

1. Define the following terms:

a. Equilibrium

forces balanced, net force = 0 - motion won't change

b. Force

push or pull that 1 body exerts on another

c. Acceleration

rate of change of velocity

d. Momentum

$p = mv$  - "strength" of motion

e. Inertia

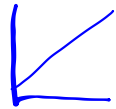
property of matter that resists changes in motion

f. Friction

force that resists motion

g. Direct relationship between variables

as 1 var. increases, other var. increases



h. Inverse relationship between variables

as 1 var. increases, other var. decreases



i. Control variable

var. kept constant in experiment

2. What does the 1<sup>st</sup> Law of Motion state?

objects in motion will stay in motion, objects at rest will stay at rest unless outside force acts.

3. What is the mathematical equation related to the 2<sup>nd</sup> Law of Motion that relates force, mass and acceleration?

$$a = F/m$$

4. What does the 2<sup>nd</sup> Law of Motion state?

accel. is directly proportional to force  
and accel. is inversely proportional to mass

5. What does the 3<sup>rd</sup> Law of Motion state?

For every action, there is an equal and opposite reaction

6. What must be true of the forces acting on objects if their motion is not changing?

balanced, net force = 0

7. A train and a car collide. What is true about the forces that each vehicle exerts on the other?

Same! (accel are diff b/c mass difference)

8. In the collision described in the previous question, why are the forces as you described?

3rd Law - only accel. is diff.  
b/c mass diff.

9. What does the 2<sup>nd</sup> Law of Motion state about the relationship between force and acceleration?

directly proportional

10. What does the 2<sup>nd</sup> Law of Motion state about the relationship between mass and acceleration?

inversely proportional

11. In the "1<sup>st</sup> and 2<sup>nd</sup> Laws of Motion" lab, what did your data show about the relationship between the force put onto the car and the speed that it attained?

greater force = greater speed

12. In the "1<sup>st</sup> and 2<sup>nd</sup> Laws of Motion" lab, what did you data show about the relationship between the mass of the car and the speed that it attained?

*inversely proportional*

13. In the "1<sup>st</sup> and 2<sup>nd</sup> Laws of Motion" lab, why did the car's speed change when the mass increased?

*higher mass = lower speed b/c greater mass  
greater inertia*

14. What is the SI unit of force? *newton (N)*

15. If you increase the force on an object by 3 times, what will be true of its acceleration?

*3x greater*

16. The action force is "the rifle pushes the bullet forward." What is the reaction force?

*the bullet pushes the rifle backward*

17. The action force is "the rocket pushes down on the exhaust gases." What is the reaction force?

*the exhaust gases push up on the rocket*

18. An insect and a car windshield collide. If the windshield exerts a 2 N force on the bug, what is the force exerted by the bug on the car windshield?

*2N!*

19. In the "3<sup>rd</sup> Law of Motion" lab, what was true of the force that moved the cars apart?

*Same every time*

20. In the "3<sup>rd</sup> Law of Motion lab, what was true of the speeds of each car when the masses were NOT equal?

*speeds not equal*

21. If a rock has 10 times more mass than an apple, how will the inertia of each object compare?

rock has 10x more inertia

22. If a train has more inertia than a bicycle, what will be true about changing the motion of each object?

train will be more difficult to change

23. What is the mathematical equation that relates momentum, mass and velocity?

$$p = mv$$

24. If a train and a bicycle are moving at the same velocity, but the train has more mass than the bicycle, which has more momentum? Why?

train, bc  $p = m \overset{\uparrow}{v}$

25. If there are 2 identical bicycles, and one has twice the velocity of the other, which one has more momentum? Why?

one w/ 2x velocity,  $p = m \overset{\uparrow}{v}$

26. If there were no friction forces at all, and you threw a rock with a 10 N force, how much force would be required to keep it moving at constant velocity?

none!

27. Why is it that we almost never see objects in motion that stay in motion on Earth?

friction forces slow/stop objs.

28. If Newton's 3<sup>rd</sup> Law states that there are equal and opposite forces acting when 2 objects interact, why don't these forces cancel out for a net force of zero?

acting on different object

For each problem below, carry out these steps:

- Write the **formula** that you will use to solve the problem
- Re-write the formula, substituting known values **with units**
- Write the answer using the proper **unit**
- Check you answer for the proper number of **significant figures**
- Check you work for accuracy

1. What is the momentum of a 30.6 kg bicycle moving at 14.2 m/s?

$$p = mv = (30.6 \text{ kg})(14.2 \text{ m/s}) = \underline{434.52 \text{ kg}\cdot\text{m/s}} \\ = \underline{435 \text{ kg}\cdot\text{m/s}}$$

2. If a rock has a mass of 18.5 kg and its momentum is 4,200 kg·m/s, what is the velocity of the rock?

$$v = \frac{p}{m} = \frac{4,200 \text{ kg}\cdot\text{m/s}}{18.5 \text{ kg}} = \underline{227.02702 \text{ m/s}} \\ = \underline{230 \text{ m/s}}$$

3. If a 70. kg swimmer pushes off the wall with a force of 180 N, what will be the acceleration of the swimmer?

$$a = \frac{F}{m} = \frac{180 \text{ N}}{70. \text{ kg}} = \underline{2.5714285 \text{ N/kg}} \text{ (m/s}^2\text{)} \\ = \underline{2.6 \text{ m/s}^2}$$

4. A construction worker raises a wooden beam with a force of 200. N and accelerates it upward at a rate of 1.3 m/s<sup>2</sup>. What is the mass of the barbell?

$$m = \frac{F}{a} = \frac{200. \text{ N}}{1.3 \text{ m/s}^2} = \underline{153.84615 \text{ kg}} \\ = \underline{150 \text{ kg}}$$

5. How much force is needed to accelerate a 4.0 kg cat at a rate of 5.7 m/s<sup>2</sup>?

$$F = ma = (4.0 \text{ kg})(5.7 \text{ m/s}^2) \\ = \underline{22.8 \text{ N}} = \underline{23 \text{ N}}$$