Pearson Edexcel

Mark Scheme (Results)

January 2023

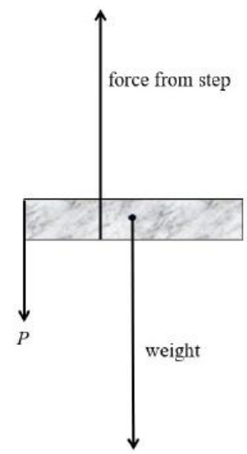
Pearson Edexcel International Advanced Subsidiary Level in Physics (WPH11)
Paper 01 Mechanics and Materials

Question Number	Answer	Mark
1	**The correct answer is C** A is not the correct answer because displacement is a vector B is not the correct answer because the moment of a force has a magnitude and a direction so is therefore a vector D is not the correct answer because weight is a force, and force is a vector	1
2	**The correct answer is A** B is not the correct answer because it should be weight, not acceleration C is not the correct answer because it should be weight, not gravitational potential energy D is not the correct answer because it should be weight, not acceleration and mass, not weight	1
3	**The correct answer is B** A is not the correct answer because gpe should be added not subtracted on the right hand side C is not the correct answer because the total elastic energy is not $F\Delta x$ and gpe should be added not subtracted on the right hand side D is not the correct answer because the total elastic energy is not $F\Delta x$	1
4	**The correct answer is D** A is not the correct answer because the drop speed would be too slow if the flow were laminar B is not the correct answer because the ball bearing should not be moving at terminal velocity at all C is not the correct answer because to calculate g you must know the initial velocity and the student isn't measuring that	1
5	**The correct answer is C** A is not the correct answer because the acceleration is not 5 m s^{-2} B is not the correct answer because the acceleration is not 9.81 m s^{-2} D is not the correct answer because this expression is not dimensionally correct and the acceleration is not 9.81 m s^{-2}	1
6	**The correct answer is B** A is not the correct answer because the diagram gives the force required for balance C is not the correct answer because the diagram gives $(W - U) - P$ D is not the correct answer because the diagram gives $P - (W - U)$	1
7	**The correct answer is B** A is not the correct answer because the acceleration is not positive C is not the correct answer because the acceleration does not increase D is not the correct answer because the acceleration does not decrease	1

8	**The correct answer is B** A is not the correct answer because the mass has not been multiplied by g C is not the correct answer because the mass has not been multiplied by g and the factor of 10^3 is missing for the power D is not the correct answer because the factor of 10^3 is missing for the power	1
9	**The correct answer is B** A is not the correct answer because the mass is not needed C is not the correct answer because radius cannot be directly measured and the mass is not needed D is not the correct answer because radius cannot be directly measured	1
10	**The correct answer is B** A is not the correct answer because the forces don't act on the same body C is not the correct answer because the forces have equal magnitudes D in not the correct answer because the forces have equal magnitudes	1

Question Number	Answer		Mark
11	Use of $s = u\,t + \frac{1}{2}\,a\,t^2$ with $u = 0$ and $a = g$ for flight time	(1)	
	Use of $s = u\,t + \frac{1}{2}\,a\,t^2$ with $a = 0$ for horizontal displacement of stone	(1)	
	Distance travelled = 5.9 m	(1)	3
	Example of calculation $12\text{ m} = 0.5 \times 9.81\text{ m s}^{-2} \times t^2$ $t = \sqrt{(12.0\text{ m} \div 4.905\text{ m s}^{-2})} = 1.56\text{ s}$ $s_{\text{stone}} = 3.8\text{ m s}^{-1} \times 1.56\text{ s} = 5.94\text{ m}$		
	Total for question 11		**3**

Question Number	Answer		Mark
12(a)	(Use balance to measure) mass and multiply mass by g to determine weight **Or** Use the balance set to read newtons to determine weight (of ball)	(1)	
	Measure the diameter (of the ball) (with the calliper) to determine volume	(1)	
	Identify upthrust with weight of fluid displaced	(1)	
	Calculate the weight of fluid displaced by multiplying the volume of the ball by the density of the liquid and g	(1)	4
12(b)	Use of $F = 6\pi\,\eta r v$	(1)	
	$\eta = 2.2 \times 10^2$ Pa s	(1)	2
	Example of calculation $1.1 \times 10^{-2}\text{ N} = 6\pi \times \eta \times 0.50 \times 10^{-2}\text{ m} \times 5.4 \times 10^{-4}\text{ m s}^{-1}$ $\eta = 1.1 \times 10^{-2}\text{ N} \div (6\pi \times 2.7 \times 10^{-6}\text{ m}^2\text{ s}^{-1}) = 216\text{ Pa s}$		
	Total for question 12		**6**

Question Number	Answer	Mark
13(a)(i)	Zero resultant/net force (in any direction) **(1)** Zero (turning) moment (about any point) **(1)**	**2**
13(a)(ii)	The point through/at which the weight of the object may be taken to act **(1)**	**1**
13(b)(i)	Downward arrow at centre of gravity labelled "weight" **Or** "*W*" **Or** "*mg*" **(1)** Upward arrow between CoG. and *P* labelled "force from step" **(1)**  	**2**
13(b)(ii)	Use of moment of a force = *F x* **(1)** Applies principle of moments **(1)** P = 52 N **(1)** <u>Example of calculation</u> Taking moments about the right hand edge of the step: 0.40 m × P = 0.05 m × 4.15 × 10^2 N = 20.8 N m P = 20.8 N m ÷ 0.40 m = 51.9 N	**3**
	Total for question 13	**8**

Question Number	Answer	Mark
14(a)	Material returns to original shape/size when stress/force/tension removed **(1)**	**1**
14(b)(i)	Determines gradient using > half drawn line **(1)** $E = 2.1 \times 10^{11}$ (Pa) **(1)** <u>Example of calculation</u> Gradient = 4.2 ÷ 2.0 = 2.1 $E = 2.1 \times (100\ \text{MPa} \div 0.1\%) = 2.1 \times 10^{11}$ Pa	**2**
14(b)(ii)	Use of $\sigma = F / A$ **(1)** Use of $E = \sigma / \varepsilon$ **Or** Use of graph **And** Use of $\varepsilon = \Delta x / x$ **(1)** Δx = 0.79 mm (allow ecf from (b)(i)) **Or** $E_{req} = 2.8 \times 10^{11}$ Pa **(1)** Valid comparison in consistent units and conclusion (allow ecf from (b)(i)) **(1)** <u>Example of calculation</u> $\sigma = 9.5 \times 10^{5}\ \text{N} \div 4.80 \times 10^{-3}\ \text{m}^2 = 1.98 \times 10^{8}$ Pa $\varepsilon = \sigma \div E = 1.98 \times 10^{8}\ \text{Pa} \div 2.10 \times 10^{11}\ \text{Pa} = 9.42 \times 10^{-4}$ $\Delta x = 0.84\ \text{m} \times 9.42 \times 10^{-4}$ $= 7.91 \times 10^{-4}\ \text{m} = 0.79\ \text{mm} > 0.6\ \text{mm} \therefore$ no	**4**
	Total for question 14	**7**

<table>
<tr><th>Question Number</th><th>Answer</th><th></th><th>Mark</th></tr>
<tr><td>15(a)</td><td>Use of $W = m\,g$
Use of resultant force = push from trampoline – weight of gymnast
Use of $\Sigma F = m\,a$
$P = 1.4 \times 10^3$ N

<u>Example of calculation</u>
$\Sigma F = P - W$
$m\,a = T - m\,g$
$58 \text{ kg} \times 14.2 \text{ m s}^{-2} = P - 58 \text{ kg} \times 9.81 \text{ N kg}^{-1}$
$P = 58 \text{ kg} \times (14.2 + 9.81) \text{ m s}^{-2} = 1.39 \times 10^3$ N</td><td>(1)
(1)
(1)
(1)</td><td>4</td></tr>
<tr><td>15(b)(i)</td><td>$T = 68$ N ÷ sin 14° Or 68 N ÷ cos 76°
$T = 280$ (N)

<u>Example of calculation</u>
$T = 68$ N ÷ sin (14°) = 281 N</td><td>(1)
(1)</td><td>2</td></tr>
<tr><td>15(b)(ii)</td><td>Use of $F = k\,\Delta x$
$k = 6.1 \times 10^3 \text{ N m}^{-1}$ (allow ecf from (b)(i))

<u>Example of calculation</u>
$F = 2.81 \times 10^2 \text{ N} = k \times 4.6 \times 10^{-2}$ m
$k = 2.81 \times 10^2 \text{ N} \div 4.60 \times 10^{-2} \text{ m} = 6.11 \times 10^3 \text{ N m}^{-1}$</td><td>(1)
(1)</td><td>2</td></tr>
<tr><td>15(c)*</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</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>
</table>

<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>
</td><td></td><td></td></tr>
</table>

	Indicative content: • The weight (of the gymnast) acts downwards on the gymnast • The normal contact force (from trampoline) acts upwards • The normal contact force decreases as she moves upwards **Or** The normal contact force increases as she moves downwards • The normal contact force is zero when gymnast makes/loses contact with trampoline **Or** The normal contact force is maximum at bottom of bounce • Resultant/net force is the difference between weight and normal contact force • When the normal contact force is less than the weight the acceleration is downwards **Or** When the normal contact force is greater than the weight the acceleration is upwards	**6**
	Total for question 15	**14**

Question Number	Answer	Mark
16(a)	Use of $p = m v$ **(1)** Use of momentum conservation **(1)** $v = 0.04$ m s^{-1} **(1)** Towards O , away from S, to left (dependent on MP3) **(1)** <u>Example of Calculation</u> 1350 kg × 0.82 m s^{-1} + 2950 v – 2100 kg × 0.58 m s^{-1} = 0 v = (1218 – 1107) kg m s^{-1} ÷ 2950 kg = 0.0376 m s^{-1}	**4**
16(b)(i)	The rocket motor exerts a force on the gases, so the gases exert a force on the rocket motor **(1)** The forces are equal and opposite according to Newton's third law (dependent on MP1) **(1)** So there is a resultant/net/unbalanced force on the descent module, which accelerates according to Newton's second law (accept Newton's first law)(independent mark) **(1)**	**3**
16(b)(ii)	Use of $v = u + at$ to find a **(1)** Use of $\Sigma F = m a$ **(1)** $\Sigma F = 3.4 \times 10^2$ N **(1)** <u>Example of Calculation</u> a = 0.58 m s^{-1} ÷ 5 s = 0.116 m s^{-2} $\Sigma F = m a$ = 2950 kg × 0.116 m s^{-2} = 342.2 N	**3**
	Total for question 16	**10**

Question Number	Answer		Mark
17(a)	The hammer head is not in free fall **Or** Person is exerting a force on the hammer <u>Work</u> is done on the hammer head by the person So additional energy is transferred to kinetic energy (MP3 dependent on MP1 or MP2)	(1) (1) (1)	3
17(b)	Use of $\Delta W = F \Delta s$ Use of ε = (useful energy output) / (total energy input) Use of $\Delta E_{grav} = m g \Delta h$ **Or** Use of $E_k = ½ m v^2$ and valid *suvat* method Δh = 1.9 m **Or** F_{req} = 83 N **Or** E_{req} = 4.0 J **and** E_{out} = 2.8 J Conclusion consistent with student's calculation e.g. The cylinder won't hit the bell because 1.9 m < 2.7 m **Or** Force needed to hit bell = 83 N > 53 N so cylinder won't hit the bell **Or** Useful output = 2.8 J but energy needed to hit bell is 4.0 J so cylinder won't hit the bell <u>Example of calculation</u> energy of hammer head = ΔW = 58 N × 1.2 m = 69.6 J useful energy output = 0.04 × 69.6 J = 2.78 J g.p.e. gained = 2.78 J = 0.15 kg × 9.81 N kg^{-1} × Δh Δh = 2.78 J ÷ 1.47 N = 1.89 m 1.9 < 2.7 ∴ no	(1) (1) (1) (1) (1)	5
17(c)	($E_k = ½mv^2$ so) kinetic energy is proportional to square of velocity **Or** ($E_k = ½mv^2$ so) kinetic energy multiplies by four (if v doubles) So cylinder could move through four times the distance	 (1) (1)	2
	Total for question 17		10

Question Number	NAnswer		Mark
18(a)(i)	Use of $\rho = m / V$ Identifies upthrust is equal to weight of fluid displaced Use of $W = m g$ Use of $D = W - U$ 1.8×10^2 (N) <u>Example of calculation</u> $m = 1030 \text{ kg m}^{-3} \times 1.60 \times 10^{-2} \text{ m}^3 = 16.5 \text{ kg}$ $U = 16.5 \text{ kg} \times 9.81 \text{ N kg}^{-1} = 162 \text{ N}$ $W = 35 \text{ kg} \times 9.81 \text{ N kg}^{-1} = 343 \text{ N}$ $D = W - U = 343 \text{ N} - 162 \text{ N} = 181 \text{ N}$	**(1)** **(1)** **(1)** **(1)** **(1)**	**5**
18(a)(ii)	Use of $D = k v^2$ $v = 9.1 \text{ m s}^{-1}$ (allow ecf from (a)(i)) <u>Example of calculation</u> $D = 181 \text{ N} = 2.2 \text{ N s}^2 \text{ m}^{-2} \times v^2$ $v = \sqrt{(181 \text{ N} \div 2.2 \text{ N s}^2 \text{ m}^{-2})} = 9.1 \text{ m s}^{-1}$	**(1)** **(1)**	**2**
18(a)(iii)	Object might not be spherical Flow might not be laminar	**(1)** **(1)**	**2**
18(b)	Drag force increases as velocity increases Until drag force plus weight equals upthrust (Resultant force is then zero) so the object stops accelerating	**(1)** **(1)** **(1)**	**3**
	Total for question 18		**12**