Pearson Edexcel

Mark Scheme (Results)

January 2019

Pearson Edexcel International Advanced Subsidiary Level
In Physics (WPH11)
Paper 01 Mechanics and Materials

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**

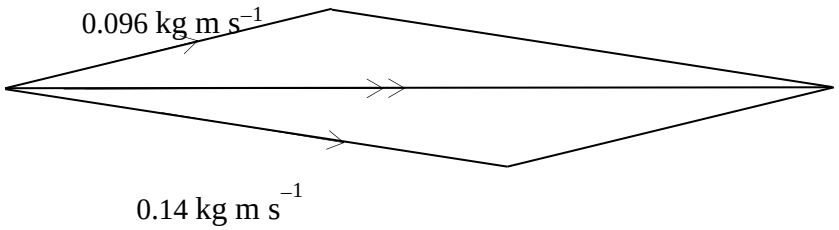
Question Number	Answer	Mark
12(a)	• Length/height of wooden rod (1) • Distance from the rod to the light gate (1)	**2**
12(b)	• $v = \frac{\text{length of rod}}{\text{time (to pass through light gate)}}$ (1) • Repeat (at each height) and (calculate) an average (1)	**2**
12(c)	• Repeat at different (release) 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>

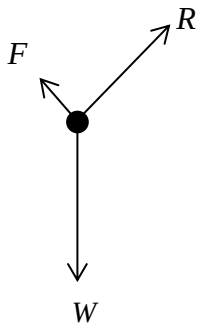
Question Number	Answer		Mark
15(a)	• Construction of correct vector diagram (parallelogram or triangle) with all 3 directions and 0.096 (kg m s^{-1}) and 0.14(kg m s^{-1}) labelled	(1)	
	• Momenta correctly scaled (ratio of lengths 0.14 to 0.096 rounds to between 1.40 and 1.50)	(1)	
	• Horizontal resultant (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**