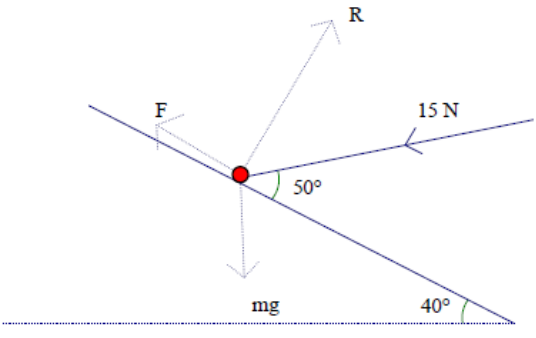


Mixed Exam Questions – Set 6

1.

<p>7a</p>	 <p>Perpendicular to the slope: $R = 2.7g \cos 40 + 15 \cos 40$ $= 31.8 \text{ (N) or } 32 \text{ (N)}$</p>	<p>M1A2 A1 (4)</p>
<p>7b</p>	<p>Parallel to the slope: $F = 2.7g \sin 40 - 15 \cos 50$ ($F = 7.366..$) Use of $F = \mu R$ $\mu = \frac{2.7g \sin 40 - 15 \cos 50}{R} = 0.23 \text{ or } 0.232$</p>	<p>M1A2 M1 A1 (5)</p>
<p>7c</p>	<p>Component of wt parallel to slope = $2.7g \sin 40^\circ (= 17.0)$ $F_{\max} = 0.232 \times 2.7 \times g \times \cos 40^\circ = 4.7... \text{ (N)}$ $17.0 > 4.70$ so the particle moves</p>	<p>B1 M1A1 A1 (4)</p>

2.

(i)	$T - 0.3g \sin 30 = 0.3a$ OR $0.4g \sin 30 - T = 0.4a$ $0.4g \sin 30 - 0.3g \sin 30 = 0.7a$ $a = 0.7 \text{ m s}^{-2}$ $T = 0.3g \sin 30 + 0.3 \times 0.7$ $T = 1.68 \text{ N}$	<p>AG A1 M1 A1 [5]</p>	<p>Either correct N2L for one particle May be awarded later in (i) Allow combined approach as "method", must be components of weight, allow $mg(\cos/\sin)30$ Allow $0.3g(\cos/\sin)30$. Accept cv(0.7)</p>	<p>Putting $a = 0.7$ into correct equation for a single particle and working out T correctly gets B1M0A0M1A1. Consult TL if this is done for both particles. May use the other equation.</p>
(ii)	$V = 1.8 \times 0.7$ $V = 1.26 \text{ m s}^{-1}$	<p>M1 A1 [2]</p>	<p>Accept cv(0.7)</p>	
(iii)	$\text{Dec} = 1.26 / 1.4$ $\text{Dec} = 0.9 \text{ m s}^{-2}$	<p>M1 A1 [2]</p>	<p>Accept $1.8 \times 0.7 / 1.4$ Or $a = +/- 0.9$</p>	<p>cv(1.26)</p>
(iv) (a)	$T - 0.3g \sin 30 = -0.3 \times 0.9$ $T = 1.2$	<p>M1 A1ft A1 [3]</p>	<p>N2L, 2 forces including cmpt of weight cv(0.9) but signs must be consistent with the direction of motion</p>	<p>Allow $mg(\cos/\sin)30$</p>
(iv) (b)	$-0.4 \times 0.9 = 0.4g \sin 30 - T - F_r$ $-0.4 \times 0.9 = 0.4g \sin 30 - 1.2 - F_r$ $F_r = 1.12 \text{ N}$	<p>M1 A1ft A1 [3]</p>	<p>N2L, 3 forces including cmpt of weight cv(0.9) and cv(1.2) but signs must be consistent with the direction of motion</p>	<p>Allow $mg(\cos/\sin)30$</p>

3.

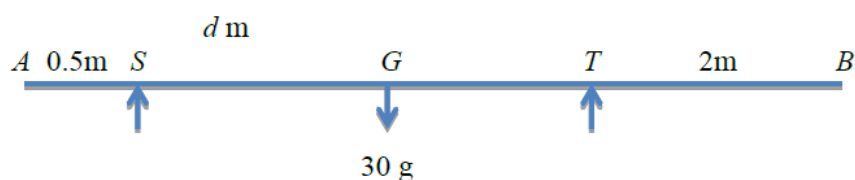
At maximum height	M1	For considering maximum height
$v^2 - u^2 = 2as \Rightarrow 0^2 - 8^2 = 2 \times (-9.8) \times h$	M1	Use of suitable <i>suvat</i> equation(s) eg finding and using <i>t</i> for maximum height (0.816 s). Allow for use of calculus.
$h = 3.265\dots$	A1	CAO but allow 3.26 as well as 3.27
(3.265... < 4) so the stone misses the pigeon	A1	Dependent on previous mark
Alternative		
Substitute $y = 4$ in $y = 8t - 4.9t^2$	M1	
Attempt to solve $4.9t^2 - 8t + 4 = 0$	M1	
Discriminant (= $64 - 4 \times 4.9 \times 4 = -14.4$) < 0	A1	
No value of <i>t</i> so the stone does not reach height 4 m	A1	
Time to house is $\frac{22.5}{15} = 1.5$ s	B1	
Height at house = $8 \times 1.5 - \frac{1}{2} \times 9.8 \times 1.5^2 = 0.975$ m	B1	Allow answers from essentially correct working that round to 0.96, 0.97 or 0.98, eg 0.96375 from $g = 9.81$
$0.8 < 0.975 < 2.0$ so it hits the window.	B1	A 2-sided inequality must be given, either in figures or in words. Condone $0.8 < 0.975 < 1.2$ Dependent on previous mark

4.

(i) (A)	$x = Ut \cos 68.5^\circ$	B1 1	
(i) (B)	$y = Ut \sin 68.5^\circ - 4.9 \times t^2$	M1 A1 2	Allow 'u' = U. Allow $s \leftrightarrow c$. Allow g as g , ± 9.8 , ± 9.81 , ± 10 . Allow +2. Accept not 'shown'. Do not allow +2. Allow e.g. $+0.5 \times (-9.8) \times t^2$ instead of $-4.9t^2$. Accept g not evaluated
(ii)	either At D, $y = 0$ so $U \sin 68.5^\circ T - 4.9 \times T^2 = 0$ $\Rightarrow T(U \sin 68.5^\circ - 4.9T) = 0$ so $T = 0$ (at C) or $T = \frac{U \sin 68.5^\circ}{4.9}$ (at D) or Use (i)(A) and put $x = 10$ with $t = T$ to get $UT \cos 68.5^\circ = 10$	M1 M1 E1 M1 M1 E1 B1 4	Equating correct y to 0 or their y to correct value. Attempting to factorise (or solve). Allow $\neq T$ without comment. Properly shown. Accept no ref to $T = 0$. Accept $T = 0$ given as well without comment. Find time to top Double time to the top
(iii)	Eliminating T from the results in (ii) gives $U \cos 68.5^\circ \times \frac{U \sin 68.5^\circ}{4.9} = 10$ so $U = 11.98729\dots$ so 12.0 (3 s. f.)	M1 M1 E1 3	Substituting, using correct expressions or their expressions from (ii). Attempt to solve for U^2 or U . Some evidence seen. e.g. $142.8025\dots < U^2 < 145.2025\dots$ with clear statement, or 11.9... seen with clear statement or 11.98... seen. Accept 11.98... seen for full marks.

(iv)	Require $Ut \sin 68.5^\circ - 4.9t^2 = -2$ Solving $4.9t^2 - Ut \sin 68.5^\circ - 2 = 0$ $t = -0.1670594541\dots, 2.4431591\dots$ (Using 12: $-0.1669052502\dots, 2.445478886\dots$) Require $U \cos 68.5^\circ \times 2.44\dots - 10 = 0.7336\dots$ so 0.734 m (3 s. f.) (Using 12 consistently, 0.7552... so 0.755 (3 s. f.))	M1 M1 A1 M1 A1 5	Equating correct y to -2 or their y to correct value. Allow use of $U, 11.987\dots$ or 12. Allow implicit ' $= 0$ ' Dep on 1 st M1. Attempt to solve a 3 term quadratic to find at least the +ve root. Allow if two correct roots seen WW. Accept only +ve root given Alternative method of e.g. finding time to highest point and then time to the ground. M1 all times attempted, at least one by a sound method. M1 both methods sound and complete. A1. Dep on first M1. Allow their expression for x . Allow ' -10 ' omitted. cao. Accept $0.73 \leq x \leq 0.76$
(v)	Eliminate t from (i) (B) using $t = \frac{x}{U \cos 68.5^\circ}$ from (i)(A) so $y = x \tan 68.5^\circ - \frac{4.9x^2}{U^2 (\cos 68.5^\circ)^2}$ We require $y = 0$ when $x = 10$ so $U = 11.98729\dots$ so 12.0 (3 s. f.)	M1 E1 M1 E1 4	May be implied. FT their (i). Clearly shown. Must see attempt to solve. Or use $x = 10.73\dots$ when $y = -2$. Must see evidence of fresh calculation or statement that they have now got the same expression for evaluation.

5.



$$M(S): Mg \leftrightarrow 0.5 = 30g(d - 0.5)$$

$$M(T): Mg \leftrightarrow 2 = 30g(4 - d)$$

$$\text{dividing:} \quad 4 = \frac{(4-d)}{(d-0.5)} \Rightarrow \text{(i) } d = 1.2$$

$$\Rightarrow \text{(ii) } M = 42$$

M1 A1
M1 A1
DM1 A1
A1

6.

a	Resolving vertically: $T + 2T (= 3T) = W$ Moments about B: $2 \times 2T = (d - 1)W$ Substitute and solve for d : $2 \times 2T = (d - 1)3T$ $d = \frac{7}{3} \text{ (m)}$	M1A1 M1A1 DM1 A1 (6)
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b	Moments about C: $(T_B \times 2) + (kW \times 1) = W \times \frac{2}{3}$ $T_B = W \frac{(2 - 3k)}{6} \quad \text{or equivalent}$	M1A1 A1 (3)
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c	solving $T_B \geq 0$ or $T_B > 0$ for k . $0 < k \leq 2/3$ or $0 < k < 2/3$ only	M1 A1 (2)
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