

Mathematics

Advanced Subsidiary GCE

Unit **4728**: Mechanics 1

Mark Scheme for January 2011

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1 i	$\Delta\text{Mom P} = 0.5(2.4 + 0.2)$ $\Delta\text{Mom P} = +/-1.3 \text{ kgms}^{-1}$	M1 A1 [2]	+/- 0.5(2.4 ± 0.2)	MR P/Q +/-0.8(1.5+/-0.2) M1A0
ii	Momentum before = $0.5 \times 2.4 - 0.8 \times 1.5$ $0.5 \times 2.4 +/- - 0.8 \times 1.5 = +/-(-0.5 \times 0.2 +/- 0.8v)$ Speed = 0.125 ms^{-1} OR $\Delta\text{Mom Q} = +/- (-0.8v - 0.8 \times 1.5)$ $1.3 = +/-(-0.8v - 0.8 \times 1.5)$ Speed = 0.125 ms^{-1}	B1 M1 A1ft A1 [4] B1 M1 A1ft A1	$+/- (0.5 \times 2.4 - 0.8 \times 1.5)$ Uses mom before = mom after Cv(Expression for before momentum) $1/8, +ve$ (not 0.13) Uses $\Delta\text{Mom P} = \Delta\text{Mom Q}$ Cv(ans(i)) = $+/- (+/-0.8v - 0.8 \times 1.5)$ $1/8, +ve$ (not 0.13)	Cont MR $0.5 \times 2.4 - 0.8 \times 1.5$ Uses mom before = mom after $0.5 \times 2.4 +/- - 0.8 \times 1.5 = +/-(-0.8 \times 0.2 +/- -0.5v)$ 0.32 B1 M1A1A1 ft
2 i	$10\text{CorS}\alpha = 8$ $10\cos\alpha = 8$ $\alpha = 36.9^\circ$ OR $10\text{CorS}\alpha = F$ $10\sin\alpha = 6$ $\alpha = 36.9^\circ$ OR $\tan\theta = F/8$ $\tan\alpha = 6/8$ $\alpha = 36.9^\circ$	M1 A1 A1 [3] M1 A1ft A1 M1 A1ft A1	Component of $10 = 8$ Accept 37 36.8 and 37 from 36.7 Using value of F(ii) Using F(=6) from (ii) OR $\tan\theta = 8/F$, using value of F from (ii)	CorS is Cos or Sin (passim) Do not accept 36.7
ii	$F = 10\sin 36.9$ $F = 6 \text{ N}$ OR $F^2 + 8^2 = 10^2$ $F = 6 \text{ N}$	M1 A1ft A1 [3] M1 A1 A1	$F = 10\text{CorS}\alpha$ Allow $10\text{Cos}53.1$ Accept 6.01 (or from $10\text{Cos}53.1$) or 6.0 Pythagoras, 3 squared terms	anything rounding to 6.0 from correct working. Accept $F^2 = 8^2 + 10^2$

<p>3 i</p>	<p>$v^2 = (+/-5)^2 + 2 \times 9.8 \times 2.5$ Speed (or v) = 8.6(0) ms^{-1} OR $0 = 5^2 - 2 \times 9.8 \times s$ with $v^2 = (0) + 2 \times 9.8(s+2.5)$ $v^2 = 2 \times 9.8 \times (2.5+1.28)$ Speed = 8.6(0) ms^{-1}</p>	<p>M1 A1 A1 [3] M1 A1 A1</p>	<p>Uses $v^2 = u^2 \pm 2gs$, u non-zero Accept $\sqrt{74}$ Do not accept -8.6(0) $s = 1.2755\dots$ $19.8 \times 3.7755\dots$ Or rounds to 8.6</p>	<p>It is common to see the upwards and downwards motion treated separately. Both parts must be attempted for M1, and both parts must be attempted accurately with cvs for the A1</p>
<p>ii</p>	<p>$8.6 = -5 + 9.8t$ Time = 1.39 s OR $9.8t^2 - 10t - 5 = 0$ Time = 1.39 s OR $2.5 = (8.6-5)t/2$ Time = 1.39 s OR $t = 5/9.8 + 8.6/9.8$ Time = 1.39</p>	<p>M1 A1ft A1 [3] M1 A1 A1 M1 A1ft A1 M1 A1ft A1</p>	<p>Uses v(from (i)) = $+/-5 +/- 9.8t$ Cv(8.60 from (i)) $+/-2.5 = 5t +/- gt^2/2$ $2.5 = +/- (5 - \text{Speed from (i)}) \times t / 2$ Cv(8.60 from (i)) Times to top and ground found and added Cv(8.60 from (i))</p>	<p>It is common to see the upwards and downwards motion treated separately. Both parts must be attempted for M1, and both parts must be attempted accurately with cvs for the A1</p>
<p>iii a) b)</p>		<p>B1 B1 B1 B1 [4]</p>	<p>Straight descending line to t axis Continues straight below t axis Inverted “parabolic” curve, starts anywhere on $t=0$ Ends below $t = 0$ level, need not be below t axis</p>	<p>Ignore values written on diagrams</p>

4 i	$2 - F = 0.8 \times 0.2$ $F = T \cos 10$ $T = 1.87 \text{ N}$ OR $2 - T \cos 10 = 0.8 \times 0.2$ $T = 1.87 \text{ N}$	M1 M1 A1 [3] M1 M1 A1	N2L 2 force terms and ma ($F = 1.84 \text{ N}$) $F = T \cos 10$ 1.8683.. N2L 2 force terms and ma $T \cos 10$	m is the block mass, award if T not F
ii	$R - 0.3 \times 9.8 + T \cos 10 = 0$ $R = 0.3 \times 9.8 - 1.87 \sin 10$ $R = 2.62$ $T \cos 10 - F_r = 0.3 \times 0.2$ $F_r = 1.78$ $\mu = 1.78 / 2.62$ OR $1.78 = 2.62 \mu$ $\mu = 0.68$	M1 A1ft A1ft M1 A1ft M1 A1 [7]	3 term equation, vertically cv(T(i)) 2.61(5..) seen or implied N2L 2 forces for P, component of T cv(T(i)) seen or implied both terms same sign	Treat as a mis-read $R - 0.8 \times 9.8 - T \cos 10 = 0$ leading to $R = 8.16$ (i.e. works on block [2/3]) OR N2L 2 forces for P+Q: $2 - F_r = (0.8 + 0.3) \times 0.2$ R, Fr unequal to T From correct value of $T = 1.87$ only
5 ia b c	$s(P) = 4.9T + 0.5 \times 4.9T^2$ $y(Q) = (0) + 0.5 \times 9.8T^2$ $(m) \times 4.9 = (m) g \sin \theta$ $\theta = 30$ $y(Q)/s(P) = \sin \theta$ OR $y(Q) = s(P) \sin \theta$ $0.5 \times 9.8(2/3)^2 / (4.9 \times 2/3 + 2.45(2/3)^2) = 0.5$ OR $0.5 \times 9.8T^2 / (4.9T + 2.45T^2) = \sin 30$ $T = 2/3 \text{ s}$ AG	M1 A1 A1 [3] M1* A1 [2] M1 D*M1 A1 [3]	$s = ut + 0.5at^2$ used along plane or vertically, with $u = 4.9$ or 0, and $a = 4.9$ or 9.8 appropriately Accept use of t or T Allow g in Y(Q) Allow CorS0 Uses appropriate trigonometry to relate distances Verification needs explicit value of $\sin(\text{cv}(\theta))$ Ratio of distances considered using cv (30)	 $\sin \theta = (0.5 \times 9.8T^2) / (4.9T + 0.5 \times 4.9T^2)$ gets M1, but in ic. Beware circular argument. This may appear in b) $0.5 \times 9.8(2/3)^2 = (4.9 \times 2/3 + 2.45(2/3)^2) \times 0.5$ OR $0.5 \times 9.8T^2 = (4.9T + 2.45T^2) \times \sin 30$
ii	$v = 4.9 + 4.9 \times 2/3$ OR $v = (0) + 9.8 \times 2/3$ $v = 8.17 \text{ ms}^{-1}$ $w = 9.8 \times 2/3 = 6.53 \text{ ms}^{-1}$	M1 A1 A1 [3]	Uses $v = u + at$, with appropriate u, a values once 8.2 6.5	

6 i	$x = \int t^2 - 9 \, dt$ $x = t^3/3 - 9t (+c)$ Finds $x(2)$ Displacement = $15\frac{1}{3}$ m OR $x(2) = [t^3/3 - 9t]_0^2$ Displacement = $15\frac{1}{3}$ m	M1* A1 D*M1 B1 [4] D*M1 B1	Uses integration of $v(t)$ Award if +c omitted Allow + c or c omitted Accept 15.3, 46/3. Must be +ve Uses limits $[\]_0^2$ on integrated $x(t)$ Must be +ve	Awarded if c omitted or assumed 0
ii	$t=0 \, s=0$ or $s=46/3$ hence $x(0)$ or $c=0$ or $46/3$ Solves $t^2 - 9 = 0$ $t = (\pm)3$ $x(3) = 3^3/3 - 9 \times 3 (+ 15.3)$ $x(3) = -18$ (or -2.67) Dist = 18 m	B1* M1* A1 D*M1 M1 D*B1 [6]	Needs explanation, may be seen in part i May be implied Value of t when direction of motion changes Substitutes $cv(t) > 2$ in integrated $x(t)$ Evaluates $c - 18$ may be implied award if .. Accept 18(.0) [c=0 assumed]	B1* awarded if limits 0 and 3 used correctly Awarded if limits used correctly
iii	$a = d(t^2 - 9)/dt$ $a = 2t$ $10 = 2t$ $t = 5$ $x(5) (= 5^3/3 - 9 \times 5 + 15.3) = 12$ m OR $[t^3/3 - 9t]_2^5 = 12$ m	M1* A1 D*M1 A1 A1 [5] A1	Uses differentiation of $v(t)$	

7 i	<p>Wt cmpts: // plane $0.6g\sin 30$ Perp plane $0.6g\cos 30$</p> <p>$0.6g\sin 30$ +/- X = 0.6×10 X = +/-3.06 $\mu = 3.06 / 5.09(22..)$ $\mu = 0.601$ OR $3.06 = \mu \times 5.09(22..)$ $\mu = 0.601$</p>	<p>B1 B1 M1 A1ft A1 M1 A1 [7] M1 A1</p>	<p>+/-2.94 +/-5.09(22.) = R N2L // plane, 2 force terms and ma (allow no g) Both weight cmpt and accn signs same May be implied (Fr = $0.6 \times 10 - 0.6g\sin 30$ used) Uses $\mu = Fr/R$ both terms same sign 0.6 Uses Fr = μR both terms same sign 0.6</p>	<p>Accept Fr for X Accept Fr = X Accept Fr = X </p>
ii a) b)	<p>$C^2 = 3.06^2 + 5.09^2$ C = 5.94 N $\tan \theta = 3.06/5.09(22..)$ Angle = (31) + 90 Angle = 121° OR $\tan \phi = 5.09(22..)/3.06$ Angle = $180 - (59)$ Angle = 121°</p> <p>C (= 0.6×9.8) = 5.88 N Angle = 60°</p>	<p>M1 A1 M1* D*M1 A1 [5] M1* D*M1 A1 B1 B1 [2]</p>	<p>Pythagoras with Fr and R, to find hypotenuse Accept 5.9, 5.95 but not 6(.0) Or $\tan \theta = \mu$ Not 120 $\tan \phi = 1/\mu$ Not 120 5.9</p>	<p>No working needed as C is vertical No working needed as C is vertical</p>

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