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Quiz 2
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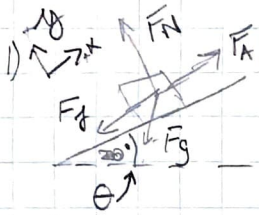
Civ 102

1)



$\sum F_y = 0$

$0 = F_N - F_g \cos\theta$

$F_N = mg\cos\theta$

$\sum F_x = 0$

$0 = F_A - F_g \sin\theta - F_f$

$F_A = mg\sin\theta + \mu_s F_N$

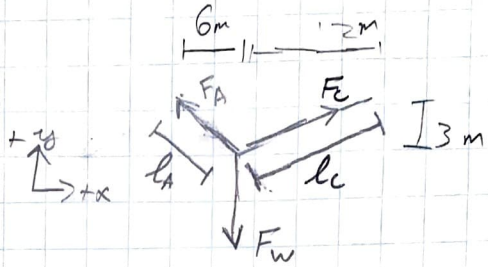
$F_A = mg\sin\theta + \mu_s mg\cos\theta$

$F_A = mg(\sin\theta + \mu_s \cos\theta)$

$\boxed{F_A = 666\ N}$

∴ A force of at least 666N is required to pull the box up the slope

2)



$l_A = \sqrt{6^2+3^2} = 3\sqrt{5}\ m$

$l_C = \sqrt{12^2+3^2} = 3\sqrt{17}\ m$

$\sum F_y = 0$

$0 = F_{Ay} + F_{Cy} - F_W$

$F_W = F_A\left(\frac{3}{3\sqrt{5}}\right) + F_C\left(\frac{3}{3\sqrt{17}}\right)$

$\sum F_x = 0$

$0 = F_{Cx} - F_{Ax}$

$F_C \cdot \left(\frac{12}{3\sqrt{17}}\right) = F_A\left(\frac{6}{3\sqrt{5}}\right)$

$F_C = F_A\left(\frac{\sqrt{17}}{2\sqrt{5}}\right)$, substitute

$F_W = F_A\left(\frac{3}{3\sqrt{5}}\right) + F_A\left(\frac{\sqrt{17}}{2\sqrt{5}}\right)\left(\frac{3}{3\sqrt{17}}\right)$

$F_W = F_A\left(\frac{1}{\sqrt{5}} + \frac{1}{2\sqrt{5}}\right)$

$F_W = F_A\left(\frac{3\sqrt{5}}{10}\right)$

$F_W = 447\ N$

$m_W = \frac{F_W}{g}$

$\boxed{m_W = 45.6\ kg}$

∴ the mass of the weight W is 45.6 kg

3) $\sigma = \frac{F}{A}$

$A = \frac{F_A}{\sigma_{max}}$, $A = \pi\left(\frac{d}{2}\right)^2$

$\pi\left(\frac{d}{2}\right)^2 = \frac{F_A}{\sigma_{max}}$

$d = \sqrt{\frac{4 F_A}{\pi \sigma_{max}}}$ $\longrightarrow$ $\boxed{d = 2.38\,mm}$

∴ the smallest usable wire diameter is 2.38 mm

4) $\sigma_B = \frac{F_w}{A_B}$

$\sigma_B = \frac{F_w}{\pi\left(\frac{d}{2}\right)^2}$

$\sigma_B = 142\,MPa$

$\sigma = E\varepsilon$

$\varepsilon = \frac{\sigma}{E}$, $\varepsilon = \frac{\Delta L}{L_o}$

$\frac{\Delta L}{L_o} = \frac{\sigma}{E}$

$\Delta L = \frac{\sigma L_o}{E}$

$\Delta L = 2.13 \cdot 10^{-3}\,m$

$\boxed{\Delta L = 2.13\,mm}$

∴ The two markers would have moved 2.13 mm apart