M1

Solutions and Mark Scheme

Final Version

1. (a) Using $v^2 = u^2 + 2as$ with $u = 18.2$, $a = (-)9.8$, $v = 0$ o.e. M1

$0 = 18.2^2 + 2(-9.8)s$ A1

$s = \underline{16.9}$ (m) cao A1

(b) Using $s = ut + at^2$ with $s = 0$, $u = 18.2$, $a = (-)9.8$ M1

$0 = 18.2t - 4.9t^2$ A1

$t = 0, \frac{26}{7}$

Ball returns to point A after $\frac{26}{7}$ s. cao A1

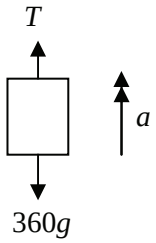
(c) Using $v = u + at$ with $u = 18.2$, $t = 2.5$, $a = (-)9.8$ M1

$v = 18.2 + (-9.8)\times 2.5$ A1

$= -6.3$

Ball is moving downwards with speed $\underline{6.3}$ ms^{-1}. A1

2. (a) (i)



Apply Newton's second law to lift dim. correct. M1

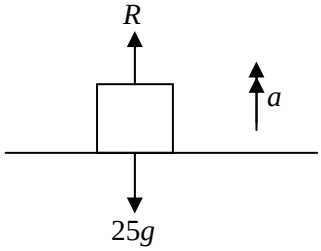
$T - 360g = 360a$ A1

When $a = -3$, $T = 360 \times 9.8 - 360 \times 3$

$= \underline{2448}$ (N) cao A1

(ii) $T = 360g = (3528$ N) B1

(b)



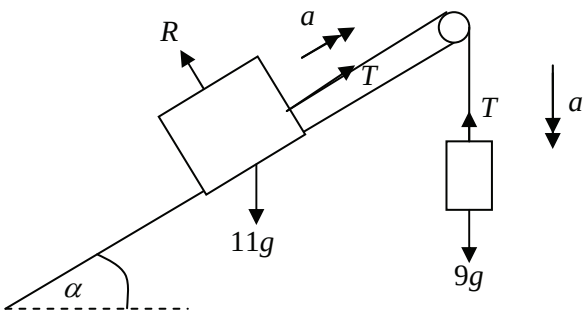
N2L dim. correct M1

$R - 25g = 25a$ A1

$a = \frac{1}{25}(280 - 25\times 9\cdot 8)$

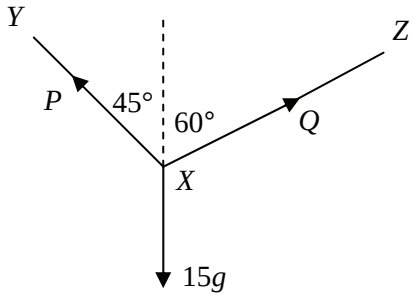
$a = \underline{1.4}$ (ms^{-2}) cao A1

3.



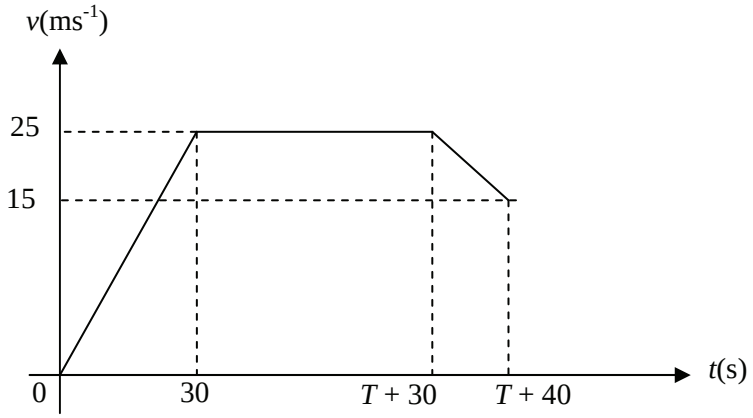
N2L applied to *B*.	dim. correct, all forces		M1
$9g - T = 9a$			A1
N2L applied to *A*.	dim. correct, all forces		M1
$T - 11g\sin\alpha = 11a$			A1
Attempt to eliminate one variable	dep. on both M's		m1
Adding $9g - 11g\sin\alpha = 20a$			
$a = \underline{2.254}$ (ms^{-2})		cao	A1
$T = \underline{67.914}$ (N)		cao	A1

4.



Resolve vertically	attempt at equation with *P*, *Q* resolved		M1
$P\cos45° + Q\cos60° = 15g$			A1
$\frac{P}{\sqrt{2}} + \frac{1}{2}Q = 15g$			
Resolve horizontally	attempt at equation with *P*, *Q* resolved		M1
$P\cos45° - Q\cos30° = 0$			A1
$\frac{P}{\sqrt{2}} - \frac{Q\sqrt{3}}{2} = 0$			
Attempt to eliminate one variable			m1
Subtract $Q\left(\frac{1}{2} + \frac{\sqrt{3}}{2}\right) = 15g$			
$Q = \underline{107.6}$ (N)		cao	A1
$P = \underline{131.8}$ (N)		cao	A1

5. (a)

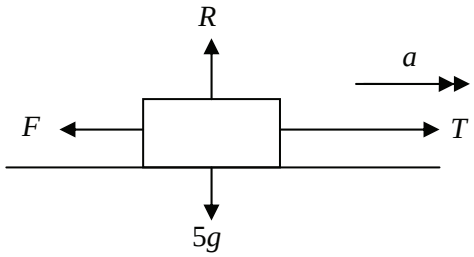


Line segment (0,0) to (30, 25)		B1
Line segment (30, 25) to ((*T* + 30), 25)		B1
Line segment ((*T* + 30), 25) to ((*T* + 40), 15)	time interval required	B1
Correct labelling + 2 previous B marks gained.		B1

(b)

An attempt at area under graph = 8000	o.e.	M1
Any correct distance		B1
$0.5 \times 25 \times 30 + 25T + 0.5\,(25 + 15) \times 10 = 8000$		A1
$375 + 25T + 200 = 8000$		
$T = \underline{297}$ s	cao	A1
Total time = 297 + 30 + 10		
= <u>337</u> s	ft	A1

6.



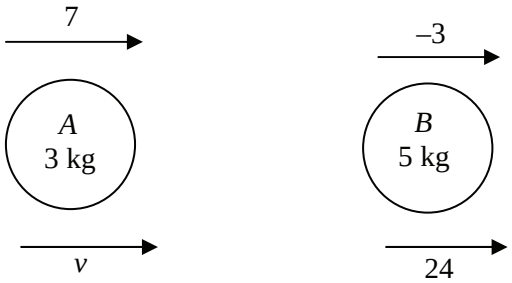
(a)

$R = 5g$		B1
Limiting friction = $5g \times 0.6$		B1
$= 3g = 29.4$ N		
N2L applied to particle	dim correct, all forces	M1
$40 - 29.4 = 5a$	ft friction	A1
$a = \underline{2.12}$ ms^{-2}	cao	A1

(b)

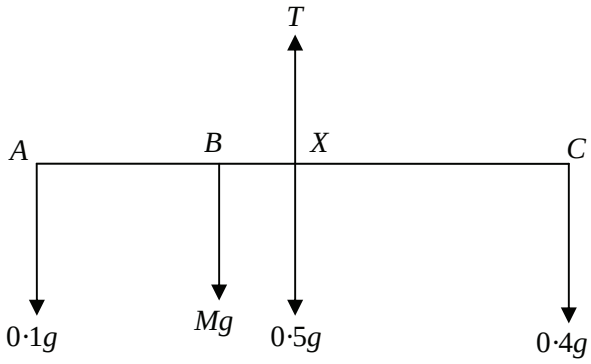
Particle will not start moving.	B1
Since $T = 20$ N, T is smaller than limiting friction. So friction will be equal to T. Since resultant is 0, there is no motion.	E1

7.



(a)	Conservation of momentum	attempted		M1
	$3v + 5\times2.4 = 7\times3 - 3\times5$	any correct form		A1
	$v = -2$ (ms^{-1})	cao		A1
	Restitution	attempted		M1
	$2.4 - v = -e(-3-7)$	any correct form		A1
	$e = \underline{0.44}$	ft v		A1
(b)	Speed of B after collision with the wall = v'			
	$v' = 0.6 \times (\pm)2.4$			M1
	$v' = (\pm)\underline{1.44}$ (ms^{-1})	cao		A1

8.



(a)	Moments about X to obtain equation.		M1
	At least one correct moment		B1
	$0.1g \times 10 + Mg \times 2 = 0.4g \times 10$	any correct equation	A1
	$M = \underline{1.5}$ (kg)	cao	A1
(b)	Resolve vertically		M1
	$T = (0.1 + 1.5 + 0.5 + 0.4)g$	ft M	A1
	$T = \underline{24.5}$ (N)	ft M	A1

9. (a)

	Area	from *AC*	from *AB*	
ABC	36	4	2	B1
PQRS	4	3	3	B1
Lamina	32	x	y	B1

Moments about *AC* M1

$32x + 4\times3 = 36\times4$ ft A1

$x = \frac{33}{8} = \underline{4.125 \text{ cm}}$ cao A1

Moments about *AB* M1

$32y + 4\times3 = 36\times2$ ft A1

$y = \frac{15}{8} = \underline{1.875 \text{ cm}}$ cao A1

(b)

Mass	x	y
10	4	0
5	3	8
2	-5	6
3	-1	2

Moments about y-axis (or x-axis) M1

$20x = 10 \times 4 + 5 \times 3 + 2 \times (-5) + 3 \times (-1)$ A1

$x = \underline{2.1}$ cao A1

Moments about x-axis

$20y = 10 \times 0 + 5 \times 8 + 2 \times 6 + 3 \times 2$ A1

$y = \underline{2.9}$ cao A1