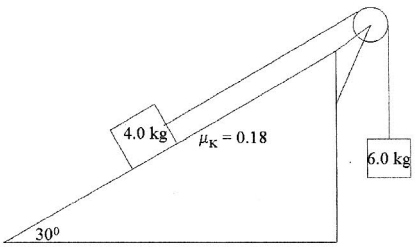
Portfolio – Grade 12 Physics Name: _____

Chapter 2&3 Challenge Questions

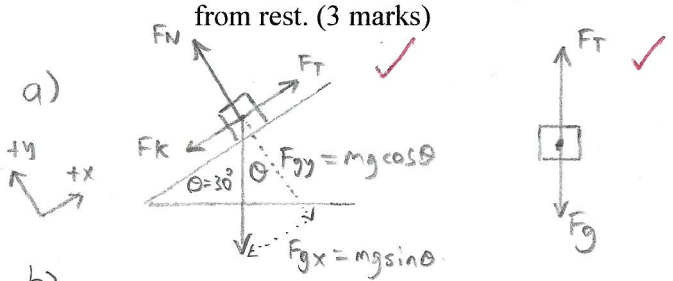
Chapter 2 – Incline & Pulley Question Combined

Two masses, 4.0 kg and 6.0 kg, are connected by a "massless" rope over a "frictionless" pulley as pictured in the diagram. The ramp is inclined at 30.0° and the coefficient of kinetic friction on the ramp is 0.18.



a) Draw free-body diagrams of both masses. (2 marks)
b) Determine the acceleration of the system once it begins to slide. (5 marks)
c) Determine the tension in the rope. (1 mark)
d) If the rope breaks when the 4.0-kg mass is 3.0 m from the bottom of the ramp, how long will it take for the mass to slide all the way down? Include a new free-body diagram and assume the sliding mass starts from rest. (3 marks)

a)



b)

Method 1

X-component of 4kg mass

$F_{NET} = F_T + (-F_k) + (-F_{gx})$

$m_1\vec{a} = F_T + (-F_N \cdot \mu_k) + (-mg\sin\theta)$

$m_1\vec{a} = F_T + (-(mg\cos\theta)\cdot\mu_k) + (-mg\sin\theta)$

$(4)\vec{a} = F_T + (-(4\times9.8\times\cos30)\cdot0.18) + (-(4\times9.8\times\sin30))$

$4\vec{a} = F_T - 6.11 - 19.6$

$4\vec{a} = F_T - 25.71$ (1)

y-component of 6kg mass

$F_{NET} = F_g + (-F_T)$

$m_2\vec{a} = F_g - F_T$

$(6)\vec{a} = mg - F_T$

$6\vec{a} = (6\times9.8) - F_T$

$6a = 58.8 - F_T$ (2)

or Method 2

$F_{Net} = F_{g(pulley)} - (F_k + F_{gx(ramp)})$

$F_{net} = 58.8 - (6.11 + 19.6)$

$F_{net} = 33.09$

$(m_1+m_2)\vec{a} = 33.09$

$\vec{a} = \frac{33.09}{(4+6)kg} = 3.309 m/s^2$

ADD BOTH EQUATIONS

$4a = F_T - 25.71$

$\oplus\ 6a = -F_T + 58.8$

$10a = 33.09$

$\vec{a} = \frac{33.09}{10}$

$\vec{a} = 3.31 m/s^2$

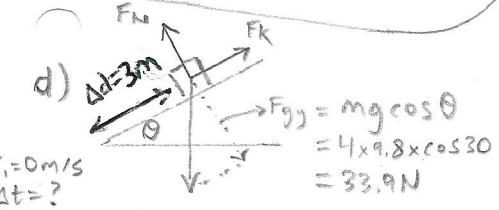
c) Sub $\vec{a} = 3.31 m/s^2$ into any equation

$4a = F_T - 25.71$

$4(3.31) + 25.71 = F_T$

$F_T = 38.95N$

d)



$V_i = 0 m/s$
$\Delta t = ?$
$a = 3.31 m/s^2$
$\Delta d = 3m$

$F_{net} = F_{gx} + (-F_k)$

$F_{net} = mg\sin\theta + (-F_{gy}\cdot\mu_k)$

$F_{net} = 4\times9.8\times\sin30 - (33.9\times0.18)$

$m\vec{a} = 13.5N$

$\vec{a} = \frac{13.5N}{4} = 3.37 m/s^2$

$\Delta d = V_i\Delta t + \frac{1}{2}a\Delta t^2$ ($V_i = 0$)

$\Delta t = \sqrt{\frac{2\Delta d}{a}} = \sqrt{\frac{2\times3}{3.37}}$

$\Delta t = 1.33 m/s^2$