Mark Scheme (Results)

June 2022

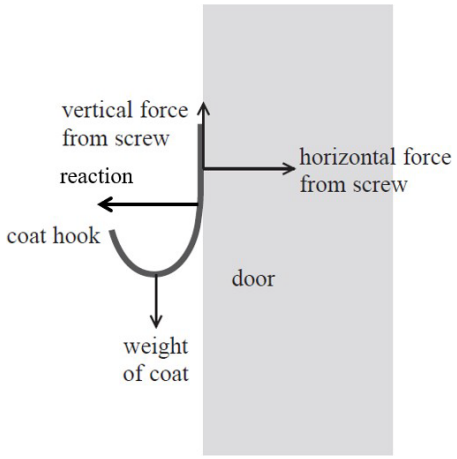
Pearson Edexcel
International Advanced Subsidiary Level in Physics
(WPH11) Paper 01: Mechanics and Materials

Question Number	Answer	Mark
1	The correct answer is **C** A is incorrect because the numerator and denominator are the wrong way around, and a factor of 1 000 is missing in the numerator B is incorrect because the factor 750 should be in the denominator and the 1 000 in the numerator D is incorrect because the numerator and denominator are the wrong way around.	**1**
2	The correct answer is **B** A is incorrect because the upthrust is constant C is incorrect because the upthrust is constant and the viscous drag is increasing D is incorrect because the viscous drag is increasing	**1**
3	The correct answer is **D** A is incorrect because force is a vector B is incorrect because momentum is a vector C is incorrect because velocity is a vector	**1**
4	The correct answer is **C** A is incorrect because area represents work done per unit volume B is incorrect because area represents work done per unit volume D is incorrect because the breaking point is outside the linear region	**1**
5	The correct answer is **B** A is incorrect because air resistance would reduce the acceleration C is incorrect because drop time is unaffected by horizontal motion D is incorrect because a greater time would give a lower acceleration	**1**

Question Number	Answer	Mark
6	The correct answer is **B** because for a constant resultant force acceleration increases if mass decreases A is incorrect because a constant acceleration for a decreasing mass would require a decreasing resultant force C is incorrect because a decreasing acceleration for a decreasing mass would require a decreasing resultant force D is incorrect because a decreasing acceleration for a decreasing mass would require a decreasing resultant force	**1**
7	The correct answer is **D** A is incorrect because springs in series increase the extension and springs in parallel decrease the extension for the same force B is incorrect because springs in series increase the extension for the same force C is incorrect because springs in parallel decrease the extension for the same force	**1**
8	The correct answer is **D** because the area below the *t* axis represents negative displacement A is incorrect because P is above the line and Q should be subtracted B is incorrect because P is above the line C is incorrect because Q should be subtracted	**1**
9	The correct answer is **D** A is incorrect because the distance moved by the force is not $\Delta h \cos \theta$ B is incorrect because the distance moved by the force is not $\Delta h / \cos \theta$ C is incorrect because the distance moved by the force is not $\Delta h \sin \theta$	**1**
10	The correct answer is **B** A is incorrect because the spring constant is $\Delta F / \Delta x$ C is incorrect because the spring constant is $\Delta F / \Delta x$ D is incorrect because the spring constant is $\Delta F / \Delta x$	**1**
	Total for Section A	**10**

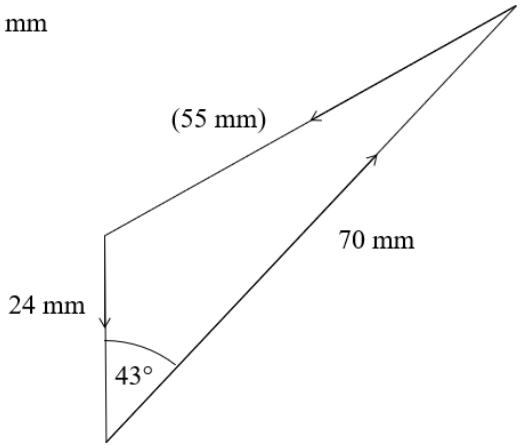
Question Number	Answer	Mark
11(a)	The forces act on the same object. **(1)** They are different types of force. **(1)**	**2**
11(b)	Downward arrow labelled magnetic force (from disc) **Or** Downward arrow labelled *F*. **(1)** Upward arrow labelled (normal) reaction / contact / *R* / *N* / **and** arrow length approximately equal to *F* + *W*. **(1)** 	**2**
	Total for question 11	**4**

Question Number	Answer	Mark
12(a)	It's the force / stress beyond which the cable does not return to its original length when the force / stress is removed **(1)**	**1**
12(b)(i)	Use of $\varepsilon = \Delta x/x$ **(1)** $\varepsilon = 0.021$ **(1)** Example of calculation $\varepsilon = 0.126 \text{ m} \div 6 \text{ m} = 0.021$	**2**
12(b)(ii)	Use of $\sigma = F/A$ **(1)** $\sigma = 1.4 \times 10^9$ Pa **(1)** Example of calculation $\sigma = 1.34 \times 10^6 \text{ N} \div 9.6 \times 10^{-3} \text{ m}^2 = 1.40 \times 10^9$ Pa	**2**
	Total for question 12	**5**

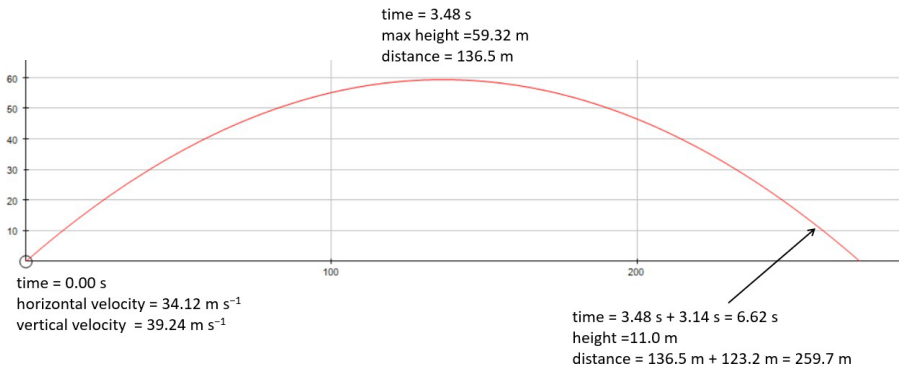
Question Number	Answer	Mark
13(a)	 **(1)** **(1)** Horizontal arrow pointing to the left labelled "reaction (force from the wall on the hook)" Arrow drawn below screw and not lower than last point of contact between hook and wall MP2 depends upon MP1	**2**
13(b)	Use of moment of force = $F\,x$ **(1)** Use of principle of moments **(1)** Use of $W = m\,g$ **(1)** Correct calculation leading to conclusion no (as maximum is two coats) **(1)** <u>Example of calculation</u> 150 N × 0.009 m = W × 0.025 m W = 1.35 N m ÷ 0.025 m = 54.0 N m = 54.0 N ÷ 9.81 N kg^{-1} = 5.50 kg 5.50 kg ÷ 2.6 kg = 2.12 ∴ two coats max, so no.	**4**
	Total for question 13	**6**

Question Number	Answer	Mark
14(a)	Use $E_K = ½\ m\ v^2$ **(1)** Use of efficiency $= \frac{\text{useful energy output}}{\text{total energy input}}$ **(1)** Efficiency = 0.56 **Or** 56% **(1)** <u>Example of calculation</u> $E_K = 0.5 \times 1\ 560\ \text{kg} \times (13\ \text{m s}^{-1})^2 = 1.32 \times 10^5\ \text{J}$ efficiency = $73.9 \times 10^4\ \text{J} \div 1.32 \times 10^5\ \text{J} = 0.56$	**3**
14(b)(i)	As the velocity increases the drag forces increase. **(1)**	**1**
14(b)(ii)	At higher speeds more work done against air resistance. **(1)** So more energy dissipated. **(1)** So a smaller proportion of energy is available to charge battery. **(1)** (Hence) the efficiency of the system is lower. **(1)**	**4**
	Total for question 14	**8**

Question Number	Answer	Mark
15*	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. **IC points / IC mark / Max linkage mark available / Max final mark** **6** / 4 / 2 / **6** **5** / 3 / 2 / **5** **4** / 3 / 1 / **4** **3** / 2 / 1 / **3** **2** / 2 / 0 / **2** **1** / 1 / 0 / **1** **0** / 0 / 0 / **0** **Marks** Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout. — 2 Answer is partially structured with some linkages and lines of reasoning — 1 Answer has no linkages between points and is unstructured — 0 **Indicative content:** • Upthrust on a bulb is equal to weight of liquid displaced. **(1)** • When upthrust equals/exceeds weight of bulb / disc, bulb floats **(1)** • Weight of a bulb / disc is constant **(1)** • As temperature increases the weight of displaced liquid decreases **(1)** **Or** As temperature increases upthrust on bulb decreases **(1)** • Until weight of a bulb / disc exceeds the upthrust **(1)** • There is a resultant force and bulb will sink	**6**
	Total for question 15	**6**

Question Number	Answer	Mark
16(a)	Two arrowed lines for 70 N and 24 N with correct orientation **(1)** [use template for angle] Lines labelled with name/force/scaled length **(1)** Tension drawn in correctly i.e. correct vector diagram with correct direction **(1)** Answer in range 55 ± 2 N **(1)** [Correct answer from trigonometry scores MP4 only] <u>Example of calculation</u> SCALE 1 N : 1 mm  	**4**
16(b)	Measure angle of string to vertical **(1)** Using a protractor **(1)** Calculate weight of mass holder and masses using $W = mg$ **(1)** Vertical component of T is equal to W **(1)** Vertical component is $T \cos \theta$, so T can be calculated **(1)**	**5**
	Total for question 16	**9**

Question Number	Answer	Mark
17(a)(i)	Use of $p = m\,v$ **(1)** Use of conservation of momentum **(1)** m = 151 (kg) **(1)** Use of $F = \Delta p / \Delta t$ scores MP1 and MP2 Example of calculation p = 250 kg × 2.10 m s^{-1} = 250 kg × 1.15 m s^{-1} + m × 1.57 m s^{-1} = 525.0 kg m s^{-1} m = (525.0 − 287.5 N s) kg m s^{-1} ÷ 1.57 m s^{-1} = 237.5 kg m s^{-1} ÷ 1.57 m s^{-1} = 151.3 kg	**3**
17(a)(ii)	No external horizontal forces acted on either car during the collision. **(1)**	**1**
17(a)(iii)	Use of $a = \Delta v / \Delta t$ **(1)** Use of $\Sigma F = ma$ **(1)** $\Sigma F = 1.76 \times 10^2$ N (ecf from (a)(i)) **(1)** Example of calculation average acceleration = 1.57 m s^{-1} ÷ 1.35 s = 1.16 m s^{-2} ΣF = 151.3 kg × 1.16 m s^{-2} = 1.76 × 10^2 N	**3**
17(b)	P exerts a force on Q so Q exerts a force on P **(1)** Due to N3 forces are equal and opposite in direction **(1)** Resultant force on P opposite to direction of motion so according to N2, P decelerates **(1)**	**3**
	Total for question 17	**10**

Question Number	Answer	Mark
18(a)	Use of trigonometry **(1)** Vertical component = 34 (m s^{-1}) **(1)** Example of calculation 52 m s^{-1} × sin 41° = 34.1 m s^{-1}	**2**
18(b)	Method 1: Use of $s = u\,t + ½\,a\,t^2$ with s = 11 m and a = − 9.81 m s^{-2} **(1)** Use of quadratic formula **(1)** t = 6.62 (s) [Allow ecf from (a)] **(1)** Method 2: Use of $v = u + at$, with $v = 0$ to find time to max height [3.48 s] **(1)** Use of $s = ½(u + v)\,t$, or other correct *suvat* equation, to find max height [59.3 m] **And** Use of $s = u\,t + ½\,a\,t^2$ to find time to fall to 11 m [3.14 s] **(1)** t = 6.62 (s) depending on rounding of (a) [Allow ecf from (a)] **(1)** (allow ecf from (a)) [Allow any valid *suvat* method] Example of calculation Let time to max height = t 11 m = 34.1 m s^{-1} × t − ½ × 9.81 m s^{-2} × t^2 4.91 × t^2 − 34.1 m s^{-1} × t + 11 m = 0 t = (34.1 ± √(34.1^2 − 4 × 11 × 4.91) m s^{-1} ÷ 9.81 m s^{-2} = 6.62 s (or 0.34 s)	**3**
18(c)	Resolves for horizontal component of velocity **(1)** Use of $s = v\,t$ **(1)** 260 m so no **(1)** (Allow ecf from (b) with correct conclusion based on student's value) Example of calculation Horizontal component of velocity = 52 m s^{-1} × cos 41° = 39.2 m s^{-1} s = 39.2 m s^{-1} × 6.62 s = 260 m Distance required 245 m to 255 m and 260 m > 255 m so no.  	**3**

	Total for question 18	8

Question Number	Answer	Mark
19(a)	The viscosity decreases (with temperature) **(1)**	**1**
19(b)(i)	Use of $V = (4/3)\pi r^3$ **(1)** Use of $\rho = m / V$ **(1)** Use of $W = m g$ **(1)** $W = 4.76 \times 10^{-3}$ N **(1)** Example of calculation volume = $(4/3)\pi \times (3.5 \times 10^{-3}\ \text{m})^3 = 1.80 \times 10^{-7}\ \text{m}^3$ $m = 1.80 \times 10^{-7}\ \text{m}^3 \times 2.70 \times 10^3\ \text{kg m}^{-3} = 4.85 \times 10^{-4}$ kg $W = 4.85 \times 10^{-4}\ \text{kg} \times 9.81\ \text{N kg}^{-1} = 4.76 \times 10^{-3}$ N	**4**
19(b)(ii)	Use of $F = 6\pi \eta r v$ **(1)** Use of U = weight of fluid displaced **(1)** Comparison of F with $W - U$ and conclusion consistent with student's values **(1)** Example of calculation $D = 6\pi \times 0.95\ \text{Pa s} \times 0.003\ 5\ \text{m} \times 0.040\ 5\ \text{m} = 2.54 \times 10^{-3}$ N $U = 1.80 \times 10^{-7}\ \text{m}^3 \times 1.26 \times 10^3\ \text{kg m}^{-3} \times 9.81\ \text{N kg}^{-1} = 2.22 \times 10^{-3}$ N $W - U = 4.76 \times 10^{-3}\ \text{N} - 2.22 \times 10^{-3}\ \text{N} = 2.54 \times 10^{-3}$ N $2.54 \times 10^{-3}\ \text{N} = D$ ∴ Stokes law obeyed	**3**
19(b)(iii)	Low speed **Or** Laminar flow **Or** Small sphere **(1)** [Accept reference to wide cylinder]	**1**
19(c)	Viscosity of blood is much lower **(1)** Drag will be lower for given velocity (proportional to diameter) **(1)** Reducing diameter gives less weight (proportional to cube of diameter) **(1)** Forces balance at lower speed **Or** Terminal velocity lower **(1)** Laminar flow needs low speed **(1)** Viscosity of blood much lower (1) (For the original sphere) drag would be (much) lower at same velocity (1)	**5**

	So terminal velocity would be (much) too large for Stokes' law (1) Reducing r reduces W much more than D OR W proportional to r3 but D proportional to r (1) (With smaller sphere) forces will still balance at low speed (1)	
	Total for question 19	**14**