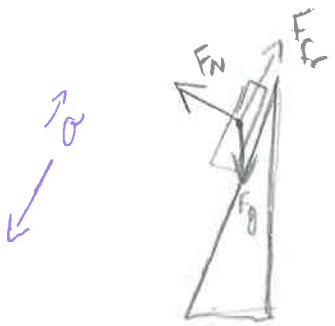
Big Exam! #6

A

1. You see something slide.

a) Estimate the coefficient of friction between the two surfaces

b) If the surface were inclined at a 45° angle, estimate the acceleration of an object moving up the slope.



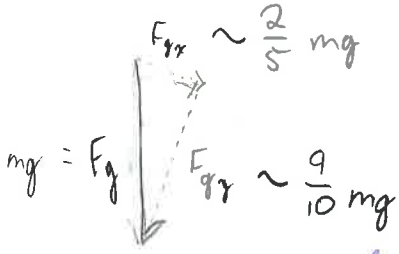
Dynamics lens (forces and acceleration)

$\sum F = ma$

object is in equilibrium at instant before it starts to slide

$\sum F_x = F_N - F_{gx} = 0$

$\sum F_y = F_{fr} - F_{gy} = 0$

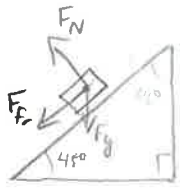


great!

$F_{fr} = F_N \mu = F_{gx} \mu$

$\sum F_y = F_{gx}\mu - F_{gy} = \frac{2}{5}(mg)\mu - \frac{9}{10}(mg) = 0$

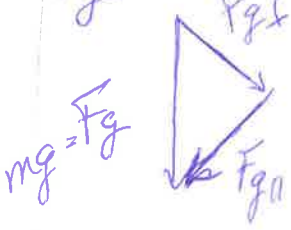
b)



Dynamics lens (acceleration and forces)

$\sum F = ma$

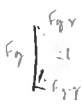
so split up F_g



$\frac{2}{5}(mg)\mu = \frac{9}{10}(mg)$

$\frac{4}{10}\mu = \frac{9}{10}$

$\mu = 9/4 = 2.25$



$F_N = F_{gy}$ $F_{fr} = \mu F_{gx}$

$\sum F_x = F_N - F_{gx} = 0$

$\sum F_y = F_{fr} + F_{gy} = \mu F_{gx} + F_{gy} = ma \Rightarrow$ $\mu(.7mg) + 0.7mg = ma$

$F_{g\parallel} \approx F_{g\perp} \approx 0.7 F_g = 0.7mg$

$2.25(0.7)g + 0.7g = a$

$= 3.25(.7)g = \approx 23\ m/s^2$

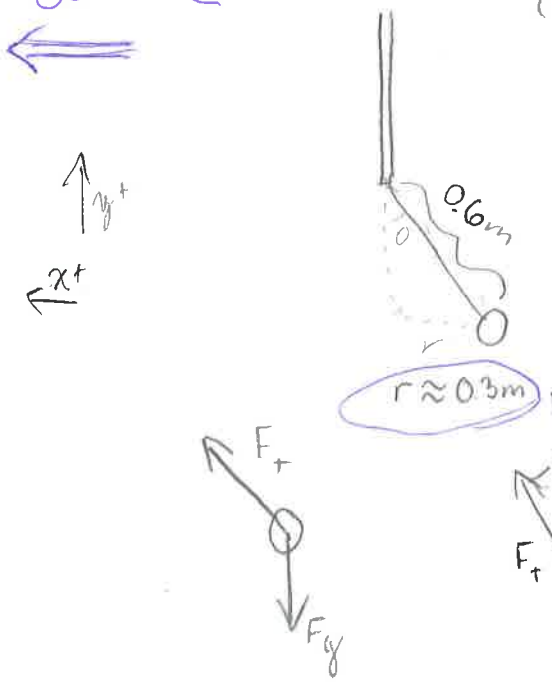
2. You see a ball on a string.
   a) Calculate the speed of the ball
   b) Calculate the tension in the string

A

Circular Motion Dynamics

(forces and centripedal acceleration)

$a = a_c$



$\sum F = ma = ma_c$

$\sum F_y = 0 = F_{Ty} - F_g$

$F_{Ty} = F_g = mg$

$F_{Tx} > \frac{1}{2} F_{Ty}$ (estimation)

$F_{Tx} \approx \frac{3}{5} mg$

$\sum F = F_{Tx} \approx \frac{3}{5} mg = ma_c$

$\frac{3}{5} g \approx a_c$

$a_c \approx 6\ m/s^2 = \frac{v^2}{r} = \frac{v^2}{0.6\ m}$

$v^2 = \frac{3.6\ m^2/s^2}{2}$ $v \approx \sqrt{\frac{3.6\ m^2/s^2}{2}}$

$\approx 1.4\ m/s$

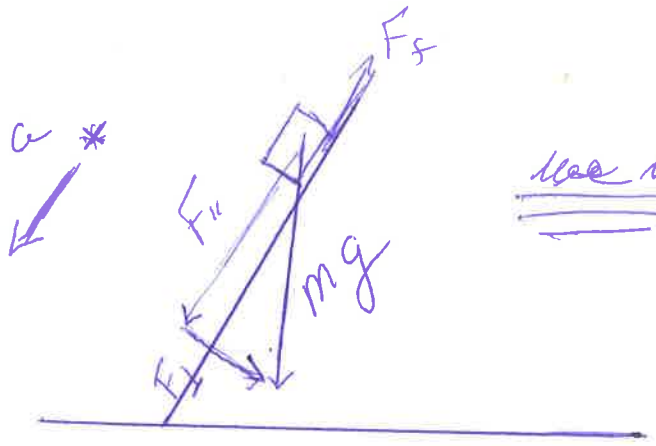
b) $F_T \approx 2 F_{Tx} = \frac{6}{5} mg$

$F_T \approx (12\ m/s^2)\ m$

m of a tennis ball is probably ~ 0.1 kg

$F_T \approx (12\ m/s^2)(0.1\ kg) = \boxed{1.2\ N}$

N



use see $F_{\parallel} \approx 0.9\,mg$

$F_\perp \approx 0.4\,mg$

$\Sigma F_{\parallel} = ma = 0$

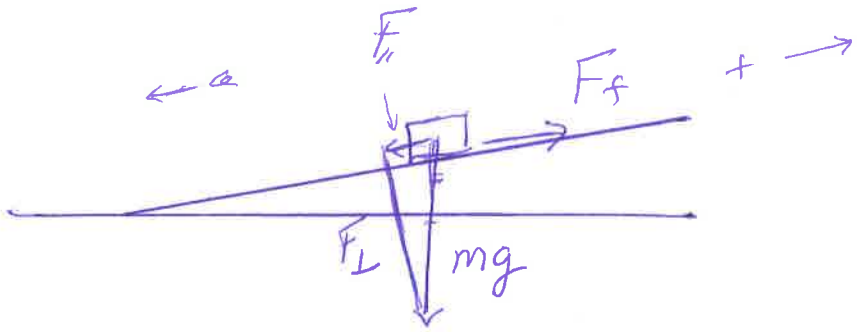
$F_{g\parallel} + F_f = 0$

$0.9mg + \mu\, 0.4mg = 0$

$\Sigma F_\perp = 0$

$F_N + F_\perp = 0 \quad F_N \approx 0.4mg$

$\mu \approx \frac{.9}{.4} = 2.25$



use see $F_\perp \approx mg$, maybe $F_\perp \approx 0.98\,mg$

$F_{g\parallel} \approx \frac{1}{4}mg$

so $\Sigma F_{\parallel} = ma_{\parallel} = 0$

$F_f + F_{g\parallel} = 0$

$\mu N = F_{\parallel}$

$\mu mg = \frac{1}{4}mg \quad \therefore \mu \approx \frac{1}{4}$