Mark Scheme (Results)

October 2020

Pearson Edexcel International Advanced Subsidiary/Advanced Level
In Physics (WPH011)
Paper 1: Mechanics and Materials

Question Number	Answer	Mark
1	**C is the correct answer** A is not the correct answer as joules are used for energy, a scalar B is not the correct answer as metres are used for distance, a scalar D is not the correct answer as watts are used for power, a scalar	**(1)**
2	**B is the correct answer** A is not the correct answer as *D* has corresponding force on the air C is not the correct answer as *W* has corresponding force on the planet and *D* has corresponding force on the air D is not the correct answer as *W* has corresponding force on the planet	**(1)**
3	**D is the correct answer** A is not the correct answer as would be difference in velocities of cars descending to ground from standing starts at P and Q and is out by factor of $\sqrt{2}$ B is not the correct answer as would be difference in velocities of cars descending to ground from standing starts at P and Q C is not the correct answer as is out by a factor of $\sqrt{2}$	**(1)**
4	**B is the correct answer** A is not the correct answer as this would give a final velocity of 80 m s^{-1} N C is not the correct answer as this would give a final velocity of 120 m s^{-1} N D is not the correct answer as this would give a final velocity of 20 m s^{-1} S	**(1)**
5	**D is the correct answer** A is not the correct answer as *R* has the wrong direction B is not the correct answer as *R* has the wrong direction C is not the correct answer as *R* is along the wrong diagonal	**(1)**
6	**D is the correct answer** A is not the correct answer as spurious factor of 100 and 0.68 multiplies B is not the correct answer as this gives a lower input than output C is not the correct answer as there is a spurious factor of 100	**(1)**
7	**B is the correct answer** A is not the correct answer as a velocity requires two measurements C is not the correct answer as a velocity requires two measurements D is not the correct answer as a velocity requires two measurements	**(1)**
8	**C is the correct answer** A is not the correct answer as $\sigma \div A$ does not give force B is not the correct answer as $\sigma \div A$ does not give force Δx squared D is not the correct answer as Δx squared	**(1)**
9	**B is the correct answer** A is not the correct answer as areas above and below time axis not equal C is not the correct answer as graph starts from zero D is not the correct answer as graph starts from zero	**(1)**

10	**C is the correct answer** A is not the correct answer as no indication in Q9 of extremely high velocity required to change displacement apparently instantly B is not the correct answer as lines straight, indicating no change in velocity D is not the correct answer as lines straight, indicating no change in velocity	**(1)**

Question Number	Answer		Mark
11(a)	• Use of Power = $\frac{\text{energy}}{\text{time}}$ • P = 72 (kW) Example of calculation $P = \frac{32 \times 10^6 \text{ J l}^{-1} \times 65 \text{ l}}{8 \text{ h} \times 3600 \text{ s}} = 72.2 \text{ kW}$	**(1)** **(1)**	**2**
11(b)	• Use of $\Delta W = F\Delta s$ • Use of power = $\frac{\text{energy}}{\text{time}}$ • Average power output of engine = 53 (kW) Example of calculation $W = 2.1 \times 10^3 \text{ N} \times 730 \times 10^3 \text{ m} = 1.53 \times 10^6 \text{ J}$ $P = \frac{2100 \text{ N} \times 730 \times 10^3 \text{ m}}{8 \text{ h} \times 3600 \text{ s}} = 53.2 \text{ kW}$	**(1)** **(1)** **(1)**	**3**
11(c)	• Use of efficiency = $\frac{\text{useful power output}}{\text{total power input}}$ • Efficiency = 0.74 or 74 % (ECF from (a) and (b)) Example of calculation $E = \frac{53.2 \times 10^3 \text{ W}}{72.2 \times 10^3 \text{ W}} = 0.74$	**(1)** **(1)**	**2**
	Total for question 11		**7**

Question Number	Answer	Mark
12(a)	• States that W is the weight of the rider (and unicycle) and R is the push/reaction force (from the ground) (1) • R and W are different types of force (1) **Or** R and W act on the same object **Or** R and W are not equal. • They are **not** a N3 pair of forces (1) MP3 conditional on MP2	**3**
12(b)	• The resultant force acting in the vertical direction is zero so the unicycle will remain at that height (1) **Or** The resultant force acting in the vertical direction is zero so zero acceleration in the vertical direction (1) • The unicycle moves at a constant (forward) speed because the resultant horizontal force is zero or horizontal forces are balanced (because forward frictional force balances backward drag forces)	**2**
	Total for question 12	**5**

Question Number	Answer	Mark
13(a)	• X is the force (or pull or tension) of the <u>wire</u> (on the flagpole) (accept tension in the wire) (1) • Y is force (or reaction or push, ignore "normal") of the <u>hinge</u> (or <u>wall</u>) (on the flagpole). (1) • Z is weight or force of gravity (of/on the flagpole) (1)	**3**
13(b)	• Use of moment of a force = Fx (1) • Use of the principle of moments (1) • T = 323 (N) < 350 (N) so wire will not break (1) **Or** Moment of weight about hinge = 88.3 (Nm) < 95.8 (Nm), max poss from wire **Or** Correct conclusion based on comparison of student's value with 350 N or 95.8 Nm MP3 depends on MP1 and MP2 being seen <u>Example of calculation</u> (15 kg × 9.81 N kg $^{-1}$ × 0.6 m) – (T sin 20° × ⅔ × 1.2 m) = 0 T = (15 kg × 9.81 N kg $^{-1}$ × 0.6 m) ÷ (0.8 m × sin 20°) = 88.29 Nm ÷ 0.2736 T = 322.7 N max available moment = 350 N × 0.8 m × sin 20° = 95.77 Nm > 88.29 Nm	**3**
	Total for question 13	**6**

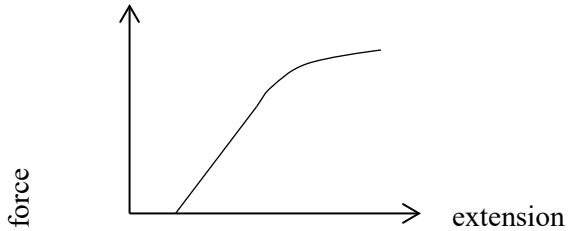
<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>*14</td><td>
This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.
Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.
The following table shows how the marks should be awarded for indicative content.
<table>
<tr><th>Number of indicative marking points seen in answer</th><th>Number of marks awarded for indicative marking points</th><th>Linkage marks available</th></tr>
<tr><td>6</td><td>4</td><td>2</td></tr>
<tr><td>5</td><td>3</td><td>2</td></tr>
<tr><td>4</td><td>3</td><td>1</td></tr>
<tr><td>3</td><td>2</td><td>1</td></tr>
<tr><td>2</td><td>2</td><td>0</td></tr>
<tr><td>1</td><td>1</td><td>0</td></tr>
<tr><td>0</td><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><th></th><th>Number of marks awarded for structure of answer and sustained line of reasoning</th></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>
Total marks awarded is the sum of marks for indicative content and the marks for structure and lines of reasoning

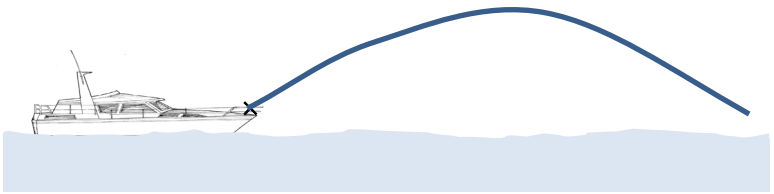
Indicative content

• Acceleration is maximum (or acceleration = g) initially
• As velocity increases the air resistance increases
• Resultant force decreases until it becomes zero and diver reaches terminal velocity
Or
(Eventually) forces balance and the diver reaches terminal velocity
• At t_1 the air resistance increases or is greater then the weight
• Skydiver decelerates or the resultant force is now upwards/negative
• Second terminal velocity is lower because air resistance = weight at a lower velocity.

Ignore mention of upthrust.
</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)(i)	• The sphere will be <u>accelerating</u> (in the oil) initially **Or** Sphere needs time/distance to <u>accelerate</u> • The sphere falls a distance (through the oil) before reaching constant/terminal <u>velocity</u> **Or** Sphere needs to reach terminal <u>velocity</u> before timing begins	(1) (1)	**2**
15(a)(ii)	**Either** • Adding a rubber band enables more than one distance to be timed (for the sphere to fall) • An average/mean value for the time/speed can then be calculated **Or** • Can compare times/velocities for more than one distance • To detemine whether terminal velocity achieved	(1) (1) (1) (1)	**2**
15(b)(i)	Weight of (solid) sphere	(1)	**1**
15(b)(ii)	Weight of oil displaced (by the sphere) **Or** upthrust	(1)	**1**
15(b)(iii)	<u>Viscous</u> drag or <u>viscous</u> force	(1)	**1**
15(b)(iv)	The temperature (of the oil) was greater than 24 °C/had increased - do not accept temperature of the room. **Or** the measured diameter of the sphere was less than true value **Or** the time measured (to determine the terminal velocity) was less than true value **Or** the meaured distance between bands was greater than true value Do not accept sphere too close to the edge of cylinder or the flow around the sphere is turbulent or densities used were incorrect	(1)	**1**
	Total for question 15		**8**

Question Number	Answer		Mark
16(a)(i)	• Point K is the limit of proportionality **Or** beyond K, the force is no longer proportional to the extension **Or** Hooke's Law no longer obeyed **Or** before K the force is proportional to the extension **Or** Hooke's Law obeyed	(1)	**1**
16(a)(ii)	• Beyond point L the spring will behave plastically • Beyond L, the spring will no longer return to its original length (once the deforming force is removed)/spring will be permanently deformed **Or** below L, the spring will return to its original length (once the deforming force is removed)	(1) (1)	**2**
16(a)(iii)	• The spring constant/stiffness (not Young modulus) is smaller or has changed (do not allow greater stiffness)	(1)	**1**
16(b)	• Same shape graph but starting from an extension > 0  	(1)	**1**
16(c)	• Same force acts through both springs • Both springs have the same extension • In this combination the (total) extension will be doubled **Or** Force required for same (total) extension is halved • Reference to $F = k\Delta x$ e.g. k is proportional to $1/\Delta x$ so k is halved	(1) (1) (1) (1)	**4**
	Total for question 16		**9**

Question Number	Answer	Mark
17(a)(i)	• Initial angle at approximately 30° (by eye) with approximately parabolic shape. **(1)** 	**1**
17(a)(ii)	• Use of $v^2 = u^2 + 2as$ (with u and v the correct way around) **(1)** **Or** Loss of KE = gain of GPE (i.e. $u_V^2 = 2gh$) • See u sin 30° for initial vertical component of velocity u_V **(1)** • $u = 57$ (m s^{-1}) **(1)** Example of calculation $0^2 = (u \sin 30°)^2 + (2\times - 9.81$ N kg^{-1} $\times$ 42 m) $u_V = u \sin 30° = 28.7$ m s^{-1} $u = 57.4$ m s^{-1}	**3**
17(a)(iii)	• Use of trig to determine the horizontal component of the initial velocity **(1)** METHOD 1 **(1)** • Use of suitable equation(s) of motion to determine the time of flight **(1)** • Use of $v = s/t$ to determine the horizontal distance travelled by the flare **(1)** • Comparison of distance to boat to distance flare travelled with conclusion consistent with student's value e.g. 7.9 km is less than 8.0 km so the flare can be seen. Example of calculation $0 = (57.4$ m s$^{-1}\times \sin 30° \times t) - (0.5\times 9.81$ N kg$^{-1}\times t^2)$ $t = 5.85$ s $s = (57.4$ m s$^{-1}\times \cos 30° \times 5.85$ s) = 49.7 m s^{-1} $\times$ 5.85 s = 291 m	**4**

	<u>METHOD 2</u> • Use of $v = s/t$ to determine the time to reach 200 m • Use of $s = ut + \frac{1}{2}at^2$ to find height reached after 200 m travel • Explains conclusion consistent with student's value e.g. flare above the sea and in range so visible	
17(b)	• Air resistance/drag is ignored **Or** air resistance/drag is **(**presumed to be) negligible **(1)**	**1**
	Total for question 17	**9**

Question Number	Answer	Mark
18(a)	• Use of $p = mv$ (1) • Use of conservation of momentum (1) • $v = 6.3$ m s^{-1} (1) Example of calculation Before: $p_{mallet} = 0.17$ kg × 1.6 m s^{-1} = 0.272 kg m s^{-1} After: $p_{mallet} = 0.17$ kg × 0.3 m s^{-1} = 0.051 kg m s^{-1} 0.272 kg m s^{-1} = 0.051 kg m s^{-1} + (0.035 kg × v) $v = 6.3$ m s^{-1}	**3**
18(b)	METHOD 1 (1) • Use of $E_k = ½mv^2$ • Use of sin 30° to determine vertical height moved by disc (1) • Use of $E_{grav} = mgh$ (1) • Use of $W = Fd$ (1) • Use of conservation of energy e.g. $E_k = E_{grav} + W$ (1) • $F_F = 6.6$ N (1) Example of calculation $E_k = ½ \times 0.035$ kg × (5.0 m s^{-1})^2 = 0.44 J $E_{grav} = 0.035$ kg × 9.81 N kg^{-1} × 0.065 m × sin 30° = 1.12 × 10^{-2} J 0.44 J = 1.12 × 10^{-2} J + (F_F × 0.065 m) 0.44 J - 0.0112 J = 0.43 J $F_F = 6.56$ N METHOD 2 • Use of $v^2 = u^2 + 2as$ to determine deceleration along ramp • $v = 0$ and a negative • Use of sin 30° to determine component of weight of disc down slope • Use of $\Sigma F = m\,a$ to determine resultant force along ramp • Subtraction of weight component from resultant force. • $F_F = 6.6$ N	**6**
	Total for question 18	**9**

Question Number	Answer	Mark
19(a)(i)	The distance between pylons **Or** length of cable **Or** the weight/mass/density of the cable/material (1)	**1**
19(a)(ii)	• See $Mg = 2T \sin\theta$ **Or** weight (or W or Mg) is proportional to $T \sin\theta$ (1) • as the sag increases, θ (or $\sin\theta$) increases (for a constant weight) (1) • (as the sag increases) $\sin\theta$ increases hence T decreases (1)	**3**
19(b)(i)	• Use of region of graph 0 to 300 MPa to determine the gradient **Or** tangent from origin (1) • E_{steel} = 1.5 × 10^{11} (Pa) to 1.8 × 10^{11} (Pa) (1) Example of calculation $E_{steel} = \frac{\mathbf{200 \times 10^6\ Pa}}{\mathbf{0.0013}} = 1.53 \times 10^{11}$ Pa	**2**
19(b)(ii)	• Use of $\sigma = \frac{F}{A}$ to obtain the stress (1) • stress = 73 MPa (1) Example of calculations F = 0.62 N m^{-1} × 270 m = 167.4 N $\sigma = \frac{0.62\ \text{N m}^{-1} \times 270\ \text{m}}{2.3 \times 10^{-6}\ \text{m}^2}$ σ = 72.8 MPa	**2**
19(b)(iii)	METHOD 1 • Use of graph to obtain the strain in steel **Or** use of Young Modulus (1) • Use of $\varepsilon = \frac{\Delta e}{l}$ (for steel $\Delta e = 0.14$ m) (1) • Comparison of the two extensions/strains e.g. the extension/strain of aluminium is larger than that of steel, so steel is used to reduce the (total) extension/sag Or Comparison of two strains/extensions e.g. lower strain for steel so stiffness of cable increased to reduce (total) extension/sag (1)	**3**

	METHOD 2 • Use of $\varepsilon = \frac{\Delta e}{l}$ to find strain (for extension of 0.95 m) • Use of graph to obtain the stress in aluminium and steel. • Comparison of two stresses (e.g. greater stress required for steel) so stiffness of cable increased to reduce (total) extension/sag Example of calculation Read off strain (when stress is 70 MPa) on Steel graph (0.0005) For Steel, $\Delta e = 0.0005 \times 270$ m = 0.14 m	
	Total for question 19	**11**