

# **M1**

## **Solutions and Mark Scheme**

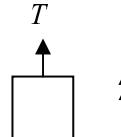
### **Final Version**

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<sup>-1</sup>. A1

2. (a) (i)



Apply Newton's second law to lift

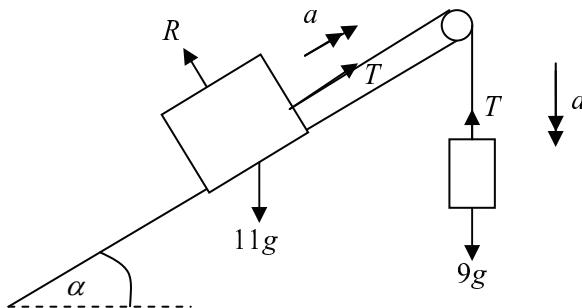
$$T - 360g = 360a$$

When  $a = -3$ ,  $T = 360 \times 9.8 - 360 \times 3$   
 $= \underline{2448}$  (N)

(ii)  $T = 360g = (3528 \text{ N})$

- (b)

3.

N2L applied to  $B$ .

$$9g - T = 9a$$

dim. correct, all forces

M1

A1

N2L applied to  $A$ .

$$T - 11g \sin\alpha = 11a$$

dim. correct, all forces

M1

A1

Attempt to eliminate one variable

dep. on both M's

m1

Adding  $9g - 11g \sin\alpha = 20a$ 

$$a = \underline{2.254} \text{ (ms}^{-2}\text{)}$$

cao

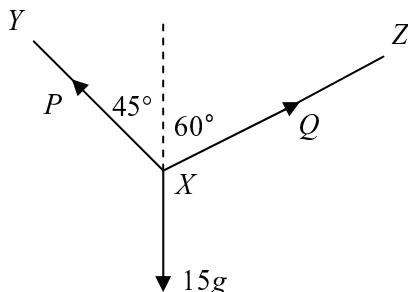
A1

$$T = \underline{67.914} \text{ (N)}$$

cao

A1

4.



Resolve vertically

attempt at equation with  $P, Q$  resolved

$$P \cos 45^\circ + Q \cos 60^\circ = 15g$$

$$\frac{P}{\sqrt{2}} + \frac{1}{2}Q = 15g$$

M1

A1

Resolve horizontally

attempt at equation with  $P, Q$  resolved

$$P \cos 45^\circ - Q \cos 30^\circ = 0$$

$$\frac{P}{\sqrt{2}} - \frac{Q\sqrt{3}}{2} = 0$$

M1

A1

Attempt to eliminate one variable

m1

$$\text{Subtract } Q \left( \frac{1}{2} + \frac{\sqrt{3}}{2} \right) = 15g$$

$$Q = \underline{107.6} \text{ (N)}$$

cao

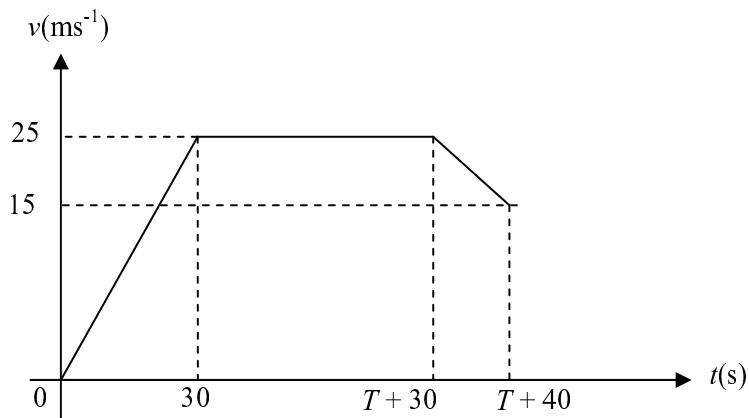
A1

$$P = \underline{131.8} \text{ (N)}$$

cao

A1

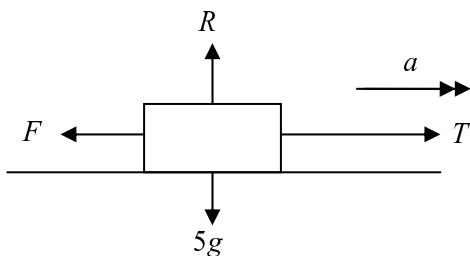
5. (a)



- 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  
 $0.5 \times 25 \times 30 + 25(T + 30) + 0.5(25 + 15) \times 10 = 8000$  A1  
 $375 + 25T + 200 = 8000$   
 $T = \underline{297}$  s cao A1  
 Total time =  $297 + 30 + 10$   
 $= \underline{337}$  s ft A1

6.

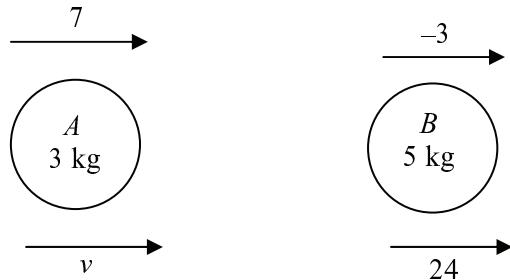


- (a)  $R = 5g$  B1  
 Limiting friction =  $5g \times 0.6$  B1  
 $= 3g = 29.4$  N

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

$$3v + 5 \times 2.4 = 7 \times 3 - 3 \times 5$$

$$v = -2 \text{ (ms}^{-1}\text{)}$$

attempted

any correct form  
cao

M1

A1  
A1

Restitution

$$2.4 - v = -e(-3 - 7)$$

$$e = \underline{0.44}$$

attempted

any correct form  
ft  $v$ 

M1

A1  
A1(b) Speed of  $B$  after collision with the wall =  $v'$ 

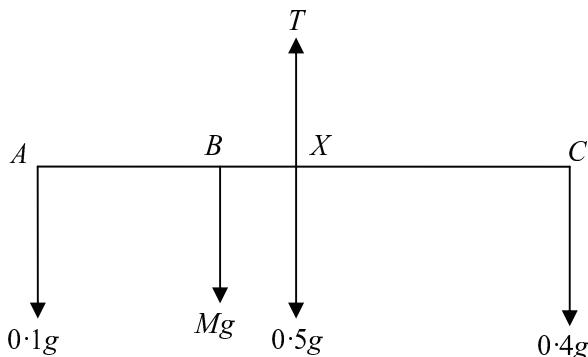
$$v' = 0.6 \times (\pm)2.4$$

$$v' = (\pm)\underline{1.44} \text{ (ms}^{-1}\text{)}$$

cao

M1  
A1

8.

(a) Moments about  $X$  to obtain equation.

At least one correct moment

$$0.1g \times 10 + Mg \times 2 = 0.4g \times 10$$

$$M = \underline{1.5} \text{ (kg)}$$

any correct equation  
cao

M1

B1  
A1  
A1

(b) Resolve vertically

$$T = (0.1 + 1.5 + 0.5 + 0.4)g$$

$$T = \underline{24.5} \text{ (N)}$$

ft  $M$   
ft  $M$ M1  
A1  
A1

9.	(a)	Area	from $AC$	from $AB$	
		$ABC$	4	2	B1
		$PQRS$	3	3	B1
		Lamina	$x$	$y$	B1

Moments about  $AC$  M1

$$32x + 4 \times 3 = 36 \times 4 \quad \text{ft} \quad \text{A1}$$

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

Moments about  $AB$  M1

$$32y + 4 \times 3 = 36 \times 2 \quad \text{ft} \quad \text{A1}$$

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

(b)	Mass	$x$	$y$	
	10	4	0	
	5	3	8	
	2	-5	6	
	3	-1	2	

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

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

$$x = \underline{2.1} \quad \text{cao} \quad \text{A1}$$

Moments about  $x$ -axis

$$20y = 10 \times 0 + 5 \times 8 + 2 \times 6 + 3 \times 2 \quad \text{A1}$$

$$y = \underline{2.9} \quad \text{cao} \quad \text{A1}$$