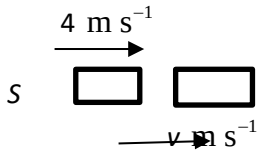
Pearson Edexcel

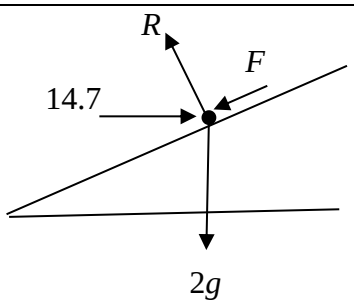
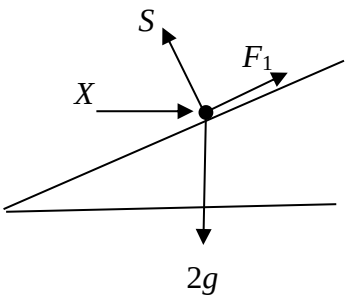
Mark Scheme (Results)

October 2022

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

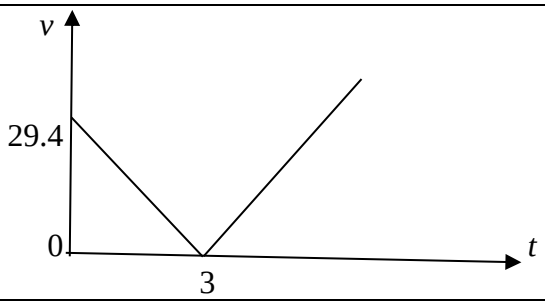
Question Number	Scheme	Marks
1.		
1(a)	$20000\times 4 = 50000v$ $v = 1.6(\text{m s}^{-1})$ **OR** $20(-v-(-4)) = 30(v-0)$	M1 A1
		(2)
1(b)	$\pm 20000(1.6-4)$ **OR** $\pm 30000\times 1.6$	M1A1**ft**
	48000 N s or 48 kN s	A1
	.	(3)
		(5)
	Notes for question 1	
1(a)	M1 for a CLM equation, condone sign errors and extra *g*'s and any equivalent equation (e.g. 2 x 4 = 5*v*, 20 x 4 = 50*v*, 200 x 4 = 500*v*,… 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)	
	A1**ft** 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), $Mga = T_D\,\frac{3a}{5}$ T_D 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 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), $Mga = T_C\,\frac{8a}{5} + T_D\,\frac{3a}{5}$ T_D 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
	$T_C = \frac{1}{10}Mg$ 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 Tc appears and never becomes zero	
	A1 Correct equation or inequality	
	A1 cao	
2(b)	M1 For an equation in Tc , 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)		
	$(\nwarrow),14.7\cos\alpha = 2g\sin\alpha + F$ (could be $-F$) **OR:** $(\rightarrow),14.7 + F\cos\alpha = R\sin\alpha$ $(\uparrow), R\cos\alpha + F\sin\alpha = 2g$ **AND** eliminate R to give an equation in F only. <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: $(\nwarrow), X\cos\alpha + F_1 = 2g\sin\alpha$ $(\nwarrow), S = X\sin\alpha + 2g\cos\alpha$ $(\rightarrow), X + F_1\cos\alpha = S\sin\alpha$ $(\uparrow), S\cos\alpha + F_1\sin\alpha = 2g$	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
	$a = 1.5$ (m s^{-2})	A1
		(3)
4(b)	$565 - mg = m \times 1.5$	M1A1**ft**
	m = 50 (kg)	A1
		(3)
		(6)
	Notes for question 4	
4(a)	M1 Equation in a **only**, correct no. of terms, condone sign errors	
	A1 Correct equation	
	A1 oe	
4(b)	M1 Equation in m (mass of A) **only**, correct terms, condone sign errors	
	A1**ft** Correct equation ft on their a	
	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 => q = -6 => Resultant force = $(2\mathbf{i}-4\mathbf{j})$	B1
	$(2\mathbf{i}-4\mathbf{j})$ = 0.5**a**	M1
	v = $(4\mathbf{i}-8\mathbf{j})\times 4$	M1
	Speed = $\sqrt{16^2+(-32)^2}$ = $\sqrt{1280}=16\sqrt{5}$ = 36 (m s^{-1}) or better	M1A1
		(5)
		(9)
	Notes for question 6	
6(a)	M1 For adding *and* collecting **i**'s and **j**'s. **N.B**. Could be implied by p = 4 *and* 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 **F** = *m***a** OR $F = ma$ where **F** (F) is their *resultan*t (must have attempted to add the two forces) (M0 if they include g)	
	M1 Use of **v** = **a***t* 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.	**D**B1
		(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
	$\overrightarrow{AB}=\mathbf{b}-\mathbf{a}=(16\mathbf{i}+6\mathbf{j})+t(p\mathbf{i}+q\mathbf{j})-\left((-9\mathbf{i}+6\mathbf{j})+t(3\mathbf{i}+12\mathbf{j})\right)$	M1 A1
	$=\left[25+t(p-3)\right]\mathbf{i}+t(q-12)\mathbf{j}\right]$	
	Compare with: $\left[(25-12t)\mathbf{i}-9t\mathbf{j}\right]$ 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)	$(25-12t)^2+(-9t)^2=15^2$ $\quad(225t^2-600t+400=0)$	M1A1
	$t=\dfrac{4}{3}$	A1
	$\pm(9\mathbf{i}-12\mathbf{j})$ Note that this a method mark.	**DM**1
	$\tan\theta=\dfrac{9}{12}$	M1
	$\theta=37^o$	A1
	Bearing is 323^o 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 *p* only and an equation in *q* only	
	A1 cao	
8(c)	M1 Use of Pythagoras to give an equation in *t* only Allow with a square root.	
	A1 Correct unsimplified quadratic equation	
	A1 $t = 1.3$ or better	
	DM1 Use of their *t* to find $\overrightarrow{AB}$ or $\overrightarrow{BA}$, dependent on previous M. May be implied. Allow if they use one of their two incorrect *t* 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 $37^o, 53^o, 127^o, etc$ or better	
	A1 cao	