Detailed marking instructions for each question

Question			Generic scheme	Illustrative scheme	Max mark
1.			•[1] Resolve forces in two perpendicular directions •[2] Use $F = ma$ with substitution •[3] Find acceleration on slope •[4] Use equations of motion to find velocity after 75 metres	•[1] $R = mg\cos\theta$ $mg\sin\theta - \mu R = ma$ •[2] $F = ma:\ mg\sin\theta - \mu mg\cos\theta = ma$ $\frac{g}{4} - \frac{g}{8} \times \frac{\sqrt{15}}{4} = a$ •[3] $a = 1\cdot264 \quad [1\cdot26]$ •[4] $v^2 = u^2 + 2as$ $= 2 \times 1\cdot264 \times 75$ $v = 13\cdot8\,\text{ms}^{-1}$	**4**

Notes:

•[4] **Accept** $13\cdot7\,\text{ms}^{-1}$

Commonly Observed Responses:

Question			Generic scheme	Illustrative scheme	Max mark
Alternative Solution:					
1.			•1 State initial values of kinetic energy and potential energy	•1 At top of the slope $\varepsilon_k + \varepsilon_P$ $0 + m \times g \times 75 \sin\theta$ $= \dfrac{75mg}{4}$ At bottom of slope $\varepsilon_K = \dfrac{1}{2}mv^2$	**4**
			•2 Calculate work done against friction	•2 $W = \mu N \times 75$ $N = mg\cos\theta$	
			•3 Use work energy principle with substitution	•3 $\dfrac{1}{8} \times \dfrac{\sqrt{15}mg}{4} \times 75 = \dfrac{75\sqrt{15}}{32}$ $\dfrac{1}{2}mv^2 = \dfrac{75mg}{4} - \dfrac{75\sqrt{15}}{32}$	
			•4 Value of speed after 75 metres	•4 $v^2 = \dfrac{75g}{2} - \dfrac{75\sqrt{15}g}{16}$ $v = 13 \cdot 8\,\text{ms}^{-1}$	
Notes: •3 and •4 can be found using definite integration					
Commonly Observed Responses:					

Question			Generic scheme	Illustrative scheme	Max mark
2.	(a)		**Quotient Rule:**		**3**
			•1 correct use of quotient rule with one term correct	•1 $f'(x)=\dfrac{2x^2\times\frac{1}{x}-\text{..........}}{\text{..............}}$	
			•2 numerator and denominator correct	•2 $f'(x)=\dfrac{2x^2\times\frac{1}{x}-\ln x\times(4x)}{4x^4}$	
			•3 **fully** simplify	•3 $f'(x)=\dfrac{2x-4x\ln x}{4x^4}=\dfrac{1-2\ln x}{2x^3}$	

Notes:

Commonly Observed Responses:

Alternative solution

			Product rule:		
			•1 express as product and start differentiation correctly	•1 $f(x)=\frac{1}{2}(\ln x)\left(x^{-2}\right)$ $f'(x)=\frac{1}{2}(\ln x)(-2x^{-3})$.........	
			•2 complete differentiation correctly	•2 $f'(x)=\frac{1}{2}(\ln x)(-2x^{-3})+\frac{1}{2}x^{-2}\left(\frac{1}{x}\right)$	
			•3 **fully** simplify	•3 $f'(x)=\left(\frac{-\ln x}{x^3}\right)+\frac{1}{2}\left(\frac{1}{x^3}\right)=\frac{1-2\ln x}{2x^3}$	

Notes:

Commonly Observed Responses:

Question			Generic scheme	Illustrative scheme	Max mark
2.	(b)		•1 1st application of chain rule •2 2nd application of chain rule •3 Substitution for y and complete solution	•1 $\frac{dy}{dx} = 2\text{cosec}3x \times 3.......$ •2 $\frac{dy}{dx} = 2\text{cosec}3x \times 3 \times -\text{cosec}3x\cot 3x$ $\frac{dy}{dx} = -6y\,\text{cos ec}^2 3x\cot 3x$ •3 $= -6y\cot 3x$ $\frac{dy}{dx} + 6y\cot 3x = 0$	3

Notes:

Accept $\frac{dy}{dx} = -6y\cot 3x$

Commonly Observed Responses:

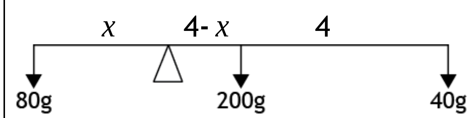
Question			Generic scheme	Illustrative scheme	Max mark
3.			•[1] Evidence of differentiation to give expression for acceleration	•[1] $\mathbf{v} = \left(3\sin 2t\right)\mathbf{i} + \left(\cos 2t - 3\right)\mathbf{j}$ $\mathbf{a} = \frac{d\mathbf{v}}{dt} = \ldots\mathbf{i} + \ldots\mathbf{j}$	**4**
			•[2] Correct expression	•[2] $\mathbf{a} = \frac{d\mathbf{v}}{dt} = (6\cos 2t)\mathbf{i} - (2\sin 2t)\mathbf{j}$	
			•[3] Substitution to give acceleration in vector form	•[3] $t = \frac{\pi}{6} : \mathbf{a} = 6\cos\frac{\pi}{3}\mathbf{i} - 2\sin\frac{\pi}{3}\mathbf{j}$ $[\mathbf{a} = 3\mathbf{i} - \sqrt{3}\mathbf{j}]$	
			•[4] Magnitude of acceleration	•[4] $\lvert\mathbf{a}\rvert = \sqrt{12} = 2\sqrt{3}\,\mathrm{ms}^{-2}$ $[3\cdot 46\,\mathrm{ms}^{-2}]$	

Notes

•[1] can be implied in •[2]

•[4] Accept $\sqrt{12}\,\mathrm{ms}^{-2}$

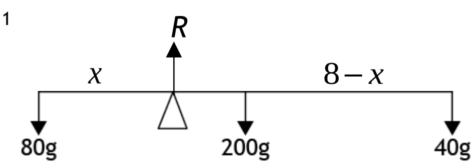
Commonly Observed Responses:

Question	Generic scheme	Illustrative scheme	Max mark
4.	•[1] model the situation by considering the forces acting on the beam and the distances of each from the pivot	•[1] 	4
	•[2] state moments about pivot anticlockwise	•[2] $80gx$	
	•[3] state moments about pivot clockwise, and equate	•[3] $80gx = 200g(4-x) + 40g(8-x)$	
	•[4] solve and interpret answer	•[4] $320gx = 1120g$ $[320x = 1120]$ $x = 3 \cdot 5$ The support is positioned $3 \cdot 5\,\text{m}$ from A	

Notes:

Commonly Observed Responses:

Alternative Solution:

•[1] model the situation by considering the forces acting on the beam and the distances of each from the pivot	•[1] 	4
•[2] Use vertical equilibrium	•[2] $R = 80g + 200g + 40g$ $R = 320g$	
•[3] Taking moments about *A*	•[3] $320g \times x = 200g \times 4 + 40g \times 8$	
•[4] solve and interpret answer	•[4] $320x = 800 + 320$ $x = 3 \cdot 5$ The support is positioned $3 \cdot 5\,\text{m}$ from A	

Notes:

Commonly Observed Responses:

Question			Generic scheme	Illustrative scheme	Max mark
5.			•[1] Write as a sum of fractions	•[1] $\frac{A}{x-3}+\frac{Bx+C}{x^2+5}$ $A\left(x^2+5\right)+\left(Bx+c\right)\left(x-3\right)=3x^2+4x+17$	**4**
			•[2] Rewrite equation with no denominator	•[2] $A=4$	
			•[3] Calculate two constants	•[3] $B=-1 \text{ or } C=1$	
			•[4] Calculate final value and rewrite original function as sum of partial fractions	•[4] $\frac{4}{x-3}+\frac{1-x}{x^2+5}$	

Notes:

•[1] if incorrect can only achieve 2 marks

Commonly Observed Responses:

Question			Generic scheme	Illustrative scheme	Max mark
6.			•[1] consider vertical forces •[2] consider forces radially •[3] combine equations and substitute for known quantities •[4] find the value of the coefficient of friction	•[1] Diagram to show forces acting or $F = mg = \mu R$ •[2] $\mu R = mg$ $R = mr\omega^2$ •[3] $\mu mr\omega^2 = mg$ $\mu(3\cdot5)(4)^2 = g$ •[4] $\mu = 0\cdot175$	**4**

Notes:
•[1] can be implied by •[2] or •[3]

Commonly Observed Responses:
A diagram was drawn showing balanced forces. This would not allow for a centripetal force.

Question			Generic scheme	Illustrative scheme	Max mark
7.			•[1] Use range to find expression for time of flight •[2] use equations of motion with constant acceleration vertically •[3] Rearrange to give expression for *t* and substitution •[4] process algebra •[5] find initial speed	•[1] $R = u\cos\theta \times t$ $60 = u\cos 28° \times t$ •[2] $s = ut + \frac{1}{2}at^2$ $0 = u\sin 28° - \frac{g}{2}t^2$ •[3] $t = \frac{60}{u\cos 28°}$ $0 = u\sin 28° \times \frac{60}{u\cos 28°} - \frac{g}{2}\left(\frac{60}{u\cos 28°}\right)^2$ •[4] $\frac{g}{2}\left(\frac{60}{u\cos 28°}\right)^2 = 60\tan 28°$ •[5] $u = 26 \cdot 6\,\text{ms}^{-1}$	**5**

Notes:

Commonly Observed Responses:

Question			Generic scheme	Illustrative scheme	Max mark
8.			•[1] Find expression for momentum before collision •[2] apply conservation of linear momentum •[3] calculate speed of Y after collision •[4] use Newton's second law to calculate deceleration of Y •[5] use appropriate equation of motion and substitute •[6] calculate distance travelled before coming to rest and communicate result relative to B	•[1] $0{\cdot}2\times6+0{\cdot}5\times3$ •[2] $0{\cdot}2\times6 + 0{\cdot}5\times3 = 0{\cdot}5\times v_y$ •[3] $v_y = 5{\cdot}4\,\text{ms}^{-1}$ •[4] $-mg\sin30 = ma$ $a = -4{\cdot}9\,\text{ms}^{-2}$ $-mg\ \sin30 = ma$ •[5] $0^2 = 5{\cdot}4^2 + 2\times(-4{\cdot}9)\times s$ •[6] $s = 2{\cdot}98\,\text{m}$ which is 52cm below B	**6**

Notes
For mark •[6] conclusion must be stated

Commonly Observed Responses:

Question			Generic scheme	Illustrative scheme	Max mark
9.	(a)		•1 Find resultant force •2 Work done by variable force with substitution •3 Integrate function •4 Calculate work done	•1 Resultant force = $(249-50\sqrt{x})-\mu R$ $=249-50\sqrt{x}-0\cdot25\times20g)$ $=200-50\sqrt{x}$ •2 Work done = $\int_0^{10}(200-50\sqrt{x})dx$ •3 $\left[200x-\frac{100}{3}x^{\frac{3}{2}}\right]_0^{10}$ •4 946 J	4
Notes					
Commonly Observed Responses:					
	(b)		•5 Work done equated to change in energy with substitution •6 Value of speed after 10 metres	•5 $\frac{1}{2}(20){v_{10}}^2-\frac{1}{2}(20)12^2=945\cdot9$ •6 $v_{10}=15\cdot4\,\text{ms}^{-1}$	
Notes					
Commonly Observed Responses:					

Question			Generic scheme	Illustrative scheme	Max mark
Alternative Solution: This solution does the question in reverse and so cannot be split into (a) and (b)					
9.	(a) +(b)		•¹ Find resultant force	•¹ Resultant force = $(249-50\sqrt{x})-\mu R$ $=249-50\sqrt{x}-0\cdot 25\times 20g)$ $=200-50\sqrt{x}$	**6**
			•² Set up differential equation	•² $F=ma:\ 20v\dfrac{dv}{dx}=(200-50\sqrt{x})$	
			•³ separate the variables	•³ $\int vdv=\int(10-\frac{5}{2}\sqrt{x})dx$	
			•⁴ Obtain the general equation for velocity at any time	•⁴ $\dfrac{v^2}{2}=10x-\dfrac{5}{3}x^{\frac{3}{2}}+c$ $x=0, v=12\Rightarrow c=72$ $\dfrac{v^2}{2}=10x-\dfrac{5}{3}x^{\frac{3}{2}}+72$	
			•⁵ Value of speed after 10 metres	•⁵ $v_{10}=15\cdot 4\,\mathrm{ms}^{-1}$	
			•⁶ Work done equated to change in energy with substitution	•⁶ $\frac{1}{2}(20)v_{10}{}^2-\frac{1}{2}(20)12^2=945\cdot 9\,\mathrm{J}$	

Notes:
•³ and •⁴ can be found using definite integration

Commonly Observed Responses:

Question			Generic scheme	Illustrative scheme	Max mark
10.			•[1] Integrate one function and differentiate other •[2] Correct choice of functions for the process •[3] Correct expression for integral •[4] Second integration by parts •[5] Substitution and final answer	$f(x)=x^2 \quad g'(x)=\sin 5x$ •[1] •[2] $f'(x)=2x \quad g(x)=-\frac{1}{5}\cos 5x$ •[3] $I=-\frac{x^2}{5}\cos 5x+\frac{2}{5}\int x\cos 5x dx$ •[4] $\int x\cos 5xdx=\frac{x}{5}\sin 5x-\frac{1}{5}\int \sin 5xdx$ $=\frac{x}{5}\sin 5x+\frac{1}{25}\cos 5xdx$ •[5] $I=\frac{-x^2}{2}\cos 5x+\frac{2}{5}\left(\frac{x}{5}\sin 5x+\frac{1}{25}\cos 5x\right)+c$ $=\left[\left(\frac{2}{125}-\frac{x^2}{5}\right)\cos 5x+\frac{2x}{25}\sin 5x+c\right]$	**5**

Notes:
•[5] Do not penalise omission of constant

Commonly Observed Responses:

Question			Generic scheme	Illustrative scheme	Max mark
11.			•¹ Differentiate $3y^2$ and 4 •² Differentiate product •³ Expression for derivative •⁴ Substitute for x and find **two** values of y •⁵ Choose correct value for y and substitute x value and y value to obtain gradient.	•¹ $6y\dfrac{dy}{dx}$ and 0 •² $-2xy - x^2\dfrac{dy}{dx}$ •³ $\dfrac{dy}{dx} = \dfrac{2xy}{6y - x^2}$ •⁴ $x = 2 \quad 3y^2 - 4y - 4 = 0$ $y = -\dfrac{2}{3};\ y = 2$ •⁵ $\dfrac{dy}{dx} = \dfrac{2\cdot 22}{6\cdot 2 - 2^2} = 1$	**5**
Notes:					
Commonly Observed Responses:					

Question			Generic scheme	Illustrative scheme	Max mark
12.	(a)		•¹ Consider body in equilibrium and Hooke's Law •² Evaluate equilibrium extension	•¹ $T = mg : \dfrac{150e}{0 \cdot 5} = 0 \cdot 75g$ •² $e = 0 \cdot 0245 = 2 \cdot 45\,\text{cm}$	**2**
Notes:					
Commonly Observed Responses:					
	(b)	(i)	•³ Apply $F = ma$ vertically •⁴ Apply Hooke's Law in extension with substitution •⁵ Complete to prove SHM	•³ $mg - T = m\ddot{x}$ •⁴ $mg - \dfrac{150(0 \cdot 0245 + x)}{0 \cdot 5} = m\ddot{x}$ $g - 400(0 \cdot 0245 + x) = \ddot{x}$ •⁵ $-400x = \ddot{x}$ [SHM with $\omega = 20$]	**3**
Notes:					
Commonly Observed Responses:					
		(ii)	•⁶ Use correct equation for speed with substitution •⁷ Find the value of speed	•⁶ $a = 0 \cdot 02 \quad \omega = 20 \quad x = 0 \cdot 015$ $v^2 = \omega^2(a^2 - x^2) \Rightarrow v^2 = 400(0 \cdot 02^2 - 0 \cdot 015^2)$ •⁷ $v = 0 \cdot 265[\text{ms}^{-1}]$	**2**
Notes:					
Commonly Observed Responses:					
	(c)		•⁸ Statement about extension that allows tension in the string	•⁸ $3\,\text{cm} > 2 \cdot 45\,\text{cm}$ so string is not in tension throughout.	**1**
Notes:					
Commonly Observed Responses:					

Question			Generic scheme	Illustrative scheme	Max mark
13.	(a)		•[1] Use Newton's law of gravitation and $\boldsymbol{F = ma}$ at earth's surface •[2] Create second equation for satellite and combine •[3] Interpret condition for gravity •[4] Find expression for height of satellite	•[1] $mg = \frac{GMm}{R^2} \quad \Rightarrow GM = gR^2$ •[2] $GM = g_s(R+h)^2 \quad g_s(R+h)^2 = gR^2$ •[3] $g_s = \frac{1}{9}g$ $\frac{1}{9}g(R+h)^2 = gR^2 \Rightarrow r = 3R$ $\frac{1}{9}g(R+h)^2 = gR^2 \quad (R+h)^2 = 9R^2$ •[4] $R+h = 3R$ $h = 2R$	**4**

Notes:

Commonly Observed Responses:

Alternative solution

			•[1] Use Newton's inverse square law and $\boldsymbol{F = ma}$ at earth's surface •[2] Create second equation for satellite and combine •[3] Interpret condition for gravity •[4] Find expression for height of satellite	•[1] $a = \frac{l}{r^2}: \ g = \frac{k}{R^2} \quad k = gR^2$ •[2] $\frac{1}{9}g = \frac{k}{(R+h)^2}$ •[3] $\frac{1}{9}g = \frac{gR^2}{(R+h)^2}$ $\frac{1}{9}g(R+h)^2 = gR^2 \quad (R+h)^2 = 9R^2$ •[4] $R+h = 3R$ $h = 2R$

Notes:

Commonly Observed Responses:

Question			Generic scheme	Illustrative scheme	Max mark
13.	(b)		•[5] Use Newton's Law of Gravitation and circular motion at surface •[6] Equate with expression from (a) and substitute for *r* •[7] Complete proof	•[5] $\frac{GMm}{r^2} = mr\omega^2 \Rightarrow GM = r^3\omega^2$ •[6] $gR^2 = r^3\omega^2$ $gR^2 = (4R)^3\omega^2$ •[7] $\omega^2 = \frac{gR^2}{64R^3} \Rightarrow \omega = \frac{1}{8}\sqrt{\frac{g}{R}}$	**3**

Notes

Commonly Observed Responses:

Alternative solution

			•[5] Use Newton's inverse square law and circular motion at surface •[6] Equate with expression from (a) and substitute for *r* •[7] Complete proof	•[5] $g = \frac{k}{R^2} \quad k = gR^2$ •[6] $a = \frac{k}{(4R)^2} = \omega^2(4R)$ •[7] $\omega^2 = \frac{gR^2}{64R^3} \Rightarrow \omega = \frac{1}{8}\sqrt{\frac{g}{R}}$	

Notes:

Commonly Observed Responses:

Question			Generic scheme	Illustrative scheme	Max mark
14.	(a)	(i)	•[1] Comment about $\mathbf{i}$ and $\mathbf{j}$ as **unit** vectors •[2] Specify $\mathbf{i}$ as in direction of East and $\mathbf{j}$ as in direction of North	•[1] As per Generic Scheme •[2] As per Generic Scheme	**2**
Notes					
Commonly Observed Responses:					
		(ii)	•[3] obtain equations for the velocity of boat A and boat B •[4] state initial positions and obtain equations for the positions of boat A and boat B at time t •[5] obtain equation for position of boat A relative to boat B	•[3] $v_A = 10\sin 60\mathbf{i} + 10\cos 60\mathbf{j} = 5\sqrt{3}\mathbf{i} + 5\mathbf{j}$ $v_B = -10\sqrt{3}\sin 30\mathbf{i} + 10\sqrt{3}\cos 30\mathbf{j} = -5\sqrt{3}\mathbf{i} + 15\mathbf{j}$ •[4] $r_A = 0\mathbf{i}$ and $r_B = 12\mathbf{i}$ $\Rightarrow$ after time t $r_A = 5\sqrt{3}t\mathbf{i} + 5t\mathbf{j}$ $r_B = (12 - 5\sqrt{3}t)\mathbf{i} + 15t\mathbf{j}$ •[5] ${}_Ar_B = r_A - r_B$ ${}_Ar_B = (5\sqrt{3}t - (12 - 5\sqrt{3}t))\mathbf{i} + (5t - 15t)\mathbf{j}$ $= (10\sqrt{3}t - 12)\mathbf{i} - 10t\mathbf{j}$	**3**
Notes					
Commonly Observed Responses:					

Question			Generic scheme	Illustrative scheme	Max mark
14.	(b)		•6 obtain expression for the magnitude relative distance between boats A and B •7 Equate distance expression to 7km •8 Obtain quadratic equation in standard form •9 Solve quadratic equation to find values for t •10 State time interval rounded to nearest minute	•6 $\lvert {}_A r_B \rvert = \sqrt{(10\sqrt{3}t - 12)^2 + (10t)^2}$ •7 $400t^2 - 240\sqrt{3}t + 144 < 49$ $400t^2 - 240\sqrt{3}t + 144 = 49$ •8 $400t^2 - 240\sqrt{3}t + 95 = 0$ •9 $t = \dfrac{240\sqrt{3} \pm \sqrt{20800}}{800}$ $t = 0\cdot339\,\text{hours}\ [20\cdot4\,\text{mins}]$ $t = 0\cdot700\,\text{hours}\ [42\cdot0\,\text{mins}]$ •10 22 minutes	**5**
Notes					
Commonly Observed Responses:					

Question			Generic scheme	Illustrative scheme	Max mark
15.	(a)		•¹ Statement of the total force •² Use of $F = ma$ with use of $mv\dfrac{dv}{dx}$	•¹ $\dfrac{P}{v} - \dfrac{mkv^2}{6}$ •² $mv\dfrac{dv}{dx} = \dfrac{6P - mkv^3}{6v}$	**2**
Notes					
Commonly Observed Responses:					
	(b)		•³ Separation of variables to prepare for integration •⁴ explicit term for x •⁵ Substitute initial values to find c or use definite integral •⁶ Expression for the displacement	•³ $\int dx = \int \dfrac{6mv^2}{6P - mkv^3} dv$ •⁴ $x = \dfrac{-2}{k}\ln\left\|6P - mkv^3\right\| + c$ •⁵ $0 = \dfrac{-2}{k}\ln(6P) + c$ $c = \dfrac{2}{k}\ln 6P$ •⁶ $x = \dfrac{2}{k}\ln 6P - \dfrac{2}{k}\ln(\left\|6P - mkv^3\right\|$ $\left[x = \dfrac{2}{k}\ln\left\|\dfrac{6P}{6P - mkv^3}\right\|\right]$	**4**
Notes:					
Commonly Observed Responses:					

Question			Generic scheme	Illustrative scheme	Max mark
16.			•¹ identify $\int P dt$ and its integration •² integrating factor •³ multiply through by IF and state derivative •⁴ integrate to give expression for *v* •⁵ use initial conditions to find *c* and state full expression for velocity	•¹ $\int \frac{-1}{t} dt = -\ln t$ •² $e^{-\ln t} = e^{\ln \frac{1}{t}} = \frac{1}{t}$ •³ $\frac{1}{t}\frac{dv}{dt} - \frac{v}{t^2} = \frac{3}{t}$ $\frac{d}{dt}\left(\frac{v}{t}\right) = \frac{3}{t}$ •⁴ $\frac{v}{t} = 3\ln t + c \quad [v = 3t\ln t + ct]$ •⁵ $c = 5 \Rightarrow v = 3t\ln t + 5t$	**5**

Notes

•⁴ must include constant.

•⁵ must be expression for *v* and not $\frac{v}{t}$.

Commonly Observed Responses:

Question			Generic scheme	Illustrative scheme	Max mark
17.	(a)		•¹ resolve forces perpendicular to the slope	•¹ $R = mg\cos\theta$ $\quad [R = 12g\frac{\sqrt{7}}{4} = 3\sqrt{7}g]$	**5**
			•² resolve forces parallel to the slope	•² $ma = mg\sin\theta - \mu R$	
			•³ combine equations to give an expression for the acceleration.	•³ $a = g\sin\theta - \mu g\cos\theta$ $a = \frac{(3-\sqrt{7}\mu)g}{4}$	
			•⁴ use appropriate equation of motion with substitution.	•⁴ $v^2 = u^2 + 2as$ $100 = 25 + \frac{2(3-\sqrt{7}\mu)gs}{4}$	
			•⁵ algebraic manipulation to give the required expression.	•⁵ $\frac{(3-\sqrt{7}\mu)gs}{2} = 75$ $s = \frac{150}{(3-\sqrt{7}\mu)g}$	

Notes

Commonly Observed Responses:

Question			Generic scheme	Illustrative scheme	Max mark
17.	(b)		•[6] consider motion of the body down slope with resisting forces •[7] consider equilibrium perpendicular to slope •[8] combine equations and substitute in values to get an expression for acceleration •[9] substitute expression for acceleration into equation of motion with original distance now halved •[10] Simplify equation •[11] complete solution to find value of μ	•[6] $ma = mg\sin\theta - \mu R - 260\cos\theta$ •[7] $R = 260\sin\theta + 12g\cos\theta$ •[8] $12a = 12g\sin\theta - \mu(260\sin\theta + 12g\cos\theta) - 260\cos\theta$ $12a = -83\cdot8 - 273\mu$ $a = -6\cdot98 - 22\cdot75\mu$ •[9] $v^2 = u^2 + 2as$ $0 = 100 + 2(-6\cdot98 - 22\cdot75\mu) \times \dfrac{75}{(3-\sqrt{7}\mu)g}$ •[10] $-100(3-\sqrt{7}\mu)g = 150(-6\cdot98 - 22\cdot75\mu)$ •[11] $\mu = 0\cdot32$	**6**

Notes
Commonly Observed Responses:

Question			Generic scheme	Illustrative scheme	Max mark
Alternative Solution:					
17.	(b)		•¹ Statement of force acting down slope	•¹ $F = (mg\sin\theta - \mu mg\cos\theta)$	**6**
			•² Change in kinetic energy	•² $\frac{1}{2}mv^2 - \frac{1}{2}mu^2 = 450$	
			•³ use of work/energy principle	•³ $(mg\sin\theta - \mu mg\cos\theta) \times s = 450$	
			•⁴ substitution of exact values	$450 = (9g - 3\sqrt{7}\mu g) \times s$ •⁴ $s = \frac{450}{(9 - 3\sqrt{7}\mu)g} = \frac{150}{g(3 - \sqrt{7}\mu)g}$	
			•⁵ algebraic manipulation to give required answer	$(3 - \sqrt{7}\mu)gs = 150$ •⁵ $s = \frac{150}{(3 - \sqrt{7}\mu)g}$	
			•⁶ Resolve forces acting down the slope	•⁶ $(mg\sin\theta - 260\cos\theta - \mu R)$	
			•⁷ Equilibrium of forces perpendicular to slope to give expression for R with substitution	•⁷ $R = 260\sin\theta + mg\cos\theta$ $(mg\sin\theta - 260\cos\theta - 260\mu\sin\theta - \mu mg\cos\theta) \times \frac{1}{2}s = -600$	
			•⁸ set up equation from the work/energy principle	•⁸ $(mg\sin\theta - 260\cos\theta - \mu R) \times \frac{1}{2}s = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$	

Question			Generic scheme	Illustrative scheme	Max mark
Alternative Solution continued:					
17.	(b)		•⁹ substitute in expression for displacement down slope	•⁹ $(-83\cdot8-273\mu)\times\dfrac{75}{(3-\sqrt{7}\mu)g}=-600$	
			•¹⁰ Process algebra	•¹⁰ $75(-83\cdot8-273\mu)=-600(3-\sqrt{7}\mu)g$	
			•¹¹ calculate value of μ	•¹¹ $\mu=0\cdot32$	
Notes					
Commonly Observed Responses:					

[END OF MARKING INSTRUCTIONS]