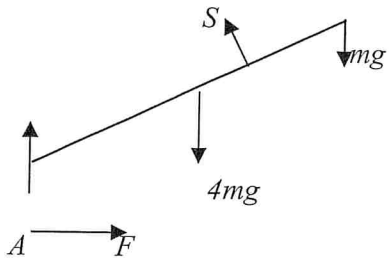
Mechanics Homework 12 Solutions

Section 1

(1)

(a)



M(*A*):
$S.3a = 4mg.2a\cos\alpha + mg.4a\cos\alpha$

$= \frac{48}{5}mga \Rightarrow S = \frac{16}{5}mg$ *

M1 A1

A1

(3)

(b)

R(↑): $R + S\cos\theta = 5mg$

R(→): $F = S\sin\theta$

M1 A1

M1 A1

$F \le \mu R \Rightarrow \mu \ge \frac{48}{61}$ *

dep on both previous M's
M1 A1

(6)

(c) Direction of *S* is perpendicular to plank
or No friction at the peg

B1

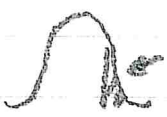
(1)

(2) a) $H_0 : \mu = 22.1$
$H_1 : \mu > 22.1$

$P(T > 25.6) = P\left(Z > \frac{25.6 - 22.1}{3.86/\sqrt{7}}\right)$

$= P(Z > 2.399) = 0.0082 < 0.01$

significant result ⇒ sufficient evidence to reject H_0

b) 

$z > 1.2816$

$\Rightarrow \frac{T - 22.1}{3.86/\sqrt{7}} > 1.2816$

$\Rightarrow T > 23.97$

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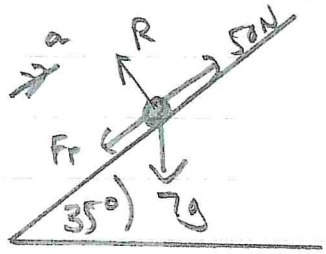
Section 2

① 

Perpendicular : $R = 7g\cos 35°$ ✓

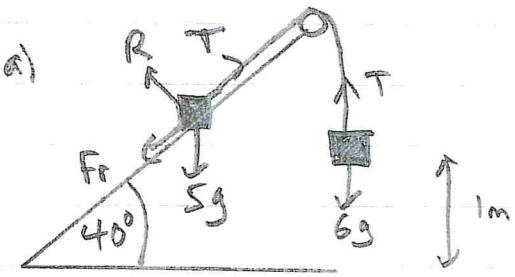
$F_r = \mu R = 0.1 \times 7g\cos 35°$ ✓

$(= 5.619\,N)$

Parallel : $50 - F_r - 7g\sin 35° = 7a$ ✓

$\Rightarrow a = \underline{\underline{0.72\ ms^{-2}}}$ to 2sf ✓

/4

② a) 

6kg mass : $u=0$ $s=1m$ $t=2sec$ $a=?$

$s = ut + \frac{1}{2}at^2$

$1 = \frac{1}{2} \times a \times 4 \Rightarrow a = 0.5\,ms^{-2}$ ✓

$F=ma$: $6g - T = 6 \times 0.5$

$\Rightarrow T = 55.8\,N$ ✓

5kg mass : $T - F_r - 5g\sin 40° = 5a$ ✓

$55.8 - F_r - 4.9\sin 40° = 5 \times 0.5$

$F_r = 55.8 - 4.9\sin 40° - 2.5 = 21.8\,N$ ✓

Perpendicular : $R = 5g\cos 40°$ $(= 37.54\,N)$ ✓

$F_r = \mu R$: $\mu = \frac{21.8}{37.54} = \underline{\underline{0.581}}$ to 3sf ✓

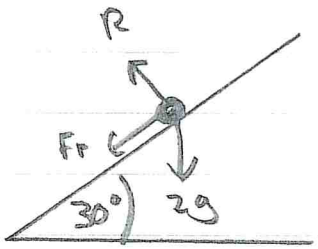
b.) i.) the tension is the same throughout each portion of the string ✓

ii) the two boxes have the same speed and the same magnitude of acceleration ✓

iii) the tension is the same on either side of the pulley ✓

/9

(3)



a.) Perpendicular : $R = 2g\cos 30°$ ✓

$F_r = \mu R = \frac{1}{2} \times 2g\cos 30°$ (≈ 8.487N) ✓

Parallel : $-F_r - 2g\sin 30° = 2a$ ✓

$-8.487 - 9.8 = 2a$

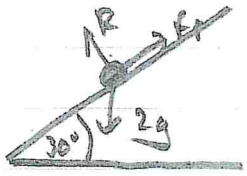
$a = \frac{-18.287}{2} \approx -9.14\ ms^{-2}$

$\Rightarrow$ deceleration $= \underline{\underline{9.1\ ms^{-2}}}$ to 2sf ✓

b) $u = 3ms^{-1}$ $a = -9.1ms^{-2}$ $v = 0$ $s = ?$

$v^2 = u^2 + 2as$: $0 = 3^2 - 2 \times 9.1 \times s$ $\Rightarrow s = \frac{9}{18.2}$ ✓

$= \underline{\underline{0.49\ m}}$ to 2sf ✓

c) 

$F_r = \frac{1}{2} \times 2g\cos 30°$ as before

$2g\sin 30° - F_r = 2a$ ✓

$9.8 - 8.487 = 2a$

$a = \frac{13.13}{2} = \underline{\underline{0.66\ ms^{-2}}}$ to 2sf ✓

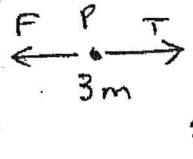
d) $u = 0$ $s = 0.49m$ $a = 0.66ms^{-2}$ $v = ?$

$v^2 = u^2 + 2as = 2 \times 0.49 \times 0.66 = 0.6468$ ✓

$v = \sqrt{0.6468} = 0.80 \ldots = \underline{\underline{0.8}}$ to 1sf

✓ 10

(4)



(a) P: $T - F = 3ma$ M1 A1

Q: $5mg - T = 5ma$ M1 A1 (4)

(b) $F = 0.6 \times 3mg \quad (= 1.8mg)$

Hence $5mg - 1.8mg = 8ma$ M1 A1

$a = \underline{0.4g}$ M1 A1 (4)

(c) Sub: $T = 3ma + F$ or $5mg - 5ma$

$\rightarrow T = \underline{3mg}$ M1 A1 (2)

(d) Speed when Q hits floor: $v^2 = 2 \times 0.4g \times h$ M1 A1√

$= \frac{4}{5}gh$

Decel^2 of P: $3mf = 1.8mg \Rightarrow f = 0.6g$ M1 A1

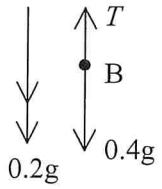
Dist moved by P: $\frac{4}{5}gh = 2 \cdot \frac{3}{5}g \cdot s$

$\Rightarrow s = \underline{\frac{2}{3}h}$ M1 A1 (6)

(16)

(5)

(a)

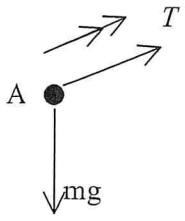


$0.4g - T = 0.4 \times \frac{1}{5}g$ M1 A1 (2)

(b)

$T = \underline{\frac{8}{25}g \quad \text{or} \quad 3.14 \quad \text{or} \quad 3.1 \text{ N}}$ M1 A1 (2)

(c)



$T - mg \sin 30° = m \times \frac{1}{5}g$ M1 A1

$\rightarrow m = \underline{\frac{16}{35}}$ * M1 A1 (4)

(d) Same T for A & B B1 (1)

(e)

$v^2 = 2 \times \frac{1}{5}g \times 1$ M1

$v = \underline{\sqrt{\frac{2g}{5}} \simeq 1.98 \quad \text{or} \quad 2 \text{ ms}^{-1}}$ A1 (2)

(f) A: $-\frac{1}{2}mg = ma \Rightarrow a = -\frac{1}{2}g$ M1 A1

$v^2 = \frac{2g}{5} - 2 \times \frac{1}{2}g \times 0.4$ M1 A1√

$\Rightarrow v = 0$ A1 (5)