Pearson Edexcel

Mark Scheme (Results)

January 2019

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.

For example:

(iii) 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.]	✓	**1**

This has a clear statement of the principle for awarding the mark, supported by some examples illustrating acceptable boundaries.

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.
   - 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 Incorrect use of case e.g. 'Watt' or 'w' will **not** be penalised.
   - 2.3 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, for example in a spreadsheet.
   - 2.4 The same missing or incorrect unit will not be penalised more than once within one question (one clip in epen).
   - 2.5 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.
   - 2.6 The mark scheme will indicate if no unit error penalty is to be applied by means of [no ue].

3. **Significant figures**
   - 3.1 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.
   - 3.2 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}

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.

4.6 Example of mark scheme for a calculation:

'Show that' calculation of weight

Use of L × W × H ✓

Substitution into density equation with a volume and density ✓

Correct answer [49.4 (N)] to at least 3 sig fig. [No ue] ✓
[If 5040 g rounded to 5000 g or 5 kg, do not give 3rd mark; if conversion to kg is omitted and then answer fudged, do not give 3rd mark]
[Bald answer scores 0, reverse calculation 2/3] **3**

Example of answer:

80 cm × 50 cm × 1.8 cm = 7200 cm^3

7200 cm^3 × 0.70 g cm^{-3} = 5040 g

5040 × 10^{-3} kg × 9.81 N/kg

= 49.4 N

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	**D is the correct answer** A is not the correct answer as work done is a scalar quantity B is not the correct answer as time is a scalar quantity C is not the correct answer as temperature is a scalar quantity	**(1)**
2	**C is the correct answer as 1 kWh = 1000 W × 3600 s = 3.6× 10^6 J** A is not the correct answer as 0.28 J= $\frac{1000\ \text{W}}{3600\ \text{J}}$ B is not the correct answer as 0.28 W= $\frac{1000\ \text{W}}{3600\ \text{J}}$ and the unit should be J and not W D is not the correct answer as the unit should be J and not W.	**(1)**
3	**D is the correct answer** A is not the correct answer as Stokes' Law does not apply to large spheres moving quickly through a fluid B is not the correct answer as Stokes' Law does not apply to large spheres C is not the correct answer as Stokes' Law does not apply to spheres moving quickly through a fluid	**(1)**
4	**C is the correct answer as efficiency = $\frac{\text{useful energy output}}{\text{total energy input}} = \frac{200\ \text{N} \times 4\ \text{m}}{90\ \text{N} \times 10\ \text{m}}$** A is not the correct answer as this is the total energy input divided by the useful energy output B is not the correct answer as this is the useful energy output divided by the total of the energy output and the energy input D is not the correct answer as this is the total energy input divided by the total of the energy output and the energy input	**(1)**
5	**B is the correct answer as the forces act in opposite directions and not the same direction** A is not the correct answer as a N3 pair of forces do act at the same time C is not the correct answer as a N3 pair of forces do act on different objects D is not the correct answer as a N3 pair of forces do have the same magnitude	**(1)**
6	**C is the correct answer as there is always an acceleration of 9.81 m s^{-2}** A is not the correct answer as there is always an acceleration of 9.81 m s^{-2} B is not the correct answer as there is always an acceleration of 9.81 m s^{-2} D is not the correct answer as there is always an acceleration of 9.81 m s^{-2}	**(1)**
7	**A is the correct answer as strain = $\frac{\text{extension}}{\text{original length}} = \frac{0.2}{50}$** B is not the correct answer as the extension in mm was not converted to cm before being used in the equation for strain C is not the correct answer as the extension in mm was not converted to cm and the incorrect formula of original length/extension was used D is not the correct answer as the incorrect formula of original length/extension was used.	**(1)**

8	**A is the correct answer as E_{grav} decreases at an increasing rate as the ball accelerates towards the ground and increases at a decreasing rate as the ball decelerates away from the ground after the bounce** B is not the correct answer as E_{grav} increases as the height of the ball above the ground decreases and decreases as height of the ball above the ground increases. C is not the correct answer as the graph does not show the change in as E_{grav} at an increasing and decreasing rate as in response A, as the height of the ball above the ground changes D is not the correct answer as E_{grav} increases as the height of the ball above the ground decreases and decreases as the height of the ball above the ground increases.	**(1)**
9	**D is the correct answer** A is not the correct answer as the stiffness constant only applies to objects B is not the correct answer as the Young modulus only applies to materials C is not the correct answer as the stiffness constant only applies to objects and the Young modulus only applies to materials	**(1)**
10	**D is the correct answer as** $\rho_L = \frac{50}{(1.5x)^3}$ and $\rho_S = \frac{50}{(x)^3}$ so $\frac{\rho_L}{\rho_S} = \frac{(x)^3}{(1.5x)^3} = 0.30$ A is not the correct answer as this is $\frac{(1.5x)^3}{(x)^3}$ B is not the correct answer as this is $\frac{1.5\,x}{x}$ C is not the correct answer as this is $\frac{x}{1.5x}$	**(1)**

Question Number	Answer	Mark
11	• Use of $a = \frac{v-u}{t}$ (1) • See 1.6 m s^{-2} **Or** see (−)4.9 to (−)5.2 m s^{-2} (1) **Max 1** • At 9 s the acceleration becomes negative (1) • From 9 s to 12 s the object is decelerating (1) • From 12 s to 17.5 seconds the object is accelerating while moving in the opposite direction (1) Example of calculation $a = \frac{14 \text{ m s}^{-1} - 0}{9} = 1.56$ m s^{-2}	3
	Total for question 11	**3**

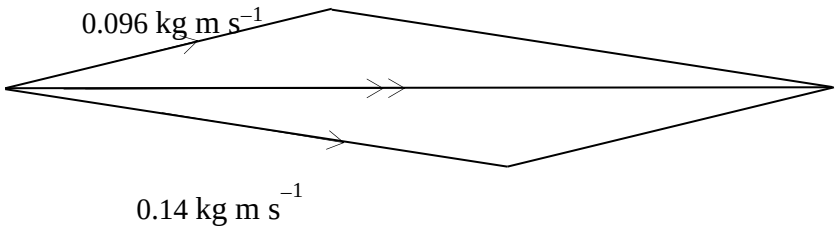
Question Number	Answer	Mark
12(a)	• Length/height of wooden rod (1) • Distance from the rod to the light gate (1)	**2**
12(b)	• $v = \frac{\text{length of rod}}{\text{time (to pass through light gate)}}$ (1) • Repeat (at each height) and (calculate) an average (1)	**2**
12(c)	• Repeat at different (release) heights (above the light gate and calculate *v* for each height) (1) • States an appropriate graph to draw (1) • Corresponding description of how to obtain the acceleration from the gradient (1) **Graph** | $s - v^2$ | $v^2 - s$ | $2s - v^2$ | $v^2 - 2s$ | $v^2/2 - s$ | $s - v^2/2$ ***a*** | 1/(2×gradient) | gradient/2 | 1/gradient | gradient | gradient | 1/gradient **Gradient** | 1/2*a* | 2*a* | 1/*a* | *a* | *a* | 1/*a*	**3**
	Total for question 12	**7**

Question Number	Answer	Mark
13(a)	• Use of $\Sigma F = 0$, seen or implied (1) • $F = 11$ N (1) • Use of moment of force = Fx (with any corresponding force and known distance from an end, A or midpoint) (1) • Use of the principle of moments (1) • $x = 0.86$ m (1) <u>Example of calculation</u> $F_A + F_B = 8.5\text{ N} + 14\text{ N} = 22.5\text{ N}$ $F_A = F_B$ $2F = 22.5\text{ N}$ $F = 11.25\text{ N}$ if moments taken from the left end $(11.25\text{ N} \times 0.15\text{ m}) + (11.25\text{ N} \times x) = (8.5\text{ N} \times 0.35\text{ m}) + (14\text{ N} \times 0.60\text{ m})$ $x = 0.861$ m if moments taken from midpoint $(11.25\text{ N} \times 0.45\text{ m}) = (11.25\text{ N} \times x) + (8.5\text{ N} \times 0.25\text{ m})$ $x = 0.261$ m so distance = 0.261 m + 0.6 m = 0.861 m if moments taken from A $(8.5\text{ N} \times 0.20\text{ m}) + (14\text{ N} \times 0.45\text{ m}) = (11.25\text{ N} \times x)$ $x = 0.711$ m so distance = 0.711 + 0.15 m = 0.861 m	**5**
13(b)	The moment (of B) must be the same (1) For a smaller distance (from the left end of the shelf), the (normal contact) force must increase (1)	**2**
	Total for question 13	**7**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>*14</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><td>Number of indicative marking points seen in answer</td><td>Number of marks awarded for indicative marking points</td></tr>
<tr><td>6</td><td>4</td></tr>
<tr><td>5–4</td><td>3</td></tr>
<tr><td>3–2</td><td>2</td></tr>
<tr><td>1</td><td>1</td></tr>
<tr><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><td></td><td>Number of marks awarded for structure of answer and sustained line of reasoning</td></tr>
<tr><td>Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout</td><td>2
(a minimum of 5 linked IC points including IC1,2 and 6)</td></tr>
<tr><td>Answer is partially structured with some linkages and lines of reasoning</td><td>1
(a minimum 2 linked IC points)</td></tr>
<tr><td>Answer has no linkages between points and is unstructured</td><td>0</td></tr>
</table>
Total marks awarded is the sum of marks for indicative content and the marks for structure and lines of reasoning

Indicative content
• Statement 1 leads to a weight/mass decrease
• Statement 2 leads to a weight/mass increase
• Volume stays the same
• Upthrust stays the same
• To rise, weight is less than upthrust (for statement 1)
Or to sink, weight is greater than upthrust (for statement 2)
• Statement 1 is correct as there is a resultant force upwards
</td><td>6</td></tr>
<tr><td></td><td>Total for question 14</td><td>6</td></tr>
</table>

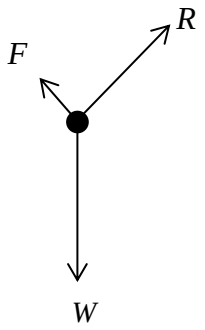
Question Number	Answer		Mark
15(a)	• Construction of correct vector diagram (parallelogram or triangle) with all 3 directions and 0.096 (kg m s^{-1}) and 0.14(kg m s^{-1}) labelled	(1)	
	• Momenta correctly scaled (ratio of lengths 0.14 to 0.096 rounds to between 1.40 and 1.50)	(1)	
	• Horizontal resultant (to within a slope of 1 small square)	(1)	
	• Total momentum = 0.22 to 0.24 (kg m s^{-1}) (Do not award MP4 if this value has been obtained by calculation or from an incorrect diagram)	(1)	**4**
			
15(b)	• The sum/total momentum before a collision is equal to the sum/total momentum after a collision	(1)	
	• Provided no external forces act (on the system) **Or** in a closed system	(1)	**2**
15(c)	• Use of $p = mv$	(1)	
	• v = 1.9 m s^{-1}	(1)	**2**
	(v = 1.7 m s^{-1} using show that value and allow ecf from (a), v = 2.0 m s^{-1} if 0.236 kg m s^{-1} used) <u>Example of calculation</u> 0.23 kg m s^{-1} = 0.12 kg × v v = 1.92 m s^{-1}		
	Total for question 15		**8**

Question Number	Answer	Mark
16(a)(i)	• Use $v^2 = u^2 + 2as$ **(1)** • a = (–) 10.6 (m s^{-2}) **(1)** Example of calculation (75 m s^{-1})^2 = (460 m s^{-1})^2 + (2 × a × 9700 m) a = – 10.6 m s^{-2}	**2**
16(a)(ii)	• Use of $F = ma$ **Or** $W = mg$ **(1)** • Use of $mg - F\cos 6 = ma$ **(1)** • F = 8700 N **(1)** (ecf from (a)(i), direction of a must be negative for MP2, F = 8900 N using the show that value) Example of calculation 600 kg × (3.8 N kg^{-1}) – Fcos6 = 600 kg × (–10.6 m s^{-2}) F = 8690 N	**3**

16(b)	**Either** • Free fall means that weight/gravity is the only force acting on the object/probe **(1)** • There will also be resistive forces acting on the probe **(1)** • Use $v^2 = u^2 + 2as$ to determine the acceleration **(1)** • $a = 2.4$ m s^{-2} **(1)** • Acceleration (of free-fall on Mars) = 3.8 (m s^{-2}) **(1)** • Comparison of their calculated acceleration to acceleration of free-fall with reason e.g. 2.4 m s^{-2} is lower than 3.8 m s^{-2} so it was not in free fall. **(1)** **Or** • Free fall means that weight/gravity is the only force acting on the object/probe **(1)** • There will also be resistive forces acting on the probe **(1)** • Use $v^2 = u^2 + 2as$ to determine the final velocity **(1)** • using $a = 3.8$ (m s^{-2}) **(1)** • $v = 181$ m s^{-1} **(1)** • Comparison of their calculated velocity to 150 m s^{-1} with reason **(1)** **Or** • Free fall means that weight/gravity is the only force acting on the object/probe **(1)** • There will also be resistive forces acting on the probe **(1)** • Use $v^2 = u^2 + 2as$ to determine the displacement **(1)** • Using $a = 3.8$ (m s^{-2}) **(1)** • $s = 2.4$ km **(1)** • Comparison of their calculated displacement to 3.7 km with reason **(1)** <u>Example of calculation</u> (150 m s^{-1})^2 = (68 m s^{-1})^2 + (2 × a × 3700 m) $a = 2.42$ m s^{-2}	**6**
	Total for question 16	**11**

Question Number	Answer	Mark
17(a)	• Use of Young modulus = gradient (of either initial linear region of graph) (1) (MP1 accept ratios of co-ordinates up to strains of (E_{28})0.0015 or (E_2) 0.0014) • See 3.2 to 3.3 × 10^{10} (Pa) **Or** 4.2 to 4.4 × 10^{10} (Pa) (1) • Comparison of the two values obtained i.e. use of E_{28}/E_2 **Or** $(E_{28}-E_2)/E_2$ (1) • E_{28}/E_2 = 1.30 to 1.40 **Or** $(E_{28}-E_2)/E_2$ = 0.30 to 0.40 (1) (MP4 is conditional on candidates using the linear sections for both graphs in MP1) <u>Example of calculation</u> $E_{28} = \frac{140 \times 10^6 \text{ Pa}}{0.0032} = 4.38 \times 10^{10}$ Pa $E_2 = \frac{104 \times 10^6 \text{ Pa}}{0.0032} = 3.25 \times 10^{10}$ Pa $E_{28}/E_2 = \frac{4.38 \times 10^{10} \text{ Pa}}{3.25 \times 10^{10} \text{ Pa}} = 1.35$	**4**
17(b)	• Use of counting squares or approximation of the area to a series of shapes from the 28-day graph (1) • $\frac{0.35 \times 10^6 - \text{area under 28-day graph}}{0.35 \times 10^6}$ (1) • Percentage reduction = 12.0 % to 15.0 % (1) <u>Example of calculation</u> ΔE_{28} = (½×80 × 10^6 Pa×0.0019) + [½(80 + 128) Pa × 10^6 × (0.0038 – 0.0019)] + (64 ×0.0001 × 4 × 10^6 Pa) = 299 200 J m^{-3} Percentage reduction = $\frac{350\,000 \text{ J m}^{-3} - 299\,200 \text{ J m}^{-3}}{350\,000 \text{ J m}^{-3}} \times 100 = 14.5$ %	**3**

17(c)	• The breaking stress/force is greater (1) • The concrete is less flexible **Or** the concrete is stiffer (1) (Do not accept a greater Young modulus) • There is a smaller plastic region **Or** the elastic region is greater **Or** there's little change in the toughness **Or** a change in the properties of the concrete after you've used it could cause problems (1)	**3**
	Total for question 17	**10**

Question Number	Answer		Mark
18(a)	• Weight/*W*/*mg* labelled • (Normal) reaction/contact force (accept *R*/*N*/*C*) • Friction/*F* • Lengths $R<W$ **and** $F<W$ (-1 off total for each additional arrowed line and MP4 conditional on MP1, 2 **and** 3) (do not accept components of forces, even if both given and accept correct direction/size by eye)  	**(1)** **(1)** **(1)** **(1)**	**4**
18(b)(i)	• Initially friction/drag negligible/small/less (as the velocity is low) • See $mg\sin\theta$ **Or** $W\sin\theta$ • $mg\sin\theta = ma$ and the masses cancel (so *a* independent of *m*)	**(1)** **(1)** **(1)**	**3**
18(b)(ii)	• As velocity increases, air resistance increases • Until frictional forces = component of weight down slope • Resultant force = 0 **and** there is no more acceleration (at max velocity) (MP2 allow frictional forces = $mg\sin\theta$)	**(1)** **(1)** **(1)**	**3**
18(b)(iii)	• A larger person would have a greater area/volume • The air resistance would be greater (accept drag)	**(1)** **(1)**	**2**

18(c)(i)	See $\theta = \tan^{-1} 0.2$ **and** $\theta = 11.3°$ **Or** see $\tan\theta = 0.2$ **and** $\theta = 11.3°$	**(1)**	**1**
18(c)(ii)	**Either** (Energy) Use of $E_k = ½ mv^2$ Use of trig to determine the component of weight along the slope or the vertical height in terms of L Use of $E_{grav} = mg\Delta h$ (to determine E_{grav}) **Or** use of $W = F\Delta s$ Use of of $E_k = E_{grav} + W$ (to determine $L = 120$ m **Or** (forces) Use of trig to determine the component of weight along the slope or the vertical height in terms of L Use of resultant force = $mg\sin 11.3° + 240$ N Use of $\Sigma F = ma$ to determine a Use of $v^2 = u^2 + 2as$ with their a (not 9.81) to determine s $L = 120$ m Example of calculation $E_k = ½ \times 95 \text{ kg} \times (33 \text{ m s}^{-1})^2 = 51728$ J $51728 \text{ J} = (95 \text{ kg} \times 9.81 \text{ N kg}^{-1} \times \sin 11.3° \times L) + (240 \text{ N} \times L)$ $L = 122$ m	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**5**
	Total for question 18		**18**

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