Pearson Edexcel

Mark Scheme (Results)

January 2023

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 means of [no ue].

3. Significant figures

3.1 Use of too many significant figures in the theory questions will not be 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 mean that one mark will not be awarded. (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 Bald (i.e. no working shown) correct answers score full marks unless in a 'show that' question.

4.2 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.

4.3 **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.

4.4 **recall** of the correct formula will be awarded when the formula is seen or implied by substitution.

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

5. Quality of Written Communication

5.1 Indicated by QoWC in mark scheme. QWC – Work must be clear and organised in a logical manner using technical wording where appropriate.

5.2 Usually it is part of a max mark, the final mark not being awarded unless the QoWC condition has been satisfied.

6. Graphs

6.1 A mark given for axes requires both axes to be labelled with quantities and units, and drawn the correct way round.

6.2 Sometimes a separate mark will be given for units or for each axis if the units are complex. This will be indicated on the mark scheme.

6.3 A mark given for choosing a scale requires that the chosen scale allows all points to be plotted, spreads plotted points over more than half of each axis and is not an awkward scale e.g. multiples of 3, 7 etc.

6.4 Points should be plotted to within 1 mm.

- Check the two points furthest from the best line. If both OK award mark.
- If either is 2 mm out do not award mark.
- If both are 1 mm out do not award mark.
- If either is 1 mm out then check another two and award mark if both of these OK, otherwise no mark.

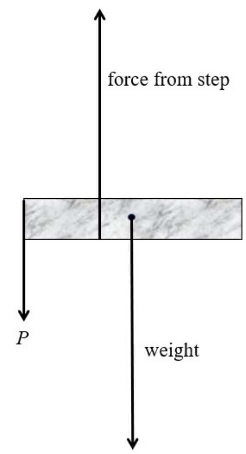
  For a line mark there must be a thin continuous line which is the best-fit line for the candidate's results.

Question Number	Answer	Mark
1	**The correct answer is C** A is not the correct answer because displacement is a vector B is not the correct answer because the moment of a force has a magnitude and a direction so is therefore a vector D is not the correct answer because weight is a force, and force is a vector	1
2	**The correct answer is A** B is not the correct answer because it should be weight, not acceleration C is not the correct answer because it should be weight, not gravitational potential energy D is not the correct answer because it should be weight, not acceleration and mass, not weight	1
3	**The correct answer is B** A is not the correct answer because gpe should be added not subtracted on the right hand side C is not the correct answer because the total elastic energy is not $F\Delta x$ and gpe should be added not subtracted on the right hand side D is not the correct answer because the total elastic energy is not $F\Delta x$	1
4	**The correct answer is D** A is not the correct answer because the drop speed would be too slow if the flow were laminar B is not the correct answer because the ball bearing should not be moving at terminal velocity at all C is not the correct answer because to calculate g you must know the initial velocity and the student isn't measuring that	1
5	**The correct answer is C** A is not the correct answer because the acceleration is not 5 m s^{-2} B is not the correct answer because the acceleration is not 9.81 m s^{-2} D is not the correct answer because this expression is not dimensionally correct and the acceleration is not 9.81 m s^{-2}	1
6	**The correct answer is B** A is not the correct answer because the diagram gives the force required for balance C is not the correct answer because the diagram gives $(W - U) - P$ D is not the correct answer because the diagram gives $P - (W - U)$	1
7	**The correct answer is B** A is not the correct answer because the acceleration is not positive C is not the correct answer because the acceleration does not increase D is not the correct answer because the acceleration does not decrease	1

8	**The correct answer is B** A is not the correct answer because the mass has not been multiplied by g C is not the correct answer because the mass has not been multiplied by g and the factor of 10^3 is missing for the power D is not the correct answer because the factor of 10^3 is missing for the power	1
9	**The correct answer is B** A is not the correct answer because the mass is not needed C is not the correct answer because radius cannot be directly measured and the mass is not needed D is not the correct answer because radius cannot be directly measured	1
10	**The correct answer is B** A is not the correct answer because the forces don't act on the same body C is not the correct answer because the forces have equal magnitudes D in not the correct answer because the forces have equal magnitudes	1

Question Number	Answer	Mark
11	Use of $s = u\,t + ½\,a\,t^2$ with $u = 0$ and $a = g$ for flight time (1) Use of $s = u\,t + ½\,a\,t^2$ with $a = 0$ for horizontal displacement of stone (1) Distance travelled = 5.9 m (1) Example of calculation $12\text{ m} = 0.5 \times 9.81\text{ m s}^{-2} \times t^2$ $t = \sqrt{(12.0\text{ m} \div 4.905\text{ m s}^{-2})} = 1.56\text{ s}$ $s_{\text{stone}} = 3.8\text{ m s}^{-1} \times 1.56\text{ s} = 5.94\text{ m}$	3
	Total for question 11	**3**

Question Number	Answer	Mark
12(a)	(Use balance to measure) mass and multiply mass by g to determine weight **Or** Use the balance set to read newtons to determine weight (of ball) (1) Measure the diameter (of the ball) (with the calliper) to determine volume (1) Identify upthrust with weight of fluid displaced (1) Calculate the weight of fluid displaced by multiplying the volume of the ball by the density of the liquid and g (1)	4
12(b)	Use of $F = 6\pi\,\eta r v$ (1) $\eta = 2.2 \times 10^2$ Pa s (1) Example of calculation $1.1 \times 10^{-2}\text{ N} = 6\pi \times \eta \times 0.50 \times 10^{-2}\text{ m} \times 5.4 \times 10^{-4}\text{ m s}^{-1}$ $\eta = 1.1 \times 10^{-2}\text{ N} \div (6\pi \times 2.7 \times 10^{-6}\text{ m}^2\text{ s}^{-1}) = 216\text{ Pa s}$	2
	Total for question 12	**6**

Question Number	Answer	Mark
13(a)(i)	Zero resultant/net force (in any direction) **(1)** Zero (turning) moment (about any point) **(1)**	**2**
13(a)(ii)	The point through/at which the weight of the object may be taken to act **(1)**	**1**
13(b)(i)	Downward arrow at centre of gravity labelled "weight" **Or** "*W*" **Or** "*mg*" **(1)** Upward arrow between CoG. and *P* labelled "force from step" **(1)** 	**2**
13(b)(ii)	Use of moment of a force = $F x$ **(1)** Applies principle of moments **(1)** P = 52 N **(1)** <u>Example of calculation</u> Taking moments about the right hand edge of the step: $0.40 \text{ m} \times P = 0.05 \text{ m} \times 4.15 \times 10^2 \text{ N} = 20.8 \text{ N m}$ $P = 20.8 \text{ N m} \div 0.40 \text{ m} = 51.9 \text{ N}$	**3**
	Total for question 13	**8**

Question Number	Answer	Mark
14(a)	Material returns to original shape/size when stress/force/tension removed **(1)**	**1**
14(b)(i)	Determines gradient using > half drawn line **(1)** $E = 2.1 \times 10^{11}$ (Pa) **(1)** <u>Example of calculation</u> Gradient = 4.2 ÷ 2.0 = 2.1 $E = 2.1 \times (100 \text{ MPa} \div 0.1\%) = 2.1 \times 10^{11}$ Pa	**2**
14(b)(ii)	Use of $\sigma = F / A$ **(1)** Use of $E = \sigma / \varepsilon$ **Or** Use of graph **And** Use of $\varepsilon = \Delta x / x$ **(1)** $\Delta x = 0.79$ mm (allow ecf from (b)(i)) **Or** $E_{req} = 2.8 \times 10^{11}$ Pa **(1)** Valid comparison in consistent units and conclusion (allow ecf from (b)(i)) **(1)** <u>Example of calculation</u> $\sigma = 9.5 \times 10^5 \text{ N} \div 4.80 \times 10^{-3} \text{ m}^2 = 1.98 \times 10^8$ Pa $\varepsilon = \sigma \div E = 1.98 \times 10^8 \text{ Pa} \div 2.10 \times 10^{11} \text{ Pa} = 9.42 \times 10^{-4}$ $\Delta x = 0.84 \text{ m} \times 9.42 \times 10^{-4}$ $= 7.91 \times 10^{-4} \text{ m} = 0.79 \text{ mm} > 0.6 \text{ mm} \therefore$ no	**4**
	Total for question 14	**7**

Question Number	Answer		Mark
15(a)	Use of $W = m\,g$ Use of resultant force = push from trampoline – weight of gymnast Use of $\Sigma F = m\,a$ $P = 1.4 \times 10^3$ N <u>Example of calculation</u> $\Sigma F = P - W$ $m\,a = T - m\,g$ $58\text{ kg} \times 14.2\text{ m s}^{-2} = P - 58\text{ kg} \times 9.81\text{ N kg}^{-1}$ $P = 58\text{ kg} \times (14.2 + 9.81)\text{ m s}^{-2} = 1.39 \times 10^3\text{ N}$	**(1)** **(1)** **(1)** **(1)**	**4**
15(b)(i)	$T = 68\text{ N} \div \sin 14°$ **Or** $68\text{ N} \div \cos 76°$ $T = 280$ (N) <u>Example of calculation</u> $T = 68\text{ N} \div \sin(14°) = 281\text{ N}$	**(1)** **(1)**	**2**
15(b)(ii)	Use of $F = k\,\Delta x$ $k = 6.1 \times 10^3\text{ N m}^{-1}$ (allow ecf from (b)(i)) <u>Example of calculation</u> $F = 2.81 \times 10^2\text{ N} = k \times 4.6 \times 10^{-2}\text{ m}$ $k = 2.81 \times 10^2\text{ N} \div 4.60 \times 10^{-2}\text{ m} = 6.11 \times 10^3\text{ N m}^{-1}$	**(1)** **(1)**	**2**
15(c)*	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 and lines of reasoning.		

IC points	IC mark	Max linkage mark available	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**

	Marks
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: • The weight (of the gymnast) acts downwards on the gymnast • The normal contact force (from trampoline) acts upwards • The normal contact force decreases as she moves upwards **Or** The normal contact force increases as she moves downwards • The normal contact force is zero when gymnast makes/loses contact with trampoline **Or** The normal contact force is maximum at bottom of bounce • Resultant/net force is the difference between weight and normal contact force • When the normal contact force is less than the weight the acceleration is downwards **Or** When the normal contact force is greater than the weight the acceleration is upwards	**6**
	Total for question 15	**14**

Question Number	Answer	Mark
16(a)	Use of $p = m v$ **(1)** Use of momentum conservation **(1)** $v = 0.04\ \text{m s}^{-1}$ **(1)** Towards O , away from S, to left (dependent on MP3) **(1)** <u>Example of Calculation</u> $1350\ \text{kg} \times 0.82\ \text{m s}^{-1} + 2950\ v - 2100\ \text{kg} \times 0.58\ \text{m s}^{-1} = 0$ $v = (1218 - 1107)\ \text{kg m s}^{-1} \div 2950\ \text{kg} = 0.0376\ \text{m s}^{-1}$	**4**
16(b)(i)	The rocket motor exerts a force on the gases, so the gases exert a force on the rocket motor **(1)** The forces are equal and opposite according to Newton's third law (dependent on MP1) **(1)** So there is a resultant/net/unbalanced force on the descent module, which accelerates according to Newton's second law (accept Newton's first law)(independent mark) **(1)**	**3**
16(b)(ii)	Use of $v = u + at$ to find a **(1)** Use of $\Sigma F = m a$ **(1)** $\Sigma F = 3.4 \times 10^{2}\ \text{N}$ **(1)** <u>Example of Calculation</u> $a = 0.58\ \text{m s}^{-1} \div 5\ \text{s} = 0.116\ \text{m s}^{-2}$ $\Sigma F = m a = 2950\ \text{kg} \times 0.116\ \text{m s}^{-2} = 342.2\ \text{N}$	**3**
	Total for question 16	**10**

Question Number	Answer		Mark
17(a)	The hammer head is not in free fall **Or** Person is exerting a force on the hammer	(1)	
	<u>Work</u> is done on the hammer head by the person	(1)	
	So additional energy is transferred to kinetic energy (MP3 dependent on MP1 or MP2)	(1)	3
17(b)	Use of $\Delta W = F\,\Delta s$	(1)	
	Use of ε = (useful energy output) / (total energy input)	(1)	
	Use of $\Delta E_{grav} = m\,g\,\Delta h$ **Or** Use of $E_k = ½\,m\,v^2$ and valid *suvat* method	(1)	
	Δh = 1.9 m **Or** F_{req} = 83 N **Or** E_{req} = 4.0 J **and** E_{out} = 2.8 J	(1)	
	Conclusion consistent with student's calculation	(1)	5
	e.g. The cylinder won't hit the bell because 1.9 m < 2.7 m **Or** Force needed to hit bell = 83 N > 53 N so cylinder won't hit the bell **Or** Useful output = 2.8 J but energy needed to hit bell is 4.0 J so cylinder won't hit the bell		
	<u>Example of calculation</u> energy of hammer head = ΔW = 58 N × 1.2 m = 69.6 J useful energy output = 0.04 × 69.6 J = 2.78 J g.p.e. gained = 2.78 J = 0.15 kg × 9.81 N kg^{-1} × Δh Δh = 2.78 J ÷ 1.47 N = 1.89 m 1.9 < 2.7 ∴ no		
17(c)	($E_k = ½mv^2$ so) kinetic energy is proportional to square of velocity **Or** ($E_k = ½mv^2$ so) kinetic energy multiplies by four (if v doubles)	(1)	
	So cylinder could move through four times the distance	(1)	2
	Total for question 17		**10**

Question Number	NAnswer		Mark
18(a)(i)	Use of $\rho = m / V$ Identifies upthrust is equal to weight of fluid displaced Use of $W = m g$ Use of $D = W - U$ 1.8×10^2 (N) <u>Example of calculation</u> $m = 1030 \text{ kg m}^{-3} \times 1.60 \times 10^{-2} \text{ m}^3 = 16.5 \text{ kg}$ $U = 16.5 \text{ kg} \times 9.81 \text{ N kg}^{-1} = 162 \text{ N}$ $W = 35 \text{ kg} \times 9.81 \text{ N kg}^{-1} = 343 \text{ N}$ $D = W - U = 343 \text{ N} - 162 \text{ N} = 181 \text{ N}$	**(1)** **(1)** **(1)** **(1)** **(1)**	**5**
18(a)(ii)	Use of $D = k v^2$ $v = 9.1 \text{ m s}^{-1}$ (allow ecf from (a)(i)) <u>Example of calculation</u> $D = 181 \text{ N} = 2.2 \text{ N s}^2 \text{ m}^{-2} \times v^2$ $v = \sqrt{(181 \text{ N} \div 2.2 \text{ N s}^2 \text{ m}^{-2})} = 9.1 \text{ m s}^{-1}$	**(1)** **(1)**	**2**
18(a)(iii)	Object might not be spherical Flow might not be laminar	**(1)** **(1)**	**2**
18(b)	Drag force increases as velocity increases Until drag force plus weight equals upthrust (Resultant force is then zero) so the object stops accelerating	**(1)** **(1)** **(1)**	**3**
	Total for question 18		**12**

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