text{distance}}{\text{time}}$ **Or** $s=vt$ **Or** $s=ut+½at^2$ with a=0 (The values must be substituted then rearranged to give the correct final equation)	(1)	**2**
13b	Use of $s = ut + \frac{1}{2}at^2$ with s = 0 **Or** Use of $v = u + at$ with v = 0 **Or** Use of $v = u + at$ with $v = -u$	(1)	
	Vertical component of velocity using sin40° or cos50°	(1)	
	Substitute $\frac{250}{u\cos 40°}$ for t (If the time to maximum height is used, the correct factor of 2 must be seen)	(1)	
	u = 50 m s^{-1}	(1)	
	[If the range formula is used Max 3 marks:		
	State $R = \frac{u^2 \sin 2\theta}{g}$	(1)	
	Correctly substitute values	(1)	
	u = 50 m s^{-1}]	(1)	
	<u>Example of calculation</u> $0 = u\sin 40° t - \frac{1}{2} 9.81\,\text{ms}^{-2} t^2$ (using the full range) **O**R $0 = u\sin 40° - 9.81(\text{ms}^{-2}) \times \frac{1}{2}t$ (using half the range) $t = \frac{u\sin 40°}{0.5 \times 9.81}$ $\frac{u\sin 40°}{0.5 \times 9.81} = \frac{250\,\text{m}}{u\cos 40°}$ $u^2 = \frac{1226}{0.4924} = 2490$ $u = 49.9\,\text{m}\,\text{s}^{-1}$		**4**
	Total for question 13		**6**

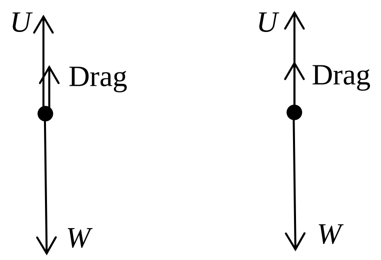
Question Number	Answer	Mark
14(a)	Power (1)	**1**
14(b)	power = force × speed **OR** $\text{power} = \dfrac{\text{force} \times \text{distance}}{\text{time}}$ (1) Conversion of speed to m s^{-1} (1) P = 124.4 (W) **Or** F = 15.9 (N) **Or** v = 27.9 (km h^{-1}) (Allow 124.3 or 124.5) (1) <u>Example of calculation</u> $\text{speed} = \dfrac{28\ \text{km h}^{-1} \times 1000}{3600} = 7.78\ \text{m s}^{-1}$ $\text{power} = 16\ \text{N} \times 7.78\ \text{m s}^{-1}$ $= 124.4\ \text{W}$	**3**
14(c)	Use of time in seconds/hours (1) Use of speed = distance/time (1) speed = 32 km h^{-1} (8.8 m s^{-1}) **Or** distance = 6.1 km (6100 m) **Or** time = 15 minutes (880 s) **Or** power = 140 W (Ecf for speed from part (b)) (1) Must be instantaneous with numerical comparison of calculated and displayed values. (1) <u>Example of calculation</u> total time = 13 min ÷ 60 = 0.2167 hours $\text{average speed} = \dfrac{6.843\ \text{km}}{0.2167\ \text{hr}}$ average speed = 31.6 km h^{-1}	**4**
	Total for question 14	**8**

Question Number	Answer		Mark
15(a)	Use of gradient **Or** equation of motion Acceleration = 4.4 (m s^{-2}) <u>Example of calculation</u> $\text{gradient} = \frac{2.4\text{ m s}^{-1}}{0.54\text{ s}}$ $a = 4.44\text{ m s}^{-2}$	(1) (1)	**2**
15(b)	Use of $a = g\sin\theta$ $\theta = 27^\circ$ (ecf a from part (a). Use of 4 m s^{-2} gives 24°) (Note there is an alternative method by calculating the height and length of the ramp for MP1) <u>Example of calculation</u> $4.44\text{ ms}^{-2} = 9.81\text{ms}^{-2}\sin\theta$ $\theta = 26.9^o$	(1) (1)	**2**
15(c)	Distance while accelerating (d_1) = area under diagonal **Or** Distance while accelerating (d_1) = ½ a t^2 for diagonal **Or** Distance while accelerating (d_1) = ½ v t for diagonal Distance at constant velocity = 0.74 – d_1 Time = 0.58 s (Dependent on correct working) **OR If area of a trapezium is used:** Area = average time × velocity $\frac{t + (t - 0.54)}{2} \times 2.4 = 0.74$ t = 0.58 s (ecf a from part (a)) <u>Example of calculation</u> Area of triangle = ½ × 0.54 s × 2.4 m s^{-1} = 0.648 m Further distance = 0.74 m – 0.648 m = 0.092 m $\text{time} = \frac{0.092\ m}{2.4\text{ m s}^{-1}} = 0.038\text{ s}$ total time = 0.54 + 0.038 = 0.578 s	 (1) (1) (1) (1) (1) (1)	**3**
15(d)	Use of kinetic energy = ½ m v^2 Use of $\Delta W = F\Delta s$ Force = 1.2 N **OR** Use of $v^2 = u^2 + 2as$ with $v = 0$ Use of $F = m\,a$ Force = 1.2 N <u>Example of calculation</u> $E_k = \frac{1}{2} \times 0.10\text{ kg} \times (2.4\text{ m s}^{-1})^2 = 0.288\text{ J}$ $0.288\text{J} = F \times 0.25\text{m}$ $F = 1.15\text{ N}$	(1) (1) (1) (1) (1) (1)	**3**

15(e)	Use light gate(s) (connected to a) data-logger/computer/timer (1) Need the velocity at each/bottom gate and the time (to go between them) **Or** Need the velocity at the gate, and the distance (from the point of release) **Or** Need the velocity at each gate and the distance (between the gates) (Do not allow if extra variables are given) (1) Recorder times a known length that interrupts light gate (1) Use of suitable equation to give the acceleration (1) **OR** Two light gates (connected to a) data-logger/computer/timer (1) Need the time (between the gates) and the distance (between the gates) (1) First light gate starts the timing and the second light gate stops it. The trolley must be released while in the top light gate. (1) Use $s = \frac{1}{2} at^2$ (1) **OR** A motion/velocity sensor (connected to a) data-logger/computer/timer (1) Need some values of the velocity and time (1) Sensor uses reflections from the trolley to measure the speed (1) Plot a velocity-time graph and determine the gradient (1) (Ignore use of camera/video)		**4**
	Total for question 15		**14**

Question Number	Answer		Mark
16(a)	Hooke’s law states that force is proportional to extension **Or** Does not obey Hooke’s law as force is not proportional to extension **Or** Initially obeys Hooke’s law as force is proportional to extension Does not obey Hooke’s law (beyond about 1 mm or 800 N) because: (Graph) is a curve **Or** (graph) not straight/linear (from the origin) **Or (**graph) should be straight/linear (from the origin) (To gain either mark, there must be a statement about obedience to Hooke’s law)	(1) (1)	**2**
16(b)	Use of stress = Force / Area Conversion of area to m^2 **Or** units of stress N mm^{-2} in final answer Stress = 4.0×10^7 N m^{-2} (accept 4×10^7 N m^{-2}) (accept Pa) **Or** correct value with consistent unit <u>Example of calculation</u> $\text{stress} = \dfrac{4000\,\text{N}}{101\times10^{-6}\,\text{m}^2}$ $= 3.96\times10^7\ \text{N m}^{-2}$	(1) (1) (1)	**3**
16(c)	Corresponding extension = 2.3 (mm) Use of strain = extension / length Strain = 0.053 / 0.054 <u>Example of calculation</u> $\text{strain} = \dfrac{2.3}{43}$ $= 0.053$	(1) (1) (1)	**3**

16(d)(i)	Use of area under graph Correct method to calculate the area Energy transferred = 10 J (accept 8.0 – 12.0) <u>Example of calculation</u> Area = are of triangle + area of trapezium = ½ × 2200 × 0.002 + ½ × (2200 + 10000) ×0.0013 =2.2 + 7.93 = 10.1 J	(1) (1) (1)	**3**
16(d)(ii)	Use of $\Delta E_{grav} = mg\Delta h$ ΔE_{grav} = 320 J <u>Example of calculation</u> $\Delta E_{grav} = 65\text{ kg} \times 9.81\text{ m s}^{-2} \times 0.5\text{ m}$ $= 319\text{ J}$	(1) (1)	**2**
16 (d)(iii)	Some energy is transferred to other body parts **Or** The force is spread over other body parts **Or** Bending knees reduces force **Or** Increasing time taken to land reduces force **Or** Ecf an incorrect large energy from (i) – The energy is less than required to damage the tendon.	(1)	**1**
	Total for question 16		**14**

Question Number	Answer	Mark
17(a)(i)	Strong – requires a large force/stress to break/fracture it (1) (Do not allow a definition of strength Allow “large breaking stress” Allow can withstand/absorb a large force/stress without breaking Do not allow just can withstand a large force)	**1**
17(a)(ii)	**2 Max** can deform plastically (1) can withstand an impact (force) (1) large amount of energy can be absorbed before fracture (1) (Max 1 if the response is an explanation of toughness)	**2**
17(b)(i)	Upthrust/*U* up (1) Drag/friction/*D* up (1) Weight/*W*/*mg* down (1) (−1 for each extra force over 3) (−1 if any arrow does not touch the dot) (Each arrow must be nearly vertical to gain the mark.) (Accept single line up with two labelled arrow heads. Ignore the length of the arrows.) Examples:  	**3**

17(b)(ii)	Use of weight $W = mg$ with m = mass of submersible (1) Use of upthrust $U = V\rho g$ (1) $R = W - U$ (1) R = 1700 N (accept 2000 N if all the working is correct) (1) <u>Example of calculation</u> $W = 11800\ \text{kg} \times 9.81\ \text{N kg}^{-1} = 115758\ \text{N}$ $U = 11.40\ \text{m}^3 \times 1020\ \text{kg m}^{-3} \times 9.81\ \text{N kg}^{-1} = 114071\ \text{N}$ $R = 115758 - 114071 = 1687\ \text{N}$	**4**
17(b)(iii)	W needs to be less than U **Or** $W < U$ **Or** $W = U$ (1) W – U or answer to (b)(ii) (1) mass = 170 kg (ecf R, W, U from part (ii)) (1) **OR** To float, density of the submersible =/< density of the water (1) (Required) mass of submersible = 1020 kg m^{-3} × 11.40 m^3 (= 11628 kg) (1) Mass released = (11800 kg – 11628 kg =) 170 kg (1) <u>Example of calculation</u> $115758 - 114071 = 1687\ \text{N}$ $m = \dfrac{1687\ \text{N}}{9.81\ \text{N kg}^{-1}} = 172\ \text{kg}$	**3**
***17(c)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Viscosity will increase (with depth or as temperature decreases) (1) Resistive/drag/frictional force will increase (1) Speed of descent reduces (1) **OR** Viscosity will increase (with depth or as temperature decreases) (1) Resistive/drag/frictional force still = $W - U$ **Or** Resistive/drag/frictional force is unchanged (1) (Terminal) velocity is lower (1)	**3**
	Total for question 17	**16**

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