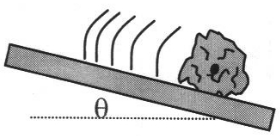
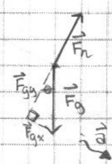
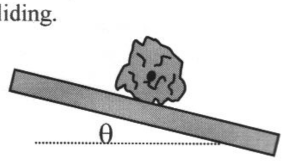
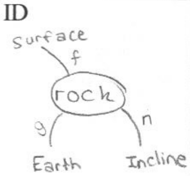
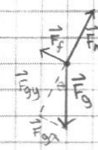
SPH4U: Understanding 2-D Forces

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

A: Rocks on Inclines

For each situation, draw the FD and ID. Write out a complete expression for Newton's 2[nd] Law in the x- and y-directions. Make sure you show your trig!

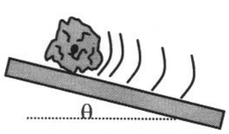
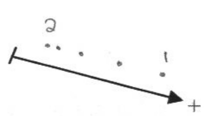
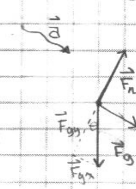
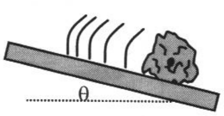
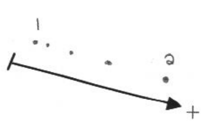
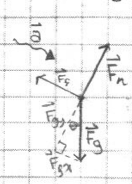
A rock is sliding without friction.	ID	FD	Newton's 2[nd] Law
			$F_{netx} = ma_x$ $F_{netx} = 0$ $F_{nety} = ma_y$ $F_n - F_{gy} = 0$ $F_n - F_g\cos\theta = 0$
Friction prevents the rock from sliding. 			$F_{netx} = ma_x$ $F_{gx} - F_f = 0$ $F_g\sin\theta - F_f = 0$ $F_{nety} = ma_y$ $F_n - F_{gy} = 0$ $F_n - F_g\cos\theta = 0$

1. **Explain.** What force or component of a force causes the acceleration in the first example?
   The x-component of the force of gravity causes the acceleration in the first example since it is the only force acting in the x-direction.
2. **Explain.** How did you choose your coordinate system for these two examples?
   We chose to use a tilted axis coordinate system for the two examples. Had we used a regular coordinate system, we would have had 2 different sets of components instead of 1. Therefore, we chose the tilted axis coordinate system to make it easier for us.

B: The Rough Incline

A rock slides up and then down an incline. There is a force of friction with a constant size, but not quite enough to prevent the rock from sliding back down.

1. **Represent.** Complete the chart below.

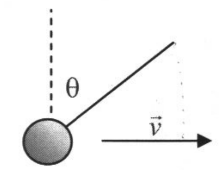
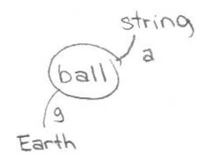
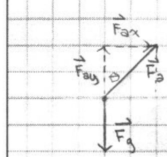
Sketch	Motion Diagram	Force Diagram	Newton's 2[nd] Law
			$F_{nety} = ma_y$ $F_n - F_{gy} = 0$ $F_n - F_g\cos\theta = 0$ $F_{netx} = ma_x$ $F_f + F_{gx} = ma_x$ $F_f + F_g\sin\theta = ma_x$
Sketch	**Motion Diagram**	**Force Diagram**	**Newton's 2[nd] Law**
			$F_{nety} = ma_y$ $F_n - F_{gy} = 0$ $F_n - F_g\cos\theta = 0$ $F_{netx} = ma_x$ $F_f - F_{gx} = ma_x$ $F_f - F_g\sin\theta = ma_x$

2. **Predict.** Will the magnitude of the rock's acceleration be the same when it is going up the incline as when it is going down? Justify your prediction. We will test this as a class – move on for now.
   The magnitude of the rock's acceleration will be different when it is going up the incline than when it's going down. This is because no new forces are added. In other words, the same forces exist for both events, so the acceleration will be the same.

C: The Floating Ball

A ball is tied to a string. Emmysays, "Watch this. I can pull the ballwith the string at an angle, like this,so it moves **horizontally** through the air.".Isaac replies, "I don't understand how that's possible. The forces simply don't work out properly."

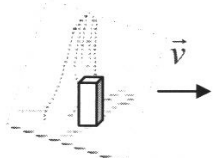
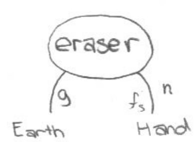
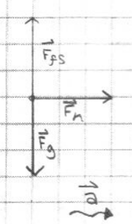
1. **Reason.** Explain to Isaac how it is possible with the assistance of the force diagram and equations.The force of air resistance is small enough to ignore.

Can the ball travel horizontally?	ID	FD	Newton's 2nd Law
			$F_{net\,x} = ma_x$ $F_{ax} = ma_x$ $F_a \sin\theta = ma_x$ $F_{net\,y} = ma_y$ $F_{ay} - F_g = 0$ $F_a \cos\theta - F_g = 0$

The only forces acting on the ball are gravity from the Earth and the applied force from the string. The y-component of the applied force must balance w/ the force of gravity since the net force in the y-direction is 0. The only force remaining is the x-component of the applied force, which is in the horizontal direction.

D: The Magic Eraser

Albert says, "Look! I can make my eraser stay in place against my vertical hand without me holding on to it!" Marie says, "Nonsense! Gravity is guaranteed to pull it down."

Can the eraser "stick" to a person's hand?	ID	FD	Newton's 2nd Law
			$F_{net\,x} = ma_x$ $F_n = ma_x$ $F_{net\,y} = ma_y$ $F_{fs} - F_g = 0$

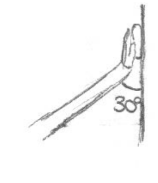
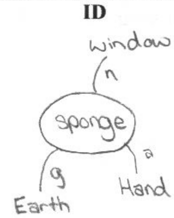
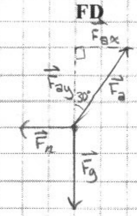
1. **Reason.** Complete the chart above.Who do you agree with? Explain.

We agree with Albert. It is possible to make the eraser stay in place if the force of friction "cancels out" the force of gravity. Since normal force affects friction, if the magnitude of F_n is large enough, the force of friction will "cancel out" gravity.

C:Washing the Windows

Albert is making a bit of money for university by washing windows. He pushes a sponge upwards along a window to get a dirty spot that is above his head.

1. **Represent.** Complete the chart for the system of the sponge at the moment Albert's arm makes a 30° angle with the window. The sponge is at rest. You may assume friction is small enough to ignore.

Sketch	ID	FD	Newton's 2nd Law
			$F_{net\,x} = ma_x$ $F_{ax} - F_n = 0$ $F_a \sin 30° - F_n = 0$ $F_{net\,y} = ma_y$ $F_{ay} - F_g = 0$ $F_a \cos 30° - F_g = 0$

2. **Reason.** Rank the size of the three forces in this problem. Explain your ranking.

The order of size for the 3 forces is: $\vec{F}_n$, $\vec{F}_g$, $\vec{F}_a$. Since the angle is smaller, the adjacent side is greater than the opposite side. This means that the y-component is greater than the x-component of the applied force. This also means that $\vec{F}_g > \vec{F}_n$. $\vec{F}_a$ is the largest b/c it's greater than any of its components.