



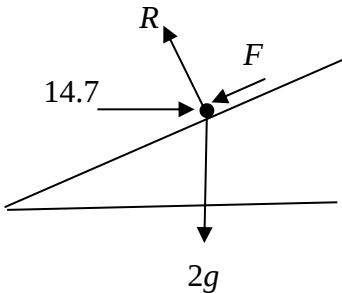
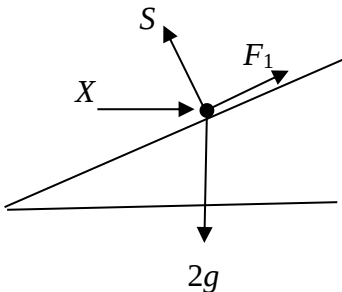
Mark Scheme (Results)

October 2022

Pearson Edexcel International Advanced Level
In Mechanics M1 (WME01) Paper 01

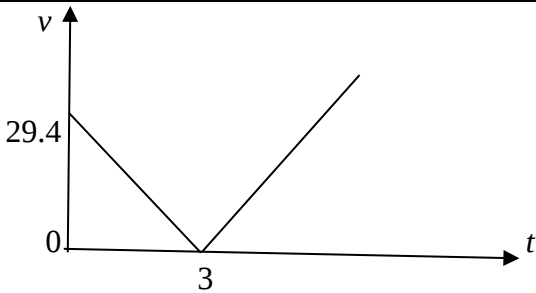
Question Number	Scheme	Marks
1.		
1(a)	$20000 \times 4 = 50000v$ $v = 1.6(\text{m s}^{-1})$ OR $20(-v - (-4)) = 30(v - 0)$	M1 A1
		(2)
1(b)	$\pm 20000(1.6 - 4)$ OR $\pm 30000 \times 1.6$	M1A1ft
	48000 N s or 48 kN s	A1
	.	(3)
		(5)
	Notes for question 1	
1(a)	M1 for a CLM equation, condone sign errors and extra g 's and any equivalent equation (e.g. $2 \times 4 = 5v$, $20 \times 4 = 50v$, $200 \times 4 = 500v$,... etc) OR : for equating impulses	
	A1 oe Units not needed but must be positive .	
1(b)	M1 impulse-momentum equation, dimensionally correct, correct no. of terms, condone sign errors but must be attempting a difference of momenta (allow 20 or 30 for the mass, M0 if g included or mass omitted)	
	A1ft a correct equation, follow through on their v (allow 20 or 30 for the mass) N.B. If using S to find the impulse, 4 and their v must have opposite signs when awarding the A1ft.	
	A1 cao units needed (allow kg m s^{-1}) and must be positive.	

Question Number	Scheme	Marks
2(a)	$M(D), \frac{3a}{5} Xg = \frac{2a}{5} Mg$ Other possible equations: $(\uparrow)T_D = Mg + Xg$ $M(A), Mga + Xg 2a = T_D \frac{7a}{5}$ $M(B), Mga = T_D \frac{3a}{5} \quad T_D \text{ would then need to be eliminated}$ $M(C), Mg \frac{3a}{5} + Xg \frac{8a}{5} = T_D a$ $M(G), Xga = T_D \frac{2a}{5}$	M1A1
	$X = \frac{2M}{3}, 0.67 M \text{ or better}$	A1 (3)
2(b)	$M(D), T_C a + \frac{1}{2} Mg \frac{3a}{5} = \frac{2a}{5} Mg$ Other possible equations: $(\uparrow)T_C + T_D = Mg + \frac{1}{2} Mg$ $M(A), Mga + \frac{1}{2} Mg 2a = T_C \frac{2a}{5} + T_D \frac{7a}{5}$ $M(B), Mga = T_C \frac{8a}{5} + T_D \frac{3a}{5} \quad T_D \text{ would need eliminating}$ $M(C), Mg \frac{3a}{5} + \frac{1}{2} Mg \frac{8a}{5} = T_D a$ $M(G), T_C \frac{3a}{5} + \frac{1}{2} Mga = T_D \frac{2a}{5}$	M1A1
	$T_C = \frac{1}{10} Mg \text{ oe}$	A1 (3)
		(6)
	Notes for question 2	
2(a)	M1 For an equation (or inequality,,) in X, M and a only (allow consistent missing a's) with correct no. of terms. Allow if one g is missing. N.B. M0 if T_c appears and never becomes zero	
	A1 Correct equation or inequality	
	A1 cao	
2(b)	M1 For an equation in T_c, M, g and a only (allow consistent missing a's or if g's) missing) with correct no. of terms M0 if they assume that $T_C = T_D$ or if they assume their X value from (a).	
	A1 Correct equation	
	A1 cao	

Question Number	Scheme	Marks
3(a)		
	(□), $14.7 \cos \alpha = 2g \sin \alpha + F$ (could be $-F$) OR: ($\rightarrow$), $14.7 + F \cos \alpha = R \sin \alpha$ AND eliminate R to give an equation in F only. ($\uparrow$), $R \cos \alpha + F \sin \alpha = 2g$ <u>Verificaton methods</u> $14.7 \cos \alpha = (11.76) = 2g \sin \alpha$ (i.e. verification that $X = 14.7 \Rightarrow F = 0$) OR: $X \cos \alpha = 2g \sin \alpha \Rightarrow X = 14.7$ (i.e. verification that $F = 0 \Rightarrow X = 14.7$)	M1 A1
	so $F = 0^*$ oe	A1*
		(3)
		
3(b)	$F_1 = 0.5S$	B1
	Two equations taken from: (□), $X \cos \alpha + F_1 = 2g \sin \alpha$ (□), $S = X \sin \alpha + 2g \cos \alpha$ ($\rightarrow$), $X + F_1 \cos \alpha = S \sin \alpha$ ($\uparrow$), $S \cos \alpha + F_1 \sin \alpha = 2g$	M1A2 M1A2

	N.B. M0 for both equations if they put $X = 14.7$ anywhere	
	$X = 4g/11$, 3.6 or 3.56 or 3.57	A1
	N.B. Enter marks for the equations on ePen in the order in which they appear above.	
		(8)
		(11)
	Notes for question 3	
3(a)	M1 Equation in F only, correct no of terms, condone sign errors and sin/cos confusion (M0 if they use $F = 0.5R$) N.B. Allow the equation without F Allow use of m instead of 2 for the Mmark	
	A1 Correct equation	
	A1* cao Must state a conclusion or , if verifying, must state clearly $X = 14.7 \Rightarrow F = 0$ OR $F = 0 \Rightarrow X = 14.7$	
3(b)	B1 $F_1 = 0.5S$ seen e.g. on a diagram (even if wrong direction)	
	M1 A resolution, correct no of terms, condone sign errors and sin/cos confusion Allow use of m instead of 2 for the A mark	
	A2 Correct equation, -1 each error	
	M1 A resolution, correct no of terms, condone sign errors and sin/cos confusion Allow use of m instead of 2 for the A mark	
	A2 Correct equation, -1 each error	
	A1 cao	

Question Number	Scheme	Marks
4(a)	$3616 - 250g - 565 - 226 = 250a$	M1 A1
	$a = 1.5 \text{ (m s}^{-2}\text{)}$	A1
		(3)
4(b)	$565 - mg = m \times 1.5$	M1A1ft
	$m = 50 \text{ (kg)}$	A1
		(3)
		(6)
	Notes for question 4	
4(a)	M1 Equation in <i>a</i> only , correct no. of terms, condone sign errors	
	A1 Correct equation	
	A1 oe	
4(b)	M1 Equation in <i>m</i> (mass of A) only , correct terms, condone sign errors	
	A1ft Correct equation ft on their <i>a</i>	
	A1 cao	

Question Number	Scheme	Marks
5(a)	$0 = 14.7^2 - 2gs$	M1A1
	22 or 22.1 (m)	A1
		(3)
5(b)	$19.6 = 29.4t + \frac{1}{2}gt^2$ N.B. $19.6 = 29.4t - \frac{1}{2}gt^2$ is M0A0 $-19.6 = 29.4t + \frac{1}{2}gt^2$ is M0A0 $-19.6 = 29.4t - \frac{1}{2}gt^2$ is M0A0 unless they go on to subtract 6 from the positive root	M1A1
	$t = 0.61$ or 0.606 (s)	A1
		(3)
5(c)		B1 shape B1 29.4 B1 3
		(3)
		(9)
	Notes for question 5	
5(a)	M1 Complete method to find distance UP N.B. They may find time UP (1.5s) AND use it to find distance UP OR: (Distance from A to top – Distance from ‘14.7’ to top) $= (44.1 - 33.075)$	
	A1 Correct equation(s) used	
	A1 cao	
5(b)	M1 Complete method to find required time N.B. They may find the speed as it hits the ground ($g\sqrt{13} = 35.334...$) AND use it to find the time.	
	A1 Correct equation(s) used	
	A1 cao N.B. If they add to or subtract from 0.606, it’s M0 for an incorrect method.	
5(c)	B1 V shape with v coord of end pt > 29.4 and each half roughly equally inclined to the t-axis. B0 if a vertical line is included at the end.	
	B1 29.4 independent	
	B1 3 independent	

Question Number	Scheme	Marks
6(a)	$(-3\mathbf{i} + 2\mathbf{j}) + (p\mathbf{i} + q\mathbf{j}) = (-3 + p)\mathbf{i} + (2 + q)\mathbf{j}$	M1
	$\frac{(-3 + p)}{(2 + q)} = \frac{1}{-2}$	M1A1
	$2p + q - 4 = 0$ * Allow $0 = 2p + q - 4$ but nothing else	A1*
		(4)
6(b)	$p = 5 \Rightarrow q = -6 \Rightarrow$ Resultant force $= (2\mathbf{i} - 4\mathbf{j})$	B1
	$(2\mathbf{i} - 4\mathbf{j}) = 0.5\mathbf{a}$	M1
	$\mathbf{v} = (4\mathbf{i} - 8\mathbf{j}) \times 4$	M1
	Speed $= \sqrt{16^2 + (-32)^2} = \sqrt{1280} = 16\sqrt{5} = 36 \text{ (m s}^{-1}\text{)} \text{ or better}$	M1A1
		(5)
		(9)
	Notes for question 6	
6(a)	M1 For adding <i>and</i> collecting i 's and j 's. N.B. Could be implied by $p = 4$ <i>and</i> $q = -4$	
	M1 Using ratios oe to set up an equation in p and q only, allow the ratio the wrong way round. M0 if they write down: $-3 + p = 1$ and $2 + q = -2$ and NEVER use ratios, but ignore these equations if they go on to use ratios	
	A1 Correct equation	
	A1* Correct answer correctly obtained	
6(b)	B1 Correct resultant force seen	
	M1 Use of $\mathbf{F} = m\mathbf{a}$ OR $F = ma$ where F (F) is their <i>resultant</i> (must have attempted to add the two forces) (M0 if they include g)	
	M1 Use of $\mathbf{v} = \mathbf{at}$ OR $v = at$ with $t = 4$ where a or a is their acceleration. (M0 if u or u is non-zero)	
	M1 Use of Pythagoras to find magnitude of v OR a OR F , including square root	
	N.B. The above 3 steps may appear in any order but must be entered on ePen in the order as above.	
	A1 Any equivalent surd or correct to at least 2 SF	

Question Number	Scheme	Marks
7(a)	$F = \mu mg$	B1
	For P: $mg - kmg = ma$ Allow $mg - T = ma$	M1A1
	For Q: $kmg - F = ma$ Allow $T - F = ma$	M1A1
	Either of these may be replaced by : $mg - F = 2ma$ (whole system)	
	Produce an equation in k and μ only using $T = kmg$	M1
	$k = \frac{1}{2}(1 + \mu)$	A1
		(7)
7(b)	Attempt to find the acceleration. [Note that some possible correct forms are: $a = \frac{1}{2}g(1 - \mu)$ or $g(1 - k)$ or $g(k - \mu)$]	M1
	$d = \frac{1}{2} \times \frac{1}{2} g(1 - \mu)t^2$	M1A1
	$t = \sqrt{\frac{4d}{g(1 - \mu)}}$	A1
		(4)
7(c)	P or Q (or the system) would not move	B1
	Accept any of $T = mg, T > mg, T \geq mg, a = 0, a < 0, a \leq 0$ $F = T, F > T, F \geq T, F > mg$. Allow F replaced by μR N.B. Forces referred to must be clearly defined so e.g. use of vague terms like ‘forward force’, ‘opposite force’, ‘force to the left or right’ is B0.	DB1
		(2)
		(13)

	Notes for question 7	
7(a)	B1 for $F = \mu mg$ seen e.g. on a diagram	
	M1 Equation of motion for P with correct no. of terms, condone sign errors	
	A1 Correct equation (allow $-a$)	
	M1 Equation of motion for Q with correct no. of terms, condone sign errors	
	A1 Correct equation (allow $-a$) N.B. ($-a$) must be used in both equations	
	M1 for producing an equation in k and μ only	
	A1 oe Must appear in (a)	
7(b)	M1 Attempt to find the acceleration in terms of g and μ or g and k or g , k and μ	
	M1 Complete method to find an equation in d , g , t and μ only, condone a sign error.	
	A1 Correct equation in d , g , t and μ only	
	A1 Any equivalent form	
7(c)	B1 Correct statement. B0 if incorrect extras.	
	DB1 Correct reason	

Question Number	Scheme	Marks	
	Allow column vectors throughout		
8(a)	$\sqrt{3^2 + 12^2}$	M1	
	$\sqrt{153}, 3\sqrt{17}, 12$ or better (km h ⁻¹)	A1	
		(2)	
8(b)	$(-9\mathbf{i} + 6\mathbf{j}) + t(3\mathbf{i} + 12\mathbf{j})$	M1	A1
	$(16\mathbf{i} + 6\mathbf{j}) + t(p\mathbf{i} + q\mathbf{j})$		A1
	$\overrightarrow{AB} = \mathbf{b} - \mathbf{a} = (16\mathbf{i} + 6\mathbf{j}) + t(p\mathbf{i} + q\mathbf{j}) - ((-9\mathbf{i} + 6\mathbf{j}) + t(3\mathbf{i} + 12\mathbf{j}))$	M1 A1	
	$= [25 + t(p - 3)]\mathbf{i} + t(q - 12)\mathbf{j}$		
	Compare with: $[(25 - 12t)\mathbf{i} - 9t\mathbf{j}]$ or e.g. use $\mathbf{b} = \mathbf{AB} + \mathbf{a}$ to obtain an equation in p only and an equation in q only. May be implied by correct answers only. ($-12 = p - 3$ and $-9 = q - 12$) N.B. This mark may not be available if they go wrong and the t 's don't cancel.	M1	
	$p = -9, q = 3$	A1	
		(7)	
8(c)	$(25 - 12t)^2 + (-9t)^2 = 15^2$ ($225t^2 - 600t + 400 = 0$)	M1A1	
	$t = \frac{4}{3}$	A1	
	$\pm(9\mathbf{i} - 12\mathbf{j})$ Note that this a method mark.	DM1	
	$\tan \theta = \frac{9}{12}$	M1	
	$\theta = 37^\circ$	A1	
	Bearing is 323° to nearest degree	A1	
		(7)	
		(16)	

	Notes for question 8	
8(a)	M1 Use of Pythagoras with square root	
	A1 cao	
8(b)	M1 Correct structure for either	
	A1 cao	
	A1 cao	
	M1 Allow a – b	
	A1 for a correct unsimplified expression for either b – a or a – b	
	M1 for an equation in <i>p</i> only and an equation in <i>q</i> only	
	A1 cao	
8(c)	M1 Use of Pythagoras to give an equation in <i>t</i> only Allow with a square root.	
	A1 Correct unsimplified quadratic equation	
	A1 $t = 1.3$ or better	
	DM1 Use of their <i>t</i> to find $\overline{AB}$ or $\overline{BA}$, dependent on previous M. May be implied. Allow if they use one of their two incorrect <i>t</i> values.	
	M1 For an equation in a relevant angle for their AB . Could be implied by a relevant angle seen on a diagram which could need checking with a calculator	
	A1 Correct relevant angle e.g $37^\circ, 53^\circ, 127^\circ, etc$ or better	
	A1 cao	