Key

W-GP Chapter 5 - 9 Pre-Test

1.) (5 pts) Briefly explain all three Newton's Laws of Motion.

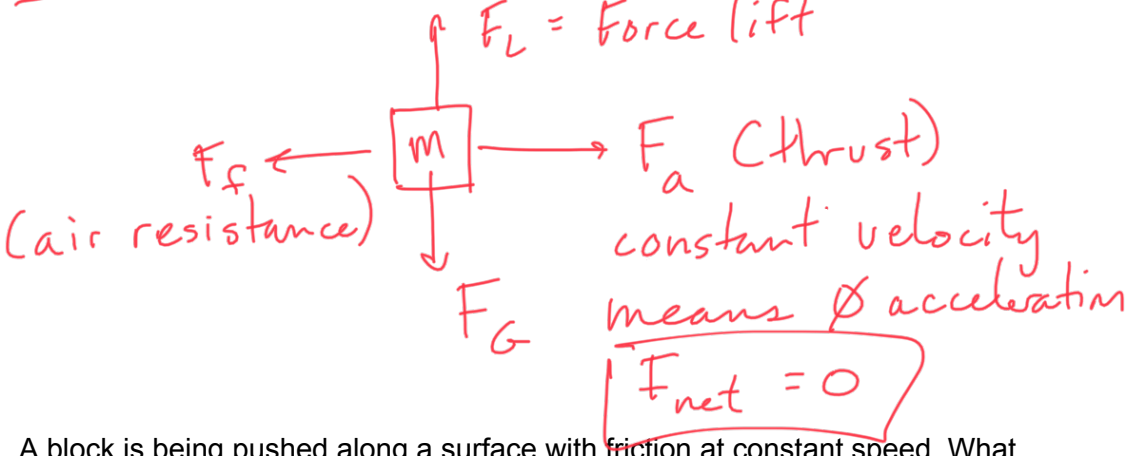
1st Law of inertia – objects in motion remain in motion unless acted upon by an outside force. (at rest / at rest)

2nd $F = ma$

3rd Forces are met with equal/opposite forces.

2.) (10 pts total, 5 pts each) **Draw each of the following free body diagrams**. Use the diagram to answer the question.

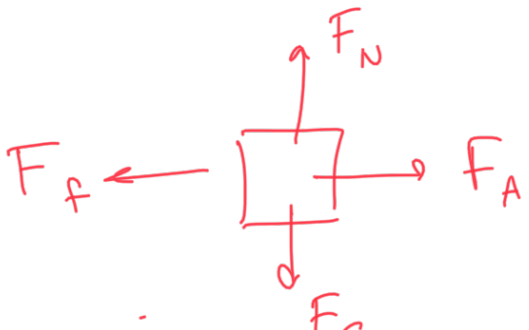
a) An airplane weighing 25,000 kg is flying at a relatively low altitude at a constant velocity. What is the net force acting on the plane?



constant velocity means ∅ acceleration

$F_{net} = 0$

b) A block is being pushed along a surface with friction at constant speed. What must be true of the applied and frictional forces?



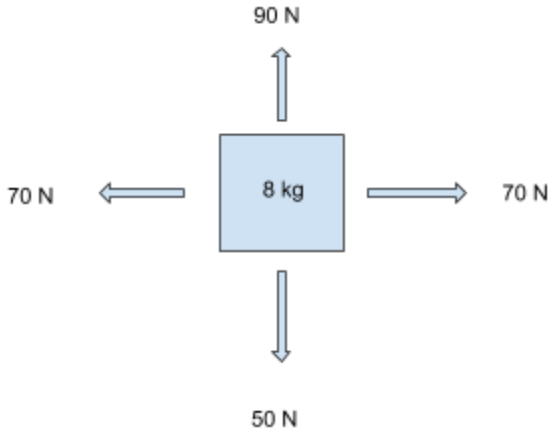
since it is moving at constant speed, there is no acceleration, $F_A = F_f$

3.) (10 pts total, 5 pts each) Find the net force applied on each of the free body diagrams. **Please make sure to find the resultant and direction.**

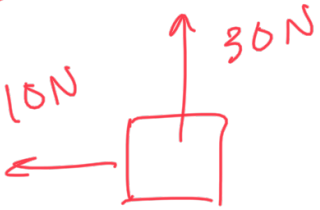
a) What is the F_{net}?

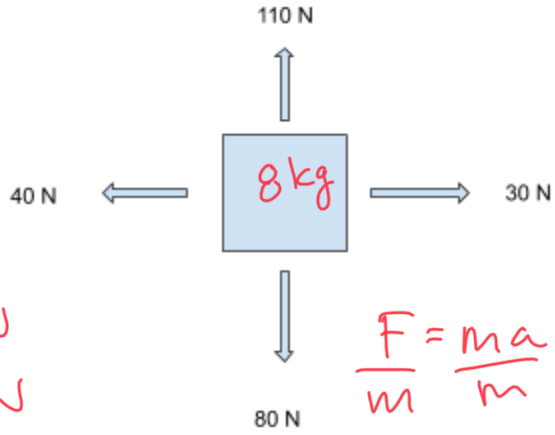
90°

or due North



b) What is the acceleration?





x component : $-10N$

y component : $30N$

net force $= \sqrt{(-10)^2 + (30)^2}$

$\sqrt{100 + 900}$

$\sqrt{1000} = \sqrt{100}\sqrt{10}$

$10\sqrt{10}\ N$

$F = ma$

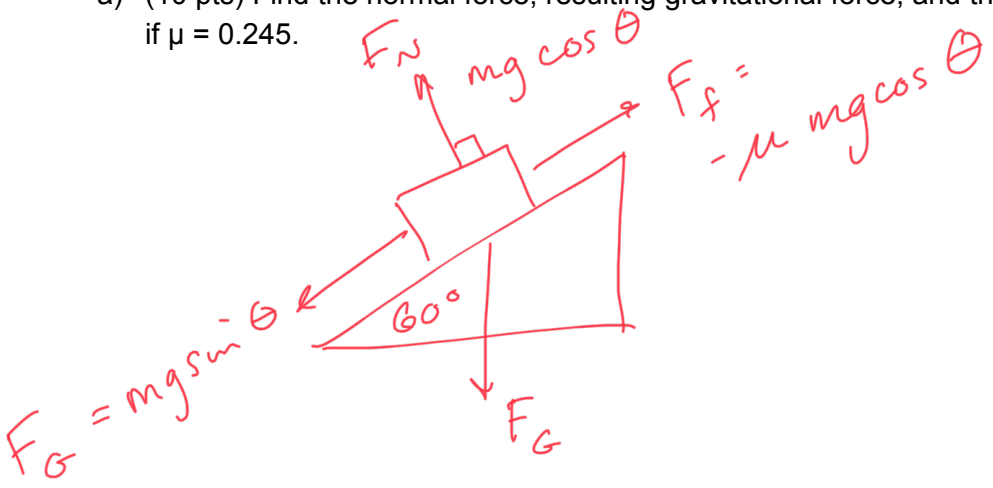
$\frac{F}{m} \quad \frac{ma}{m}$

$\frac{10\sqrt{10}\ kg\ m/s^2}{8\ kg}$

$3.95\ m/s^2$

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.



$$F_N = -mg\cos\theta = -(120\,kg)(9.8\,m/s^2)\cos 60^\circ$$
$$\boxed{-588\,N}$$

$$F_G = mg\sin\theta = (120\,kg)(9.8\,m/s^2)\sin 60^\circ$$
$$\boxed{1018\,N}$$

$$F_f = -\mu mg\cos\theta = -(0.245)(120\,kg)(9.8\,m/s^2)\cos 60^\circ$$
$$\boxed{-144\,N}$$

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

yes

$$1018\,N + (-144\,N)$$
$$874\,N$$

$$F = ma \qquad a = \frac{874\,N}{120\,kg} = \boxed{7.29\,m/s^2}$$
$$m \quad m$$

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?

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

$$v_1 = \frac{(4350\ kg)(45\ m/s)}{75\ kg} = 2610\ m/s$$

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?

$$I = F * t$$

$$(5500\ kg\ m/s^2)(0.04\ s)$$

$$220\ kg\ m/s$$

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

Elastic - kinetic energy conserved and momentum conserved

inelastic - momentum conserved, mass combined.

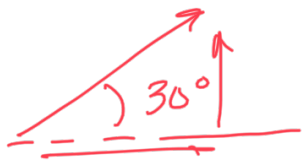
Elastic only possible at atomic level

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.

$$\frac{m_1 v_1 + m_2 v_2}{m_1 + m_2} = \frac{(m_1 + m_2) V}{m_1 + m_2}$$

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

banana



Hello Kitty

x direction

$(2400\text{ kg})(96\text{ m/s})\cos 30°$
$+$
$-(3{,}500\text{ kg})(72\text{ m/s})\cos 60°$

$199{,}532 - 126000$

$73{,}532\text{ kg m/s}$

y direction

$(2400\text{ kg})(96\text{ m/s})\sin 30°$
$+$
$(3{,}500\text{ kg})(72\text{ m/s})\sin 60°$

$115{,}200 + 218{,}238$

$333{,}438\text{ kg m/s}$

$$\sqrt{(73{,}532)^2 + (333{,}438)^2}$$

$341{,}450\text{ kg m/s}$

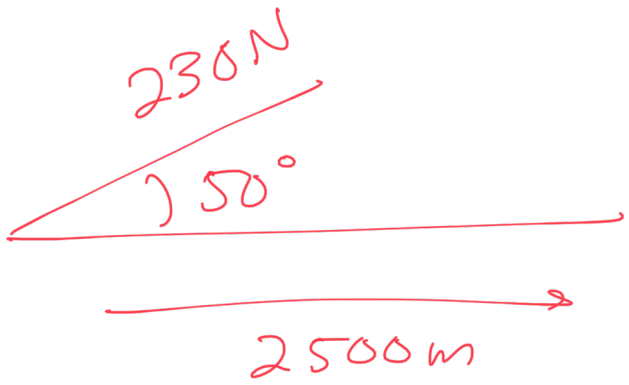
$$\tan^{-1}\left(\frac{333{,}438}{73{,}532}\right) = 77.6°$$

$$\frac{341{,}450\text{ kg m/s}}{(2400 + 3500)\text{ kg}}$$

$49.5\text{ m/s}, 77.6°$.

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?

$W = Fd$



$(230\,N \cos 50°)(2500\,m)$

369,603 J

or

369.6 kJ

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.

$(4.0i + 5.0j)(2.0i + 3.0j)$

$8i^2 + 12ij^{0} + 10ij^{0} + 15j^2$

$8i^2 + 15j^2 \qquad i^2 = 1 \quad j^2 = 1$

$8(1) + 15(1) = \boxed{23\ J} \qquad \frac{A \cdot B}{AB} = \cos\theta$

$A \cdot B = AB\cos\theta \qquad \frac{23}{\sqrt{41}\sqrt{13}} = \cos\theta$

$A = \sqrt{4^2 + 5^2} = \sqrt{41} \qquad B = \sqrt{2^2 + 3^2} = \sqrt{13}$

$\Delta r \qquad \sqrt{16 + 25} \qquad F \qquad \sqrt{4 + 9} \qquad \theta = \cos^{-1}\frac{23}{\sqrt{41}\sqrt{13}}$

$\theta = 5^\circ$

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

a) Δr = displacement = $\boxed{\sqrt{41}m}$ $\tan^{-1}\frac{5}{4} = \theta = \boxed{51.3^\circ}$

F = force = $\boxed{\sqrt{13}N}$ $\tan^{-1}\frac{3}{2} = \theta = \boxed{56.3^\circ}$

b) $\boxed{23\ J}$ $\boxed{5^\circ}$

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?

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

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

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

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

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

$$= \sqrt{2(9.8\ m/s^2)(720m)}$$

$$\boxed{118.8\ m/s}$$