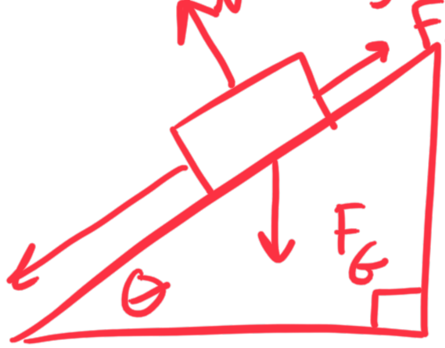
4.) (15 pts total) A 120 kg block is resting on a ~~frictionless~~ incline at an angle of 60°. Draw the corresponding free body diagram.

a) (10 pts) Find the normal force, resulting gravitational force, and the frictional force if μ = 0.245.

$F_N = -mg\cos\theta$

F_f

$F_f = -\mu mg\cos\theta$



F_m

$mg\sin\theta$

$F_N = -mg\cos\theta$

$-(120)(-9.8)\cos 60$

$= \boxed{588\,N}$

$F_m = mg\sin\theta$

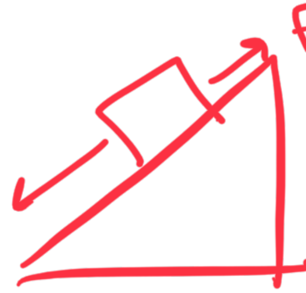
$(120)(-9.8)\sin 60 = \boxed{-1018N}$

$F_f = -\mu mg\cos\theta$

$-(0.245)(120)(-9.8)\cos 60° = \boxed{144\,N}$

b) (5 pts) Based on your diagram, will the block move down the incline. If so, what is its acceleration?

F_f 144N



$F_{net} = F_m + F_f$

F_m

$-1018N$

$-1018N + 144N$

If $f_m > f_f$ moves

$-874N$ block moves

$F = ma \quad a = \frac{F}{m} = \frac{-874N}{120\,kg} = \boxed{-7.3\,m/s^2}$

5.) (10 pts) In a world without pain or injury, a 75 kg person is struck by a 4,350 kg automobile traveling 45 m/s. What is the resulting velocity of this cartoon person?

$p = mv$

$$\frac{m_1 v_1}{m_1} = \frac{m_2 v_2}{m_1}$$

$$v_1 = \frac{m_2 v_2}{m_1} = \frac{(4350\,kg)(45\,m/s)}{75\,kg} = \boxed{2610\,m/s}$$

6.) (5 pts) What is the impulse of a puck when struck by a hockey stick exerting a constant force of 5,500 N for 0.04 s?

$I = F * t$

$$(5500\,N)(0.04\,s) = \boxed{220\,kg\,m/s}$$

$(kg\,m/s^{2})\,s$

7.) (5 pts) Define both elastic and perfectly inelastic collisions. Highlights the two major differences between the two.

Elastic - momentum & kinetic energy conserved

Perfectly inelastic - momentum conserved

8.) (10 pts) A 2,400 kg inflatable banana travelling at 96 m/s 30° above horizontal collides with a 3,500 kg Hello Kitty doll travelling 72 m/s 60° above horizontal. If the collision is perfectly inelastic, find the resulting velocity.

$x = r\cos\theta$

$y = r\sin\theta$

(1)

	m_1		m_2
x component	$mv\cos\theta$ $(2400)(96)\cos 30$ 199,532.3	+	$mv\cos\theta$ $(3500)(72)\cos 60$ −126,000
y component	$mv\sin\theta$ $(2400)(96)\sin 30$ 115,200	+	$mv\sin\theta$ $(3500)(72)\sin 60$ 218,238.4

$m_1v_1 + m_2v_2 = (m_1+m_2)v_f$

total x: 73,532.3 y: 333,438.4

total momentum

$r = \sqrt{x^2 + y^2}$

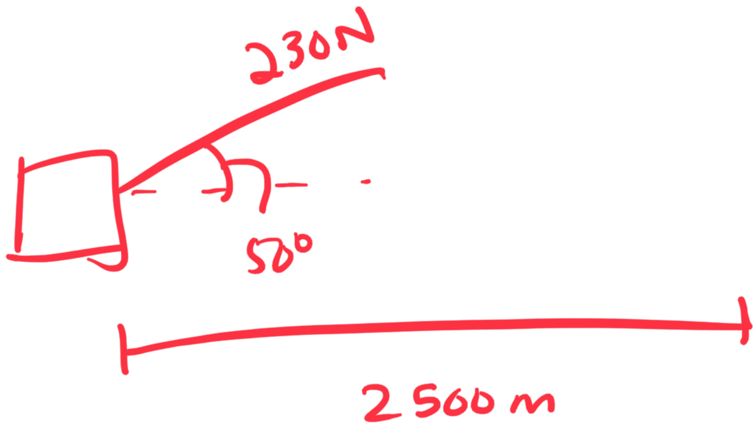
$\sqrt{(73{,}532.3)^2 + (333{,}438.4)^2} = 341{,}450$

$\theta = \tan^{-1}\frac{y}{x} = \tan^{-1}\frac{333{,}438.4}{73{,}532.3} = 77.6°$

$\text{velocity} = \frac{\text{total momentum}}{m_1 + m_2} = \frac{341{,}450}{2400 + 3500}$

57.9 m/s

9.) (10 pts) Stewart is also dragging a motionless… ummm… everything bagel. The bagel tied 50° from the horizontal (on level ground) and is being pulled with a force of 230 N. If Stewart pulls this tasty bagel 2500 meters, how much work is he doing on the object?



$W = F \cdot d$

$W = Fd\cos\theta$

$(230N)(2500m)\cos 50°$

369,603 J

10.) (10 pts total, 5 pts each) A particle moving in the *xy* plane undergoes a displacement Δ□**r** □(4.0**i** + □5.0**j**) m as a constant force **F**□(2.0**i** + □3.0**j**) N acts on the particle.

a) (5 pts) Calculate the magnitudes of the displacement and the force.

$d: \langle 4.0\hat{i} + 5.0\hat{j} \rangle$

$F: \langle 2.0\hat{i} + 3.0\hat{j} \rangle$

magnitude = r

$r = \sqrt{x^2+y^2}$

$|d| = \sqrt{(4)^2+(5)^2}$

$\sqrt{16+25} = \boxed{\sqrt{41}\ m}$

$|F| = \sqrt{(2)^2+(3)^2}$

$\sqrt{4+9} = \boxed{\sqrt{13}\ N}$

x y

b) (5 pts) Calculate the work done by **F**.

$W = F \cdot d$

$(F_x * d_x) + (F_y * d_y)$

$d: \langle 4.0\hat{i} + 5.0\hat{j} \rangle$

$F: \langle 2.0\hat{i} + 3.0\hat{j} \rangle$

$8 + 15 = 23$

$F \cdot d = \boxed{23 J}$

$\theta = \cos^{-1}\left(\frac{F \cdot d}{|F||d|}\right) = \cos^{-1}\left(\frac{23}{(\sqrt{13})(\sqrt{41})}\right) = 4.97°$

$\boxed{23 J,\ 4.97°}$

11.) (10 pts) A 150 kg stuffed Tampy doll is pushed off of a 720 m building. Assuming no wind or air resistance, what is Tampy's velocity just prior to impact?

$PE = mgh$

$PE \rightarrow KE$

$\cancel{m}gh = \frac{1}{2}\cancel{m}v^2$

$2(gh) = \left(\frac{1}{2}v^2\right)2$

$\sqrt{2gh} = \sqrt{v^2}$

$V = \sqrt{2gh}$

$KE = \frac{1}{2}mv^2$

$V = \sqrt{2(9.8)(720}$

$= \boxed{118.79\ m/s}$