Mark Scheme (Results)

January 2025

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. '<u>resonance</u>'

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 B (the gradient of the graph)** A is not correct because the Young modulus is not the area under the graph C is not correct because stress × strain is not equivalent to the Young modulus D is not correct because the Young modulus should be stress / strain	1
2	**The only correct answer is C (initial acceleration is same for coin and feather, and time taken to reach the ground is less for coin)** A is not correct because both objects have the same initial acceleration B is not correct because both objects have the same initial acceleration and object A has a greater terminal velocity D is not correct because object A has a greater terminal velocity	1
3	**The only correct answer is C (acceleration is a vector and work done is a scalar)** A is not correct because acceleration is a vector B is not correct because acceleration is a vector and work done is a scalar D is not correct because work done is a scalar	1
4	**The only correct answer is D (the spring does not return to its original length)** A is not correct because beyond the elastic limit force is not proportional to extension B is not correct because plastic deformation starts occurring after the spring reaches the elastic limit C is not correct because plastic deformation occurs beyond the elastic limit	1
5	**The only correct answer is D (the change in velocity of the aeroplane during time *t*)** A is not correct because displacement is the area under a velocity-time graph B is not correct because displacement is the area under a velocity-time graph C is not correct because the shaded area is the change in velocity during time *t*	1
6	**The only correct answer is A $\left(\frac{2}{3}\Delta x\right)$** B is not correct because doubling the force does not give half the extension and three times the stiffness does not give three times the extension C is not correct because doubling the force does not give half the extension D is not correct because three times the stiffness does not give three times the extension	1
7	**The only correct answer is C (Quantity plotted on x-axis is $(\text{time})^2$, and gradient of graph is $\frac{g}{2}$)** A is not correct because time on the x-axis will not give a straight line B is not correct because time on the x-axis will not give a straight line D is not correct because the gradient of this graph is g / 2	1

8	**The only correct answer is D** $\left(\frac{5vt}{2}\right)$ A is not correct because this gives the distance travelled at a constant velocity 2v for time 2t B is not correct because this gives twice the distance travelled C is not correct because $\frac{3vt}{2}$ is not the area under the graph	**1**

9	**The only correct answer is C** $(\mathbf{90 - 49 - (5 \times 4)})$ A is not correct because this gives the resultant force B is not correct because the resultant force is not zero D is not correct because this assumes that the object is accelerating downwards	**1**
10	**The only correct answer is B** $\left(\frac{W}{2\sin\theta}\right)$ A is not correct because $W = 2\sin\theta \times \text{tension}$ C is not correct because $T\cos\theta$ is the horizontal component of tension T D is not correct because $T\cos\theta$ is the horizontal component of tension T	**1**

Question Number	Answer	Mark
11	Use of $F = ma$ **(1)** Difference in mass calculated **(1)** Mass of people = 150 kg **(1)** <u>Example calculation</u> $460\text{ N} = m_{\text{total}} \times 0.23\text{ m s}^{-2}$ $m_{\text{total}} = 1850\text{ kg} + m_{\text{people}}$ (= 2000 kg) $m_{\text{people}} = 2000\text{ kg} - 1850\text{ kg} = 150\text{ kg}$	**3**
	Total for question 11	**3**

Question Number	Answer		Mark
12	Use of appropriate trigonometry to determine component of g acting down the slope	**(1)**	
	Use of $v^2 = u^2 + 2as$ with u = 7.1 m s^{-1} **or** Use of other valid suvat method to determine v with u = 7.1 m s^{-1}	**(1)**	
	Speed = 11 m s^{-1}	**(1)**	
	OR		
	Use of appropriate trigonometry to determine vertical displacement	**(1)**	
	Use of $\Delta E_{\text{grav}} = \Delta mgh$ **Or** Use of $E_{\text{k}} = \frac{1}{2}mv^2$	**(1)**	
	Speed = 11 m s^{-1}	**(1)**	**3**
	<u>Example calculation</u> $a = 9.81 \text{ m s}^{-2} \times \sin(14°) = 2.37 \text{ m s}^{-2}$ $v^2 = (7.1 \text{ m s}^{-1})^2 + 2 \times 2.37 \text{ m s}^{-2} \times 15 \text{ m} = 122 \text{ m}^2 \text{ s}^{-2}$ $v = 11.0 \text{ m s}^{-1}$		
	Total for question 12		**3**

Question Number	Answer		Mark
13(a)	Use of $\Delta W = F\Delta s$	**(1)**	
	Distance = 23 m	**(1)**	**2**
	<u>Example calculation</u> $8.0 \times 10^6\ \mathrm{J} = 3.5 \times 10^5\ \mathrm{N} \times \Delta s$ $\Delta s = \dfrac{8.0 \times 10^6\ \mathrm{J}}{3.5 \times 10^5\ \mathrm{N}} = 22.9\ \mathrm{m}$		
13(b)	(uses $F = ma$ to show) $a \propto \frac{mg}{m}$ **Or** $W = mg$ and $F = ma$, so $mg \propto ma$ (and g is constant) **Or** resistive force is proportional to mass (of vehicle) and $F = ma$ (so $km=ma$ where k is a constant)	**(1)**	
	(So) the deceleration of the car is the same (as that of the truck)	**(1)**	**2**
	Total for question 13		**4**

Question Number	Answer		Mark
14(a)	A exerts a force on B **and** B exerts an equal (magnitude) and opposite (direction) force on A **OR** The gliders exert equal (magnitude) and opposite (direction) forces on each other	**(1)** **(1)**	**1**
14(b)	Use of $p = mv$ Total momentum = 0.026 kg m s^{-1} (to the right) **Or** Final velocity = 0.074 m s^{-1} (to the right) **Or** Initial momentum of A = 0.048 kg m s^{-1} (to the right) **and** initial momentum of B = 0.022 kg m s^{-1} (to the left) So after the collision the gliders will move to the right and the prediction is not correct (dependent on a valid calculation for MP2) <u>Example calculation</u> If a momentum to the right is positive, then Total momentum = $0.15\ \text{kg} \times 0.32\ \text{m s}^{-1} - 0.20\ \text{kg} \times 0.11\ \text{m s}^{-1}$ $= 0.048\ \text{kg m s}^{-1} - 0.022\ \text{kg m s}^{-1}$ $= 0.026\ \text{kg m s}^{-1}$ So total momentum is to the right so the prediction is not correct	**(1)** **(1)** **(1)**	**3**
	Total for question 14		**4**

Question Number	Answer		Mark
15(a)	Use of $\rho = \frac{m}{V}$	(1)	
	Use of trigonometry to calculate Δh	(1)	
	Use of $\Delta E_{\text{grav}} = mg\Delta h$	(1)	
	Use of $P = \frac{E}{t}$	(1)	
	$P = 87.7$ (MW)	(1)	
	OR		
	Use of $\rho = \frac{m}{V}$	(1)	
	Use of trigonometry to calculate component of g along pipe	(1)	
	Use of appropriate suvat equation(s) to determine velocity of water at bottom of pipe **and** Use of $E_{\text{k}} = \frac{1}{2}mv^2$	(1)	
	Use of $P = \frac{E}{t}$	(1)	
	$P = 87.7$ (MW)	(1)	5
	<u>Example calculation</u> $1100\ \text{kg m}^{-3} = \dfrac{m}{1700\ \text{m}^3}$ $m = 1700\ \text{m}^3 \times 1100\ \text{kg m}^{-3} = 1.87 \times 10^6\ \text{kg}$ $\Delta h = 350\ \text{m} \times \sin(55°) = 287\ \text{m}$ $\Delta E_{\text{grav}} = 1.87 \times 10^6\ \text{kg} \times 9.81\ \text{N kg}^{-1} \times 287\ \text{m} = 5.26 \times 10^9\ \text{J}$ $P = \dfrac{5.26 \times 10^9\ \text{J}}{60\ \text{s}} = 87.7 \times 10^6\ \text{W}$		
15(b)	Use of efficiency $= \frac{\text{useful power output}}{\text{total power input}}$	(1)	
	Efficiency = 0.27 **Or** Efficiency = 27% [ecf from (a)]	(1)	2
	<u>Example calculation</u> Useful power output = 4 × 87.7 MW – 256 MW = 350.8 MW – 256 MW = 94.8 MW Efficiency = $\frac{94.8}{350.8} = 0.27$		
	Total for question 15		**7**

Question Number	Answer	Mark
16(a)	Resultant force is zero **(1)** Resultant moment (about any point) is zero **(1)**	**2**
16(b)	Use of Moment of force $= Fx$ **(1)** Use of principle of moments with dish in original position **(1)** Uses total weight = weight of rice + weight of dish to determine weight of one portion of rice **(1)** Use of principle of moments with dish in new position **Or** Calculates clockwise moment with 3 portions of rice in new position **and** calculates anticlockwise moment of weight of beam **(1)** Dish contains 8.2 portions of rice **(1)** Comparison with 3 portions **and** consistent conclusion **(1)** <u>Example calculation</u> Moment of weight of beam = $3.1\text{ N} \times 0.08\text{ m} = 0.248\text{ N m}$ $0.248\text{ N m} = (\text{weight of dish and rice}) \times 0.25\text{ m}$ Weight of dish and rice $= \dfrac{0.248\text{ N m}}{0.25\text{ m}} = 0.992\text{ N}$ Weight of one portion of rice = 0.992 N – 0.64 N = 0.352 N 0.248 N m = (portions × 0.352 N + 0.64 N) × 0.07 m Number of portions = $\dfrac{\frac{0.248\text{ N m}}{0.07} - 0.64\text{ N}}{0.352\text{ N}} = 8.247$ The dish contains 8.2 portions, not 3 portions of rice	**6**
	Total for question 16	**8**

<table>
<tr><th>Question Number</th><th>Answer</th><th></th><th>Mark</th></tr>
<tr><td>17(a)</td><td>Use of $\varepsilon = \frac{\Delta x}{x}$

ε = 0.035 (given to at least 2 significant figures)

<u>Example calculation</u>
$\varepsilon = \frac{38.1\ \text{m} - 36.8\ \text{m}}{36.8\ \text{m}} = 0.03533$</td><td>(1)

(1)</td><td>2</td></tr>
<tr><td>17(b)(i)</td><td>Stress = 110 (MPa) (allow answers in the range 108 to 112 (MPa))

Calculates cross-sectional area of rope

Use of $\sigma = \frac{F}{A}$

$F = 4.2 \times 10^6$ N (allow answers in the range 4.1×10^6 N to 4.3×10^6 N)

<u>Example calculation</u>
$A = \frac{\pi \times (220 \times 10^{-3}\ \text{m})^2}{4} = 0.0380\ \text{m}^2$

$110 \times 10^6\ \text{Pa} = \frac{F}{0.0380\ \text{m}^2}$

$F = 110 \times 10^6\ \text{Pa} \times 0.0380\ \text{m}^2 = 4.18 \times 10^6\ \text{N}$</td><td>(1)

(1)

(1)

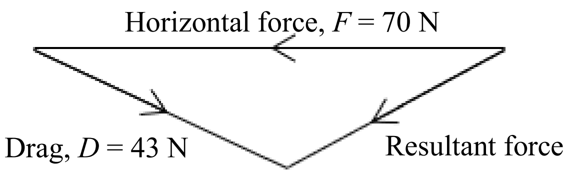
(1)</td><td>4</td></tr>
<tr><td>17(b)(ii)</td><td>Energy stored = area under graph × volume (of rope)
Or
Area under graph = energy stored per unit volume of rope
Or
Area under stress-strain graph multiplied by volume is equivalent to the area under a force extension graph (which gives elastic potential energy)

Area under graph $\propto \frac{F}{A} \times \frac{\Delta x}{x}$
Or
Stress × strain = $\frac{F}{A} \times \frac{\Delta x}{x}$

(And) $\frac{F}{A} \times \frac{\Delta x}{x} = \frac{F \times \Delta x}{V}$
Or
(And) $A \times x$ = Volume of rope</td><td>(1)

(1)

(1)</td><td>3</td></tr>
<tr><td></td><td>Total for question 17</td><td></td><td>9</td></tr>
</table>

Question Number	Answer		Mark
18(a)	Straight arrow at least 3.5 cm long representing horizontal force, with label *F*, horizontal force or 70 N	**(1)**	
	Vector triangle drawn with at least two sides in the triangle labelled, and horizontal force on the longest side.	**(1)**	
	All three arrows in correct relative directions (dependent on MP2)	**(1)**	
	Magnitude = 36 N (allow an answer in the range 34 N to 38 N)	**(1)**	
	Angle to horizontal = 30° **Or** 150° (allow a tolerance of ± 2°)	**(1)**	**5**
	<u>Example diagram</u> 		

Question Number	Answer	Mark
*18(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.	

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 resultant force on the submarine is zero

IC2 So tension = weight – upthrust

IC3 As the submarine leaves the water, the volume / mass / weight of water displaced decreases

IC4 So the upthrust on the submarine decreases

IC5 and the tension in the cable increases

IC6 When the submarine is out of the water the tension in the cable is equal (in magnitude) to the weight of the submarine

		Mark
*18(b)		**6**
	Total for question 18	**11**

Question Number	Answer	Mark
19(a)(i)	Use of trigonometry to determine u_h **(1)** Use of $s = ut + ½ at^2$ with $a = 0$ **(1)** Time = 32 (s) **(1)** <u>Example calculation</u> $u_h = 500\ \text{m s}^{-1} \times \cos(22°) = 4.64 \times 10^2\ \text{m s}^{-1}$ $t = \dfrac{15 \times 10^3\ \text{m}}{4.64 \times 10^2\ \text{m s}^{-1}} = 32.4\ \text{s}$	3
19(a)(ii)	Use of trigonometry to determine u_v **(1)** Use of $s = ut + \frac{1}{2}at^2$ with $a = -g$ **(1)** (Allow use of any valid suvat method to determine s) Adds launch height **(1)** Height above ship = 3.0×10^3 m [ecf from (a)(i)] ("show that" value gives 3.2×10^3 m) **(1)** <u>Example calculation</u> $u_v = 500\ \text{m s}^{-1} \times \sin 22° = 1.87 \times 10^2\ \text{m s}^{-1}$ $s = 1.87 \times 10^2\ \text{m s}^{-1} \times 32\ \text{s} - 0.5 \times 9.81\ \text{m s}^{-2} \times (32\ \text{s})^2 = 9.61 \times 10^2\ \text{m}$ Height = $9.61 \times 10^2\ \text{m} + 2 \times 10^3\ \text{m} = 2.96 \times 10^3\ \text{m}$	4
19(b)	(As the launch angle increased) the horizontal (component of) velocity / speed decreased **(1)** (and) the vertical (component of) velocity / speed increased **(1)** So the time (in air) increases **(1)** Horizontal distance travelled = time (in air) × horizontal velocity (which will reach a maximum value) **(1)**	4
	Total for question 19	**11**

Question Number	Answer	Mark
20(a)	(Initially) weight is greater than upthrust (+ drag) **Or** (Initially) there is a resultant force downwards **(1)** (so) the sphere accelerates **Or** (so) the speed / velocity of the sphere increases **(1)** drag increases (and upthrust remains constant) (dependent on MP2) **(1)** (until) the resultant force becomes 0 (and the sphere moves at constant / terminal velocity) **(1)**	**4**
20(b)(i)	Use of $s = ut + \frac{1}{2}at^2$ with $a = 0$ **(1)** Use of $F = 6\pi\eta rv$ **(1)** $F = 2.2 \times 10^{-4}$ N **(1)** <u>Example calculation</u> $u = \frac{0.45 \text{ m}}{7.3 \text{ s}} = 0.0616 \text{ m s}^{-1}$ $F = 6\pi \times 2.1 \times 10^{-1} \text{ Pa s} \times 0.90 \times 10^{-3} \text{ m} \times 0.0616 \text{ m s}^{-1}$ $= 2.19 \times 10^{-4}$ N	**3**
20(b)(ii)	(For the larger sphere at the same speed) drag is greater (because drag is proportional to radius) **Or** drag is proportional to diameter / radius **(1)** But upthrust and weight increase by a greater factor than drag **Or** Weight and upthrust are both proportional to diameter / radius cubed, **(1)** (So) the new sphere had a greater (terminal) velocity, and therefore time taken (for the new sphere) was less **(1)**	**3**
	Total for question 20	**10**

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