1. Define the following terms:
   a. Equilibrium
      $F_{net} = 0$, balanced forces
   b. Force
      push or pull on object
   c. Acceleration
      change in velocity
   d. Momentum
      p = mass x velocity - "strength of motion"
   e. Inertia
      property of matter - resists changes in motion
   f. Friction
      force - resist motion
   g. Direct relationship between variables
      as 1 var. ↑, other var. ↑
   h. Inverse relationship between variables
      as 1 var. ↑, other var. ↓
   i. Strong relationship between variables
      large change in 1 var., large change in other var.
   j. Weak relationship between variables
      large change in 1 var., small change in other var.
   k. Control variable
      var. kept constant
2. What does the 1st Law of Motion state?
   OBJ. in motion stay in motion, object @ rest stays @ rest unless outside force acts
3. What is the mathematical equation related to the 2nd Law of Motion that relates force, mass and acceleration?
   $F = ma$ $\left(a = \frac{F}{m}\right)$
4. What does the 2nd Law of Motion state?
   accel. is dir. prop. to force + inversely prop. to mass

5. What does the 3rd Law of Motion state?

FOR EVERY ACTION, THERE IS AN EQUAL + OPPOSITE REACTION.

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

$F_{net} = 0$, balanced

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

SAME!

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

3rd Law

ACCELS ARE diffent, MASS is diff.

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

$F \sim a$

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

$a \sim \frac{1}{m}$

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

greater FORCE → Higher speed

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

greater mass → lower speed

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

$a \sim \frac{1}{m}$

14. What is the SI unit of force?

N = newton

15. If 3 times the force is applied to the same object, what will be true of its acceleration?

3x accel. ($a \sim F$)

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

the bullet pushes rifle backward

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

the ex. gases push up on 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 "3rd Law of Motion" lab, what was true of the force that moved the cars apart?

SAME whole time

20. In the "3rd 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 - 10x more inertia
(mass ~ inertia)

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

train - harder to change motion

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

$p = mv$ momentum = mass x veloc.

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 – more mass

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

faster bike – veloc. ↑

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?

NO FORCE

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

FRICTION

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?

$$p = m \cdot v = (30.6\,kg)(14.2\,m/s) = 435\ kg \cdot m/s$$

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?

$$v = p/m = \frac{4200\ kg \cdot m/s}{18.5\,kg} = 230\ m/s$$

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

$$a = \frac{F}{m} = \frac{180N}{70.\,kg} = 2.6\ N/kg\,(m/s^2) \qquad N = kg \cdot m/s^2$$

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^2. What is the mass of the barbell?

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

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

$$F = ma = (4.0\,kg)(5.7\,m/s^2) = 23\ N$$