



Mark Scheme (Final)

Summer 2023

Pearson Edexcel International Advanced
Subsidiary Level In Physics (WPH11)

Paper 01

Unit 1: Mechanics and Materials

Question Number	Answer	Mark
1	D is the correct answer A is incorrect because efficiency is not a vector quantity B is incorrect because energy is not a vector quantity C is incorrect because power is not a vector quantity	1
2	B is the correct answer A is incorrect because the force is not acting in the direction of motion D is incorrect because $\tan 40^\circ$ does not give parallel component of force C is incorrect because $\sin 40^\circ$ does not give parallel component of force	1
3	C is the correct answer A is incorrect because shorter wire gives less extension B is incorrect because shorter and thicker wire gives less extension D is incorrect because thicker wire gives less extension	1
4	B is the correct answer A is incorrect because area under graph is not a rectangle B is incorrect because work done is not the gradient of the graph C is incorrect because work done is not the gradient ⁻¹ of the graph	1
5	A is the correct answer B is incorrect because N3 pairs must have the same magnitude C is incorrect because N3 pairs must act at the same time D is incorrect because N3 pairs must be of the same type	1
6	B is the correct answer A is incorrect because the gradient gives a quarter of the acceleration C is incorrect because the gradient gives the wrong units D is incorrect because the gradient gives the wrong units	1
7	D is the correct answer A is incorrect because 15 is not the time taken B is incorrect because 2×15 is not the time taken C is incorrect because the displacement has not been doubled	1
8	C is the correct answer Because KE gained is GPE lost and the height lost is $20 \text{ m} \times \sin 23^\circ$	1
9	B is the correct answer A is incorrect because viscosity decreases C is incorrect because viscosity decreases D is incorrect because weight of the ball bearing is constant	1
10	D is the correct answer A is incorrect because it would give a result in mm N^{-1} B is incorrect because two such springs in series would give an extension of 60 mm for a tension of 45 N, not 15 mm C is incorrect because it would give a result in mm N^{-1}	1

Question Number	Answer	Mark
11	<p>Use of $v^2 = u^2 + 2 a s$ with $u = 0$ (1)</p> <p>Substitutes $a = 0.38 g$ (1)</p> <p>$\frac{v_M}{v_E} = 0.62$ (1)</p> <p><u>Example calculation</u></p> <p>$v_M^2 = 0 + 2 \times 0.38 g s$</p> <p>$v_E^2 = 0 + 2 \times g s$</p> <p>$\left(\frac{v_M}{v_E}\right)^2 = \frac{0.38gs}{gs} = 0.38$</p> <p>$\frac{v_M}{v_E} = \sqrt{0.38} = 0.62$</p>	3
	Total for question 11	3

Question Number	Answer	Mark
12(a)(i)	(Initial) gradient = 0 Or Tangent horizontal (at $t = 0$)	1
12(a)(ii)	EITHER Draws tangent at (1.5, 0.0) (-)14 \pm 1 m s ⁻¹ by graphical method OR <i>suvat</i> method using quantities read from the graph and/or $a = \pm g$. Correct answer from <i>suvat</i> calculation	2
12(b)	Straight line from 0 to (1.5, - [magnitude from (a)(ii)]) Second straight line from end of first line to (2.1, 0.0) [Ignore lines beyond 2.1 s]	2
Total for question 12		5

Question Number	Answer	Mark
13(a)	Use of $E_k = \frac{1}{2} m v^2$ (1) $E_k = 2.1 \times 10^9 \text{ (J)}$ (1) <u>Example calculation</u> $E_k = 0.5 \times 7.2 \times 10^5 \text{ kg} \times (76 \text{ m s}^{-1})^2 = 2.08 \times 10^9 \text{ J}$	2
13(b)	Use of $P = W / t$ (1) $D = 8.0 \times 10^8 \text{ J}$ (ecf from (a)) (1) <u>Example calculation</u> $W = 16 \times 10^6 \text{ W} \times 180 \text{ s} = 2.9 \times 10^9 \text{ J}$ $D = 2.9 \times 10^9 \text{ J} - 2.1 \times 10^9 \text{ J} = 8.0 \times 10^8 \text{ J}$	2
	Total for question 13	4

Question Number	Answer	Mark
14	Resolves horizontal and vertical component of velocity (1) Use of $s = u t + \frac{1}{2} a t^2$ with $a = -g$ and $u = u_v$ (1) Use of $s = u t + \frac{1}{2} a t^2$ with $a = 0$ and $u = u_h$ (1) Horizontal distance = 130 m (1) <u>Example calculation</u> $u_v = 37 \text{ m s}^{-1} \times \sin 53^\circ = 29.5 \text{ m s}^{-1}$ $t = 2 \times 29.5 \text{ m s}^{-1} \div 9.81 = 6.02 \text{ s}$ $u_h = 37 \text{ m s}^{-1} \times \cos 53^\circ = 22.3 \text{ m s}^{-1}$ $s_h = 22.3 \text{ m s}^{-1} \times 6.02 \text{ s} = 134.1 \text{ m}$	4
	Total for question 14	4

Question Number	Answer	Mark
15(a)	<p>Total momentum is conserved (because no external forces act)</p> <p>Or</p> <p>Total momentum before is equal to total momentum after (because no external forces act)</p> <p>Or</p> <p>Momentum of system is conserved (because no external forces act) (1)</p> <p>Total/system/initial momentum is zero (1)</p> <p>(Final momentum of machine is not zero because) final ball momentum is not zero</p> <p>Or</p> <p>Machine and ball have (equal but) opposite momenta (1)</p>	3
15(b)	<p>Use of $p = mv$ (1)</p> <p>Use of conservation of momentum (1)</p> <p>Velocity of machine = $(-)0.087 \text{ m s}^{-1}$ (1)</p> <p><u>Example calculation</u></p> <p>$2.9 \text{ kg} \times v + 0.056 \text{ kg} \times 4.5 \text{ m s}^{-1} = 0$</p> <p>$v = -0.252 \text{ m kg s}^{-1} \div 2.9 \text{ kg} = -0.0869 \text{ m s}^{-1}$</p>	3
Total for question 15		6

Question Number	Answer	Mark
16(a)	Flow (around sphere must be) laminar Or Flow (around sphere is) not turbulent (1)	1
16(b)(i)	Use of upthrust = weight of displaced fluid (1) $U = 5.2 \times 10^{-7} \text{ (N)}$ (1) <u>Example calculation</u> $U = 5.3 \times 10^{-11} \text{ m}^3 \times 998 \text{ kg m}^{-3} \times 9.81 \text{ N kg}^{-1}$ $= 5.19 \times 10^{-7} \text{ N}$	2
16(b)(ii)	Use of $V = \frac{4}{3}\pi r^3$ (1) Use of $F = 6\pi\eta r v$ (1) $F = 1.5 \times 10^{-7} \text{ N}$ Or Required $v = 0.12 \text{ m s}^{-1}$ Or Required $V = 2.4 \times 10^{-9} \text{ m}^3$ Or Required $r = 8.3 \times 10^{-4} \text{ m}$ and $r = 2.3 \times 10^{-4} \text{ m}$ Or Required $\eta = 3.4 \times 10^{-3} \text{ Pa s}$ (1) Valid conclusion by comparison of relevant student values (ecf from (b)(i)) (1)	4
	<u>Example calculation</u> $5.3 \times 10^{-11} \text{ m}^3 = \frac{4}{3}\pi r^3$ $r = \sqrt[3]{\frac{3 \times 5.3 \times 10^{-11} \text{ m}^3}{4\pi}} = 2.33 \times 10^{-4} \text{ m}$ If Stokes' law applies, $F = U$ $F = 6\pi \times 9.5 \times 10^{-4} \text{ Pa s} \times 2.33 \times 10^{-4} \text{ m} \times 3.50 \times 10^{-2} \text{ m s}^{-1}$ $= 1.46 \times 10^{-7} \text{ N} \neq 5.19 \times 10^{-7} \text{ N}$ \therefore Stokes' law does not apply	
	Total for question 16	7

Question Number	Answer	Mark
17(a)(i)	<p>Equates horizontal component with force from current (1)</p> <p>$F = 480 \text{ (N)}$ (1)</p> <p><u>Example calculation</u> $F \sin 33^\circ = 260 \text{ N}$ $F = 260 \text{ N} \div \sin 33^\circ = 477 \text{ N}$</p>	2
17(a)(ii)	<p>Resolves vertical component of F (1)</p> <p>Equates vertical forces (1)</p> <p>Weight of buoy = 2500 N (ecf from (a)(i)) (1)</p> <p><u>Example calculation</u> $477 \text{ N} \cos 33^\circ = 400 \text{ N}$ $400 \text{ N} + \text{Weight of buoy} = 2.9 \times 10^3 \text{ N}$ $\text{Weight of buoy} = 2900 \text{ N} - 400 \text{ N} = 2500 \text{ N}$</p>	3
17(b)	<p>EITHER</p> <p>Horizontal component of F increases (to maintain equilibrium) and Vertical component of F remains the same (because vertical forces do not change, upthrust and weight are constant) (1)</p> <p>$F^2 = F_h^2 + F_v^2$ so F increases [dependent on MP1] (1)</p> <p>$\tan \theta = F_h/F_v$ so θ increases [dependent on MP1] (1)</p> <p>OR</p> <p>Horizontal component of F increases (to maintain equilibrium) and Vertical component of F remains the same (because vertical forces do not change, upthrust and weight are constant) (1)</p> <p>$F^2 = F_h^2 + F_v^2$ so F increases [dependent on MP1] Or $\tan \theta = F_h/F_v$ so θ increases [dependent on MP1] (1)</p> <p>$F \cos \theta$ is constant so increase in either F or θ implies an increase in the other [dependent on MP2] (1)</p>	3
	Total for question 17	8

Question Number	Answer	Mark																																								
*18	<p>This question assesses a student’s ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.</p> <p>Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.</p> <p>The following table shows how the marks should be awarded for indicative content and lines of reasoning.</p> <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> <p>Indicative content:</p> <p>IC1 Balloon exerts a (backwards) force on the air</p> <p>IC2 By N3 the air exerts an opposite (forwards) force on balloon</p> <p>IC3 The forward force on the balloon is greater than resistive forces</p> <p>IC4 By N2 the resultant force causes acceleration</p> <p>IC5 As speed increases forces change until resistive force equals forward force</p> <p>IC6 By N1 resultant force equals zero so acceleration equals zero (at maximum speed)</p>	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	6
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																																							
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Answer has no linkages between points and is unstructured	0																																									
	Total for question 18	6																																								

Question Number	Answer	Mark
19(a)	<p>Use of $\Delta W = F \Delta x$ or $\Delta E_{grav} = mg\Delta h$ (1)</p> <p>Use of $P = W / t$ (1)</p> <p>Use of efficiency = useful power output / total power input Or Use of efficiency = useful energy output / total energy input (1)</p> <p>Total power input = 2.0×10^4 W (1)</p> <p><u>Example of calculation</u> $\Delta W = 4.4 \times 10^4 \times 15 \text{ m} = 6.6 \times 10^5 \text{ J}$ Output power = $6.6 \times 10^5 \text{ J} \div 70 \text{ s} = 9.4 \times 10^3 \text{ W}$ Efficiency = $\frac{9.4 \times 10^3 \text{ W}}{\text{Total power input}} = 0.47$ Total power input = $\frac{9.4 \times 10^3 \text{ W}}{0.47} = 2.0 \times 10^4 \text{ W}$</p>	4
19(b)(i)	<p>Total clockwise must balance total anticlockwise moment (about tower) Or Net/resultant/total moment (about tower) must be zero. (1)</p> <p>Total anticlockwise moment is due to counterweight and Total clockwise moment is due to sum of moment from beam and load (1)</p> <p>Increasing the distance of the load increases the (cw) moment (distance of CoG remains the same) (1)</p> <p>Distance of counterweight needs to be increased [dependent on MP3] (1)</p>	4

19(b)(ii)	Use of moment = $F x$ (1)	5
	Position of centre of mass of beam identified (1)	
	Use of principle of moments (1)	
	Maximum distance of load = 15 m	
	Or, for load at 22 m ...	
	CW moment = $1.18 \times 10^6 \text{ Nm}$ and max ASW moment = $8.8 \times 10^5 \text{ Nm}$	
	Or	
	Required distance of counterweight = 11 m	
	Or	
	Required counterweight = $1.5 \times 10^5 \text{ N}$	
	Or	5
	Maximum load = $3.0 \times 10^4 \text{ N}$	
	Or	
	Required distance to CoG = 2.9 m	
	Or	
	Required weight of beam = $1.3 \times 10^4 \text{ N}$	
	Or	
	Resultant moment = $3.0 \times 10^5 \text{ Nm (cw)}$ (1)	
	Valid conclusion by comparison of relevant student values (1)	
	<u>Example of calculation</u>	
	For equilibrium:	13
	$3.0 \times 10^4 \text{ N} \times 7.0 \text{ m} + 4.4 \times 10^4 \text{ N} \times x = 1.1 \times 10^5 \text{ N} \times 8.0 \text{ m}$	
	where x is the maximum distance of the load from the tower.	
	$x = (8.8 \times 10^5 \text{ Nm} - 2.1 \times 10^5 \text{ Nm}) \div 4.4 \times 10^4 \text{ N}$	
	$= 6.7 \times 10^5 \text{ Nm} \div 4.4 \times 10^4 \text{ N} = 15.2 \text{ m}$	
	$15.2 \text{ m} < 22.0 \text{ m}$ so crane would topple if load moved to end of beam	
Total for question 19		13

Question Number	Answer	Mark
20(a)	Stress (or strain) value at/beyond which a material/object undergoes a sudden or large plastic deformation (1)	1
20(b)(i)	The force/tension from/in the cable (on the actor) is greater than the weight of the actor (1)	2
	(So) there is a resultant/net/unbalanced force (upwards) (1)	

20(b)(ii)	<p>Use of $W = m g$ (1)</p> <p>Use of $\Sigma F = m a$ (1)</p> <p>Tension = 917 (N) (1)</p> <p><u>Example calculation</u> $W = 77 \text{ kg} \times 9.81 \text{ N kg}^{-1} = 755 \text{ N}$ $T - 755 \text{ N} = 77 \text{ kg} \times 2.1 \text{ m s}^{-2}$ $T = 162 \text{ N} + 755 \text{ N} = 917 \text{ N}$</p>	3
20(b)(iii)	<p>Use of $A = \pi r^2$ (1)</p> <p>Use of $\sigma = F \div A$ (ecf from (b)(ii)) (1)</p> <p>Allowed stress (15% yield stress of steel) = $3.8 \times 10^7 \text{ Pa}$ and $\sigma = 2.0 \times 10^7 \text{ Pa}$ Or $(15\%)^{-1}$ of cable stress = $1.3 \times 10^8 \text{ Pa}$ Or Max safe tension = $1.7 \times 10^3 \text{ N}$ Or Min safe diameter = $5.6 \times 10^{-3} \text{ m}$ Or Percentage of yield stress = 8% Or Max safe acceleration = 12.3 m s^{-2} (1)</p> <p>Valid conclusion by comparison of relevant student values (1)</p> <p><u>Example calculation</u> $A = \frac{\pi d^2}{4} = \frac{\pi \times (7.6 \times 10^{-3} \text{ m})^2}{4} = 4.54 \times 10^{-5} \text{ m}^2$ $\sigma = \frac{917 \text{ N}}{4.54 \times 10^{-5} \text{ m}^2} = 2.02 \times 10^7 \text{ Pa}$ (show that value gives $2.03 \times 10^7 \text{ Pa}$) $0.15 \times 2.5 \times 10^8 \text{ Pa} = 3.75 \times 10^7 \text{ Pa}$ $2.03 \times 10^7 \text{ Pa} < 3.75 \times 10^7 \text{ Pa}$ so it is safe.</p>	4
20(c)	<p>New cable has a greater cross sectional area, (but same breaking stress) so a greater force is required (1)</p> <p>Because new cable has smaller Young modulus, there is a greater strain for the same stress (1)</p> <p>So (at breaking stress) there will be a greater extension (because cables are the same length) [dependent on MP2] Or Smaller Young modulus implies greater extension (at breaking stress, because cables are the same length) [independent mark] (1)</p> <p>(And as) force and extension both increase, work done to break the new cable is greater than that for the original cable [independent mark] (1)</p>	4
Total for question 20		14