Pearson Edexcel

Mark Scheme (Results)

January 2022

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

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

SECTION A

Question Number	Answer	Mark
1	**A is the only correct answer** B is incorrect because final displacement is measured from 0, not −1 C is incorrect because displacement is not the area between the line and the *t* axis, and velocity is 3 m ÷ 6 s, not 6 m ÷ 3 s D in incorrect because velocity is 3 m ÷ 6 s, not 6 m ÷ 3 s	**1**
2	**D is the only correct answer** A is not the correct answer because mass is a scalar and force and acceleration are vectors B is not the correct answer because force is a vector C is not the correct answer because mass is a scalar and acceleration is a vector	**1**
3	**A is the only correct answer** B is incorrect because the velocity is always zero C is incorrect because the velocity is always positive D in incorrect because velocity is zero except for a very short time.	**1**
4	**C is the only correct answer** A is incorrect because the magnitude is the sum of the squares not the difference B is incorrect because the magnitude is the sum of the squares not the difference and a tangent is required for the angle, not a sine. D is incorrect because a tangent is required for the angle, not a sine.	**1**
5	**C is the only correct answer** A is incorrect because the 2 should be above the line, and the 0.63 should be squared B is incorrect because the 2 should be above the line D is incorrect because he 0.63 should be squared	**1**
6	**B is the only correct answer** A is incorrect because a greater viscosity would reduce terminal velocity giving a lower gradient C is incorrect because because a greater viscosity would reduce terminal velocity giving a lower gradient D is incorrect because because a greater viscosity would reduce terminal velocity giving a lower gradient	**1**
7	**B is the only correct answer** A is incorrect because force *P* and *R* act on the same object C is incorrect because force *Q* and *S* act on the same object D is incorrect because forces *P* and *S* are not the same type of force.	**1**
8	**A is the only correct answer** B is incorrect because doubling the diameter gives four times the cross section, requiring four times the tension for the same stress. C is incorrect because increasing the diameter increases the cross section, requiring a greater tension for the same stress, not less D is incorrect because increasing the diameter increases the cross section, requiring a greater tension for the same stress, not less	**1**
9	**C is the only correct answer** A is incorrect because moments must balance about the centre of mass. B is incorrect because moments must balance about the left support. D is incorrect because the total reaction must be equal to the weight.	**1**
10	**B is the only correct answer** A is incorrect because one watt is defined as one joule per second C is incorrect because a 1 N = 1 kg m s^{-2} D is incorrect because a joule is the unit for work, and work = force × distance	**1**
	Total for Section A	**10**

SECTION B

Question Number	Answer		Mark
11(a)	Sum of momenta before (collision) = sum of momenta after (collision) **Or** Total momentum before (a collision) = total momentum after (a collision) **Or** Total momentum remains constant **Or** The momentum of a system remains constant Provided no external/unbalanced/resultant force acts **Or** in a closed/isolated system	 **(1)** **(1)**	**2**
11(b)(i)	Use of $p = m\,v$ $m = 8.22 \times 10^{13}$ (kg) <u>Example of calculation</u> 1.80×10^{17} N s = $m \times 2.19 \times 10^{3}$ m s^{-1} $m = 1.80 \times 10^{17}$ N s $\div\ 2.19 \times 10^{3}$ m s^{-1} = 8.219×10^{13} kg	**(1)** **(1)**	**2**
11(b)(ii)	Use of $p = m\,v$ with combined final mass Use of momentum conservation $v = 3.05 \times 10^{3}$ m s^{-1} (ecf from (i)) <u>Example of calculation</u> 1.80×10^{17} N s + (5.90×10^{12} kg × 15.0×10^{3} m s^{-1}) = (8.219×10^{13} kg + 5.90×10^{12} kg) × v $v = 2.685 \times 10^{17}$ N s $\div\ 8.81 \times 10^{13}$ kg = 3.048×10^{3} m s^{-1}	**(1)** **(1)** **(1)**	**3**
	Total for question 11		**7**

Question Number	Answer	Mark
12(a)	Amount of work from the electric motor is reduced **(1)** Because there is energy transfer between the counterweight and the lift **Or** Because counterweight contributes to total work done (on lift cage) **Or** Because the counterweight reduces the force required from the motor **Or** Because total work done (on lift cage) is sum of work done by counterweight/gravity and by the motor. **(1)**	**2**
12(b)	Use of $\Delta W = F\Delta x$ **or** $\Delta E_{grav} = mg\Delta h$ **(1)** Use of conservation of energy **(1)** Use of P = W / t **(1)** P = 12.4 (kW) **(1)** **Or** Calculates resultant force **(1)** Use of $\Delta W = F\Delta x$ **(1)** Use of P = W / t **(1)** P = 12.4 (kW) **(1)** <u>Example of calculation</u> For counterweight $\Delta E_{grav} = mg\Delta h$ $= 1300 \text{ kg} \times 9.81 \text{ ms}^{-2} \times 40.0 \text{ m} = 5.101 \times 10^5 \text{ J}$ For lift $\Delta E_{grav} = mg\Delta h$ $= 2250 \text{ kg} \times 9.81 \text{ ms}^{-2} \times 40.0 \text{ m} = 8.829 \times 10^5 \text{ J}$ Energy required = $8.829 \times 10^5 \text{ J} - 5.101 \times 10^5 \text{ J} = 3.728 \times 10^5 \text{ J}$ $P = 3.728 \times 10^5 \text{ J} \div 30 \text{ s} = 1.243 \times 10^4 \text{ W}$	**4**
12(c)	Use of efficiency = useful power output ÷ total power input **(1)** Efficiency = 0.78 (ecf from (b)) **(1)** <u>Example of calculation</u> Efficiency = 12.4 kW÷ (12.4 + 3.6) kW = 0.775	**2**
	Total for question 12	**8**

Question Number	Answer	Mark
13(a)	Vertical component of tension = $T \cos 76°$ **(1)** Use of 650 N = 2 × vertical component of tension **(1)** $T = 1.34 \times 10^3$ (N) **(1)** <u>Example of calculation</u> 650 N = 2 T cos 76° T = ½ × 650 N ÷ cos 76° = 1 343 N	**3**
13(b)(i)	Use of sin76° or cos 14° to find new length of cord **(1)** Use of $\varepsilon = \Delta x \div x$ **(1)** ε = 0.03 or 3% **(1)** <u>Example of calculation</u> $(x + \Delta x) \div 2$ = 60 m ÷ sin 76° = 61.8 m Δx = (61.8 × 2) m − 120.0 m = 3.7 m ε = 3.7 m ÷ 120 m = 0.031	**3**
13(b)(ii)	Use of $\sigma = F \div A$ with F = tension from (a) **(1)** Use of $E = \sigma \div \varepsilon$ **(1)** $E = 1.4 \times 10^8$ Pa (ecf from (a) and (b)(i)) **(1)** <u>Example of calculation</u> $\sigma = 1.34 \times 10^3$ N ÷ 3.14×10^{-4} m^2 = 4.28 MPa E = 4.28×10^6 Pa ÷ 0.031 = 1.38×10^8 Pa	**3**
	Total for question 13	**9**

Question Number	Answer	Mark
14*	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.	**6**

IC points	IC mark	Max linkage mark available	Max final mark
6 or more	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:

IC1 The force of the lift/scales on the student is the reading on the scales
Or
The reaction/contact force is the reading on the scales

IC2 At constant speed, the resultant force on the student is zero
Or
Weight/W = Reaction/R

IC3 At constant speed the reading on the scales would be 600 N.
Or
At rest the reading on the scales would be 600 N

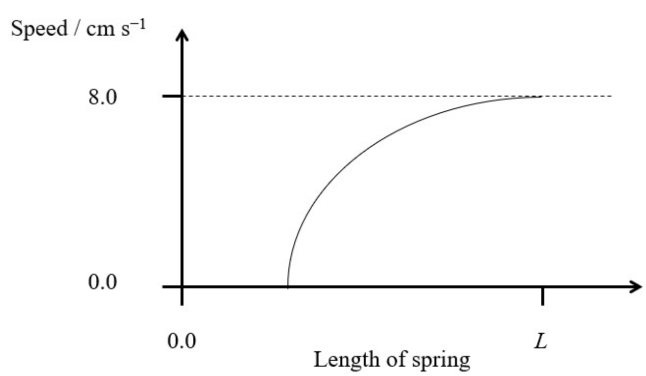
IC4 As lift decelerates reaction is less than weight

IC5 As the lift decelerates there is a resultant downward force (on the student).

IC6 As the lift decelerates the reading on the scales will be less than 600 N (because the upward force on the student is less than his weight)

	Total for question 14	**6**

Question Number	Answer	Mark
15(a)	There is an upthrust which is equal to the weight of water displaced **(1)** The upthrust is equal to the weight of the cylinder (when it's partially submerged) **(1)** **OR** The (overall) density (of the cylinder) is less than the density of the water. **(1)** The weight of water displaced is equal to the weight of the cylinder **(1)**	**2**
15(b)(i)	Use of Volume = $\pi r^2 l$ **(1)** Use of 63% with their volume **(1)** Use of $\rho = m / V$ **(1)** $m = 8.8 \times 10^{-3}$ (kg) **(1)** <u>Example of calculation</u> volume of cylinder= $\pi \times (1.05 \text{ cm})^2 \times 4 \text{ cm} = 1.39 \times 10^{-5} \text{ m}^3$ volume submerged = $0.63 \times$ volume of cylinder $= 0.63 \times 1.39 \times 10^{-5} \text{ m}^3 = 8.76 \times 10^{-6} \text{ m}^3$ mass of cylinder = mass of water displaced $= 1\,000 \text{ kg m}^{-3} \times 8.76 \times 10^{-6} \text{ m}^3 = 8.76 \times 10^{-3} \text{ kg}$	**4**
15(b)(ii)	Use of $\rho = m / V$ to calculate the volume of brass **(1)** Use of $\rho = m / V$ to calculate the mass of the same volume of gold (not volume of whole cylinder) **(1)** Use of $\rho = m / V$ to calculate the volume of water needed to float the cylinder **Or** Use of $\rho = m / V$ to calculate the maximum mass/weight of water that could be displaced **(1)** Correct conclusion from comparison of displaced volume of water required to float gold ($1.9 \times 10^{-5} \text{ m}^3$) with volume of cylinder ($1.4 \times 10^{-5} \text{ m}^3$) **Or** Correct conclusion from comparison of weight of gold cylinder (0.19 N) with max weight of water that could be displaced (0.14 N) (ecf from (b)(i)) **Or** Correct conclusion from comparison of mass of gold cylinder (0.019 kg) with max mass/weight of water that could be displaced (0.014 kg) (ecf from (b)(i)) **(1)** <u>Example of calculation</u> volume of gold = volume of brass $= 8.73 \times 10^{-3} \text{ kg} \div 8.7 \times 10^3 \text{ kg m}^{-3} = 1.00 \times 10^{-6} \text{ m}^3$ mass of gold = $1.00 \times 10^{-6} \text{ m}^3 \times 19.3 \times 10^3 \text{ kg m}^{-3} = 0.019\,3 \text{ kg}$ volume of water required = $0.019\,3 \text{ kg} \div (1.00 \times 10^3 \text{ kg m}^{-3}) = 1.93 \times 10^{-5} \text{ m}^3$ $1.93 \times 10^{-5} \text{ m}^3 > 1.39 \times 10^{-5} \text{ m}^3 \therefore$ sinks	**4**
	Total for question 15	**10**

Question Number	Answer		Mark
16(a)	Use of $E_k = ½\, m\, v^2$ $E_k = 3.8 \times 10^{-5}$ (J) <u>Example of calculation</u> $E_k = 0.5 \times 12 \times 10^{-3}$ kg $\times (8.0 \times 10^{-2}$ m s$^{-1})^2 = 3.84 \times 10^{-5}$ J	**(1)** **(1)**	**2**
16(b)	Use of $\Delta E_{el} = ½\, F\, \Delta x$ $F = 1.5 \times 10^{-3}$ N (allow ecf from (a)) <u>Example of calculation</u> $\Delta E_{el} = E_k = 3.84 \times 10^{-5}$ J $= 0.5 \times F \times 0.05$ m $F = 3.84 \times 10^{-5}$ J $\div 0.025$ m $= 1.54 \times 10^{-3}$ N	**(1)** **(1)**	**2**
16(c)	Use of $F = k\, \Delta x$ $k = 0.03$ N m^{-1} (allow ecf from (b)) <u>Example of calculation</u> 1.54×10^{-3} N $= k \times 0.05$ m $k = 1.54 \times 10^{-3}$ N $\div 0.05$ m $= 0.031$ N m^{-1}	**(1)** **(1)**	**2**
16(d)	Line has initially decreasing positive gradient Line starts at $v = 0$ and a non-zero value of length Line levels off to horizontal at length = L Final velocity marked as 8.0 cm s^{-1} **Or** Original compressed length marked as "$L - 5$" in cm 	**(1)** **(1)** **(1)** **(1)**	**4**
	Total for question 16		**10**

Question Number	Answer		Mark
17(a)	**Max 2**		
	Object must be a sphere	**(1)**	
	Low speed/velocity	**(1)**	
	Laminar flow	**(1)**	**2**
17(b)(i)	Use of $F = 6\pi \eta r v$	**(1)**	
	Subtraction of two forces	**(1)**	
	Resultant force = 7×10^{-6} N	**(1)**	**3**
	<u>Example of calculation</u> drag force = $6\pi \times 7.1 \times 10^{-2}$ Pa s $\times 2.25 \times 10^{-3}$ m $\times 5.2 \times 10^{-3}$ m s^{-1} = 1.6×10^{-5} N Resultant force = 2.3×10^{-5} N − 1.6×10^{-5} N = 0.7×10^{-5} N		
17(b)(ii)	Use of $F = 6\pi \eta r v$ with $F = 2.3 \times 10^{-5}$ N	**(1)**	
	$v = 7.6 \times 10^{-3}$ m s^{-1}	**(1)**	**2**
	<u>Example of calculation</u> 2.30×10^{-5} N = $6\pi \times 7.10 \times 10^{-2}$ Pa s $\times 2.25 \times 10^{-3}$ m $\times v$ $v = 2.30 \times 10^{-5}$ N ÷ ($6\pi \times 7.10 \times 10^{-2}$ Pa s $\times 2.25 \times 10^{-3}$ m) = 7.64×10^{-3} m s^{-1}		
17(c)	Larger diameter gives larger drag force (at given speed) **Or** Larger diameter gives a lower speed (for the same constant force)	**(1)**	
	Lower temperature so viscosity is greater	**(1)**	
	Greater viscosity gives larger drag force (at given speed) **Or** Greater viscosity gives lower speed (for the same constant force)	**(1)**	
	Maximum speed will decrease (dependent on MP1 and MP3)	**(1)**	**4**
	Total for question 17		**11**

Question Number	Answer	Mark
18(a)	Use of appropriate trigonometry **(1)** v_x =32 m s^{-1} **and** v_y =15 m s^{-1} **(1)** <u>Example of calculation</u> v_x =35 m s^{-1} × cos 25° = 31.7 m s^{-1} v_y =35 m s^{-1} × sin 25° = 14.8 m s^{-1}	**2**

18(b)	Use of $s = u_x t$ to find time taken to travel 100 m horizontally **(1)** Use of $s = u_y t + ½ a t^2$ with $a = - g$ to find distance fallen in time t Accept other correct SUVAT methods **(1)** Distance fallen = 2.1 m **(1)** Conclusion consistent with comparison of student's values, e.g. 2.1 m < 3.0 m so rider lands on other side of river **(1)** **Or** Use of correct SUVAT method with $a = - g$ to find time to descend by 3 m. **(1)** Use of $s = u_x t$ to find horizontal distance travelled in time t. **(1)** Distance travelled = 102 m **(1)** Conclusion consistent with comparison of student's values **(1)** **Or** Use of $s = u_x t$ to find time taken to travel 100 m horizontally **(1)** Use of correct SUVAT method with $a = - g$ to find time to descend by 3 m. **(1)** Time = 3.21 s **(1)** Conclusion consistent with comparison of student's values, e.g. 3.15 s < 3.21 s so rider lands on other side of river **(1)** <u>Example of calculation</u> time taken to travel 100 m = 100 m ÷ 31.7 m s^{-1} = 3.15 s vertical displacent = 14.8 × 3.15 − 0.5 × 9.81 × 3.15^2 = − 2.12 m 2.1 m < 3.0 m, so rider lands on other side of river	**4**

18(c)	Air resistance act to oppose the motion of the motorcyclist **(1)** So it decreases the time for which the motorcyclist is in the air **Or** There is deceleration in the horizontal direction **Or** Speed in horizontal direction is reduced **Or** The (maximum) height reached by the motorcyclist is reduced **(1)** Horizontal distance travelled is reduced (dependent on MP1 or MP2) **(1)**	**3**
	Total for question 18	**9**

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