Author: <u>Naga Karthik</u>

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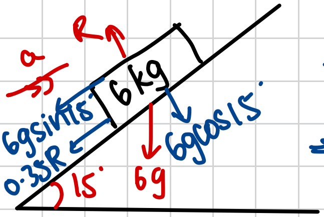
Set A

BRONZE :



a) ↑ = ↓ (as there is no movement in y-axis)

⇒ $R = 6g\cos 15$

⇒ $f = 0.35R$ ⇒ $0.35(6g\cos 15°) = 19.9N$ (3sf)

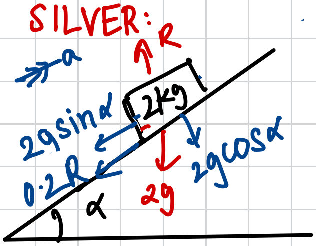
b) $u = 10$ $v = 0$ $t = t$ $a = a$

⇒ $6g\sin 15° + 0.35(6g\cos 15°) = 6a$ ⇒ $a = 5.84155...$

⇒ $v = u - at$ ⇒ $0 = 10 - 5.96591t$ ⇒ $t = \frac{-10}{-5.84}$ ⇒ $t = 1.718$ (3sf)

c) It would take longer to come to rest.

SILVER:



a) ↑ = ↓ ⇒ $R = 2g\cos\alpha$

→ = ← = $2g\sin\alpha = 0.4g\cos\alpha$

⇒ $\tan\alpha = \frac{0.4}{2}$ ⇒ $\alpha = 11.3°$ (3sf)

b) R(↗) ⇒ $2g\sin\alpha + 0.2(2g\cos\alpha) = 2a$

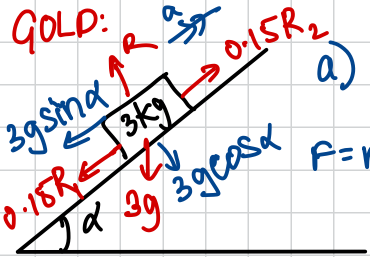
$a = 3.84......$

b) $u = 20$ $v = 0$ $a = 3.84...$ $t = t$

$v = u - at$ ⇒ $0 = 20 - 3.84..$ ⇒ $t = 5.20s$ (3sf)

c) The size of α would be greater, as a great component of the weight of the particle would need to act down the slope to maintain limiting equilibrium.

GOLD:



a) ↑ = ↓ ⇒ $R = 3g\cos\alpha$ — (1)

$F = ma$; $3g\sin\alpha - 0.15R = 3a$

$\Rightarrow 3g\sin\alpha - 0.15(3g\cos\alpha) = 3a$.

$\Rightarrow 3g\sin\alpha > 0.15(3g\cos\alpha) \Rightarrow \dfrac{3g\sin\alpha}{3g\cos\alpha} > 0.15$

$\Rightarrow \tan\alpha > 0.15 \Rightarrow \alpha > 8.53^\circ$ (3sf)

b) R(↗) ⇒ $F = ma \Rightarrow (3g\sin\alpha + 0.15R) = 3a$

$\Rightarrow a = g\left(\dfrac{3\sin 20^\circ + 0.15(3\cos 20^\circ)}{3}\right) \Rightarrow a = 4.7331455 7$. (deaccelerati[on])

$\Rightarrow s = s \quad u = 15 \quad v = 0 \quad a = -4.73314557$

$\Rightarrow v^2 = u^2 - 2as \Rightarrow s = \dfrac{-15^2}{-2a} \Rightarrow s = 23.76854856$.

$\Rightarrow s = 23.768\ldots \quad a = -4.73314557 \quad u = 15 \quad t = t$.

$\Rightarrow s = ut + \frac{1}{2}at^2 \Rightarrow -2.366t^2 + 15t - 23.768\ldots = 0$

$t = 3.1695$ or $t = 3.1686 \Rightarrow t = 3.17$ (3sf) (Time taken for the particle to move upwards.

R(↙) ⇒ $F = ma \Rightarrow a = g\left(\dfrac{3\sin 20 - 0.15(3\cos 20^\circ)}{3}\right) \Rightarrow a = 1.9704\ldots$

$\Rightarrow s = 23.768\ldots \quad u = 0 \quad t = t_1 \quad a = 1.9704\ldots$

$\Rightarrow s = ut_1 + \frac{1}{2}at_1^2 \Rightarrow 23.768\ldots = 0.5(1.9704\ldots)t_1^2$

$\Rightarrow t = \sqrt{\dfrac{23.768\ldots}{0.5(1.9704\ldots)}} \Rightarrow t_1 = 4.91$ (3sf)

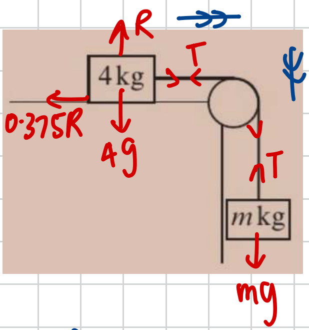
Total time = $t + t_1 \Rightarrow 3.17 + 4.91$

$t \Rightarrow 8.08$ sec (3sf)

c) The component of the weight that acts down the slope and the frictional force both have a factor of m, so the conditions for limiting equilibrium and the acceleration of the particle would be unchanged.

Set B

BRONZE:



a) 4kg:

$\nwarrow a = 1.2$ $R(\rightarrow) \Rightarrow F = ma \Rightarrow T - 0.375R = 4(1.2)$

$\Rightarrow \uparrow = \downarrow \Rightarrow \boxed{R = 4g}$ $\Rightarrow T - 0.375(4g) = 4(1.2)$

$T = 19.5N$

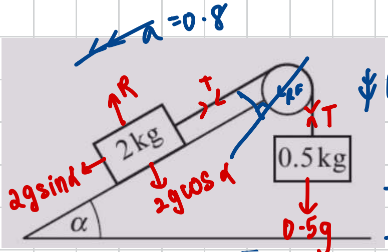
b) mkg:

$R(\downarrow) \Rightarrow mg - T = ma$ $\Rightarrow m(9.8) - 19.5 = m(1.2) \Rightarrow 9.8m - 1.2m = 19.5$

$\Rightarrow m = 2.27$ (3sf)

c) Tension equal on both sides of the pulley.

SILVER:



$\nwarrow a$ a) For 2kg:

$\uparrow = \downarrow \Rightarrow R = 2g\cos\alpha$

For 0.5kg:

$\Rightarrow R(\uparrow) \Rightarrow 0.5g - T = 0.5(0.8)$

$\Rightarrow T = 4.9 - 0.4$ $T = 4.5N$

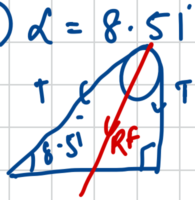
$\Rightarrow R(\nearrow) \Rightarrow T - 2g\sin\alpha = 2(0.8)$ $\Rightarrow \dfrac{4.5 - 1.6}{2g} = \sin\alpha$

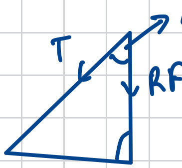
$\Rightarrow \alpha = 8.51°$ (3sf)

$\cdot R(\downarrow) = T - 0.5g = 0.4$ $T = 5.3N$

$\Rightarrow R(\swarrow) \Rightarrow 2g\sin\alpha - T = 2(0.8)$ $\Rightarrow \sin\alpha = \dfrac{1.6 + 5.3}{2g} \Rightarrow \alpha = 20.6°$ (3sf)

b) $\alpha = 8.51°$





$\Rightarrow RF = T\cos(40.745°)$

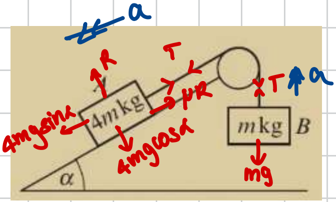
$\Rightarrow RF = 3.409298755$

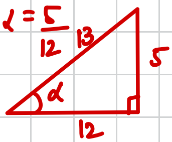
$RF = 2T\cos\alpha$ $\Rightarrow RF = 6.82N$ (3sf)

i) The force exerted on the pulley would be greater.

GOLD:

$\tan\alpha = \frac{5}{12}$ $\quad \sin\alpha = \frac{5}{13}$ $\quad \cos\alpha = \frac{12}{13}$





a) For mkg:

$R(\uparrow) \Rightarrow F = ma \Rightarrow T - mg = ma \Rightarrow T = ma + mg$ ①

For 4mkg:

$\uparrow = \downarrow \Rightarrow R = 4mg\cos\alpha \Rightarrow R = \frac{12}{13} \times 4mg \Rightarrow R = \frac{48}{13}mg$

$R(\swarrow) \Rightarrow F = ma \Rightarrow 4mg\sin\alpha - \mu R - T = 4ma$

$\Rightarrow 4mg \times \frac{5}{13} - \mu\left(\frac{48}{13}mg\right) - ma - mg = 4ma$

$\Rightarrow \frac{20}{13}mg - \frac{48}{13}mg\mu - mg = 5ma$

$\Rightarrow m\left[\frac{20}{13}g - g - \frac{48}{13}g\mu\right] = 5ma \Rightarrow \frac{7}{13}g - \frac{48}{13}g\mu > 0$

$\Rightarrow \frac{7}{13}g > \frac{48}{13}g\mu \Rightarrow \mu < \frac{7}{48}$

b) $\mu = 0.1 \Rightarrow \frac{7}{13}g - \frac{48}{13}g(0.1) = 5a \Rightarrow a = \frac{11}{65} \times \frac{1}{5}g$

$a = \frac{11}{325}g$

c) i) a is independent of m, so the acceleration would be unchanged.

ii) Tension initially is $T = mg + ma$; when m is doubled $T = 2mg + 2ma = 2(mg + ma)$, so the tension in the string would double.