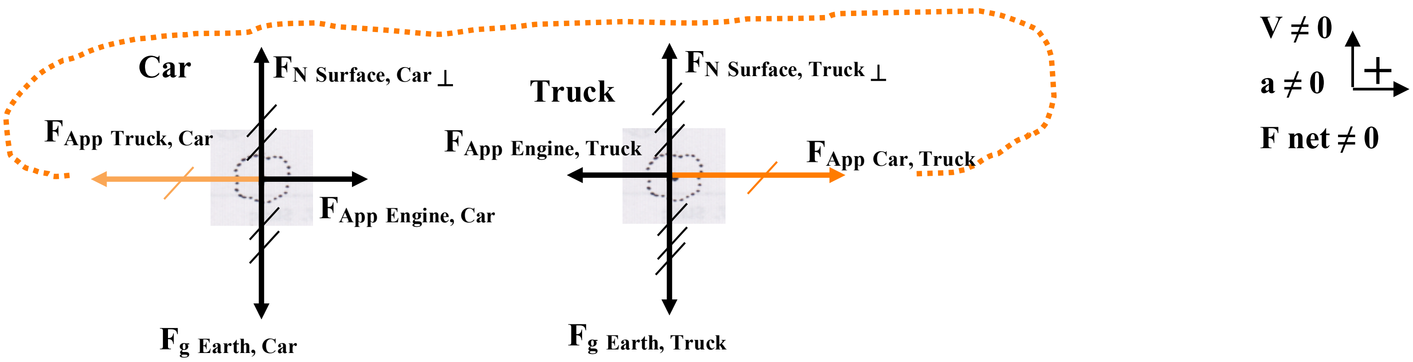
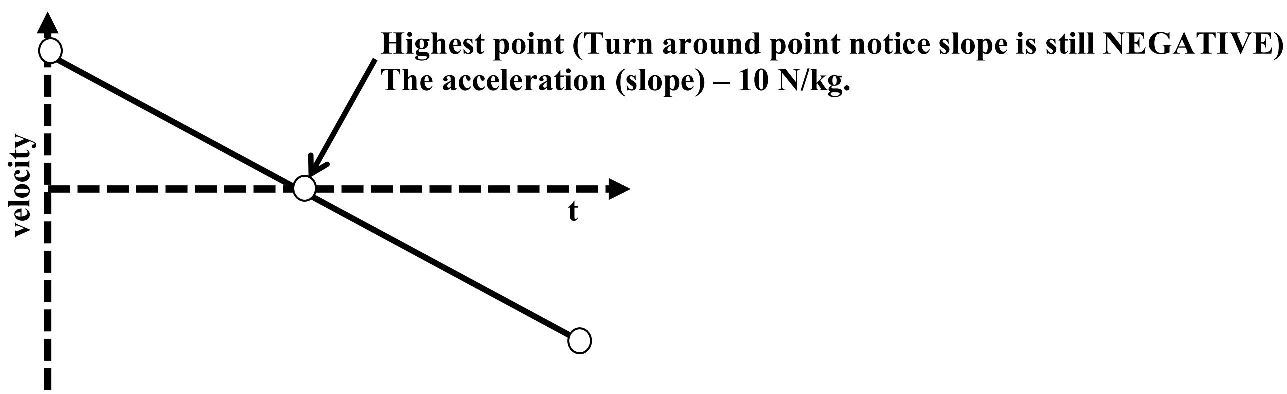
Unit 4 & 5 Force Review **Name** **KEY**
Date ________ **Pd** ___

1. Consider a collision between a small car and a heavy truck that are moving towards each other. In such a collision, how does the size of the force exerted on the car by the truck compare with the size of the force exerted on the truck by the car? **Explain** your reasoning.

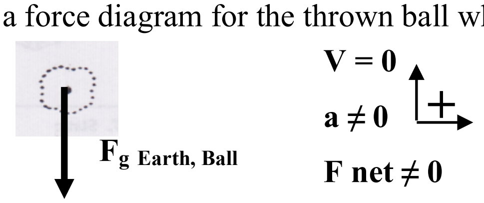


Since they are Newton's 3rd law paired forces they must be equal in size, but opposite in direction. Sizes of the paired forces does not depend on if an object accelerates.

2. a. Draw a velocity-time graph for a ball thrown vertically into the air during its up-and-down motion.



b. Draw a force diagram for the thrown ball when it reaches its highest point.



c. At the highest point, is the velocity zero? **Explain**.

Yes, the ball must stop going up in order for it to come down.

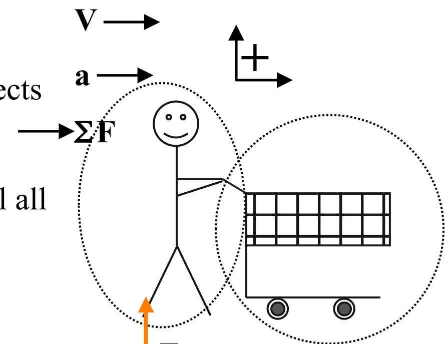
d. At the highest point, is the acceleration zero? **Explain**.

No, The only force acting on it the Force of the Earth on the Ball so the Ball has a net force in the downward direction, which means there is a negative acceleration.

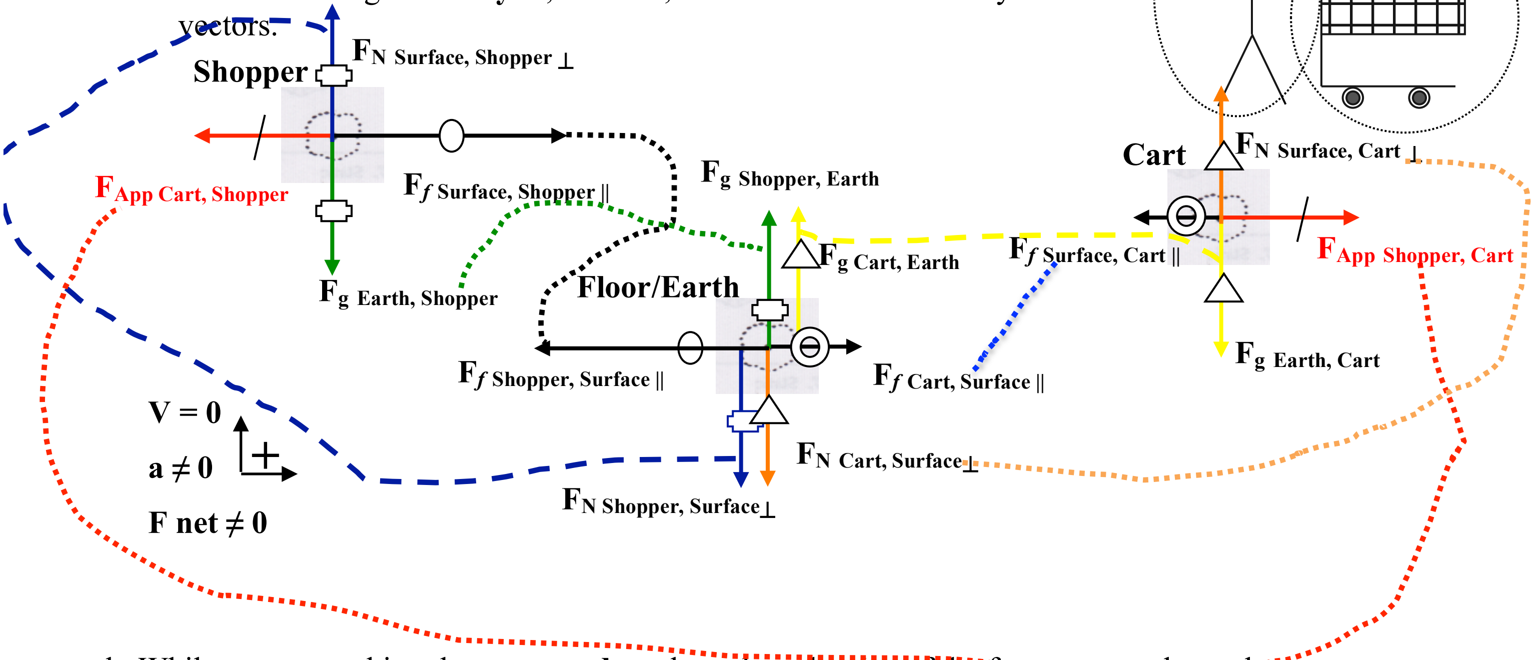
e. At the highest point, is the net force zero (i.e. are the forces unbalanced)? **Explain** how you know.

No, The only force acting on it the Force of the Earth on the Ball so the Ball has a net force in the downward direction.

4. You push a grocery cart along a level floor in the presence of friction effects between the cart and the floor.



a. Draw force diagrams for **you**, the **cart**, and the **floor/earth**. Fully label all vectors.



b. While you are making the cart **speed up**, how does the size of the force you apply on the cart compare to the size of the force the cart exerts on you? **Explain**.

According to Newton's 3rd Law they have to be equal in size and opposite in direction.

c. While you are making the cart **speed up**, how does the size of the frictional force on the *cart* by the floor compare to the frictional force on *you* by the floor?

1. $F_{app\ Shopper,\ Cart} > F_{f\ Surface,\ Cart\ ||}$ (Friction on Cart)
Newton's 2nd Law

1. For Cart to speed up

2. $F_{app\ Shopper,\ Cart} = F_{app\ Cart,\ Shopper}$
Newton's 3rd Law

3. $F_{f\ Surface,\ Shopper\ ||}$ (Friction on Shopper) > $F_{app\ Cart,\ Shopper}$
Newton's 2nd Law

3. For Shopper to speed up

4 . Therefore

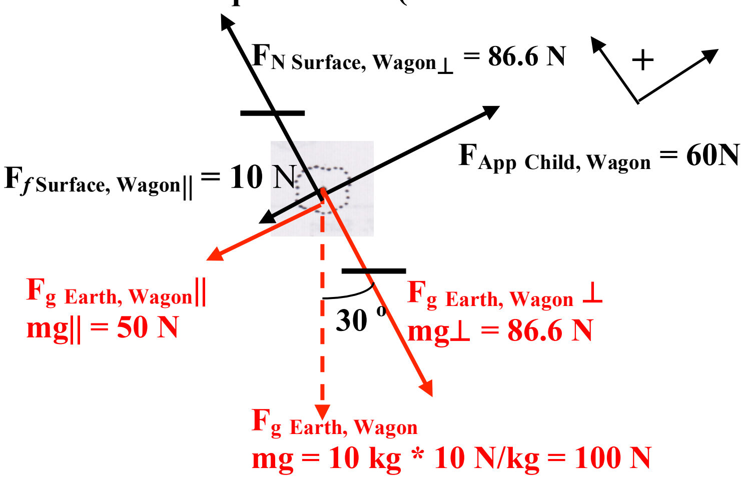
$F_{f\ Surface,\ Shopper\ ||}$ (Friction on Shopper) > $F_{f\ Surface,\ Cart\ ||}$ (Friction on Cart)

d. **Identify** all of the Newton's Third Law pairs in your force diagrams. List the pairs below.

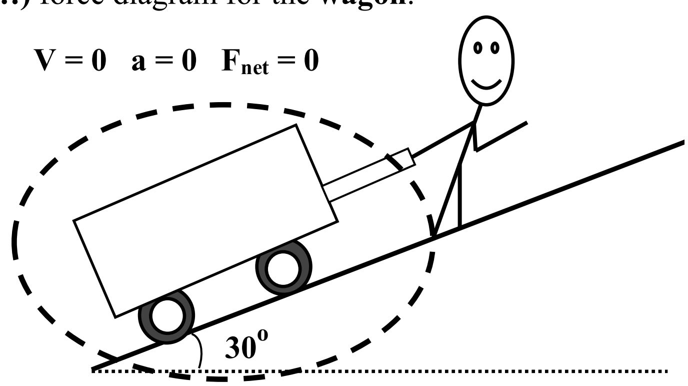
1. $F_{N\ Surface,\ Shopper\ \perp}$ | $F_{N\ Shopper,\ Surface\ \perp}$
2. $F_{f\ Surface,\ Shopper\ ||}$ | $F_{f\ Shopper,\ Surface\ ||}$
3. $F_{g\ Earth,\ Shopper}$ | $F_{g\ Shopper,\ Earth}$
4. $F_{app\ Cart,\ Shopper}$ | $F_{app\ Shopper,\ Cart}$
5. $F_{f\ Surface,\ Cart\ ||}$ | $F_{f\ Cart,\ Surface\ ||}$
6. $F_{N\ Surface,\ Cart\ \perp}$ | $F_{N\ Cart,\ Surface\ \perp}$
7. $F_{g\ Earth,\ Cart}$ | $F_{g\ Cart,\ Earth}$

5. A 35 kg child pulls a 10 kg wagon up a hill **at a constant speed of** 0.6 m/s. **The wagon exerts 60 N of force on the child**.

a. Draw a **quantitative (Hint numbers should be involved…)** force diagram for the **wagon**.



V = 0 a = 0 $F_{net} = 0$



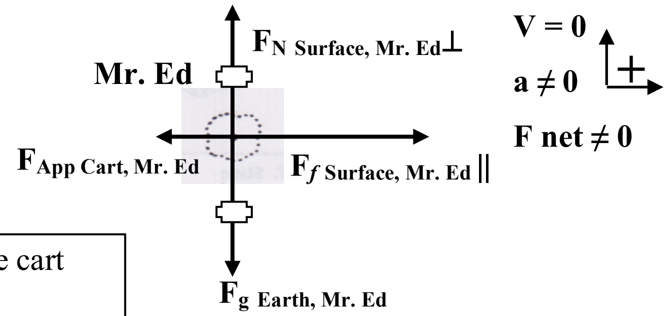
b. **Explain** how you applied Newton's **second** law to make the force diagram quantitative.

$\Sigma F = m*a_{\|\|}$	$F_{App\ Child,\ Wagon} - F_{f\ Surface,\ Wagon\|\|} - mg_{\|\|} = \cancel{ma_{\|\|}} \to 0$ $F_{f\ Surface,\ Wagon\|\|} = 60\ N - (10\ kg * 10\ N/kg * \sin(30^o))$ $F_{f\ Surface,\ Wagon\|\|} = 10\ N$	$mg_{\|\|} = mg \sin(\theta)$
$\Sigma F = m*a_{\perp}$	$F_{N\ Surface,\ Wagon\ \perp} - mg_{\perp} = \cancel{ma_{\perp}} \to 0$ $F_{N\ Surface,\ Wagon\ \perp} = 10\ kg * 10\ N/kg * \cos(30^o)$ $F_{N\ Surface,\ Wagon\ \perp} = 86.6\ N$	$mg_{\perp} = mg \cos(\theta)$

c. **Explain** how you applied Newton's **third** law to make the force diagram quantitative.

Due to Newton's 3rd Law the wagon pulls on the child with a force of 60 N so the Child has to pull on the wagon with a force of 60 N in the opposite direction.

6. Mr. Ed the talking horse is being hitched to a cart. He refuses to pull the cart due to his understanding of Newton's Third Law. He believes that if he pulls on the cart there is an equal but opposite force that will keep the cart from moving. How do you reason with him? Draw force diagrams to prove your point.



Due to Newton's 3rd Law the Horse has to pull the cart with an equal amount of force.

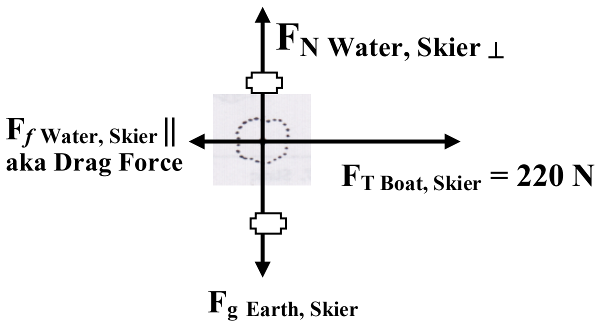
BUT to figure out acceleration you have to look at just Mr. Ed and see what forces are acting **ON HIM AND HIM ONLY USING NEWTON'S 2ND LAW!!!**

So if $\mathbf{F}_{f\ \text{Surface, Mr. Ed}\ \parallel}$ is greater than $\mathbf{F}_{\text{app Cart, Mr. Ed}}$ **Mr. Ed will accelerate.**

Unit 5

For each problem draw a picture, a force diagram, list the known and unknowns, show your work, and use units!

1. An 80 kg water skier is being pulled by a boat with a force of 220 N causing the skier to accelerate at 1.8 N/kg. Find the drag force by the water on the skier.



$V \neq 0$

$a = 1.8$ N/kg

$F_{net} \neq 0$

$\Sigma F = ma$

$F_{T\ Boat,\ Skier}$ - Drag Force = ma

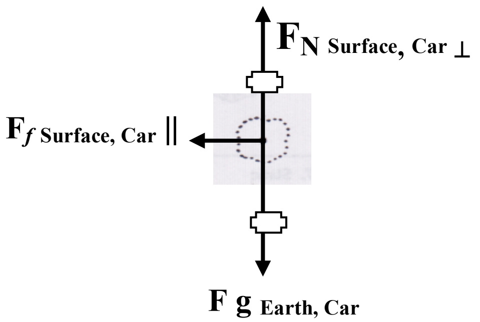
220 N – Drag = 80 kg * 1.8 N/kg

Drag = 220 N – 80 ~~kg~~ * 1.8 N/~~kg~~

Drag = 220 N – 144 N

Drag = 76 N

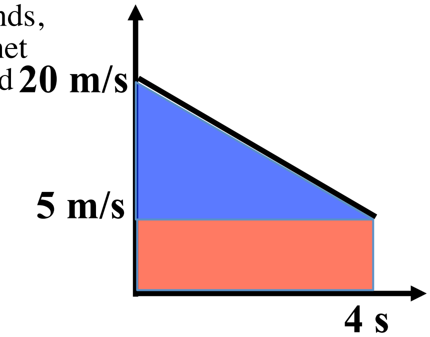
2. A 2000 kg car is slowed down uniformly from 20 m/s to 5 m/s in 4 seconds, this gives the car an acceleration of -3.75 N/kg. Determine the average net force on the car during this time, and sketch a Velocity vs time graph find the displacement of the car during this time from your graph.



V = 0

a ≠ 0

F net ≠ 0



Displacement = Area under Curve

meters = m/s * s

There is a rectangle and a triangle under the curve.

$\Delta X = V_5 * t + \frac{1}{2} * (V_{20} - V_5) * t$

$\Delta X = 5\ m/s * 4\ s + \frac{1}{2} * (20\ m/s - 5\ m/s) * 4\ s$

$\Delta X = 20\ m + 30\ m$

$\boxed{\Delta X = 50\ m}$

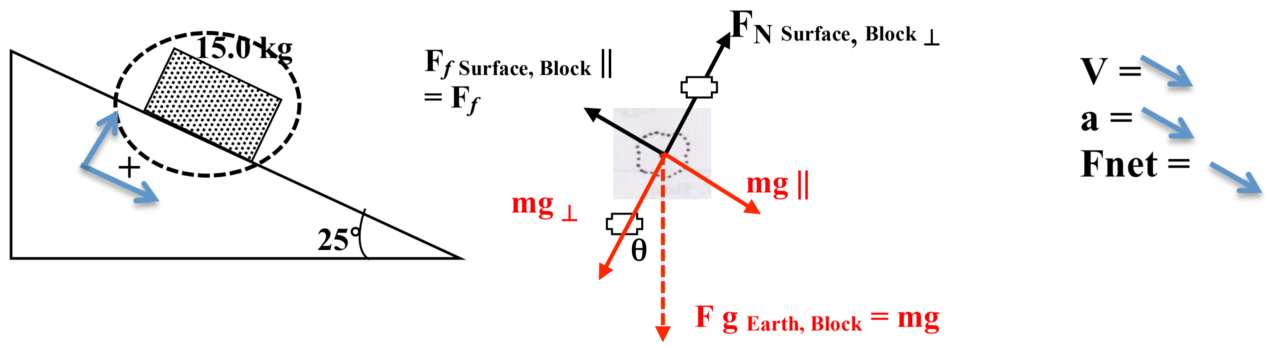
$\Sigma F = ma$

$\Sigma F = F_{f\ Surface,\ Car\ \parallel} = ma$

$\Sigma F = F_{f\ Surface,\ Car\ \parallel} = 2000\ kg * -3.75\ N/kg$

$\boxed{\Sigma F = F_{f\ Surface,\ Car\ \parallel} = -\ 7500\ N}$

3. A 15.0 kg block is allowed to slide down a ramp with $\mu_k = 0.20$.



a. What is the value of the frictional force opposing the block's slide down the ramp?

$F_f = \mu * F_N$

$F_N = mg \cos(\theta) = 15.0\text{ kg} * 10\text{ N/kg} * \cos(25^{o})$

$F_f = 0.20 * 136\text{ N}$

$\boxed{F_f = 27.2\text{ N}}$

b. What is the acceleration of the block?

$\Sigma F = ma$

$mg_{||} - F_f = m\,a$

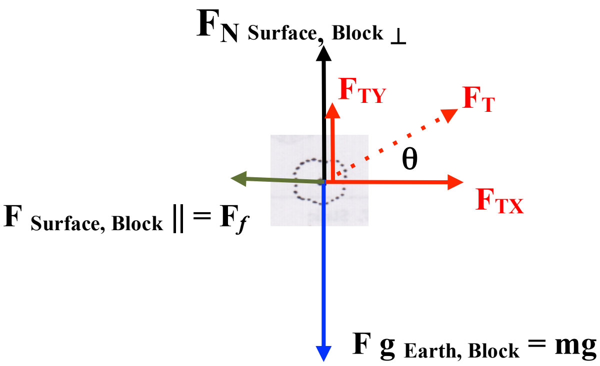
$mg_{||} = mg \sin(\theta)$

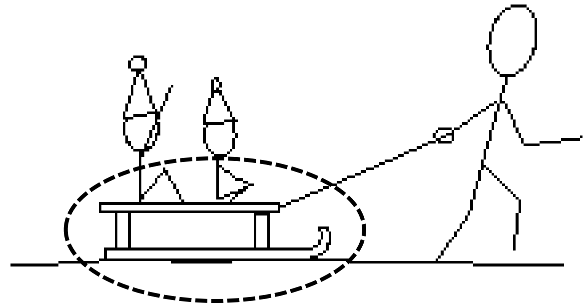
$a = (mg_{||} - F_f) / m$

$a = (15.0\text{ kg} * 10\text{ N/kg} * \sin(25^{o}) - 27.2\text{ N}) / 15.0\text{ kg}$

$\boxed{a = 2.41\text{ N/kg}}$

4. In the diagram to the right, the cord makes a 25° angle with the horizontal, the mass of the sled and occupants is 100 kg. The tension in the cord is 120 N and the friction force is 15 N. Find the acceleration of the sled.





$\Sigma F = ma$

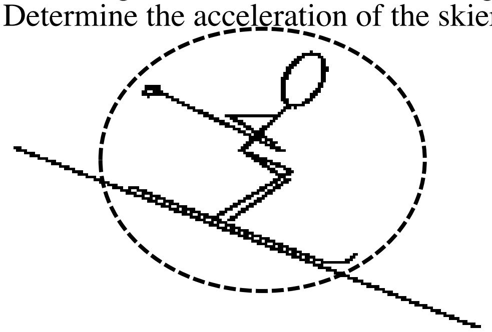
$F_{T\ X} - F_f = m\ a$ $\qquad F_{T\ X} = F_T \cos(\theta)$

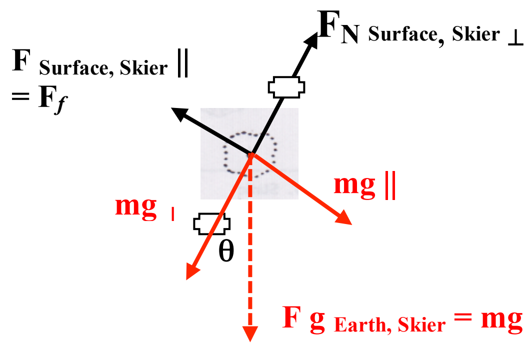
$a = (F_{T\ X} - F_f) / m$

$a = (120\ N \cos(25^o) - 15\ N) / 100\ kg$

$a = 0.938\ N/kg$

5. The 60 kg skier shown below is skiing down a 35° incline with a coefficient of friction is 0.08. Determine the acceleration of the skier.





$F_f = \mu * F_N$ $\quad\quad$ $F_N = mg\cos(\theta) = 60\ \text{kg} * 10\ \text{N/kg} * \cos(35^o) = 491\ \text{N}$

$F_f = 0.08 * 491\ \text{N}$

$F_f = 39\ \text{N}$

$\Sigma F = ma$

$mg_{\|} - F_f = m\,a$ $\quad\quad$ $mg_{\|} = mg\sin(\theta)$

$a = (mg_{\|} - F_f) / m$

$a = (60\ \text{kg} * 10\ \text{N/kg} * \sin(35^o) - 39\ \text{N}) / 60\ \text{kg}$

$a = 5.1\ \text{N/kg}$