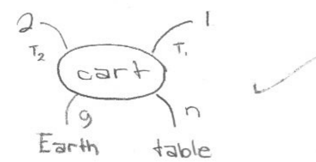
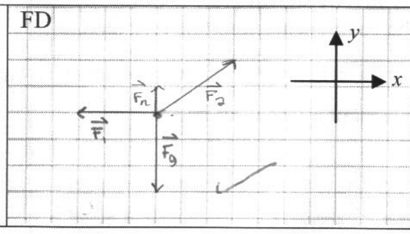
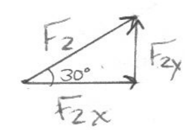
SPH4U: Forces in 2-D

Recorder: ______
Manager: ______
Speaker: ______
0 1 2 3 4 5

A: Tilted Forces

The cart experiences a force, $\vec{F}_1$ = 5 N [Left] and a force $\vec{F}_2$ which is directed [Right 30° Up]. The cart remains at rest on a level surface.

1. **Represent.** Draw the ID and FD for this situation. Construct a component triangle for the force $\vec{F}_2$.

ID	FD	Component Triangle for $\vec{F}_2$
		

2. **Explain.** Howare the forces or components of forces balancing in this situation?

Force 1 will have the same magnitude as the x-component of F_2. Force of Gravity will have the same magnitude as the normal force plus the y-component of F_2 ✓

3. **Predict.** How do you think the magnitude of $\vec{F}_2$ compares with $\vec{F}_1$? Predict a value for F_2. Explain your reasoning.

The magnitude of F_2 will always be larger than F_1. Since the magnitude of the x-component is equal to F_1's magnitude and we know that the hypotnuse of a right triangle is always the largest, F_2's magnitude will be greater than F_1's

a possible F_2 value is (6N ± 0.5N)

4. **Reason.** Now it's time to get two 10-N spring scales, one dynamics cart, and one protractor. What is the readability of your spring scale? If you make a series of measurements of one quantity with your scale and compute an average value, what do you think the uncertainly of that result might be? Provide an estimate.

The readability of the spring scale is 0.5N. If we made a series of measurements, the uncertainty would still be 0.5N ?

Spring Scale Tips:
1) Hold the scale in the vertical or horizontal position in which it will be used. Calibrate it to read 0 N with no forces applied.
2) Do not twist it when forces are applied. The internal pieces may bind and give a false reading.

5. **Test and Evaluate.** Create this situation using two spring scales for $\vec{F}_1$ and $\vec{F}_2$, and a protractor. Measure the size of $\vec{F}_2$ and record it here with its uncertainty. Does this result agree with your prediction?

$\vec{F}_2$ = 5.5N ± 0.3N

This result agrees with our prediction since it is slightly higher than the F_1.

6. **Represent.** Write an equation for Newton's 2nd Law in the *x*- and *y*-directions. Get in to the habit of always showing the *sin* or *cos* functions for your components.

$F_{netx} = ma_x$
$F_{2x} - F_1 = 0$
$F_2 \cos 30° - F_1 = 0$ ✓

$F_{nety} = ma_x$
$(F_n + F_{2y}) - F_g = 0$
$(F_n + F_2 \sin 30°) - F_g = 0$ ✓

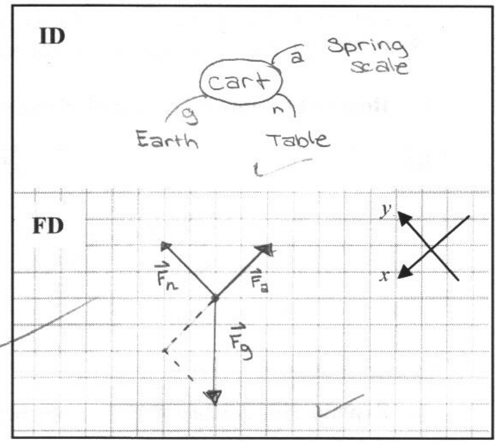
7. **Reason.** Isaac says,"Finding the size of the normal force is easy! It is the same size as the force of gravity." Do you agree or disagree? Explain.

We disagree. The normal force can change depending on the situation, but the force of gravity will be the same. In this situation, there is a y-component of exerting a force and it must also be considered

B: Forces on a Tilt

The cart is at rest on asurface inclined at an angle θ to the horizontal. It is held in place by a force, $\vec{F}_a$,that is provided by your spring scale and is parallel to the incline. Later, you will use the incline set up at the front of the room.

1. **Represent.** Draw an ID and FD for the cart. Show the components of any forces that make an angle with this special choice of coordinate system.



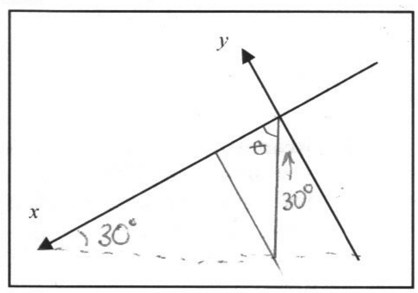
Draw the components of a force that is already shown in a FD using dashed lines or a different colour so the components won't be mistaken for another, new force.

2. **Reason.** Which forces, or components of a force, act in each direction?

+ x	- x	+ y	- y
x-component of gravity F_{gx}	applied force F_a	normal force F_n	y-component of gravity F_{gy}

3. **Reason.** Which forces, or components of a force, balance each other? How can you tell?
The applied force is balanced by the x-component of gravity and the normal force is balanced by the y-component of gravity. We can tell because the x must balance and the y must balance
Why must they balance?

4. **Reason.** Which force or component of a force pulls the cart down along the incline?
The x-component of the force of gravity would pull the cart down along the incline



5. **Represent.**Draw the component triangle for the force of gravity $\vec{F}_g$ relative to the tilted coordinate system. Locate angle θin the triangle. What are the magnitudes of the components of $\vec{F}_g$? Write these components using *sin* or *cos*.
$F_{gx} = F_g \cos\theta$ $F_{gy} = F_g \sin\theta$

6. **Predict.** Measure the angle of the incline and the weight of your cart.Use Newton's 2nd law in the *x*-direction to predict the size of $\vec{F}_a$.
The incline is 30° $F_g = 12.5N$
$F_{net\,x} = ma_x$
$F_{gx} - F_a = 0$
$F_g \cos 30° = F_a$ (sin)
$F_a = 12.5N \cos 30°$ (sin)
$= 6.25N \pm 0.3N$
Compare with group.

7. **Test.** Use the incline at the front of the class to measure the magnitude of $\vec{F}_a$. How does this compare with your prediction? (Did you remember the uncertainty?)
The measured magnitude was 6.5N ± 0.5N. This agrees with our pridiction, 6.25N ± 0.3N, since it falls within the range

8. **Predict.**Explain how $F_a$would change if the angle of the incline is increased. Test this (lift up the incline a bit).
$F_a = F_g \cos 60$
F_a would ~~not~~ change had the angle of incline increased. The x-component of gravity would not change, only the y-component would. Only the x-component affects the F_a

9. **Calculate.** Use Newton's 2nd law in the *y*-direction to find the magnitude of $\vec{F}_n$.
$F_{net\,y} = ma_y$
$F_n - F_{gy} = 0$
$F_n - F_g \cos\theta = 0$
$F_n = 12.5N \cos 30°$
$= 10.83N \pm 0.3N$

10. **Reason.** Explain how $F_n$would change if the angle of the incline is increased.The normal force exists because the two surfaces are being pressed together. What has happened to the amount of pressing as the angle increases?
F_n would decrease if the inclined is increased. This is b/c the y-component of gravity decreases as the angle of incline increases. The amount of pressing decreases as the angle increases.