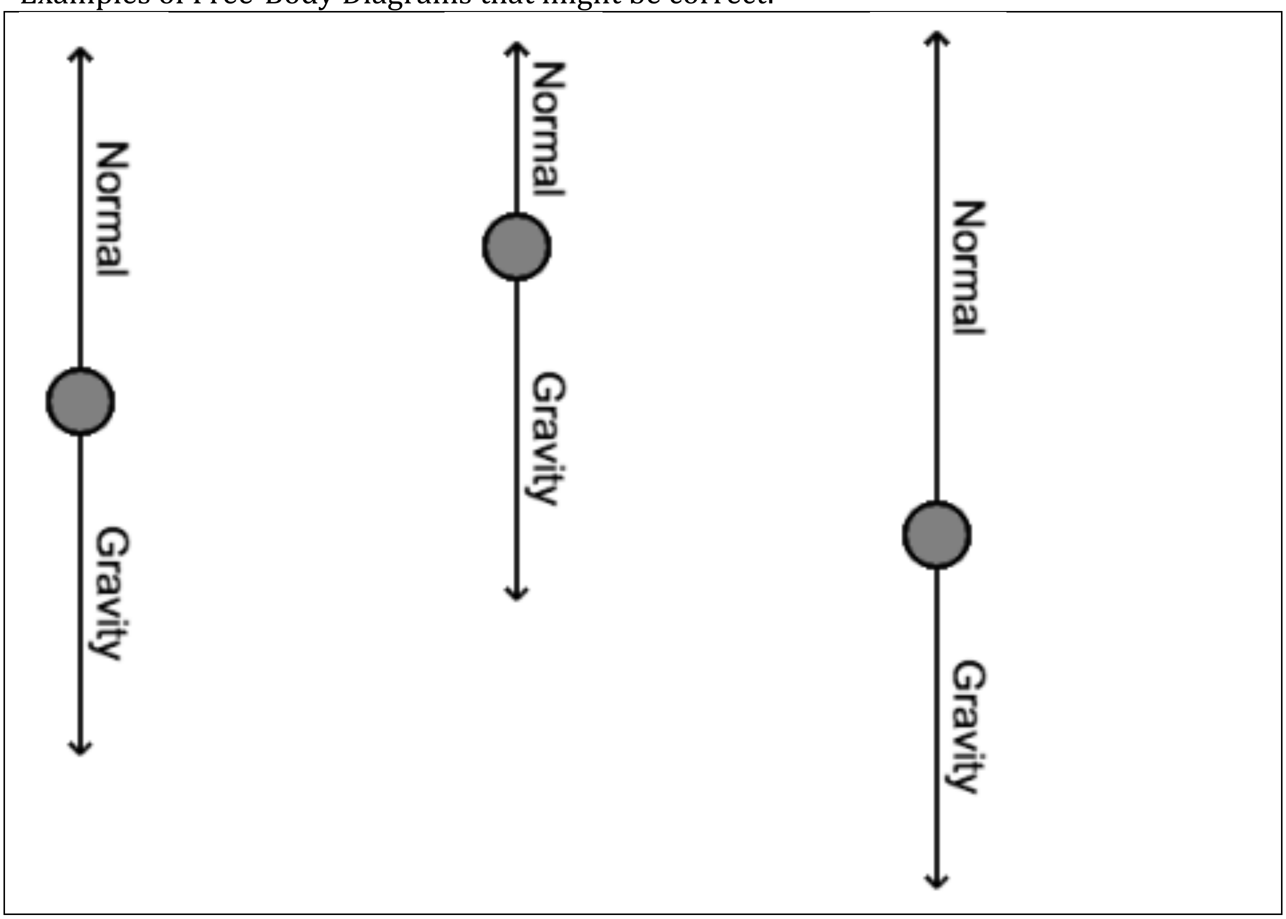
Elevator Problems   Name ____________________

Goal:
Imagine you are in an elevator. You feel various forces upward and downward on your body as the elevator moves up and down, and yet these forces do not always comply with the direction an elevator is moving.
The object of this packet is to create a mathematical model that explains the motion and forces on your body within an elevator.

Directions:
Skim the first two pages, labeled the **Elevator Rules**.
The first two pages set out the Laws of Physics that you need to know in order to answer the questions on other pages.
Then, approach the questions on other pages. Whenever you try one of these questions look *back* to the statements on the first two pages.

Elevator Rules:
Inside the elevator, there are always *two forces* acting on the object: gravity and the normal force. These forces are always there, and always act in the same directions:
Examples of Free-Body Diagrams that might be correct:



Gravity:

The *direction* of gravity is always DOWN.
The *magnitude* of gravity is always (mass)*(9.81 m/s^2)
This is written:

$$F_g = mg$$

Symbol	Quantity	SI Unit
F_g	Force of gravity	Newtons (N)
m	Mass	Kilograms (kg)
g	Free-fall acceleration [equal to 9.81 m/s^2 on earth]	m/s^2

Note that, because we are on earth, gravity is also referred to as *weight*.

Normal Force:

The *direction* of normal force is always perpendicular to the floor.
Inside of an elevator, this is always UP.

The *magnitude* of normal force is always equal to *whatever it must be in order to match the motion provided*.
Normal force is called a **constraint force.**

Newton's Second Law:

$$\Sigma F = ma$$

If an object is not moving, the net force is always equal to zero.
If an object is moving at a *constant velocity*, the net force is always equal to zero.
If an object is *speeding up*: then the net force is not equal to zero and is in the *same direction* as velocity.
If an object is *slowing down*: then the net force is not equal to zero and is in the *opposite direction* as velocity.

Forces you Feel:

Human beings do not actually, ever in their lives, *feel* the force of gravity.
The force that human beings describe as 'gravity' or 'weight' is the normal force

If the magnitude of the normal force is equal to the weight of a person, then they feel normal.
If the magnitude of the normal force is less than the weight of a person, then they feel 'light' or 'weightless'
If the magnitude of the normal force is greater than the weight of a person, then they feel 'heavy' or 'pressed into.'

Problem G.1:
Elevator Eddie is standing in an elevator, and the elevator is not moving:
Eddie has a mass of 70 kg.

What is the *net force* acting on Eddie? How do you know.

Fill out the table below to fully comprehend the situation:

Picture of Eddie	**Free-Body Diagram**	**Net Force**	**Velocity Vector** Velocity = 0

Name of Force	**Magnitude**	**Direction**	**How did you determine the magnitude?**
Gravity			
Normal Force			

Problem G.2:
Elevator Evelyn is standing in the elevator, and it is moving *upward at a constant velocity*. Evelyn has a mass of 60 kg.

What is the net force acting on Evelyn and how do you know?

Picture of Evelyn	**Free-Body Diagram**	**Net Force**	**Velocity Vector**
			

Name of Force	**Magnitude**	**Direction**	**How did you determine the magnitude?**
Gravity			
Normal Force			

Problem G.3:
Elevation Ezekiel is in the elevator
Ezekiel has a mass of 68 kg.
The elevator is moving upward and is accelerating *upward* at a rate of 0.8 m/s^2!

What is the *magnitude and direction* net force acting on Ezekiel? How do you know?

Picture of Ezekiel	**Free-Body Diagram**	**Net Force Vector**	**Velocity Vector**

Name of Force	**Magnitude**	**Direction**	**How did you determine the magnitude?**
Gravity			
Normal Force			

Problem G.4
Esther of the Elevator is standing in an elevator, and it is moving downward and *accelerating downward* at a rate of 0.9 m/s^2. Esther has a mass of 64 m/s^2.
Esther has a mass of 64 kg.

What is the *magnitude* and *direction* of the net force acting on Esther?

Picture of Esther	**Free-Body Diagram**	**Net Force Vector**	**Velocity Vector**
			

Name of Force	**Magnitude**	**Direction**	**How did you determine the magnitude?**
Gravity			
Normal Force			

Answers:

Problem G.1:
Net Force = 0. You know because he is not moving.

Name of Force	**Magnitude**	**Direction**	**How did you determine the magnitude?**
Gravity	687 N	Down	Mass * free-fall acceleration
Normal Force	687 N	Up	Must equal force of gravity for net force of 0

Problem G.2:
Net Force = 0. You know because net force is always zero when velocity is constant.

Name of Force	**Magnitude**	**Direction**	**How did you determine the magnitude?**
Gravity	589 N	Down	Mass * free-fall acceleration
Normal Force	589 N	Up	Must equal force of gravity for net force of 0

Problem G.3:

Net Force = 54.4 N upward. You know by applying Newton's Second Law (F = ma)

Name of Force	**Magnitude**	**Direction**	**How did you determine the magnitude?**
Gravity	667 N	Down	
Normal Force	721 N	Up	You must have this normal force for a net force of 54.4 UP.

Problem G.4:
Net Force = 57.6 N DOWNWARD

Name of Force	**Magnitude**	**Direction**	**How did you determine the magnitude?**
Gravity	627 N	DOWN	
Normal Force	570 N	UP	You must have this normal force for a net force of 58 N downward.