

NEWTON'S LAWS OF MOTION

Use the resources on Mr. Hanna's website to complete the following assignment.

VOCABULARY:

- 1) NEWTON'S FIRST LAW – *An object at rest will remain at rest, and an object in motion will remain in constant motion (constant velocity and direction) unless acted on by an unbalanced force.*
- 2) INERTIA – *the tendency of an object to resist a change in its motion*
- 3) MOMENTUM – *the inertia of a moving object (Newton's "quantity of motion")*
- 4) NEWTON'S SECOND LAW – *An object will accelerate in the direction of a net force that is applied to it (proportional to its mass).*
- 5) WEIGHT – *the effect of the Earth's gravity on an object's mass*
- 6) NEWTON'S THIRD LAW – *If one object exerts a force on another object, then the second object exerts an equal but opposite force on the first.*

SHORT ANSWER:

- 7) What is the ONLY way to CHANGE an object's motion?
The only way to change an object's motion is to apply an unbalanced force to it.
- 8) If you are riding in a car when the driver slams on the breaks, why does your body feel like it's being thrown forward toward the front of the car (*this is why you must wear your seatbelt!!!*)?
Because your body has mass, it also has inertia, which means it will resist a change in its motion. Since your body was moving forward with the car as you were riding along, it wants to continue moving in a constant direction/speed even though the car stopped. This is why your body is thrown forward when the driver slams on the breaks.
- 9) If you try to push a light object (such as an empty box) and a heavy object (such as a refrigerator) across the floor, why is it harder to move the heavy object?
The heavier object has more mass, therefore more inertia. That means it will be harder to change the motion of the heavier object, so it requires more force to accelerate it from rest.
- 10) A medicine ball (heavy) and a basketball (light) are dropped at the same time from the same height. Most people would predict that the medicine ball will drop faster and hit the ground first, but that isn't the case. The two balls will fall at the same rate and hit the ground at the same time. Use the concept of inertia to explain why (*if you're able, watch the video in the PowerPoint or posted on my website*).
Because the medicine ball has more mass, it has more inertia. The gravitational force is greater on the medicine ball (because it has more mass), but it also requires a greater force to accelerate (because of inertia). These differences "cancel out", so the two balls accelerate down at the same rate (as all objects would).
- 11) You could say that momentum is a "type" of inertia...in what way is this true?
Inertia is the resistance of an object to a change in its motion. Objects have inertia when they are at rest (not moving) and when they are moving. Momentum is specifically referring to the inertia of a MOVING object (how hard it is to change its motion).
- 12) When you apply an unbalanced force to an object, in which direction will the object accelerate?
The object will accelerate in the direction of the net force.
- 13) What are the metric units for "force"?
Newtons (N)
- 14) How do we calculate an object's weight?
 $W=mg$
- 15) Explain how "weight" is an example of Newton's second law of motion.

Weight is a FORCE (the force of gravity on an object). It is a result of the object's MASS and its ACCELERATION due to gravity ($g = 9.8\text{m/s}^2$). So, $W=mg$ is the same as saying $F=ma$.

16) Explain how the Normal Force is an example of Newton's third law of motion.

The normal force only occurs when an object is on a surface. It is the reaction force to the object's weight pushing down on the surface, so it will be equal and opposite to the weight of the object.

PRACTICE: (remember to show the 3 steps for math problems)

17) A baseball player throws a 0.4 kg baseball at a speed of 20 m/s. What is the momentum of the ball?

$$p=mv \quad p=(0.4\text{kg})(20\text{m/s}) \quad p=8 \text{ kg}\cdot\text{m/s}$$

18) What net force must you apply to accelerate a toy car with a mass of 0.5 kg at a rate of 2 m/s²?

$$F=ma \quad F=(0.5\text{kg})(2\text{m/s}^2) \quad F=1\text{N}$$

19) What is the weight of a 100 kg box?

$$W=mg \quad W=(100\text{kg})(9.8\text{m/s}^2) \quad W=980\text{N}$$

20) If you push a box along the floor at a constant speed, then its acceleration is 0 m/s² (there is no change in motion). If the box has a mass of 20 kg, what is the net force that you are applying to the box? (**You must show me the math to back up your answer!**)

$$F=ma \quad F=(20\text{kg})(0\text{m/s}^2) \quad F=0\text{N}$$