Mark Scheme (Results)

October 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.

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.**

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 e.g. '**and**' when two pieces of information are needed for 1 mark.

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 This does not apply in 'show that' questions or in any other question where the units to be used have been given, for example in a spreadsheet.

2.3 The mark will not be awarded for the same missing or incorrect unit only once within one clip in epen.

2.4 Occasionally, it may be decided not to insist on a 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.

2.5 The mark scheme will indicate if no unit error is to be applied by placing brackets around the unit.

3. Significant figures

3.1 Use of too many significant figures in the theory questions will not prevent a mark being awarded if the answer given rounds to the answer in the MS.

3.2 Too few significant figures will mean that the final mark cannot be awarded in 'show that' questions where one more significant figure than the value in the question is needed for the candidate to demonstrate the validity of the given answer.

3.3 The use of one significant figure might be inappropriate in the context of the question e.g. reading a value off a graph. If this is the case, there will be a clear indication in the MS.

3.4 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}

3.5 In questions assessing practical skills, a specific number of significant figures will be required e.g. determining a constant from the gradient of a graph or in uncertainty calculations. The MS will clearly identify the number of significant figures required.

4. Calculations

4.1 **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.

4.2 If a 'show that' question is worth 2 marks, then both marks will be available for a reverse working. If the question is worth 3 marks then only 2 marks will be available.

4.3 The mark scheme will show a correctly worked answer for illustration only.

5. Quality of Written Expression

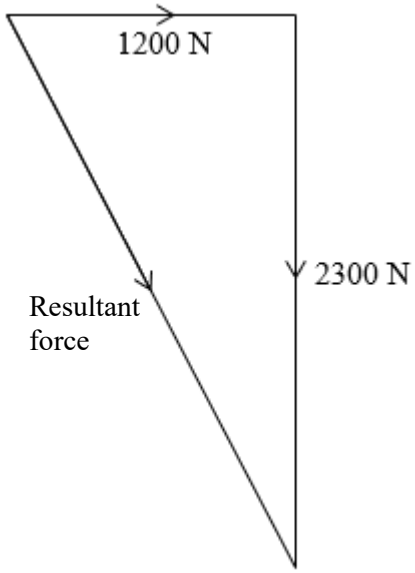
5.1 Questions that asses the ability to show a coherent and logically structured answer are marked with an asterisk.

5.2 Marks are awarded for indicative content and for how the answer is structured.

5.3 Linkage between ideas, and fully-sustained reasoning is expected.

Question Number	Answer	Mark
1	**The only correct answer is D ($J\ s^{-1}$)** A is not correct because this is equivalent to the joule B is not correct because this is the unit for stiffness C is not correct because the watt is the joule per second	1
2	**The only correct answer is A (acceleration, weight)** B is not correct because kinetic energy is a scalar quantity C is not correct because strain is a scalar quantity D is not correct because Young modulus is a scalar quantity	1
3	**The only correct answer is D (The displacement at 4 hours divided by a time of 4 hours)** A is not correct because the area under a displacement-time graph has no significance B is not correct because this would give the instantaneous speed at the end of the marathon C is not correct because this would give the instantaneous speed at 2 hours	1
4	**The only correct answer is B (The gravitational pull of the cable car on the Earth)** A is not correct because air resistance is not a gravitational force C is not correct because upthrust is not a gravitational force D is not correct because normal contact force is not a gravitational force	1
5	**The only correct answer is A (The component of the weight parallel to the slope is equal to the sum of the resistive forces)** B is not correct because this would cause the box to accelerate C is not correct because the component of the weight perpendicular to the slope does not affect the speed of the box D is not correct because the component of the weight perpendicular to the slope does not affect the speed of the box	1
6	**The only correct answer is C ($\frac{5000}{42\times0.63}$)** A is not correct because the useful output power should not be inverted B is not correct because the useful output power should not be inverted and should be divided by 0.63 D is not correct because the useful output power should be divided by 0.63	1
7	**The only correct answer is A (the wire is elastically deformed)** B is not correct because only elastic deformation occurs below the elastic limit. C is not correct because plastic deformation beyond the elastic limit increases the extension D is not correct because the wire can be extended beyond the elastic limit before it snaps	1

8	**The only correct answer is B ($\frac{2}{3}\ v$)** A is not correct because the momentum and mass of the ball should not be multiplied together C is not correct because the mass of the ball should not be divided by the momentum of the ball D is not correct because the momentum and mass of the cricket ball should not be multiplied together	**1**
9	**The only correct answer is C ($F_A\cos(31°) + F_B\cos(27°)$)** A is not correct because $\sin(31°)$ gives a component perpendicular to the forwards direction B is not correct because $\sin(27°)$and $\sin(31°)$ give components perpendicular to the forwards direction D is not correct because $\sin(27°)$ gives a component perpendicular to the forwards direction	**1**
10	**The only correct answer is A ($\frac{Fx}{y} + F$)** B is not correct because $W = \frac{Fx}{y} + F$ C is not correct because $W = \frac{Fx}{y} + F$ D is not correct because $W = \frac{Fx}{y} + F$	**1**

Question Number	Answer	Mark
11	Correct vector triangle with arrows in correct directions. **(1)** Resultant force = 2600 (N) (allow an answer between 2550 and 2650 N) **(1)** <u>Example</u>  	**2**
	Total for question 11	**2**

Question Number	Answer	Mark
12	Use of $\Delta F = k\Delta x$ to calculate Δx **(1)** Length = 0.46 m **(1)** Example calculation $7.0\ \text{N} = 25\ \text{N m}^{-1} \times \Delta x$ $\Delta x = \frac{7.0\ \text{N}}{25\ \text{N m}^{-1}} = 0.28\ \text{m}$ $l = 0.28\ \text{m} + 0.18\ \text{m} = 0.46\ \text{m}$	**2**
	Total for question 12	**2**

Question Number	Answer	Mark
13(a)	Use of appropriate trigonometry **(1)** Use of moment of force = Fx **(1)** Moment = 110 N m **(1)** Example calculation $580\ \text{N} \times 0.21\ \text{m} \times \cos(24°) = 111\ \text{N m}$	**3**
13(b)	The horizontal/perpendicular distance between W and the pivot decreases **Or** The component of W perpendicular to the lever decreases **Or** $\cos(\theta)$ decreases (from 1 to zero) **(1)** So the moment (of W about the pivot) decreases **and** F decreases (to zero) **(1)**	**2**
	Total for question 13	**5**

Question Number	Answer	Mark
14(a)	The ball fell a smaller distance (during each flash of the laboratory strobe) **Or** Each image of the ball would be smaller (using the laboratory strobe) **(1)** The uncertainty was less (with the laboratory strobe) MP2 dependent on MP1 **(1)**	**2**
14(b)(i)	(allow *a* for *g* throughout) $s = (ut+)\frac{1}{2}gt^2$ **and** *g* is constant **(1)** Comparison of $s = \frac{1}{2}gt^2\ (+ut)$ with $y = mx\ (+c)$ **Or** *s* is proportional to t^2 so the gradient of graph is constant **(1)**	**2**
14(b)(ii)	Use of $s = \frac{1}{2}at^2$ and a pair of corresponding values from the graph **Or** Pair of corresponding values from the graph used to determine gradient **(1)** g = 10.0 m s^{-2} (allow answers in the range 9.8 m s^{-2} to 10.1 m s^{-2}) (dependent on MP1) (answer must be consistent with their calculation) **(1)** Example of calculation $\frac{\Delta h}{\Delta t^2} = \frac{0.30}{0.060} = 5.00$ $g = 5.00\ \text{m s}^{-2} \times 2 = 10.00\ \text{m s}^{-2}$	**2**
	Total for question 14	**6**

Question Number	Answer	Mark
15(a)	By Newton's third law, the ground exerts an upwards force of 890 N on the athlete **Or** By Newton's third law, the ground exerts a force equal (in magnitude) and opposite (in direction) on the athlete **(1)** The upwards force is greater than the athlete's weight **Or** 890 N > 680 N **Or** 890 N – 680 N = 210 N **(1)** (So) there is a resultant force (upwards on the athlete) **(1)**	**3**

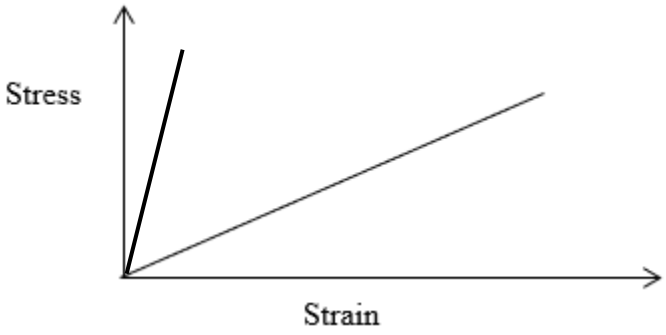
15(b)(i)	Use of $W = mg$	**(1)**	**3**
	Use of $E_k = \frac{1}{2}mv^2$	**(1)**	
	$v = 3.44$ (m s^{-1})	**(1)**	
	Example calculation $m = \frac{680 \text{ N}}{9.81 \text{ N kg}^{-1}} = 69.3 \text{ kg}$ $v = \sqrt{\frac{2 \times 409 \text{ J}}{69.3 \text{ kg}}} = 3.436 \text{ m s}^{-1}$		
15(b)(ii)	Use of equations of motion to calculate final vertical velocity **Or** Use of $\Delta E_{grav} = \Delta E_k$	**(1)**	**5**
	Use of Pythagoras' equation	**(1)**	
	Magnitude of final velocity = 6.3 m s^{-1} (allow ecf from (b)(i)) (show that value gives 6.2 m/s)	**(1)**	
	Use of appropriate trigonometry using velocities	**(1)**	
	Angle from vertical = 33° (allow ecf from (b)(i))	**(1)**	
	OR		
	Use of $W = mg$ **and** use of $E_k = \frac{1}{2}mv^2$	**(1)**	
	Use of conservation of energy	**(1)**	
	Magnitude of final velocity = 6.3 m s^{-1} (allow ecf from (b)(i)) (show that value gives 6.2 m/s)	**(1)**	
	Use of appropriate trigonometry using velocities	**(1)**	
	Angle from vertical = 33° (allow ecf from (b)(i))	**(1)**	
	Example calculation $v_{\text{vertical}} = \sqrt{2 \times 9.81 \text{ m s}^{-1} \times 1.4 \text{ m}} = 5.24 \text{ m s}^{-1}$ Magnitude of final velocity = $\sqrt{(5.24 \text{ m s}^{-1})^2 + (3.44 \text{ m s}^{-1})^2} = 6.27 \text{ m s}^{-1}$ Angle = $\tan^{-1}\left(\frac{3.44}{5.24}\right) = 33.3°$		
	Total for question 15		**11**

Question Number	Answer	Mark
16(a)	Upwards arrow labelled upthrust or U **and** downwards arrow labelled weight / W / mg **(1)** Arrows of equal length **(1)**	**2**
16(b)(i)	Any two from • The upthrust is equal to the weight of water displaced • The upthrust equals the weight of the hydrometer **Or** The upthrust is the same (in both types of water) • The weight of displaced water equals the weight of the hydrometer **Or** The weight of displaced water is the same in both types of water **(2)** (So) a smaller volume of seawater needs to be displaced (because seawater has a greater density) **(1)**	**3**
16(b)(ii)	Use of $W = mg$ **(1)** Use of $\rho = \frac{m}{V}$ to calculate volume of displaced water **(1)** Use of $V = \pi r^2 l$ **(1)** Subtracts position in seawater from position in pure water **(1)** Change in vertical position = 8 mm **(1)** <u>Example of calculation</u> Mass of hydrometer $= \frac{0.324\ \text{N}}{9.81\ \text{N kg}^{-1}} = 0.033\ \text{kg}$ Volume of pure water displaced $= \frac{0.033\ \text{kg}}{997\ \text{kg m}^{-3}} = 3.31 \times 10^{-5}\ \text{m}^3$ Depth of hydrometer in pure water $= \frac{4 \times 3.31 \times 10^{-5}\ \text{m}^3}{\pi \times (1.23 \times 10^{-2})^2} = 0.2786\ \text{m}$ Volume of seawater displaced $= \frac{0.033\ \text{kg}}{1025\ \text{kg m}^{-3}} = 3.22 \times 10^{-5}\ \text{m}^3$ Depth of hydrometer in seawater $= \frac{4 \times 3.22 \times 10^{-5}\ \text{m}^3}{\pi \times (1.23 \times 10^{-2})^2} = 0.2710\ \text{m}$ $\Delta L = 0.2786\ \text{m} - 0.2710\ \text{m} = 0.0076\ \text{m}$	**5**
	Total for question 16	**10**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>*17(a)</td><td>
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.
<table>
<tr><th>IC points</th><th>IC mark</th><th>Max linkage mark</th><th>Max final mark</th></tr>
<tr><td>6</td><td>4</td><td>2</td><td>6</td></tr>
<tr><td>5</td><td>3</td><td>2</td><td>5</td></tr>
<tr><td>4</td><td>3</td><td>1</td><td>4</td></tr>
<tr><td>3</td><td>2</td><td>1</td><td>3</td></tr>
<tr><td>2</td><td>2</td><td>0</td><td>2</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td></tr>
</table>
The following table shows how the marks should be awarded for structure and lines of reasoning.
<table>
<tr><th></th><th>Number of marks awarded for structure of answer and sustained line of reasoning</th></tr>
<tr><td>Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout</td><td>2</td></tr>
<tr><td>Answer is partially structured with some linkages and lines of reasoning</td><td>1</td></tr>
<tr><td>Answer has no linkages between points and is unstructured</td><td>0</td></tr>
</table>
Indicative content
IC1 Initially, weight is greater than tension (so resultant force is downwards)
IC2 So acceleration is downwards
IC3 Tension increases (as length of rope increases)
IC4 (Between A and B) resultant force decreases, so acceleration decreases
IC5 At B, resultant force is zero so acceleration is zero.
Or At B, tension is equal to weight so acceleration is zero
Or At B, forces are balanced so acceleration is zero
IC6 Below B resultant force is upwards and the student decelerates
</td><td>6</td></tr>
</table>

17(b)	Use of $\Delta E_{\text{grav}} = mg\Delta h$	**(1)**	
	Use of $\Delta E_{\text{el}} = \frac{1}{2}F\Delta x$ **Or** $F = k\Delta x$	**(1)**	
	(At 35 m below bridge) $\Delta E_{\text{grav}} = 22$ kJ **and** $\Delta E_{\text{el}} = 41$ kJ	**(1)**	
	Comparison of calculated values for ΔE_{grav} and ΔE_{el} and consistent conclusion	**(1)**	**4**
	<u>Example of calculation</u> $\Delta E_{\text{grav}} = 65\text{ kg} \times 9.81\text{ Nkg}^{-1} \times 35\text{ m} = 22\,300\text{ J}$ $F = 250\text{ N m}^{-1} \times (35\text{ m} - 17\text{ m}) = 4500\text{ N}$ $\Delta E_{\text{el}} = \frac{1}{2}4500\text{ N} \times (35\text{ m} - 17\text{ m}) = 40\,500\text{ J}$ $40\,500\text{ J} > 22\,300\text{ J}$ so the student will not reach the river		
	Total for question 17		**10**

Question Number	Answer	Mark
18(a)	Use of $A = \pi r^2$ **(1)** Use of $\sigma = \frac{F}{A}$ **(1)** $F = 4.9 \times 10^{-5}\text{N}$ **(1)** Example calculation $A = \pi \times (1.9 \times 10^{-6}\text{ m})^2 = 1.13 \times 10^{-11}\text{ m}^2$ $F = 4.3 \times 10^{6}\text{ Pa} \times 1.13 \times 10^{-11}\text{m}^2 = 4.88 \times 10^{-5}\text{ N}$	**3**
18(b)	Use of $E = \frac{\sigma}{\varepsilon}$ **(1)** Use of $\varepsilon = \frac{\Delta x}{x}$ **(1)** Use of stretched length $= x + \Delta x$ **(1)** Length at limit of proportionality = 25.9 m **(1)** Example calculation $\varepsilon = \frac{300 \times 10^{6}\text{ Pa}}{8.70 \times 10^{9}\text{ Pa}} = 3.448 \times 10^{-2}$ $\Delta x = 3.448 \times 10^{-2} \times 25.0\text{ m} = 0.862\text{ m}$ $L = 25\text{ m} + 0.862\text{ m} = 25.86\text{ m}$	**4**

18(c)(i)	Straight line steeper than spider silk line, starting from the origin **(1)** Line extending to a slightly greater stress than the spider silk line (dependent on MP1) **(1)**  	**2**
18(c)(ii)	The force applied to the steel is (slightly) greater than that applied to the spider silk **(1)** The extension / strain of the spider silk is much greater than the extension / strain of the steel **(1)** (So) elastic strain energy of the spider silk is greater than the elastic strain energy of the steel (dependent on MP2) **(1)** **OR** Elastic strain energy is proportional to area under graph **(1)** The area under the spider silk graph is greater than the area under the steel graph **(1)** (So) elastic strain energy of the spider silk is greater than the elastic strain energy of the steel (dependent on MP2) **(1)**	**3**
	Total for question 18	**12**

Question Number	Answer	Mark
19(a)(i)	Small, spherical object **Or** Spherical object with low speed **(1)** laminar flow **Or** flow is not turbulent **(1)**	**2**
19(a)(ii)	Use of $v = \frac{s}{t}$ **(1)** Use of $V = \frac{4}{3}\pi r^3$ **(1)** Use of $F = 6\pi\eta r v$ **(1)** $F = 0.035$ N **(1)** comparison of their calculated force with 4.6 (N) and consistent conclusion **(1)** <u>Example calculation</u> $v = \frac{25\text{ m}}{0.36\text{ s}} = 69.4\text{ m s}^{-1}$ $r = \sqrt[3]{\frac{3 \times 45 \times 10^{-6}\text{ m}^3}{4 \times \pi}} = 0.0221\text{ m}$ $F = 6 \times \pi \times 1.2 \times 10^{-3}\text{Pa s} \times 0.0221\text{ m} \times 69.4\text{ m s}^{-1} = 0.0347\text{ N}$ 0.0347 N < 4.6 N so Stokes' law does not apply.	**5**

19(b)(i)	The areas between the line and the *x*-axis should be determined **Or** The area between the line and the *x*-axis represents displacement **(1)** The diver will be at the surface if the area below the *x*-axis (before 25 s) is equal to the area above the *x*-axis (after 25 s). **Or** The diver will be at the surface if the total (positive and negative values of) area is equal to zero **(1)**	**2**
19(b)(ii)	Draws tangent at 70 s **(1)** Determines values for Δv and Δt **(1)** Acceleration = (−)0.008 m s^{-2} (allow an answer in the range (−)0.007 m s^{-2} to (−)0.01 m s^{-2}) **(1)** <u>Example calculation</u> Acceleration = $\frac{-0.50 \text{ m s}^{-1}}{65 \text{ s}} = -0.0077 \text{ m s}^{-2}$	**3**
	Total for question 19	**12**

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