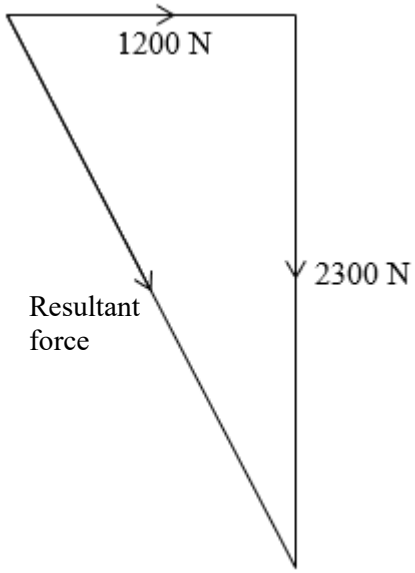
Mark Scheme (Results)

October 2024

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

Question Number	Answer	Mark
1	**The only correct answer is D (J s^{-1})** A is not correct because this is equivalent to the joule B is not correct because this is the unit for stiffness C is not correct because the watt is the joule per second	1
2	**The only correct answer is A (acceleration, weight)** B is not correct because kinetic energy is a scalar quantity C is not correct because strain is a scalar quantity D is not correct because Young modulus is a scalar quantity	1
3	**The only correct answer is D (The displacement at 4 hours divided by a time of 4 hours)** A is not correct because the area under a displacement-time graph has no significance B is not correct because this would give the instantaneous speed at the end of the marathon C is not correct because this would give the instantaneous speed at 2 hours	1
4	**The only correct answer is B (The gravitational pull of the cable car on the Earth)** A is not correct because air resistance is not a gravitational force C is not correct because upthrust is not a gravitational force D is not correct because normal contact force is not a gravitational force	1
5	**The only correct answer is A (The component of the weight parallel to the slope is equal to the sum of the resistive forces)** B is not correct because this would cause the box to accelerate C is not correct because the component of the weight perpendicular to the slope does not affect the speed of the box D is not correct because the component of the weight perpendicular to the slope does not affect the speed of the box	1
6	**The only correct answer is C ($\frac{5000}{42\times0.63}$)** A is not correct because the useful output power should not be inverted B is not correct because the useful output power should not be inverted and should be divided by 0.63 D is not correct because the useful output power should be divided by 0.63	1
7	**The only correct answer is A (the wire is elastically deformed)** B is not correct because only elastic deformation occurs below the elastic limit. C is not correct because plastic deformation beyond the elastic limit increases the extension D is not correct because the wire can be extended beyond the elastic limit before it snaps	1

8	**The only correct answer is B ($\frac{2}{3}\ v$)** A is not correct because the momentum and mass of the ball should not be multiplied together C is not correct because the mass of the ball should not be divided by the momentum of the ball D is not correct because the momentum and mass of the cricket ball should not be multiplied together	**1**
9	**The only correct answer is C ($F_A\cos(31°) + F_B\cos(27°)$)** A is not correct because $\sin(31°)$ gives a component perpendicular to the forwards direction B is not correct because $\sin(27°)$and $\sin(31°)$ give components perpendicular to the forwards direction D is not correct because $\sin(27°)$ gives a component perpendicular to the forwards direction	**1**
10	**The only correct answer is A ($\frac{Fx}{y} + F$)** B is not correct because $W = \frac{Fx}{y} + F$ C is not correct because $W = \frac{Fx}{y} + F$ D is not correct because $W = \frac{Fx}{y} + F$	**1**

Question Number	Answer	Mark
11	Correct vector triangle with arrows in correct directions. **(1)** Resultant force = 2600 (N) (allow an answer between 2550 and 2650 N) **(1)** <u>Example</u>  	**2**
	Total for question 11	**2**

Question Number	Answer	Mark
12	Use of $\Delta F = k\Delta x$ to calculate Δx **(1)** Length = 0.46 m **(1)** Example calculation $7.0\ \text{N} = 25\ \text{N m}^{-1} \times \Delta x$ $\Delta x = \frac{7.0\ \text{N}}{25\ \text{N m}^{-1}} = 0.28\ \text{m}$ $l = 0.28\ \text{m} + 0.18\ \text{m} = 0.46\ \text{m}$	**2**
	Total for question 12	**2**

Question Number	Answer		Mark
13(a)	Use of appropriate trigonometry	**(1)**	
	Use of moment of force = Fx	**(1)**	
	Moment = 110 N m	**(1)**	**3**
	Example calculation $580\ \text{N} \times 0.21\ \text{m} \times \cos(24°) = 111\ \text{N m}$		
13(b)	The horizontal/perpendicular distance between W and the pivot decreases **Or** The component of W perpendicular to the lever decreases **Or** $\cos(\theta)$ decreases (from 1 to zero)	**(1)**	
	So the moment (of W about the pivot) decreases **and** F decreases (to zero)	**(1)**	**2**
	Total for question 13		**5**

Question Number	Answer	Mark
14(a)	The ball fell a smaller distance (during each flash of the laboratory strobe) **Or** Each image of the ball would be smaller (using the laboratory strobe) **(1)** The uncertainty was less (with the laboratory strobe) MP2 dependent on MP1 **(1)**	**2**
14(b)(i)	(allow *a* for *g* throughout) $s = (ut+)\frac{1}{2}gt^2$ **and** *g* is constant **(1)** Comparison of $s = \frac{1}{2}gt^2\ (+ut)$ with $y = mx\ (+c)$ **Or** *s* is proportional to t^2 so the gradient of graph is constant **(1)**	**2**
14(b)(ii)	Use of $s = \frac{1}{2}at^2$ and a pair of corresponding values from the graph **Or** Pair of corresponding values from the graph used to determine gradient **(1)** g = 10.0 m s^{-2} (allow answers in the range 9.8 m s^{-2} to 10.1 m s^{-2}) (dependent on MP1) (answer must be consistent with their calculation) **(1)** <u>Example of calculation</u> $\frac{\Delta h}{\Delta t^2} = \frac{0.30}{0.060} = 5.00$ $g = 5.00\ \text{m s}^{-2} \times 2 = 10.00\ \text{m s}^{-2}$	**2**
	Total for question 14	**6**

Question Number	Answer	Mark
15(a)	By Newton's third law, the ground exerts an upwards force of 890 N on the athlete **Or** By Newton's third law, the ground exerts a force equal (in magnitude) and opposite (in direction) on the athlete **(1)** The upwards force is greater than the athlete's weight **Or** 890 N > 680 N **Or** 890 N – 680 N = 210 N **(1)** (So) there is a resultant force (upwards on the athlete) **(1)**	**3**

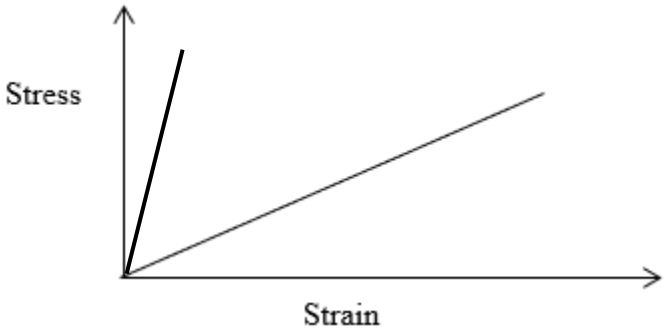
15(b)(i)	Use of $W = mg$	**(1)**	**3**
	Use of $E_k = \frac{1}{2}mv^2$	**(1)**	
	$v = 3.44$ (m s^{-1})	**(1)**	
	Example calculation $m = \frac{680 \text{ N}}{9.81 \text{ N kg}^{-1}} = 69.3 \text{ kg}$ $v = \sqrt{\frac{2 \times 409 \text{ J}}{69.3 \text{ kg}}} = 3.436 \text{ m s}^{-1}$		
15(b)(ii)	Use of equations of motion to calculate final vertical velocity **Or** Use of $\Delta E_{grav} = \Delta E_k$	**(1)**	**5**
	Use of Pythagoras' equation	**(1)**	
	Magnitude of final velocity = 6.3 m s^{-1} (allow ecf from (b)(i)) (show that value gives 6.2 m/s)	**(1)**	
	Use of appropriate trigonometry using velocities	**(1)**	
	Angle from vertical = 33° (allow ecf from (b)(i))	**(1)**	
	OR		
	Use of $W = mg$ **and** use of $E_k = \frac{1}{2}mv^2$	**(1)**	
	Use of conservation of energy	**(1)**	
	Magnitude of final velocity = 6.3 m s^{-1} (allow ecf from (b)(i)) (show that value gives 6.2 m/s)	**(1)**	
	Use of appropriate trigonometry using velocities	**(1)**	
	Angle from vertical = 33° (allow ecf from (b)(i))	**(1)**	
	Example calculation $v_{\text{vertical}} = \sqrt{2 \times 9.81 \text{ m s}^{-1} \times 1.4 \text{ m}} = 5.24 \text{ m s}^{-1}$ Magnitude of final velocity = $\sqrt{(5.24 \text{ m s}^{-1})^2 + (3.44 \text{ m s}^{-1})^2} = 6.27 \text{ m s}^{-1}$ Angle = $\tan^{-1}\left(\frac{3.44}{5.24}\right) = 33.3°$		
	Total for question 15		**11**

Question Number	Answer	Mark
16(a)	Upwards arrow labelled upthrust or U **and** downwards arrow labelled weight / W / mg **(1)** Arrows of equal length **(1)**	**2**
16(b)(i)	Any two from • The upthrust is equal to the weight of water displaced • The upthrust equals the weight of the hydrometer **Or** The upthrust is the same (in both types of water) • The weight of displaced water equals the weight of the hydrometer **Or** The weight of displaced water is the same in both types of water **(2)** (So) a smaller volume of seawater needs to be displaced (because seawater has a greater density) **(1)**	**3**
16(b)(ii)	Use of $W = mg$ **(1)** Use of $\rho = \frac{m}{V}$ to calculate volume of displaced water **(1)** Use of $V = \pi r^2 l$ **(1)** Subtracts position in seawater from position in pure water **(1)** Change in vertical position = 8 mm **(1)** <u>Example of calculation</u> Mass of hydrometer $= \frac{0.324\ \text{N}}{9.81\ \text{N kg}^{-1}} = 0.033\ \text{kg}$ Volume of pure water displaced $= \frac{0.033\ \text{kg}}{997\ \text{kg m}^{-3}} = 3.31 \times 10^{-5}\ \text{m}^3$ Depth of hydrometer in pure water $= \frac{4 \times 3.31 \times 10^{-5}\ \text{m}^3}{\pi \times (1.23 \times 10^{-2})^2} = 0.2786\ \text{m}$ Volume of seawater displaced $= \frac{0.033\ \text{kg}}{1025\ \text{kg m}^{-3}} = 3.22 \times 10^{-5}\ \text{m}^3$ Depth of hydrometer in seawater $= \frac{4 \times 3.22 \times 10^{-5}\ \text{m}^3}{\pi \times (1.23 \times 10^{-2})^2} = 0.2710\ \text{m}$ $\Delta L = 0.2786\ \text{m} - 0.2710\ \text{m} = 0.0076\ \text{m}$	**5**
	Total for question 16	**10**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>*17(a)</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>IC points</th><th>IC mark</th><th>Max linkage mark</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>
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>
Indicative content
IC1 Initially, weight is greater than tension (so resultant force is downwards)
IC2 So acceleration is downwards
IC3 Tension increases (as length of rope increases)
IC4 (Between A and B) resultant force decreases, so acceleration decreases
IC5 At B, resultant force is zero so acceleration is zero.
Or At B, tension is equal to weight so acceleration is zero
Or At B, forces are balanced so acceleration is zero
IC6 Below B resultant force is upwards and the student decelerates
</td><td>6</td></tr>
</table>

17(b)	Use of $\Delta E_{\text{grav}} = mg\Delta h$ Use of $\Delta E_{\text{el}} = \frac{1}{2}F\Delta x$ **Or** $F = k\Delta x$ (At 35 m below bridge) $\Delta E_{\text{grav}} = 22$ kJ **and** $\Delta E_{\text{el}} = 41$ kJ Comparison of calculated values for ΔE_{grav} and ΔE_{el} and consistent conclusion Example of calculation $\Delta E_{\text{grav}} = 65\text{ kg} \times 9.81\text{ Nkg}^{-1} \times 35\text{ m} = 22\,300\text{ J}$ $F = 250\text{ N m}^{-1} \times (35\text{ m} - 17\text{ m}) = 4500\text{ N}$ $\Delta E_{\text{el}} = \frac{1}{2}4500\text{ N} \times (35\text{ m} - 17\text{ m}) = 40\,500\text{ J}$ $40\,500\text{ J} > 22\,300\text{ J}$ so the student will not reach the river	**(1)** **(1)** **(1)** **(1)**	**4**
	Total for question 17		**10**

Question Number	Answer	Mark
18(a)	Use of $A = \pi r^2$ **(1)** Use of $\sigma = \frac{F}{A}$ **(1)** $F = 4.9 \times 10^{-5}\text{N}$ **(1)** Example calculation $A = \pi \times (1.9 \times 10^{-6}\text{ m})^2 = 1.13 \times 10^{-11}\text{ m}^2$ $F = 4.3 \times 10^{6}\text{ Pa} \times 1.13 \times 10^{-11}\text{m}^2 = 4.88 \times 10^{-5}\text{ N}$	**3**
18(b)	Use of $E = \frac{\sigma}{\varepsilon}$ **(1)** Use of $\varepsilon = \frac{\Delta x}{x}$ **(1)** Use of stretched length $= x + \Delta x$ **(1)** Length at limit of proportionality = 25.9 m **(1)** Example calculation $\varepsilon = \frac{300 \times 10^{6}\text{ Pa}}{8.70 \times 10^{9}\text{ Pa}} = 3.448 \times 10^{-2}$ $\Delta x = 3.448 \times 10^{-2} \times 25.0\text{ m} = 0.862\text{ m}$ $L = 25\text{ m} + 0.862\text{ m} = 25.86\text{ m}$	**4**

18(c)(i)	Straight line steeper than spider silk line, starting from the origin **(1)** Line extending to a slightly greater stress than the spider silk line (dependent on MP1) **(1)**  	**2**
18(c)(ii)	The force applied to the steel is (slightly) greater than that applied to the spider silk **(1)** The extension / strain of the spider silk is much greater than the extension / strain of the steel **(1)** (So) elastic strain energy of the spider silk is greater than the elastic strain energy of the steel (dependent on MP2) **(1)** **OR** Elastic strain energy is proportional to area under graph **(1)** The area under the spider silk graph is greater than the area under the steel graph **(1)** (So) elastic strain energy of the spider silk is greater than the elastic strain energy of the steel (dependent on MP2) **(1)**	**3**
	Total for question 18	**12**

Question Number	Answer	Mark
19(a)(i)	Small, spherical object **Or** Spherical object with low speed **(1)** laminar flow **Or** flow is not turbulent **(1)**	**2**
19(a)(ii)	Use of $v = \frac{s}{t}$ **(1)** Use of $V = \frac{4}{3}\pi r^3$ **(1)** Use of $F = 6\pi\eta r v$ **(1)** $F = 0.035$ N **(1)** comparison of their calculated force with 4.6 (N) and consistent conclusion **(1)** <u>Example calculation</u> $v = \frac{25\text{ m}}{0.36\text{ s}} = 69.4\text{ m s}^{-1}$ $r = \sqrt[3]{\frac{3 \times 45 \times 10^{-6}\text{ m}^3}{4 \times \pi}} = 0.0221\text{ m}$ $F = 6 \times \pi \times 1.2 \times 10^{-3}\text{Pa s} \times 0.0221\text{ m} \times 69.4\text{ m s}^{-1} = 0.0347\text{ N}$ 0.0347 N < 4.6 N so Stokes' law does not apply.	**5**

19(b)(i)	The areas between the line and the *x*-axis should be determined **Or** The area between the line and the *x*-axis represents displacement **(1)** The diver will be at the surface if the area below the *x*-axis (before 25 s) is equal to the area above the *x*-axis (after 25 s). **Or** The diver will be at the surface if the total (positive and negative values of) area is equal to zero **(1)**	**2**
19(b)(ii)	Draws tangent at 70 s **(1)** Determines values for Δv and Δt **(1)** Acceleration = (−)0.008 m s^{-2} (allow an answer in the range (−)0.007 m s^{-2} to (−)0.01 m s^{-2}) **(1)** <u>Example calculation</u> Acceleration = $\frac{-0.50 \text{ m s}^{-1}}{65 \text{ s}} = -0.0077 \text{ m s}^{-2}$	**3**
	Total for question 19	**12**