**Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Period\_\_\_\_\_\_Date\_\_\_\_\_\_\_\_\_\_\_\_**

**Physical Science**

**Guided Notes - Force**

***Newton’s Laws***

***Newton’s \_\_\_\_\_\_\_\_\_\_\_\_ Law of Motion***

* An object at \_\_\_\_\_\_\_\_\_\_\_ will \_\_\_\_\_\_\_\_\_\_\_\_\_ at rest and an object in \_\_\_\_\_\_\_\_\_\_\_ will continue \_\_\_\_\_\_\_\_\_\_\_\_\_at a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ unless acted upon by a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Law of Inertia
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: tendency of an object to \_\_\_\_\_\_\_\_\_\_\_ any \_\_\_\_\_\_\_\_\_\_\_ in its motion
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + The tendency to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in motion
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is always caused by a force
  + Objects with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ need \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to change their motion

***Newton’s \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Law of Motion***

* Exerting a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ on an object causes a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ change in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + A greater change in velocity means there is greater \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of an object is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ acting on it and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to its mass
* AKA: When \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, acceleration goes \_\_\_\_\_\_\_\_\_. When \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, acceleration goes \_\_\_\_\_\_\_\_\_\_.
  + - * + F:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
        + m:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**F**

* + - * + a:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
        + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**m**

**a**

***Gravity***

* Gravity: the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_between any two objects in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_as:
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_)

**m**

* + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: the force of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ on an object.

**W**

* + - * + W:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
        + m:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**g**

* + - * + g:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* Mass: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Weight\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Would you weigh more on Jupiter or Earth? Why?

*Acceleration due to Gravity*

* In the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of air resistance, \_\_\_\_\_\_ falling objects have the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* On Earth \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Practice Calculations and Problems***

1. **What force would be required to accelerate a 40 kg mass by 4 m/s2?**
2. **A 4.0 kg shotput is thrown with 30 N of force. What is its acceleration?**
3. **Mrs. Ellis weighs 572 N. What is her mass?**
4. **True or False: An astronaut has less mass on the moon since the moon exerts a weaker gravitational force. Why?**

***Free Fall***

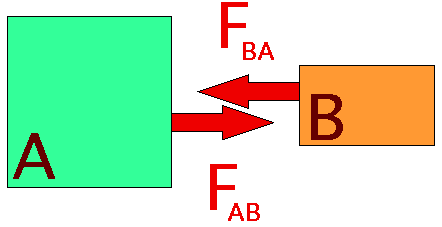
* When an object is influence \_\_\_\_\_\_\_ by the force of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Weightlessness***

* Sensation produced when an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* ***\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*** are falling at the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ so they don’t exert a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ on the object

**Problem: True or False: An astronaut on the Space Shuttle feels weightlessness because there is no gravity in space.**

***Newton’s \_\_\_\_\_\_\_\_\_\_\_\_\_\_Law of Motion***

* When an object exerts a force on a second object, the second object exerts an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* One object exerts a force on the second object, the second exerts a force back that is equal in strength, but opposite in direction.

Problem: How can a horse pull a cart if the car is pulling back on the horse with an equal but opposite force? Aren’t these “balanced forces” resulting in no acceleration?

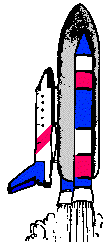
Explanation:

* Forces are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ but act on \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ objects
* They are not \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* The movement of the horse depends on the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_



Action-Reaction Pairs

* Forces \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, they can act on \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ objects or spread out in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_



* The rocket exerts a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ force on the

\_\_\_\_\_\_\_\_\_\_\_\_ gases

* The gases exert an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Force \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ on the rocket

* Both objects \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**a**

**m**

* The amount of acceleration depends on the \_\_\_\_\_\_\_\_\_\_\_ of the object

**F**

* Small mass=\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Large mass=\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Momentum:***

**p**

* + - * p:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
      * m:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**v**

**m**

* + - * v:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**  in motion
* When you’re moving \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ keeps you moving
* An object with lots of momentum is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Momentum is a vector quantity, so a complete answer will include magnitude (number) and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Calculations and Problems***

1. **Find the momentum of a bumper car if it has a total mass of 280 kg and a velocity of 3.2 m/s.**
2. **The momentum of a second bumper car is 675 kg ●m/s. What is its velocity if its total mass is 300 kg?**
3. **What is the momentum of a 150 kg defensive tackle at 5 m/s north towards the end zone?**

*Changing Momentum*

* To change the momentum of an object, you must change:
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Usually \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_changes
    - Change in velocity is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    - To make an object accelerate, a \_\_\_\_\_\_\_\_\_\_\_ is required

**Impulse**

* What \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Depends on \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of collision
* Impulse = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Impulse = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Units for impulse are the same as units for momentum
* Impulse:

*Calculations with impulse:*

1. A hockey player applies an average force of 80.0 N to a 0.25 hockey puck for a time of 0.10 seconds. Determine the impulse experienced by the puck.
2. What is the change in momentum (impulse) of a 950 kg car that travels from 40 m/s to 31 m/s?
3. If the from the last problem had an impulse of 8550 kg\*m/s, and it took 30 seconds to change speeds, then what force caused the change?

* Time and force are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ proportional
* For an object in collision,
  + To decrease the effect of force, the time must be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + To increase the effect of force, the time must be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Law of the Conservation of Momentum:** the \_\_\_\_\_\_\_\_\_ momentum in a group of objects \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_unless \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ act on the objects.

* **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Collision:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Collision:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Calculations and Problems (HONORS HONLY)**

1. **A 5 kg cart traveling at 1.2 m/s strikes a stationary 2 kg cart and they connect. Find their speed after the collision.**
2. **A 50 kg clown is shot out of a 250 kg cannon at a speed of 20 m/s. What is the recoil speed of the cannon?**