Mark Scheme (Results)

January 2024

Pearson Edexcel International Advanced Subsidiary Level In Physics (WPH11)
Paper 01: Mechanics and Materials

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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.

Question Number	Answer	Mark
1	**D is the correct answer** A is not correct because this is the unit for mass divided by area B is not correct because this is the unit for area divided by mass C is not correct because this is equivalent to 1 Pa^{-1}	**1**
2	**A is the correct answer** B is not correct because density, work done and time are scalar quantities C is not correct because mass is a scalar quantity D is not correct because kinetic energy and temperature are scalar quantities	**1**
3	**A is the correct answer** B is not correct because the answer should not be square rooted C is not correct because the answer is inverted and should not be square rooted D is not correct because the answer is inverted	**1**
4	**D is the correct answer** A is not correct because the initial power output should be a constant greater than zero, and the power output whilst going uphill should be constant B is not correct because whilst going uphill the power output should be constant C is not correct because the power output should increase	**1**
5	**C is the correct answer** A is not correct because air resistance would increase the time taken to fall B is not correct because air resistance would increase the time taken to fall and cause the final velocity to be less than calculated D is not correct because air resistance would cause the final velocity to be less than calculated	**1**
6	**C is the correct answer** A is not correct because the components of T acting vertically should be cos B is not correct because the components of T acting vertically should be cos and should form the denominator D is not correct because the components of T acting vertically should form the denominator	**1**
7	**C is the correct answer** A is not correct because this would give the work done to stretch the spring B is not correct because an area on this graph would represent an energy D is not correct because it would give an answer of $\frac{1}{k}$	**1**
8	**D is the correct answer** A is not correct because the answer is inverted and should not be cubed B is not correct because the answer is inverted C is not correct because the answer should not be cubed	**1**

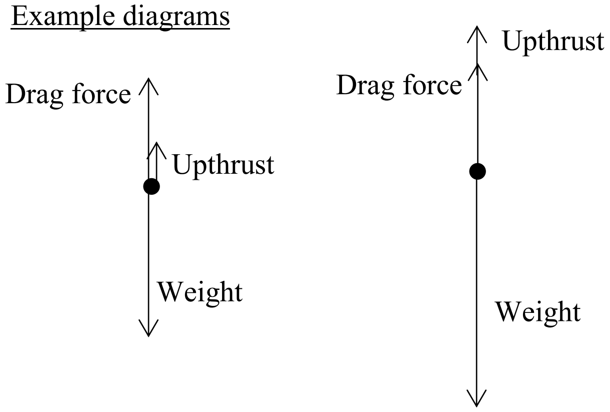
9	**C is the correct answer** A is not correct because P has a smaller breaking stress than Q B is not correct because P has a smaller breaking strain than Q D is not correct because graph P has an initial gradient greater than graph Q	1
10	**D is the correct answer** A is not correct because this gives the change in velocity of the object B is not correct because this gives the average velocity of the object C is not correct because this gives twice the distance travelled by the object	1

Question Number	Answer		Mark
11(a)	When the force was removed the rubber band returned to its original length. **Or** When the force was removed the extension was 0. **Or** The decreasing force line returns to the origin.	**(1)**	1
11(b)	Indication that E_{el} = area under force-extension graph. Uses area between graph lines to determine energy. Energy = 0.048 J (allow a range from 0.0425 J to 0.053 J) <u>Example of calculation</u> 1 cm^2 on graph $\equiv 0.5\ N \times 0.005\ m = 0.0025\ J$ Area between graphs $\approx 19\ cm^2$ Energy that caused heating = $19\ cm^2 \times 0.0025\ J\ cm^{-2} = 0.0475\ J$	**(1)** **(1)** **(1)**	3
	Total for question 11		**4**

Question Number	Answer	Mark
12(a)	Resolves velocity to determine vertical component **(1)** Use of $v = u + at$ Allow use of any valid suvat method **(1)** t = 0.139 (s) **(1)** <u>Example of calculation</u> $u = 15.6\ \text{m s}^{-1} \times \sin(5°) = 1.36\ \text{m s}^{-1}$ $0 = 1.36\ \text{m s}^{-1} - 9.81\ t$ $t = \frac{1.36\ \text{m s}^{-1}}{9.81\ \text{m s}^{-2}} = 0.139\ \text{s}$	**3**
12(b)	Use of $s = ut + 0.5at^2$ with $a = 0$ and horizontal component of u **(1)** $D = 2.2$ m (allow ecf from 12(a)) **(1)** <u>Example of calculation</u> $D = 15.6 \times \cos(5°) \times 0.139 = 2.16\ \text{m}$	**2**
	Total for question 12	**5**

Question Number	Answer	Mark
13	(As the volume of the air bubble decreases) the upthrust (of the bubble) decreases **Or** (As water enters the diver) the weight (of the tube, air bubble and water inside) increases. **(1)** (So) weight is greater than upthrust. **(1)** (So) there is a resultant force downwards. **(1)** If no other mark scored, allow one mark for the density of the diver becomes greater than the density of water.	**3**
	Total for question 13	**3**

Question Number	Answer		Mark
14(a)(i)	The gradient / steepness of the slide varies (So) the acceleration (of the child) varies The equations of motion require a constant acceleration	**(1)** **(1)** **(1)**	**3**
14(a)(ii)	Use of $\Delta E_{\text{grav}} = mgh$ Use of $\Delta E_k = \frac{1}{2}mv^2$ $v = 5.8 \text{ m s}^{-1}$ Do not accept use of equations of motion. <u>Example of calculation</u> $\Delta E_{\text{grav}} = 24 \text{ kg} \times 9.81 \text{ N kg}^{-1} \times 1.7 \text{ m} = 400 \text{ J}$ $400 \text{ J} = 0.5 \times 24 \text{ kg} \times v^2$ $v = \sqrt{\frac{2 \times 400}{24}} = 5.77 \text{ m s}^{-1}$	**(1)** **(1)** **(1)**	**3**
14(b)	$v_X = v_Y$ **Maximum 2 from**: $\Delta E_{\text{grav}} = \Delta E_k$ and mass is in both equations (Maximum) speed of child = $\sqrt{2g\Delta h}$ (and g is constant) (Maximum) speed does not depend on mass of child **Or** (Maximum) speed is (only) dependent on Δh	**(1)** **(1)** **(1)** **(1)**	**3**
	Total for question 14		**9**

Question Number	Answer		Mark
15(a)	Moving at low speed Laminar <u>flow</u> **Or** <u>Flow</u> not turbulent	**(1)** **(1)**	**2**
15(b)(i)	Upwards arrow labelled upthrust or U, and downward arrow labelled weight or W or mg. Both arrows start from dot. Length of weight arrow ≈ length of drag arrow + length of upthrust arrow <u>Example diagrams</u> 	**(1)** **(1)**	**2**
15(b)(ii)	Calculates volume of sphere Use of $\rho = \frac{m}{V}$ Use of $W = mg$ Use of weight = upthrust + viscous drag Use of viscous drag= $6\pi\eta r v$ η is 0.94 (Pa s) ≈ 0.93 (Pa s) valid conclusion based on comparison of 0.94 with value supplied in question. <u>Example of calculation</u> $V = \frac{4}{3} \times \pi \times (2.3 \times 10^{-3}\ \mathrm{m})^3 = 5.10 \times 10^{-8}\ \mathrm{m}^3$ $m = 1.26 \times 10^3\ \mathrm{kg\ m^{-3}} \times 5.10 \times 10^{-8}\ \mathrm{m}^3 = 6.43 \times 10^{-5}\ \mathrm{kg}$ Weight of liquid displaced $= 6.43 \times 10^{-5}\ \mathrm{kg} \times 9.81\ \mathrm{N\ kg^{-1}}$ $= 6.31 \times 10^{-4}\ \mathrm{N}$ viscous drag $= 6.31 \times 10^{-4}\ \mathrm{N} - 4.00 \times 10^{-3}\ \mathrm{N} = 3.37 \times 10^{-3}\ \mathrm{N}$ $\eta = \frac{3.37 \times 10^{-3}\ \mathrm{N}}{6\,\pi \times 2.3 \times 10^{-3}\ \mathrm{m} \times 0.0824\ \mathrm{m\ s^{-1}}} = 0.943\ \mathrm{Pa\ s}$	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**6**
	Total for question 15		**10**

Question Number	Answer		Mark
16(a)	A value of v and corresponding value of t read from graph	**(1)**	
	Use of $a = \frac{\Delta v}{\Delta t}$ using values of t between 14 ms and 50 ms or using a value of $\Delta t \leq 36$ ms.	**(1)**	
	Average acceleration = 86 m s^{-2}	**(1)**	**3**
	<u>Example of calculation</u> $a = \frac{2.85 \text{ m s}^{-1}}{48 \times 10^{-3} \text{ s} - 15 \times 10^{-3} \text{ s}} = 86.3 \text{ m s}^{-2}$		
***16(b)**	This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully sustained reasoning. Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning. The following table shows how the marks should be awarded for indicative content.		**6**

IC points	IC mark	Max linkage mark	Max final mark
6	4	2	6
5	3	2	5
4	3	1	4
3	2	1	3
2	2	0	2
1	1	0	1
0	0	0	0

The following table shows how the marks should be awarded for structure and lines of reasoning.

	Number of marks awarded for structure of answer and sustained line of reasoning
Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout	2
Answer is partially structured with some linkages and lines of reasoning	1
Answer has no linkages between points and is unstructured	0

Indicative content

IC1 The ball applies a force to the skittle.
IC2 The skittle applies a force to the ball.
IC3 Newton's 3rd Law means that the forces (on the skittle and the ball) are equal (in size) and opposite (in direction).
IC4 There is a resultant force acting on the skittle / ball.
IC5 The skittle / ball accelerates according to Newton's second law.
IC6 The skittle accelerates (to the left) and the ball decelerates.

16(c)	Use of $p = mv$	**(1)**	
	Use of total momentum before collision = total momentum after collision	**(1)**	
	Mass of ball = 0.78 kg	**(1)**	**3**

	<u>Example of calculation</u> $m \times 7.2\ \text{m s}^{-1} = m \times 1.6\ \text{m s}^{-1} + 1.4\ \text{kg} \times 3.1\ \text{m s}^{-1}$ $m = \dfrac{1.4\ \text{kg} \times 3.1\ \text{m s}^{-1}}{7.2\ \text{m s}^{-1} - 1.6\ \text{m s}^{-1}} = 0.775\ \text{kg}$	
	Total for question 16	**12**

Question Number	Answer	Mark
17(a)	Measure (diameter) at several positions along the wire **(1)** Measure (diameter) at several orientations **(1)**	**2**
17(b)(i)	(Safety) goggles should be worn **(1)** (Because) the wire could break. **(1)**	**2**
17(b)(ii)	The vernier scale has a better resolution **Or** The vernier scale has a resolution of 0.1 mm **(1)** There is a smaller (percentage) uncertainty (when using the vernier scale). **(1)**	**2**

17(c)	**EITHER** Use of $A = \pi r^2$ **(1)** Use of $\Delta\sigma = \frac{\Delta F}{A}$ with initial force greater than 0 N **(1)** Use of $\Delta\varepsilon = \frac{\Delta x}{x}$ **(1)** Use of $E = \frac{\Delta\sigma}{\Delta\varepsilon}$ **(1)** E = 107 (GPa) ≈ 106 (GPa) so material is brass **(1)** **OR** Use of $A = \pi r^2$ **(1)** Determines gradient of graph **(1)** Calculates $\frac{x}{A}$ **(1)** Use of $E = \frac{\Delta\sigma}{\Delta\varepsilon}$ **(1)** E = 107 (GPa) ≈ 106 (GPa) so material is brass **(1)** <u>Example of calculation</u> $A = \pi \times \left(\dfrac{0.17 \times 10^{-3}\ \text{m}}{2}\right)^2 = 2.27 \times 10^{-8}\ \text{m}^2$	**5**

	$\Delta\sigma = \frac{14\text{ N}}{2.27 \times 10^{-8}\text{ m}^2} = 6.17 \times 10^8\text{ Pa}$ $\Delta\varepsilon = \frac{0.0104\text{ m}}{1.80\text{ m}} = 5.78 \times 10^{-3}$ $E = \frac{6.17 \times 10^8\text{ Pa}}{5.78 \times 10^{-3}} = 1.07 \times 10^{11}\text{ Pa}$ 107 GPa ≈ 106 GPa so material is brass.	
	Total for question 17	**11**

Question Number	Answer	Mark
18(a)	No resultant force **(1)** No resultant moment (about any point) **(1)**	**2**
18(b)	The point at which the weight of an object is considered to act **(1)**	**1**
18(c)(i)	Use of $W = mg$ **(1)** Horizontal distance from edge of door to centre of gravity identified as $\frac{w}{2}$ **(1)** Use of moment of force $= Fx$ **(1)** Use of clockwise moment = anticlockwise moment **(1)** Horizontal component of force of hinge Y on door = 37.5 (N) **(1)** **OR** Use of $W = mg$ **(1)** Use of tan θ with dimensions of door **(1)** Use of vertical component of force of hinge Y on door = W/2 **(1)** Use of tan θ with vertical and horizontal components of force of hinge Y on door **(1)** Horizontal component of force of hinge Y on door = 37.5 (N) **(1)** <u>Example of calculation</u> $W = 14.4\text{ kg} \times 9.81\text{N kg}^{-1} = 141\text{ N}$ $141\text{ N} \times \frac{0.85\text{ m}}{2} = F_{\text{horizontal}} \times 1.60\text{ m}$ $F_{\text{horizontal}} = \frac{60.0\text{ N m}}{1.60\text{ m}} = 37.5\text{ N}$	**5**

18(c)(ii)	Use of appropriate trigonometry to determine θ θ = 28° (allow ecf from 18(c)(i)) (show that answer gives 30°) Use of Pythagoras' theorem to determine *F* **Or** Use of appropriate trigonometry to determine *F* F = 80 N (allow ecf from 18(c)(i)) (show that answer gives 81 N) <u>Example of calculation</u> $\theta = \tan^{-1}\left(\frac{37.5}{\left(\frac{141}{2}\right)}\right) = 28.0°$ $F = \sqrt{(37.5\text{ N})^2 + \left(\frac{141\text{ N}}{2}\right)^2} = 80.0\text{ N}$	**(1)** **(1)** **(1)** **(1)**	**4**
18(c)(iii)	Moment of weight of door (about X) remains the same. **Or** $mg \times \frac{w}{2} = F_{\text{horizontal}} \times L$ (and *m*, *g* and *w* remain the same). (So) horizontal (component of) force increases (when *L* decreases). Vertical (component of) force remains the same. **Or** Each hinge still holds half the weight of the door. (So) *F* increases and θ increases.	**(1)** **(1)** **(1)** **(1)**	**4**
	Total for question 18		**16**

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