Conceptual Physics Review (Chapters 4, 5, & 6)

Chapter 4

- Review and describe Aristotle's concepts of natural and violent motion.
- Review and describe Galileo's experiments with a ball rolling on an incline.
- Define force.
- State Newton's first law of motion.
- Explain the relationship between mass and inertia.
- Distinguish among mass, volume, and weight, and be able to recognize common units for measuring each.
- Be able to calculate the net force on an object by combining force vectors.
- Explain why force is a vector quantity and not a scalar.
- Describe what is meant by equilibrium. Distinguish between static and dynamic equilibrium.
- Explain how Newton's first law applies to objects in each type of equilibrium.
- Explain why (in terms of Newton's laws) a helicopter cannot hover above the earth waiting for Los Angeles to show up where New York was, as the earth spins underneath the stationary helicopter.

Chapter 5

- State the relationship between acceleration and net force on an object.
- State the relationship between acceleration and the mass of an object.
- State Newton's second law of motion.
- Describe the effect of friction on stationary and moving objects.
- Explain why the acceleration of an object in free fall does not depend on the mass of the object. Use Newton's first and second laws in your explanation.
- Describe the effect of air resistance on a falling object.

Chapter 6

- Discuss forces involved in an interaction between two objects. What is true of the magnitudes and directions of the force pairs involved in any interaction?
- State Newton's third law of motion.
- Given an action force, identify the reaction force.
- Explain why the accelerations caused by action and reaction forces do not have to be equal.
- Explain why an action force is not canceled by the corresponding reaction force.
- Explain why the horse was wrong when he said that the force he exerts on the cart would be canceled by the force the cart exerts on him and so he would not move if he pulled on the cart.

Labs and Worksheets

- Review Lab: Asteroids (Newton's First Law of Motion)
- Review Lab: Newton's Second Law of Motion
- Review Lab: Summary of Newton's Three Laws of Motion
- Review all Worksheets from chapters 4, 5, and 6 thoroughly, as well as all homework problems you have been assigned from the chapter assessments and from Appendix F.

Sample Questions and Calculations

1. If you were in a spaceship and launched a cannonball into frictionless space, how much force would have to be exerted on the ball to keep it moving at a constant velocity? Explain in terms of Newton's laws of motion.

2. Does a 2-kilogram rock have twice the mass of a 1-kilogram rock? Twice the inertia? Twice the weight (when weighed in the same location)?

3. If you hold a coin above your head while in a bus that is not moving (relative to the earth), the coin will land at your feet when you drop it. Where will it land if you drop it while the bus is moving in a straight line at constant speed (relative to the earth)? Explain in terms of Newton's laws of motion.

4. Calculate in Newtons and in lbs the weight of a 2.50 kg melon.

5. Susie Small weighs 300N. Explain what this means in terms of her gravitational interaction with the earth. Calculate Susie's mass in kilograms. Would her weight or her mass change if she were on a different planet?

6. When you compress a sponge, what changes: its mass, its inertia, its weight, or its volume?

7. If I went to a planet that had twice the gravity of earth, how would that affect my mass? How would it affect my weight? How would it affect my acceleration in free fall?

8. What is the net force (sum of all forces) acting on an object in static equilibrium? In dynamic equilibrium?

9. True or false: If no force acts on a moving object, the object will eventually come to a stop. If it's false, explain why.

10. Suppose a pilot announces that the plane is flying at a constant 900km/h and the thrust of the engines is a constant 80,000 N.

a. What is the acceleration of the airplane?

b. What is the net force acting on the airplane?

c. Are there any other forces that you can identify that are acting on the airplane other than the push of its engines?

d. Draw a picture of the plane with vectors representing all forces *acting on the plane*. This is a free body diagram for the plane. Label each force vector with what it represents (for example, "Force of A pushing on B" or "Force of B pulling on A", but specify what exactly A and B are for the particular force).

11. Describe the motion of an object of fixed mass when a constant net force is applied to it. Discuss whether it is moving or not, and what you know about its velocity and its acceleration. Think about the skateboard lab.

12. A 100-kg skydiver is falling toward the earth.

a. What is the skydiver's weight?

b. Three seconds into his fall, the air resistance on the skydiver is 400 N. Draw a picture of the skydiver and clearly label (with words or symbols AND a numerical value) each vector to indicate what force it represents at this instant.

c. Determine the net force acting on the skydiver. Be sure to mention both the magnitude and the direction of the net force.

d. What is the acceleration of the skydiver at this instant?

13. a. When the force of air resistance on a falling object is equal to the object's weight, what is the net force on the object? (Think about the direction in which each force (weight and air resistance) acts.)

b. Draw a picture of the object and use force vectors to represent all forces acting on the falling object.

c. What is the acceleration of the object?

d. Does that mean that the object abruptly comes to a halt in midair at the instant that air resistance equals weight? Explain.

14. A skydiver jumps from a high-altitude balloon. Answer each of the following questions in a complete sentence or two.

a. As she falls through the air, does her velocity increase, decrease, or stay the same?

b. Does air resistance increase, decrease, or stay the same?

c. Does the force exerted on her by gravity increase, decrease, or stay the same?

d. Does the net force on her increase, decrease, or stay the same?

e. Does her acceleration increase, decrease, or stay the same?

15. After she jumps, a skydiver reaches terminal velocity after 10.0 seconds.

a. Does she gain more speed during the first second of fall or the ninth second of fall?

b. Compared with the first second of fall, does she fall a greater or lesser distance during the ninth second of fall?

16. We know that the Earth pulls on the moon. Does the moon also pull on the earth? Which pull is stronger? Explain in terms of Newton's laws of motion. Which one of Newton's laws refers to interactions between two objects? Draw a picture of the earth and the moon, including force vectors representing the interaction between the two objects. Label each force vector with words, as you did in problem # 10.

17. Apply Newton's third law to a tug-of-war. If the action is you pulling on the rope, is the reaction force the ground pushing back on you or your opponent pulling back on the rope or something else?

18. Describe the relative motions of two people of *equal* mass who push off from each other on slippery ice. Then describe the relative motions of two people of *different* mass who push off each other on the ice. Use Newton's laws of motion in your explanations. Discuss the magnitudes of the forces involved as well as the resulting accelerations of the two people.

19. What is the acceleration given to a 30.0-kg block of cement when it is pulled sideways with a net force of 600 N?

20. A 600-kg car and an 1800-kg truck both go from zero to 60.0 miles per hour in 10.0 seconds flat. Calculate the acceleration of each vehicle, including units with your answer. Do they have the same acceleration? Is the same force required to cause this amount of acceleration in each vehicle? Explain using Newton's laws of motion.

Conversions:

Be sure to show your work and box in your final answer. Don't forget units!

1. How many seconds are in one year?

2. How many days are in a century?

3. How many millimeters are in a kilometer?

4. How many Gm are there in 2.56×10^{19} pm?

5. How many Mg are there in 3.7×10^{5} kg?

6. How many nm are there in 8.64×10^{9} μm?

7. How many mg are there in 2.89 cg?

8. How many cm^2 are in 400 m^2?

9. How many m^3 are in 3.0×10^{5} mm^3?

10. Convert 85 m/sec to nm/hr.