



Mark Scheme (Results)

June 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] ✓ 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. '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 open).
- 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 $g = 10 \text{ m s}^{-2}$ 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 $L \times W \times H$ ✓

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:

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

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

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

$$= 49.4 \text{ N}$$

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.

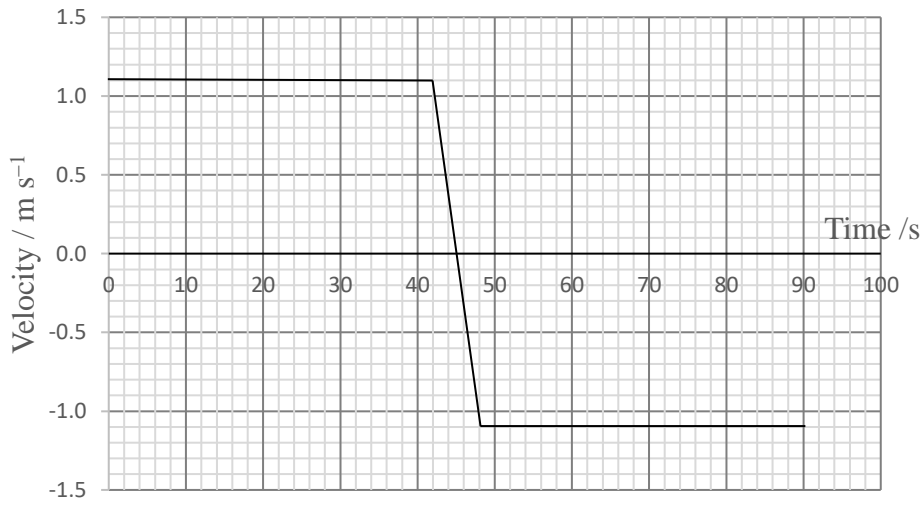
6. Graphs

- 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.

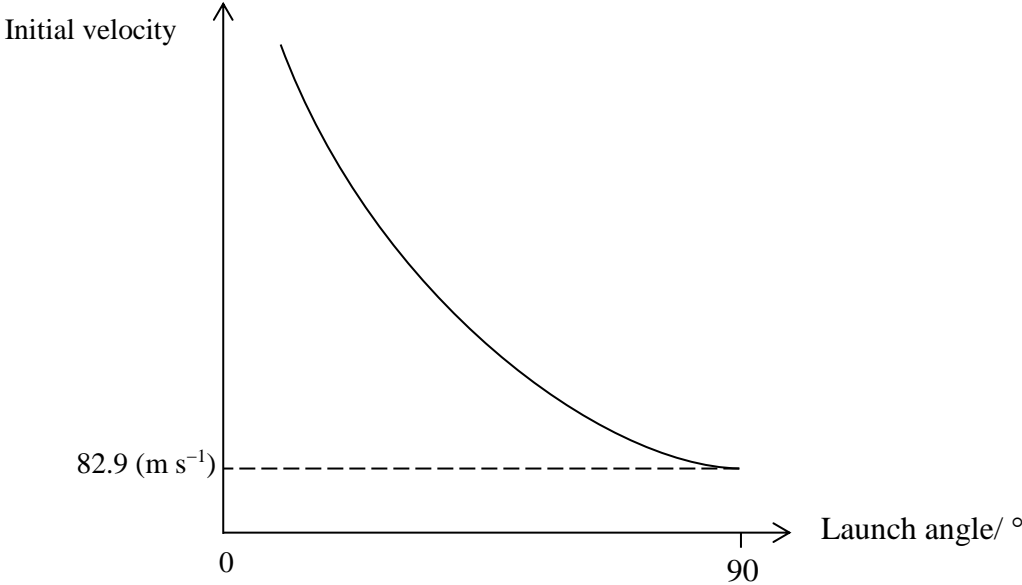
Question Number	Answer	Mark
1	D is the correct answer X is not the correct answer as, X is not the correct answer as, X is not the correct answer as, <div style="border: 1px solid black; padding: 5px; display: inline-block; color: red;">Distractor descriptions to be completed after QPEC</div>	(1)
2	C is the correct answer X is not the correct answer as, X is not the correct answer as, X is not the correct answer as,	(1)
3	B is the correct answer X is not the correct answer as, X is not the correct answer as, X is not the correct answer as,	(1)
4	B is the correct answer X is not the correct answer as, X is not the correct answer as, X is not the correct answer as,	(1)
5	D is the correct answer X is not the correct answer as, X is not the correct answer as, X is not the correct answer as,	(1)
6	C is the correct answer X is not the correct answer as, X is not the correct answer as, X is not the correct answer as,	(1)
7	B is the correct answer X is not the correct answer as, X is not the correct answer as, X is not the correct answer as,	(1)
8	C is the correct answer X is not the correct answer as, X is not the correct answer as, X is not the correct answer as,	(1)
9	B is the correct answer X is not the correct answer as, X is not the correct answer as, X is not the correct answer as,	(1)
10	C is the correct answer X is not the correct answer as, X is not the correct answer as, X is not the correct answer as,	(1)

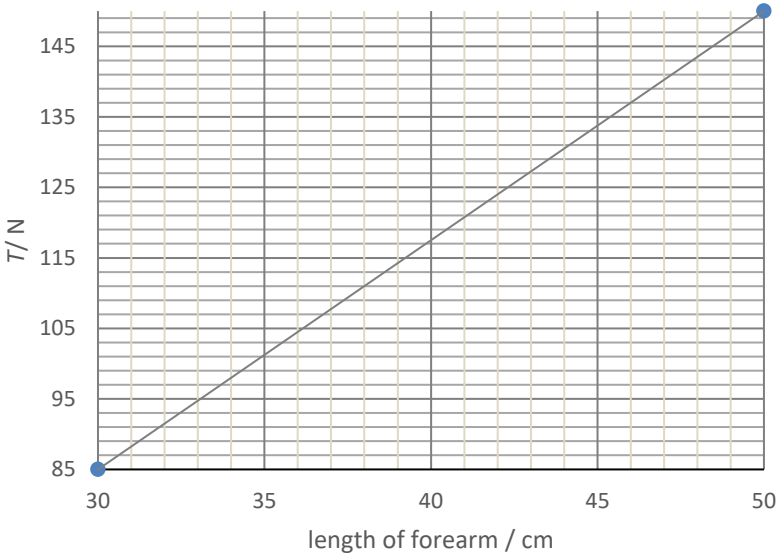
Question Number	Answer	Mark
11	<p>Max 4</p> <ul style="list-style-type: none"> Initial momentum (of the child, ball and skateboard/total) is zero (1) Due to conservation of momentum, the total momentum before the ball is thrown = total momentum after the ball is thrown (so final total momentum is zero) (1) [accept collision/explosion for “ball is thrown”] The momentum of the child/skateboard is equal to the momentum of the ball (1) The momentum of the child/skateboard is opposite in direction to the momentum of the ball (1) As the mass of the child/skateboard greater (than the mass of ball), the velocity (of the child/skateboard) will be lower (1) <p>(all symbols to be defined, ‘mv’ to be defined if used for momentum) (MP3 accept to the right/positive for forwards)</p>	4
	Total for question 11	4

Question Number	Answer	Mark
12	<p>Either (1)</p> <ul style="list-style-type: none"> • Use of $\sin \theta = \frac{2.0}{15}$ Or use of $\theta = 7.7^\circ$ (1) • Use of Work done = $F\Delta s$ Or use of $E_{\text{grav}} = mg\Delta h$ (1) • Use of efficiency = $\frac{\text{useful energy output}}{\text{total energy input}} (\times 100 \%)$ (1) • Efficiency = 83 or 84 % so less than 90 % (MP4 dependent on scoring all points MP1& 2 &3) <p><u>Example of calculation</u> (1)</p> <p>$\sin^{-1}\left(\frac{2.0}{15}\right) = 7.7^\circ$ (1)</p> <p>$W_{50} = 50 \text{ kg} \times 9.81 \text{ N kg}^{-1} \times 2.0 \text{ m} \times \frac{2.0}{15} = 130.8 \text{ J}$ (1)</p> <p>$W_8 = 8.0 \text{ kg} \times 9.81 \text{ N kg}^{-1} \times 2.0 \text{ m} = 157.0 \text{ J}$ (1)</p> <p>Efficiency = $\frac{130.8\text{J}}{157.0\text{J}} \times 100 \% = 83 \%$</p>	4
	Total for question 12	4

Question Number	Answer	Mark
13(a)	<ul style="list-style-type: none"> • Use of $v = s/t$ Or use of gradient (1) • $v = (\pm) 1.1$ to $1.2 \text{ (m s}^{-1}\text{)}$ (1) • Scaling of the velocity axis so that the graph covers at least 50% of the paper above and below the axes. (A minimum of 1 number on each axis required e.g. 1 and -1) (1) • A positive constant velocity from 0 to 42 s and the same negative constant velocity from 48 s to 90 s with connecting line/curve (tolerance of $\pm 1 \text{ s}$) (1) <p><u>Example of calculation</u></p> <p>Initial velocity = $\frac{46 \text{ m}}{40 \text{ s}} = 1.15 \text{ m s}^{-1}$</p> 	4
13(b)(i)	<p>The graph should be a curve initially (1)</p> <p>with a decreasing gradient up to 15 m (by eye) (1)</p> <p>[ignore any part of the graph above 15 m –]</p>	2

13(b)(ii)	1 mark for a simplification	(1)	2										
	1 mark for a corresponding explanation	(1)											
	<table border="1"><thead><tr><th>Simplification</th><th>Explanation</th></tr></thead><tbody><tr><td>Velocity constant Or velocity doesn't change Or velocity is an average Or no regions of acceleration/deceleration</td><td><ul style="list-style-type: none">• Variation in velocity during each stroke• The force applied to the swimmer/water varies (within the stroke)• As the swimmer moves above/below water to breathe, the velocity changes• The speed would change as they went from gliding to swimming</td></tr><tr><td>The velocity of the swimmer has the same magnitude in both parts of the race</td><td>The swimmer may have tired and this could be less for the second half of the race</td></tr><tr><td>The initial velocity after the turn would be greater</td><td>The swimmer would probably glide (underwater) after the turn</td></tr><tr><td>Gradient should initially increase from zero</td><td>Swimmer initially pushes off from starting block/turn</td></tr></tbody></table>			Simplification	Explanation	Velocity constant Or velocity doesn't change Or velocity is an average Or no regions of acceleration/deceleration	<ul style="list-style-type: none">• Variation in velocity during each stroke• The force applied to the swimmer/water varies (within the stroke)• As the swimmer moves above/below water to breathe, the velocity changes• The speed would change as they went from gliding to swimming	The velocity of the swimmer has the same magnitude in both parts of the race	The swimmer may have tired and this could be less for the second half of the race	The initial velocity after the turn would be greater	The swimmer would probably glide (underwater) after the turn	Gradient should initially increase from zero	Swimmer initially pushes off from starting block/turn
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Treat references to drag as neutral.													
Total for question 13													
		8											


Question Number	Answer	Mark
14(a)(i)	<ul style="list-style-type: none"> Use of equation(s) of motion to determine u_v (1) Or Use of $E_k = E_{\text{grav}}$ (1) $u_v = 83 \text{ (m s}^{-1}\text{)}$ [for mp2 must have used $v = 0$ and $-g$] (1) <p>Example of calculation $0^2 = u^2 + 2(-9.81 \text{ m s}^{-2})(350 \text{ m})$ $u = 82.9 \text{ m s}^{-1}$</p>	2
14(a)(ii)	<ul style="list-style-type: none"> Launch angle increasing as initial velocity decreases (i.e. negative gradient) (1) Curve drawn (1) Minimum initial velocity marked, and graph passes through (90, 82.9/80) Or other correct pair of points labelled and plotted (1) Initial velocity axis asymptotic (1) 	4
14(b)	<p>(Perpendicular) distance to firework = time (counted) \times speed of sound (1) [for mp1 must have used speed of sound] (1)</p> <p>Diameter of firework = $2 \times \text{distance} \times \tan(\phi/2)$ (allow Diameter of firework = distance $\times \tan(\phi/2)$)</p>	2
Total for question 14		8

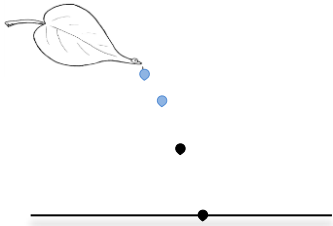
Question Number	Answer	Mark
15(a)	<ul style="list-style-type: none"> Estimate of length of forearm 30 – 50 (cm) (1) Use of trig to determine the perpendicular component of the tension Or see $T \sin 70$ Or see $T \cos 20$ (1) Use of moment = Fx with a corresponding force and distance (1) Use of the principle of moments (1) Value for T in range 85 N to 150 N ($l = 30$, $T = 85$ N and $l = 50$, $T = 150$ N) (1) <p>(add notes to a practice items to explain if incorrect distances used – must all be credible moments)</p> <p><u>Example of calculation</u> (for $l = 0.40$ m)</p> <p>$(0.04 \text{ m} \times T \times \sin 70) = (0.31 \text{ m} \times 4.5 \text{ N}) + (0.20 \text{ m} \times 15 \text{ N})$</p> <p>$T = 117 \text{ N}$</p> 	5
15(b)	<ul style="list-style-type: none"> The forearm is not uniform/symmetrical (1) The centre of gravity[/mass] is not in the middle (1) 	2
Total for question 15		7

Question Number	Answer	Mark
16(a)	<ul style="list-style-type: none"> • Use a micrometer (screw gauge) Or (vernier)digital calipers (1) • At different orientations and/or positions along the wire (1) • Calculate/determine/take/find a mean/average value (1) 	3
16(b)	<ul style="list-style-type: none"> • Use of $A = \pi \left(\frac{d}{2}\right)^2$ (1) • Calculate gradient of linear section (up to 3×10^{-3} m, 6.8 N) of graph Or use of a corresponding pair of points for F and Δx from the linear region of the graph (1) • Use of $\sigma = \frac{F}{A}$ and $\varepsilon = \frac{\Delta x}{l}$ (1) Or use of $E = \frac{Fl}{A\Delta x}$ (1) Or Use of $E = \text{gradient} \times \frac{l}{A}$ (1) • $E = (1.2 - 1.3) \times 10^{11}$ Pa (MP4 conditional on scoring MP1 & MP2 & MP3) <p><u>Example of calculation using gradient</u></p> $A = \pi \left(\frac{2.3 \times 10^{-4} \text{ m}}{2}\right)^2 = 4.15 \times 10^{-8} \text{ m}^2$ $\text{Gradient} = \frac{6.5 \text{ N}}{2.9 \times 10^{-3} \text{ m}} = 2.2 \times 10^3 \text{ N m}^{-1}$ $E = 2.2 \times 10^3 \text{ N m}^{-1} \times \frac{2.4 \text{ m}}{4.15 \times 10^{-8} \text{ m}^2} = 1.27 \times 10^{11} \text{ Pa}$	4

*16(c)	<ul style="list-style-type: none">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> <ul style="list-style-type: none">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</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> <p>Total marks awarded is the sum of marks for indicative content and the marks for structure and lines of reasoning</p> <p>Indicative content</p> <ul style="list-style-type: none">For long(er) wire, the extension will be large(r)(For the same load) extension is proportional to the original length <p>Or $\frac{\text{extension}}{\text{original length}} = \text{constant}$</p> <ul style="list-style-type: none">For a thin(ner) wire, the extension will be large(r)(For the same load) extension is inversely proportional to cross-sectional area (may be explained in terms of E, σ and ϵ)The percentage uncertainty in the extension/length will be lower (although this will be greater for the cross-sectional area)A small(er) load can be used with a long/thin wire <p>[For 1 linkage mark there must be 3 IC points to include either IC1 and IC2/IC5 Or IC3 and IC4/IC5 For 2 linkage marks there must be at least 5 IC points including IC1 and IC2/IC5 and IC3 and IC4/IC5]</p>	Number of indicative marking points seen in answer	Number of marks awarded for indicative marking points	6	4	5–4	3	3–2	2	1	1	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	
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	Total for question 16	6 13																				

Question Number	Answer	Mark
17(a)(i)	<p>Use of fall factor = $\frac{\text{height fallen before the rope begins to stretch}}{\text{total unstretched length of rope}}$ (1)</p> <p>Use of $\varepsilon = \frac{\Delta x}{x}$ with $x = 15.0$ m (1)</p> <p>Use of $E_{\text{grav}} = mg\Delta h$ (1)</p> <p>Use of $E_{\text{grav}} = E_{\text{el}}$ with their Δx (1)</p> <p>$F_{\text{max}} = 14\,000$ (N) (1)</p> <p><u>Example of calculation</u></p> <p>Height fallen = $15.0 \text{ m} \times 0.8 = 12 \text{ m}$ $\Delta x = 0.09 \times 15.0 \text{ m} = 1.35 \text{ m}$</p> <p>$E_{\text{grav}} = 71 \text{ kg} \times 9.81 \text{ N kg}^{-1} \times 12 \text{ m} = 8358 \text{ J}$ (from fall)</p> <p>$E_{\text{grav}} = 71 \text{ kg} \times 9.81 \text{ N kg}^{-1} \times 1.35 \text{ m} = 940.3 \text{ J}$ (from extension)</p> <p>$8358 \text{ J} + 940.3 \text{ J} = \frac{1}{2} \times F_{\text{max}} \times 1.35 \text{ m}$</p> <p>$F_{\text{max}} = 13\,775 \text{ N}$</p>	5
17(a)(ii)	<ul style="list-style-type: none"> This would not be a good idea, as the climber would reach a higher velocity (just before the rope stretches) (1) (Hence) the climber's deceleration/force (as the rope stretches) would be greater (1) <p>[Allow max 1 mark for greater distance or time falling]</p>	2
17(b)	<p>Max 6</p> <ul style="list-style-type: none"> Use of area under the graph to determine the stored energy (1) Energy = 800 J (new) (1) Energy = 700 J (old) (1) The old rope would absorb/store less energy (1) Use of $F = k\Delta x$ to determine k (accept gradient of a tangent) (1) Calculation of k for both ropes at same applied force (1) The old rope is not as stiff as the new rope (1) Or The old rope extends more (1) The old rope would break at a smaller applied force/stress 	6
	Total for question 17	13

Question Number	Answer	Mark
18(a)(i)	<p>Explanation</p> <ul style="list-style-type: none"> Terminal velocity is the constant/maximum velocity the rain reaches Or terminal velocity is the velocity when acceleration = 0 (1) When weight = Drag (+ upthrust) Or when forces is equilibrium Or when resultant force = 0 (accept when the total upward force = total downward force) (1) <p>Diagram</p> <ul style="list-style-type: none"> Weight and air resistance (and upthrust) only drawn with correct directions (arrowed lines must touch dot, and labels included) (1) Arrow lengths of weight and air resistance same length (if upthrust drawn, upthrust line + drag line = weight line) (MP4 dependent on MP3) (1) <div style="text-align: center;"> <p>Air resistance/F/D</p>  <p>Weight/W/mg</p> </div>	4

18(a)(ii)	<ul style="list-style-type: none"> • Use of $A = \pi r^2$ and $V = \frac{4}{3} \pi r^3$ (1) • Use of $\rho = \frac{m}{V}$ and $W = mg$ (1) • Use of $W = F$ (1) • $v = 6.5 - 7.0 \text{ m s}^{-1}$ (1) <p><u>Example of calculation</u> $A = \pi \times (0.002)^2 = 1.26 \times 10^{-5} \text{ m}^2$ $V = \frac{4}{3} \pi \times (0.002 \text{ m})^3 = 3.35 \times 10^{-8} \text{ m}^3$ $m = 1000 \text{ kg m}^{-3} \times 3.35 \times 10^{-8} \text{ m}^3 = 3.35 \times 10^{-5} \text{ kg}$ $W = 3.35 \times 10^{-5} \text{ kg} \times 9.81 \text{ N kg}^{-1} = 3.29 \times 10^{-4} \text{ N}$ $3.29 \times 10^{-4} \text{ N} = 0.45 \times 1.2 \text{ kg m}^{-3} \times 1.26 \times 10^{-5} \text{ m}^2 \times v^2$ $3.29 \times 10^{-4} \text{ N} = 6.79 \times 10^{-8} \times v^2$ $v = 6.96 \text{ m s}^{-1}$</p>	4
18(b)(i)	<ul style="list-style-type: none"> • Vertical displacement increasing (1) • Horizontal displacement constant (same as first two drops) (1) <p>(Mark all added drops but there must be a minimum of 2 additional drops to award MP1 & 2)</p> 	2
18(b)(ii)	<ul style="list-style-type: none"> • Use of $s = ut + \frac{1}{2} at^2$ with $u = 0$ (1) [accept use of $t = 0.2 \text{ s}, 0.25 \text{ s}, 0.75 \text{ s}, 1.0 \text{ s}$] (1) • See 0.8 s for the time since the drop left the leaf (1) • $s = 3.1 \text{ m}$ <p><u>Example of calculation</u> $s = \frac{1}{2} \times 9.81 \text{ N kg}^{-1} \times (0.8 \text{ s})^2 = 3.14 \text{ m}$</p>	3
Total for question 18		13