Pearson Edexcel

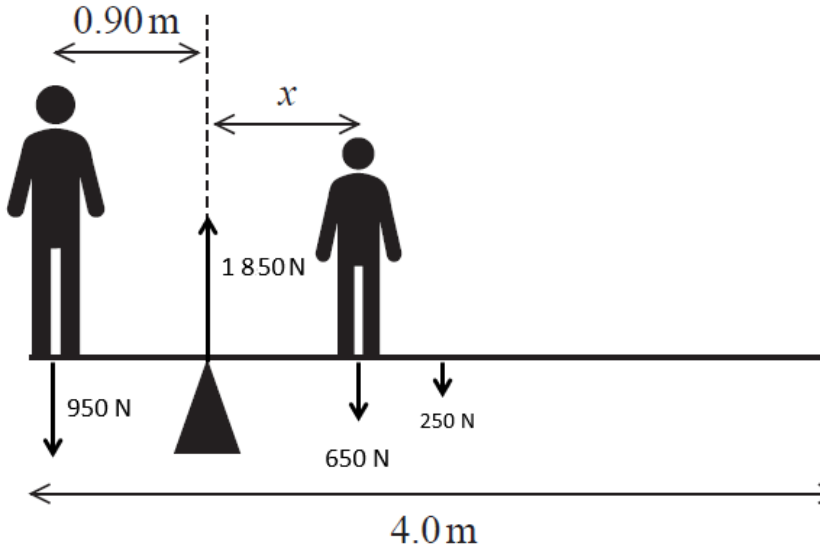
Mark Scheme (Results)

January 2021

Pearson Edexcel International Advanced Subsidiary/ Advanced Level In Physics (WPH11)

Paper 1: Mechanics and Materials

Question Number	Answer	Mark
1	**C is the correct answer** A is incorrect because the velocity should be squared B is incorrect because the displacement should be doubled and the velocity squared D is incorrect because the displacement should be doubled	**(1)**
2	**C is the correct answer** A is incorrect because it takes no account of the k.e. B is incorrect because the energy dissipated would be greater than the original energy D is incorrect because the energy dissipated could not be negative	**(1)**
3	**D is the correct answer** A is incorrect because the acceleration is not positive B is incorrect because the acceleration is decreasing C is incorrect because the acceleration is constant	**(1)**
4	**B is the correct answer** A is incorrect because the graph would have a gradient of $g/2$ C is incorrect because the graph would have a gradient of $2/g$ D is incorrect because the graph would have a gradient of $1/g$	**(1)**
5	**C is the correct answer** A is incorrect because breaking stress is material property independent of dimensions B is incorrect because density is material property independent of dimensions D is incorrect because Young modulus is material property independent of dimensions	**(1)**
6	**A is the correct answer** B is incorrect because object B has greater leftward momentum than object A C is incorrect because total momentum is not the sum of the magnitudes D is incorrect because total momentum is not the sum of the magnitudes	**(1)**
7	**C is the correct answer** A is incorrect because the ball bearing is not in the oil at V B is incorrect because the ball bearing has not reached terminal velocity at W D is incorrect because the ball bearing has not reached terminal velocity at W	**(1)**
8	**C is the correct answer** A is incorrect because density is not a vector B is incorrect because kinetic energy is not a vector D is incorrect because viscosity is not a vector	**(1)**
9	**B is the correct answer** A is incorrect because the forces do act in opposite directions C is incorrect because the forces are of the same type D is incorrect because the forces do have the same magnitude	**(1)**
10	**C is the correct answer** A is incorrect because time is not speed/distance B is incorrect because time is not speed/distance D is incorrect because the powers of ten are incorrect	**(1)**

Question Number	Answer	Mark
11(a)	• Three downward arrows to show the forces of the people and the weight of the plank **(1)** • Upward arrow to show reaction/contact/value force at the pivot. **(1)** 	**2**
11(b)	• Use of moment = Fx **(1)** • Application of principle of moments **(1)** • x = 0.89 m **(1)** Example of calculation x = (0.9 m × 950 N − 1.1 × 250) / 650 N = 0.89 m	**3**
	Total for question 11	**5**

Question Number	Answer	Mark
12(a)	• Use of $\Delta E_{\text{grav}} = mg\Delta h$ **(1)** • Use of trigonometry to calculate Δh **(1)** • P = 180 (W) **(1)** **OR** • Use of $W = Fs$ **(1)** • Use of trigonometry to calculate component of weight along slope **(1)** • P = 180 (W) **(1)** <u>Example of calculation:</u> P = 72 kg × 9.81 N kg^{-1} × 0.51m s^{-1} × sin 30° = 180 W	**3**
12(b)	• Use of efficiency = useful power output/total power input **(1)** • Calculates useful power output **(1)** • Power input = 3500 W **(1)** <u>Example of calculation</u> 15 × 180 W / 0.78 = 3.46 × 10^3 W	**3**
	Total for question 12	**6**

Question Number	Answer	Mark
13(a)	• Use of $v^2 = u^2 + 2as$ **(1)** • Vertical component, $u_V = u \sin 35°$ **(1)** • Speed of ball = 17.3 (m s^{-1}) **(1)** Example of calculation 0 = u_v^2 – 2 × 9.81 m s^{-2} × 5.0 m u_v^2 = 98.1, u_v = √98.1 = 9.9 m s^{-1} u = 9.9 / sin 35° = 17.3 m s^{-1}	**3**
13(b)	• Use of $u_H = u \cos \theta$ **(1)** • Use of $t = s/u_H$ **(1)** • Use of $s = ut + \frac{1}{2}at^2$ with $u_V = u \sin \theta$ and $a = -g$ **(1)** • Height = 3.2 (m) **(1)** • Comparison of result consistent with calculation of height at 22 m. **(1)** Example of calculation Horizontal speed = 17.0 cos 35° = 13.9 m s^{-1} Time to travel 22 m = 22 ÷ 13.9 = 1.58 s Initial vertical speed = 17.0 sin 35° = 9.8 m s^{-1} Height gained in 1.58 s = 9.8× 1.58 – 0.5 × 9.81 ×1.58^2 = 3.16 m	**5**
	Total for question 13	**8**

Question Number	Answer		Mark
14(a)(i)	• Use of $\rho = \frac{m}{V}$ • Use of $A = \pi r^2$ • Use of volume in 1 second = cross section area × speed • Speed = 37.1 (m s^{-1}) Example of calculation $\frac{V}{t} = \frac{300 \text{ kg s}^{-1}}{1030 \text{ kg m}^{-3}} = 0.291 \text{ m}^3\text{s}^{-1}$ $A = \pi \times 0.05^2 = 7.85 \times 10^{-3}$ m^2 Speed = 0.291 m^3 s^{-1}/ 7.85×10^{-3} m^2 = 37.1 m s^{-1}	(1) (1) (1) (1)	4
14(a)(ii)	• Use of $p = mv$ • Rate of change of momentum = 1.1×10^4 kg m s^{-2} (ecf from (a)(i)) Example of calculation mass × speed = 300 kg ×37.1 m s^{-1} = 1.11×10^4 kg m s^{-2}	(1) (1)	2
14(b)	• Pump applies a (forward) force to the water. • By Newton 3, water applies an (equal and) opposite/backward force to the pump **Or** By Newton 3, water applies a force to the pump in the opposite direction to the (flow of) water.	(1) (1)	2
14(c)	• Initially (speed is constant because) drag force = forward force • Turning on pump gives resultant force backwards, so boat slows. • Drag force becomes less (as boat slows) until forces balance again.	(1) (1) (1)	3
	Total for question 14		11

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>15</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 and lines of reasoning.
<table>
<tr><th>IC points</th><th>IC mark</th><th>Max linkage mark available</th><th>Max final mark</th></tr>
<tr><td>6 or more</td><td>4</td><td>2</td><td>6</td></tr>
<tr><td>5</td><td>3</td><td>2</td><td>5</td></tr>
<tr><td>4</td><td>3</td><td>1</td><td>4</td></tr>
<tr><td>3</td><td>2</td><td>1</td><td>3</td></tr>
<tr><td>2</td><td>2</td><td>0</td><td>2</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td></tr>
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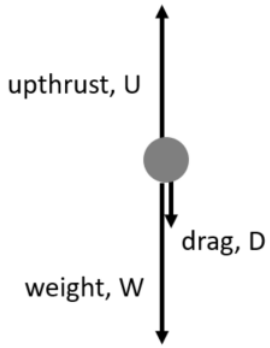
<table>
<tr><th></th><th>Marks</th></tr>
<tr><td>Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout.</td><td>2</td></tr>
<tr><td>Answer is partially structured with some linkages and lines of reasoning</td><td>1</td></tr>
<tr><td>Answer has no linkages between points and is unstructured</td><td>0</td></tr>
</table>
Indicative content

In stage 1 the kinetic energy of the jumper is increasing
Because work is done by gravitational force
In stage 2 the kinetic energy of the jumper is increasing but at a decreasing rate
Because work is done on the cord (as the cord stretches) (as well as increasing k.e.)
In stage 3 the kinetic energy of the jumper is decreasing
Because work is done on the cord at a greater rate than the gravitational force does work on the jumper
Or
He comes to rest because the total work done by gravitational forces is equal to work done stretching the bungee

</td><td>6</td></tr>
<tr><td></td><td>Total for question 15</td><td>6</td></tr>
</table>

Question Number	Answer		Mark
16(a)	• Micrometer (screw gauge) **Or** digital (not Vernier) calliper(s)	**(1)**	**1**
16(b)(i)	• Attempt to calculate gradient • Use of linear section, or tangent at origin, with use of large triangle • $E = 1.2 \pm 0.05 \times 10^{11}$ Pa Example of calculation Extending straight section to 1% 120×10^6 Pa ÷ 0.01 = 1.2×10^{11} Pa	**(1)** **(1)** **(1)**	**3**
16(b)(ii)	• Breaking stress read from graph • Use of $A = \pi r^2$ • Use of $\sigma = F/A$ • $F = 2.6 \times 10^4$ N Example of calculation Area = $\pi \times (2.525 \times 10^{-3})^2 = 2.00 \times 10^{-5}$ m^2 Force = $1\,280 \times 10^6 \times 2 \times 10^{-5} = 2.56 \times 10^4$ N	**(1)** **(1)** **(1)** **(1)**	**4**
16(b)(iii)	• Use of area under graph = ½σε • Substitution of $F = \sigma A$ and $\Delta x = \varepsilon x$ • Substitution of $Ax = V$ and $\Delta W = ½ F\Delta x$ Example of calculation Area = ½σε = ½ $(F / A)(\Delta x / x)$ = ½ $F \Delta x / (A x)$ = $\Delta W / V$	**(1)** **(1)** **(1)**	**3**
16(b)(iv)	• Calculation of area under graph by a valid method. • Area in range 60 to 64 (MJ m^{-3}) • Calculation of volume of sample • Energy = 500±20 J Example of calculation One large square = $200 \times 10^6 \times 0.01 = 2 \times 10^6$ J m^{-3} 31 large squares Volume of sample = 0.40 m × 2.0×10^{-5} m^2 = 8.0×10^{-6} m^3 Work = $31 \times 8 \times 10^{-6}$ m^3 × 2×10^6 J m^{-3} = 4.96×10^2 J	**(1)** **(1)** **(1)** **(1)**	**4**
	Total for question 16		**15**

Question Number	Answer	Mark
17(a)	• Use of $\Delta F = k\Delta x$ **(1)** • k = 1.9 (N cm^{-1}) **(1)** Example of calculation: k = 15 N ÷ 8 cm = 1.875 N cm^{-1}	**2**
17(b)	• Use of $w = mg$ **(1)** • Use of force triangle and Pythagoras to find F **(1)** **Or** F resolved into components • Use of trigonometry to find θ. **(1)** • Use of $\Delta x = \frac{\Delta F}{k}$ **(1)** • Δx = 5.4 cm (ecf from (a), "show that" value gives 5.0 cm) **(1)** • θ = 32° (ecf from (a)) **(1)** Example of calculation: $\theta = \tan^{-1}(0.55 \text{ kg} \times 9.81 \text{ N kg}^{-1} \div 8.5 \text{ N}) = 32.4°$ $\Delta x = \sqrt{((0.55 \times 9.81)^2 + 8.5^2)} \div 1.88 = 5.37$ cm	**6**
	Total for question 17	**8**

Question Number	Answer	Mark
18(a)	• Weight **Or** W, downwards **(1)** • Drag **Or** D, downwards **(1)**  	**2**
18(b)	• Use of $V = \frac{4}{3}\pi r^3$ **(1)** • Use of $\rho = \frac{m}{V}$ and $W = mg$ **(1)** • Upthrust = 3.06×10^{-4} (N) **(1)** Example of calculation Volume of bead = $4/3 \times \pi \times (2.00 \times 10^{-3}\,\text{m})^3 = 3.35 \times 10^{-8}\,\text{m}^3$ Weight of displaced fluid = $930\,\text{kg m}^{-3} \times 3.35 \times 10^{-8}\,\text{m}^3 \times 9.81\,\text{N kg}^{-1}$ $= 3.06 \times 10^{-4}$ N	**3**
18(c)(i)	• The flow must be laminar **(1)** **Or** There must be no turbulent flow	**1**
18(c)(ii)	• States $D = U - W$ **(1)** • Use of $F = 6\pi\eta rv$ **(1)** • $v = 0.16\,(\text{m s}^{-1})$ **(1)** • Calculate $v_R = 0.13\,(\text{m s}^{-1})$ **(1)** • Comparison of v with v_R and correct conclusion (ecf from (b)) **(1)** Alternative method of comparison of $F(0.13)$ with D scores full marks. Example of calculation $U - W = 3.06 \times 10^{-4} - 1.05 \times 10^{-5} = 2.96 \times 10^{-4}$ N $v = 2.96 \times 10^{-4}\,\text{N} / (6\pi \times 4.9 \times 10^{-2}\,\text{Pa s} \times 2.0 \times 10^{-3}\,\text{m}) = 1.60 \times 10^{-1}\,\text{m s}^{-1}$ $v_R = 10 \times 4.9 \times 10^{-2}\,\text{Pa s} / (930\,\text{kg m}^{-3} \times 4.0 \times 10^{-3}\,\text{m}) = 1.32 \times 10^{-1}\,\text{m s}^{-1}$	**5**
	Total for question 18	**11**