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Mark Scheme (Results)

January 2020

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] ✓ **1**

[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.]

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. '<u>resonance</u>'
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:

<u>'Show that' calculation of weight</u>

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]

Example of answer:

$80\text{ cm} \times 50\text{ cm} \times 1.8\text{ cm} = 7200\text{ cm}^3$

$7200\text{ cm}^3 \times 0.70\text{ g cm}^{-3} = 5040\text{ g}$

$5040 \times 10^{-3}\text{ kg} \times 9.81\text{ N/kg}$ **3**

$= 49.4\text{ N}$

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.

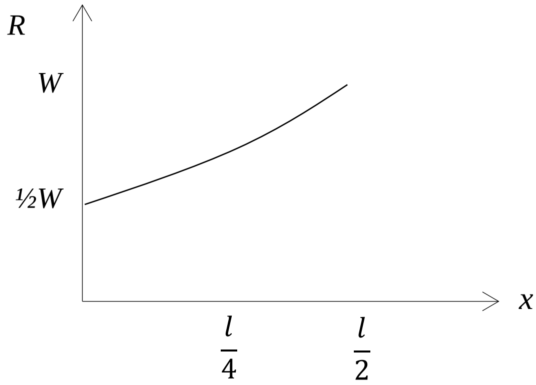
- Check the two points furthest from the best line. If both OK award mark.
- If either is 2 mm out do not award mark.
- If both are 1 mm out do not award mark.
- If either is 1 mm out then check another two and award mark if both of these OK, otherwise no mark.
- For a line mark there must be a thin continuous line which is the best-fit line for the candidate's results.

Question Number	Answer	Mark
1	**C is the correct answer** A is not the correct answer as units would be kg m s^{-2} B is not the correct answer as units would be kg m s^{-1} D is not the correct answer as units would be kg m^2 s^{-2}	**(1)**
2	**B is the correct answer** A is not the correct answer as force per unit length has no meaning. C is not the correct answer as this is the gravitational force. D is not the correct answer as this is gravitational potential.	**(1)**
3	**B is the correct answer** A is not the correct answer as the magnitude of the final velocity would be greater and a little less to the right. C is not the correct answer as the final velocity would be greater and to the left of the original velocity. D is not the correct answer as the final velocity would be similar to C, but more to the left and of a lesser magnitude.	**(1)**
4	**D is the correct answer** A is not the correct answer as the velocity is not constant at all times. B is not the correct answer as the velocity is still not constant at all times. C is not the correct answer as the air resistance does not act in the opposite direction to gravity when an object travels upwards.	**(1)**
5	**D is the correct answer** A is not the correct answer as the areas under the two graphs are not both zero. B is not the correct answer as the areas under the two graphs are not equal. C is not the correct answer as P is <u>at</u> the initial position.	**(1)**
6	**A is the correct answer** B is not the correct answer as the change in velocity is not 2 m s^{-1}. C is not the correct answer as it gives a negative time, and the collision takes a positive amount of time. D is not the correct answer for the same reason that B is not.	**(1)**
7	**D is the correct answer** A is not the correct answer as it contradicts Newton's Third Law. B is not the correct answer as it also contradicts Newton's Third Law. C is not the correct answer as the force of Y on X is in the opposite direction to the velocity of X.	**(1)**
8	**D is the correct answer** A is not the correct answer as it gives units of J^{-1} which is not a unit for energy. B is not the correct answer for the same reason that A is not. C is not the correct answer as $68 \neq 68\%$.	**(1)**
9	**C is the correct answer** A is not the correct answer as every column is wrong. B is not the correct answer as the P and Q columns are the wrong way round. D is not the correct answer as the Q and R columns are the wrong way round.	**(1)**

10	**A is the correct answer** B is not the correct answer as the gravitational force does not increase. C is not the correct answer as an increase in temperature would reduce the viscosity which would not account for a decrease in acceleration. D is not the correct answer as the upthrust depends on the density of the fluid and the volume of the sphere, neither of which changes.	**(1)**

Question Number	Answer		Mark
11	• Reference to $s = ut + ½ at^2$ with $u = 0$ • Correct variable labels on graph axes to give a straight line through origin. • Reference to time in s and distance in m (this can be taken from the axes labels or a suitable unit conversion) • Straight line through origin. • Correct method to determine g using their graph.	**(1)** **(1)** **(1)** **(1)** **(1)**	**(5)**
	Total for question 11		**5**

Question Number	Answer		Mark
12(a)	• Laminar/non-turbulent flow **Or** Slow moving sphere	(1)	**(1)**
12(b)	• Use of $W = mg$ • $W = U + D$ • Use of $F = 6\pi r\eta v$ • Use of $W = U + D$ to obtain quantity to compare, *e.g.* $D = (-)\ 7.8 \times 10^{-3}$ (N) • Comparison leading to valid conclusion from candidate's calculation. e.g. $F = 2.5 \times 10^{-5}$ N $\neq D$ **or** v = 155 m s$^{-1} \neq 0.5$ m s^{-1} *et al.* <u>Example of calculation</u> $W = 9.1 \times 10^{-4}\ \text{kg} \times 9.81\ \text{N kg}^{-1} = 9.0 \times 10^{-3}\ \text{N}$ $\Sigma F = 9.0 \times 10^{-3}\ \text{N} - 1.1 \times 10^{-3}\ \text{N} - \text{drag} = 0$ Drag = $(-)\ 7.9 \times 10^{-3}$ N $F = 6 \times \pi \times 3.0 \times 10^{-3}\ \text{m} \times 8.9 \times 10^{-4}\ \text{Pa s} \times 0.50\ \text{m s}^{-1}$ $F = 2.5 \times 10^{-5}$ N	(1) (1) (1) (1) (1)	**(5)**
	Total for question 12		**6**

Question Number	Answer	Mark
13(a)	• Point at which weight is taken to act. (1)	**(1)**
13(b)	• Gradient everywhere positive (1) • Stops at R = weight/W/mg at l/2 (1) • Starts at R = ½ weight/0.5W/0.5mg etc. (1) 	**(3)**
13(c)	• Centre of gravity/mass is not above the shelf. **Or** Line of action of weight does not pass through the shelf. (1) • There is a net moment clockwise. **Or** No anticlockwise moment to balance moment of weight. (1)	**(2)**
	Total for question 13	**6**

Question Number	Answer	Mark
***14**	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**

	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

- No change in properties at low strain/stress.
Or A change in properties after a certain point/stress.
- Energy absorbed by capsule concrete can be greater than plain concrete.
- Area under graph for capsule concrete greater.
- (At greater stress) capsule concrete is stiffer
Or (at greater stress) capsule concrete has greater Young Modulus.
- Graph is steeper for capsule concrete (at high stress)
Or ratio of stress to strain is greater (at high stress).
- Maximum stress/force greater for capsule concrete
Or capsule concrete is stronger.

(6)

	Total for question 14	**6**

Question Number	Answer	Mark
15(a)	• Use of $v^2 = u^2 + 2as$ AND $u = 0$ **Or** $mgh = ½mv^2$ (1) • $v = 3.4$ (m s^{-1}) (1) <u>Example of calculation</u> $v^2 = 2 \times 9.81$ m $s^{-2} \times 0.60$ m $v = \sqrt{11.77}$ m s^{-1} $v = 3.43$ m s^{-1}	**(2)**
15(b)	• Horizontal 3.4 × sin 70° **Or** 3.4 × cos 20° **Or** calculated value. (1) • Vertical 3.4 × cos 70° **Or** 3.4 × sin 20° 1.16 **Or** calculated value. (1) Allow e.c.f. from part (a)	**(2)**

15(c)	Use of $v = s/t$ to determine time to end of ramp (0.38 s). • Use of $s = ut - ½ g t^2$ to determine drop in altitude after time t (0.27 m). • Ball does not bounce on the ramp. • Justifies conclusion from numbers calculated. e.g. 0.86 – 0.27 > 0.00 means has not reached ground by end of ramp. <u>Example of calculation</u> $t = \frac{1.23\ \mathrm{m}}{3.4\ \mathrm{m\ s^{-1}} \times \sin 70°}$ $t = 0.39$ s $s = (3.4\ (\mathrm{m\ s^{-1}}) \times \cos 70° \times 0.39\ \mathrm{s}) + (½ \times (-9.81\ \mathrm{m\ s^{-2}}) \times (0.39\ \mathrm{s})^2)$ $s = -0.28$ m **Or** • Use of $s = ut - ½ g t^2$ to determine time to $s = -0.86$ • Use of $s = vt$ to calculate s • Ball does not bounce on the ramp. • Justifies conclusion from numbers calculated. e.g. 1.23 < 1.79 **Or** • Use of $v = u - gt_1$ with $v = 0$ to get time to max height (0.12s) **and** use of $s = ½ g t_1^2$ to get gain in height (0.07m) **and** use of $s = ut + ½ g t_2^2$ with $u = 0$ and $s = 0.93$ to get time from there to the ground (0.44s) Total time $t = t_1 + t_2$. • Use of $s = vt$ to calculate s • Ball does not bounce on the ramp. • Justifies conclusion from numbers calculated. e.g. 1.23 < 1.79	(1) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	**(4)**
	Total for question 15		**8**

Question Number	Answer	Mark
16(a)(i)	• Use measurement and scaling factor (1) **(1)** • h = 3.4 ± 0.1 cm **(1)** **OR** • Use of $s = \frac{1}{2}at^2$ with t = 0.083 s **(1)** • h = 3.4 cm **(1)**	**(2)**
16(a)(ii)	• Use of (average) speed = s/t with s = value from part (a)(i) **(1)** • Use of initial speed = 2 × average speed **(1)** • Speed = 0.82 m s^{-1} ecf from (a)(i) **(1)** **OR** • Use of $E_g = mgh$ with h = value from (a)(i) **(1)** • Use of $½mv^2 = E_g$(initial) **(1)** • Speed = 0.82 m s^{-1} ecf from (a)(i) **(1)** **OR** • Use of $v = u + at$ with v = 0 **(1)** • Use of $a = -g$ **(1)** • Speed = 9.81 × 0.083 = 0.81 m s^{-1} **(1)** **OR** • Use of with $s = ut + ½at^2$ with s = value from part (a)(i) **(1)** • Use of $a = -g$ **(1)** • Speed = 0.82 m s^{-1} ecf from (a)(i) **(1)** <u>Example of calculation</u> $u = s/t - ½at$ u = 0.034/0.083 + ½ × 9.81 × 0.083 **OR** • Use of $v^2 = u^2 + 2as$ with s = value from (a)(i) and v = 0 **(1)** • Use of $a = -g$ **(1)**	

	• Speed = 0.82 m s^{-1} ecf from (a)(i) Example of calculation Actual distance travelled by popcorn = 6.2 cm ÷ 1.8 = 3.4 cm (average speed) = $\frac{0.034\text{ m}}{83\times10^{-3}\text{ s}} = 0.41\text{ m s}^{-1}$ Initial speed = 2 × average speed = 0.82 m s^{-1}	**(1)**	**(3)**
16(b)	• Use of 14% to determine mass (of water/popcorn). **Or** $m_{popcorn}/m_{water}$ = 86/14 • Use of $p = mv$ • Use of momentum conservation • v = (–) 9.2 m s^{-1} Example of calculation 0 = (0.0946 g × 1.5 m s^{-1}) + (0.0154 g × v) $v = \frac{-0.0946\text{ g}\times1.5\text{ m s}^{-1}}{0.0154\text{ g}}$ v = –9.21 m s^{-1}	**(1)** **(1)** **(1)** **(1)**	**(4)**
	Total for question 16		**9**

Question Number	Answer		Mark
17(a)(i)	• $E_{el} = ½\ k\ \Delta x^2$ **Or** Use of $E_{el} = ½\ F\Delta x$ **and** use of $F = k\ \Delta x$. • Elastic PE is transferred into kinetic energy **Or** $E_{el} = E_k$ • $½\ m\ v^2 = ½\ k\ \Delta x^2$ • States that m and k are constant so $v \propto \Delta x$. **Or** States that $= \sqrt{\frac{k}{m}}\Delta x$.	(1) (1) (1) (1)	**(4)**
17(a)(ii)	• Gradient calculated. **Or** Use of a point on the line in a relevant equation. • Use of $½\ k\ \Delta x^2 = ½\ m\ v^2$ **or** gradient = $\sqrt{(k/m)}$ i.e. $k = m \times$ gradient^2 • k in range 22 – 26 N m^{-1} Example of calculation Gradient $\frac{4.8\ \text{m s}^{-1} - 2.2\ \text{m s}^{-1}}{0.30\ \text{m}} = 8.67\ (\text{s}^{-1})$ k = mass × gradient^2 $k = 3.0 \times 10^{-1}\ \text{kg} \times (8.67\ \text{s}^{-1})^2$ $k = 22.6\ \text{N m}^{-1}$	(1) (1) (1)	**(3)**
17(b)	• Limit of proportionality exceeded. **Or** Extension no longer proportional to force. • Range of Hooke's Law exceeded. **Or** Hooke's Law no longer applies.	(1) (1)	**(2)**
	Total for question 17		**9**

Question Number	Answer	Mark
18(a)	• Ratio of stress to strain (for a material). **Or** stress per unit strain. **Or** σ / ε with symbols defined. **Or** $\frac{F\,x}{A\,\Delta x}$ with symbols defined. (1)	**(1)**
18(b)(i)	• Mean diameter = 0.234 mm (rounds to) (1) • Use of $A = \pi r^2$ (1) • A = 4.3 x 10^{-8} m^2 **or** 0.043 mm^2 (1) <u>Example of calculation</u> Mean diameter = ¼ (0.230 + 0.235 + 0.230 + 0.240) = 0.234 mm Area = $\pi \frac{(0.234 \times 10^{-3}\ m)^2}{4}$ = 4.30×10^{-8} m^2	**(3)**
18(b)(ii)	• Use of $W = m\,g$ (1) • Use of gradient = $m / \Delta x$ in Young Modulus formula i.e. E = gradient × g × x /A (1) • $E = 1.6 \times 10^{11}$ Pa e.c.f. from (b)(i) (1) <u>Example of calculation</u> Young modulus = $195 \times 9.81\ \text{N kg}^{-1} \times \frac{3.50\ \text{m}}{4.30 \times 10^{-8}\ \text{m}^2}$ $= 1.56 \times 10^{11}$ Pa	**(3)**
18(b)(iii)	Shorter wire gives greater gradient. (1) Young modulus the same. (1)	**(2)**
	Total for question 18	**9**

Question Number	Answer		Mark
19(a)	• Upthrust/*U* upwards • Tension/*T* upwards • Weight/*W*/*mg* downwards (-1 for each extra force over three, -1 if any arrow does not touch the dot, -1 if any arrow is not close to vertical. Accept a single line up with two labelled arrowheads.)	(1) (1) (1)	**(3)**
19(b)(i)	• Water exerts upward force on sphere. **Or** Water exerts an upthrust on the sphere. • Sphere exerts a downwards/opposite force on water by Newton's Third Law. • Extra downward force on water (increases reading on balance).	(1) (1) (1)	**(3)**
19(b)(ii)	• Mass of displaced water = 150 g • Use of $V = m/\rho$ for water with ρ = 1 000 kg m^{-3} (150 ml) • Use of $m = \rho V$ for sphere WITH ρ = 2 000 kg m^{-3} • m = 0.30 kg <u>Example of calculation</u> Increase in weight of water = force of ball on water = upthrust on ball Mass of displaced water = 465 g – 315 g = 150 g Volume of sphere = $\frac{0.150\ \text{kg} \times \cancel{g}}{1000\ \text{kg m}^{-3} \times \cancel{g}}$ = 1.5 × 10^{-4} m^3 Mass of sphere = 2000 kg m^{-3}× 1.5 × 10^{-4}	(1) (1) (1) (1)	**(4)**
19(b)(iii)	• Upthrust less in oil **or** weight of displaced oil less **or** downward force of sphere on oil less • (Therefore increase in) balance reading less (than for water). (MP2 dependent on MP1)	(1) (1)	**(2)**
	Total for question 19		**12**

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