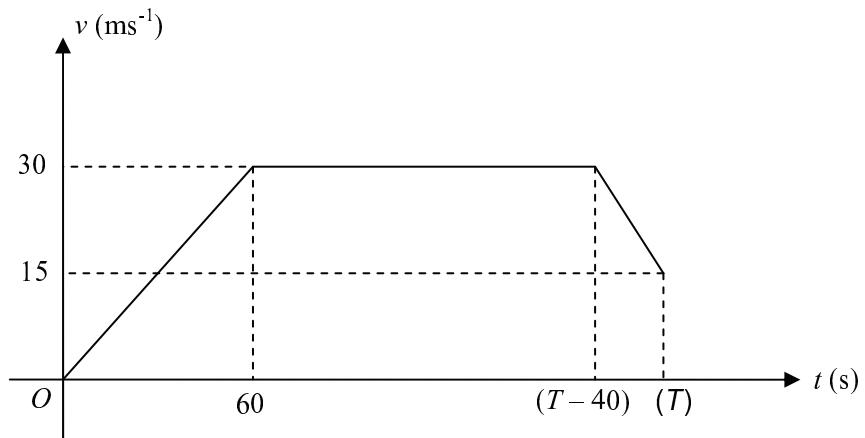


M1

1. (a)



v-t graph and (0, 0) to (60, 30) M1

(60, 30) to (?, 30) A1

(?, 30) to (?, 15) A1

All labels and units; all correct A1

$$(b) \quad \text{acceleration} = \frac{30 - 0}{60} \quad \text{M1}$$

$$= 0.5 \text{ ms}^{-1} \quad \text{A1}$$

$$\text{distance} = 0.5 \times 60 \times 30 \quad \text{any correct method} \quad \text{M1}$$

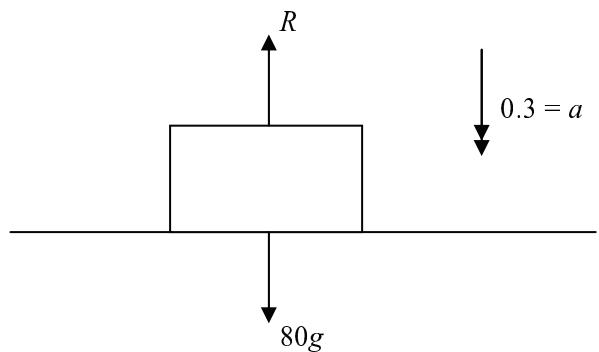
$$= 900 \text{ m} \quad \text{A1}$$

$$(c) \quad \text{Total area under graph} = 24 \times 1000 \quad \text{M1}$$

$$900 + (T - 40 - 60) \times 30 + 0.5 \times 40 (30 + 15) = 24000 \quad \text{A1 A1}$$

$$\text{Total time} = T = 840 \text{ s} \quad \text{A1}$$

2. (a)



N2L applied to trunk

dim. correct, R and $80g$ opposing

M1

$$80g - R = 80 \times 0.3$$

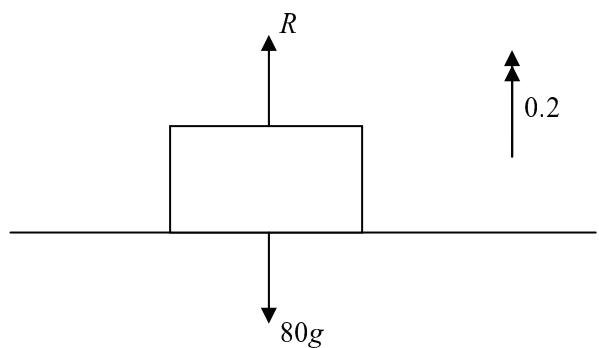
A1

$$R = \underline{760 \text{ N}}$$

cao

A1

(b)



N2L applied to trunk

dim. correct, R and $80g$ opposing

M1

$$R - 80g = 80 \times 0.2$$

A1

$$R = \underline{800 \text{ N}}$$

cao

A1

(c) $R = 80g$ since $a = 0$

$$= \underline{784 \text{ N}}$$

B1

3. (a) Using $v = u + at$ with $u = 0$, $t = 0.8$, $a = (\pm) 9.8$ (downwards positive) M1

$$v = 0 + 9.8 \times 0.8 \quad \text{A1}$$

$$v = \underline{7.84 \text{ ms}^{-1}} \quad \text{A1}$$

- (b) Using $v^2 = u^2 + 2as$ with $u = u$, $s = 0.9$, $v = 0$ (upwards positive) M1

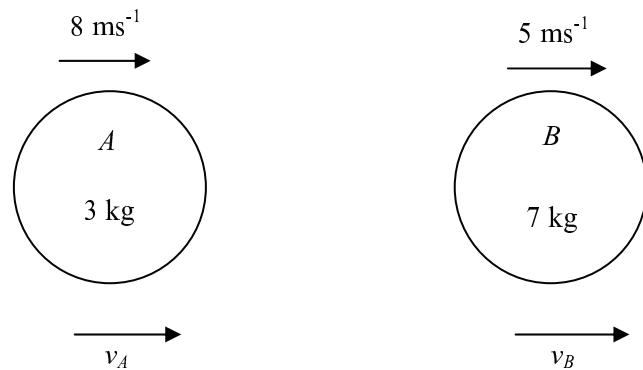
$$0 = u^2 - 2 \times 9.8 \times 0.9 \quad \text{A1}$$

$$u = \underline{4.2 \text{ ms}^{-1}} \quad \text{A1}$$

$$\text{Coefficient of restitution} = \frac{4.2}{7.84} = \left(\frac{15}{28} \right) \quad \text{M1}$$

$$= \underline{0.536} \text{ (to 3 sig figs)} \quad \text{ft } u, v \quad \text{A1}$$

4. (a)



Conservation of momentum

M1

$$3 \times 8 + 7 \times 5 = 3v_A + 7v_B$$

A1

Restitution

M1

$$v_B - v_A = -0.4(5 - 8)$$

A1

$$-7v_A + 7v_B = 8.4$$

$$3v_A + 7v_B = 59$$

$$\text{Subtract } 10v_A = 50.6$$

m1

$$v_A = \underline{5.06 \text{ ms}^{-1}}$$

cao

A1

$$v_B = \underline{6.26 \text{ ms}^{-1}}$$

cao

A1

(b) Impulse required = change in momentum of B used M1

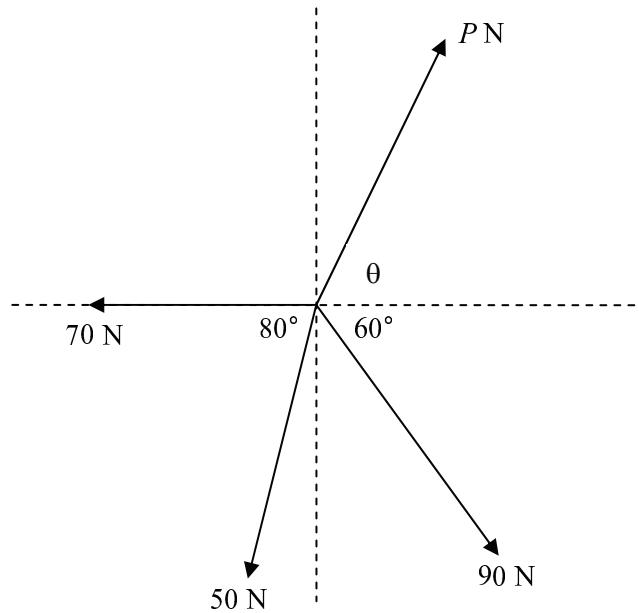
$$= 7(6.26 - 5)$$

$$= \underline{8.82 \text{ Ns}}$$

ft $v_B > 5$

A1

5.



Resolve in direction parallel to 70 N (\rightarrow) all forces M1

$$P\cos\theta + 90\cos 60^\circ = 70 + 50\cos 80^\circ \quad \text{A1}$$

$$P\cos\theta = 33.6824$$

Resolve in direction perpendicular to 70 N (\uparrow) all forces M1

$$P\sin\theta = 90\sin 60^\circ + 50\sin 80^\circ \quad \text{A1}$$

$$P\sin\theta = 127.1827$$

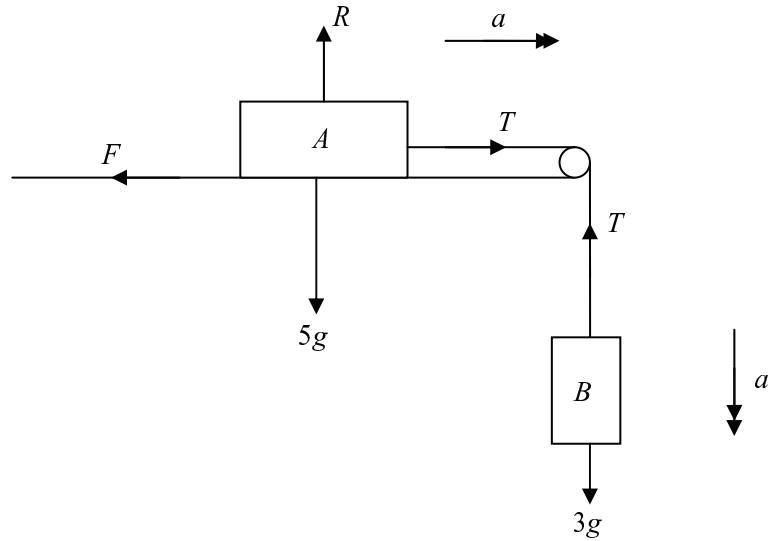
$$P = \sqrt{33.6824^2 + 127.1827^2} \quad \text{M1}$$

$$P = \underline{131.6 \text{ N}} \quad \text{ft} \quad \text{A1}$$

$$\theta = \tan^{-1}\left(\frac{127.1827}{33.6824}\right) \quad \text{M1}$$

$$\theta = \underline{75.2^\circ} \quad \text{ft} \quad \text{A1}$$

6. (a)



At A, resolve vertically $R = 5g$ si B1

Limiting friction = $\mu R = 0.4 \times 5g$ si B1

$$F = 19.6 \text{ N}$$

N2L applied to B M1

$$3g - T = 3a \quad \text{A1}$$

N2L applied to A M1

$$T - F = 5a \quad \text{ft } F \quad \text{A1}$$

Adding $8a = 3 \times 9.8 - 19.6$ m1

$$a = \underline{1.225 \text{ ms}^{-2}} \quad \text{cao} \quad \text{A1}$$

$$T = \underline{25.725 \text{ N}} \quad \text{cao} \quad \text{A1}$$

(b) Least value of μ is given by $a = 0$

M1

$$3g - 5\mu g = 0$$

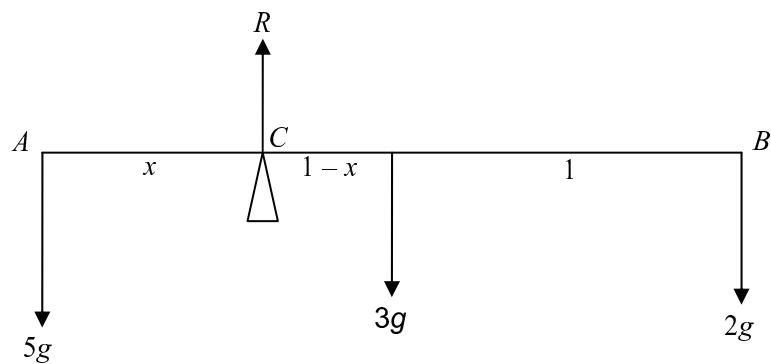
m1

$$\text{least } \mu = \underline{0.6}$$

cao

A1

7.



Resolve vertically

M1

$$R = 5g + 3g + 2g$$

$$= 10g$$

$$= \underline{98 \text{ N}}$$

A1

Moments about C

all forces

M1

$$5gx = 3g(1-x) + 2g(2-x)$$

B1 A1

$$5x = 3 - 3x + 4 - 2x$$

$$10x = 7$$

$$x = \underline{0.7}$$

A1

8.	(a)	Area	from <i>AD</i>	from <i>AB</i>
	<i>ABCD</i>	120	5	6 B1
	Circle	9π	4	7 B1
	Lamina	$120 - 9\pi$	x	y B1

Moments from AD M1

$$120 \times 5 = 9\pi \times 4 + (120 - 9\pi) \times x \quad \text{A1}$$

$$x = \underline{5.308 \text{ cm}} \quad \text{cao} \quad \text{A1}$$

Moments from AB M1

$$120 \times 6 = 9\pi \times 7 + (120 - 9\pi) \times y \quad \text{A1}$$

$$y = \underline{5.692 \text{ cm}} \quad \text{cao} \quad \text{A1}$$

(b) Required angle = $\theta = \tan^{-1}\left(\frac{y}{x}\right)$ M1

$$\theta = \tan^{-1} \left(\frac{5 \cdot 692}{5 \cdot 308} \right) \quad \text{ft } x, y \quad \text{A1}$$

$$\theta = \underline{47.0^\circ} \quad \text{ft x, y} \quad \text{A1}$$

$$(c) \quad DP = 5.308 \text{ cm} \quad \text{ft } x \quad B1$$