

GIANCOLI READING ACTIVITY

Section(s) 5-1 to 5-3

1. Big Idea(s):

- a. 1: Objects and systems have properties such as mass and charge. Systems may have internal structure.
- b. 3: The interactions of an object with other objects can be described by forces.
- c. 4: Interactions between systems can result in changes in those systems.

2. Enduring Understanding(s):

- a. 1.A: The internal structure of a system determines many properties of the system.
- b. 1.C: Objects and systems have properties of inertial mass and gravitational mass that are experimentally verified to be the same and that satisfy conservation principles.
- c. 3.A: All forces share certain common characteristics when considered by observers in inertial reference frames.
- d. 3.B: Classically, the acceleration of an object interacting with other objects can be predicted by using $\vec{a} = \frac{\Sigma \vec{F}}{m}$.
- e. 4.A: The acceleration of the center of mass of a system is related to the net force exerted on the system, where $\vec{a} = \frac{\Sigma \vec{F}}{m}$.

3. Essential Knowledge(s):

- a. 1.A.1: A system is an object or a collection of objects. Objects are treated as having no internal structure.
 - i. A collection of particles in which internal interactions change little or not at all, or in which changes in these interactions are irrelevant to the question addressed, can be treated as an object.
- b. 1.C.1: Inertial mass is the property of an object or a system that determines how its motion changes when it interacts with other objects or systems.
- c. 1.C.2: Gravitational mass is the property of an object or a system that determines the strength of the gravitational interaction with other objects, systems, or gravitational fields.
 - i. The gravitational mass of an object determines the amount of force exerted on the object by a gravitational field.
- d. 3.A.1: An observer in a particular reference frame can describe the motion of an object using such quantities as position, displacement, distance, velocity, speed, and acceleration.
 - i. Displacement, velocity, and acceleration are all vector quantities.

- ii. Displacement is change in position. Velocity is the rate of change of position with time. Acceleration is the rate of change of velocity with time. Changes in each property are expressed by subtracting initial values from final values.
 - iii. A choice of reference frame determines the direction and the magnitude of each of these quantities.
- e. 3.A.2: Forces are described by vectors.
 - i. Forces are detected by their influence on the motion of an object.
 - ii. Forces have magnitude and direction.
- f. 3.A.3: A force exerted on an object is always due to the interaction of that object with another object.
 - i. The acceleration of an object, but not necessarily its velocity, is always in the direction of the net force exerted on the object by other objects.
- g. 3.B.1: If an object of interest interacts with several other objects, the net force is the vector sum of the individual forces.
- h. 4.A.1: The linear motion of a system can be described by the displacement, velocity, and acceleration of its center of mass.
- i. 4.A.2: The acceleration is equal to the rate of change of velocity with time, and velocity is equal to the rate of change of position with time.
 - i. The acceleration of the center of mass of a system is directly proportional to the net force exerted on it by all objects interacting with the system and inversely proportional to the mass of the system.
 - ii. Force and acceleration are both vectors, with acceleration in the same direction as the net force.

4. Learning Objective(s):

- a. (1.C.1.1): The student is able to design an experiment for collecting data to determine the relationship between the net force exerted on an object, its inertial mass, and its acceleration.
- b. (3.A.1.1): The student is able to express the motion of an object using narrative, mathematical, and graphical representations.
- c. (3.A.1.2): The student is able to design an experimental investigation of the motion of an object.
- d. (3.A.1.3): The student is able to analyze experimental data describing the motion of an object and is able to express the results of the analysis using narrative, mathematical, and graphical representations.
- e. (3.A.2.1): The student is able to represent forces in diagrams or mathematically using appropriately labeled vectors with magnitude, direction, and units during the analysis of a situation.
- f. (3.A.3.1): The student is able to analyze a scenario and make claims (develop arguments, justify assertions) about the forces exerted on an object by other objects for different types of forces or components of forces.
- g. (3.A.3.3): The student is able to describe a force as an interaction between two objects and identify both objects for any force.
- h. (3.B.1.1): The student is able to predict the motion of an object subject to forces exerted by several objects using an application of Newton's second law in a variety of physical situations with acceleration in one dimension.

- i. (3.B.1.2): The student is able to design a plan to collect and analyze data for motion (static, constant, or accelerating) from force measurements and carry out an analysis to determine the relationship between the net force and the vector sum of the individual forces.
- j. (3.B.1.3): The student is able to reexpress a free-body diagram representation into a mathematical representation and solve the mathematical representation for the acceleration of the object.
- k. (3.B.1.4): The student is able to predict the motion of an object subject to forces exerted by several objects using an application of Newton's second law in a variety of physical situations.
- l. (4.A.1.1): The student is able to use representations of the center of mass of an isolated two-object system to analyze the motion of the system qualitatively and semi-quantitatively.
- m. (4.A.2.1): The student is able to make predictions about the motion of a system based on the fact that acceleration is equal to the change in velocity per unit time, and velocity is equal to the change in position per unit time.
- n. (4.A.2.2): The student is able to evaluate using given data whether all the forces on a system or whether all the parts of a system have been identified.
- o. (4.A.2.3): The student is able to create mathematical models and analyze graphical relationships for acceleration, velocity, and position of the center of mass of a system and use them to calculate properties of the motion of the center of mass of a system.

5. Read section(s) 5-1 to 5-3 in your textbook.

6. Write a definition for each of the terms listed below.

- a. uniform circular motion - _____

- b. centripetal or radial acceleration - _____

- c. frequency - _____
- d. period (not the punctuation mark) - _____
- e. centrifugal force - _____

7. Answer the following questions and/or complete the following sentences:

- a. If the net force acts at an angle to the direction of motion of an object, the object moves _____
_____.
- b. Give an example of this type of motion that we have already studied: _____
- c. In uniform circular motion, the _____ of the velocity remains constant, but the _____ of the velocity is continuously changing.
- d. Since acceleration is defined as _____, a change in _____ of velocity constitutes an acceleration just as does a change in _____ of velocity.
- e. Thus, an object revolving in a circle is continuously _____ even when the speed remains constant.
- f. Give the equation for centripetal or radial acceleration: _____

- g. An object moving in a circle of radius r with constant speed v has an acceleration whose direction is _____ and whose magnitude is _____
- h. For an object moving in a circle with constant speed, how does acceleration vary with distance from the center? _____
- i. The velocity and acceleration vectors are _____ to each other at every point in the path for uniform circular motion.
- j. In projectile motion, are velocity and acceleration in the same direction? _
- k. What are the 'units' for frequency (consider 'rev' for revolutions a unit)? _____
- l. What are the 'units' for period (consider 'rev' for revolutions a unit)? _____
- m. Give two relationships between period and frequency. _____
- n. Velocity is defined as distance divided by time. How do you compute the distance around a circle?

- o. What is the name and symbol for the time it takes to go around a circle? _____
- p. Using n. and o. above, how do we define velocity in uniform circular motion? _____
- q. According to Newton's second law, an object that is accelerating must have _____

- r. Using Newton's second law, give an expression for the force acting on a body to cause radial acceleration. _____
- s. Since a_R is directed toward the center of the circle at any moment, what must then be true of the net force? _____
- t. What would happen if the net force went away? _____

- u. Write an equation for the centrifugal force. _____
- v. If you are twirling a ball on a string and the string breaks, in what direction will the ball travel in relation to the circle it was originally moving in? _____
- w. If you are doing this in the house and the ball knocks over and breaks your mother's favorite lamp, what will be your punishment? (use 3 significant figures) _____
- x. If you are twirling a ball of mass m in a vertical circle at a constant speed, what is the difference in tension in the string between the top and bottom of the circle? _____
- y. Most cars are now equipped with an anti-lock brake system that prevents the brakes from locking up in an emergency stopping situation. What is the difference in friction for a rolling tire versus a skidding tire due to the brakes being locked up? _____

z. Why do banked curves reduce the chances of skidding? _____

8. Answers may be typed or neatly printed. Drawings may be freehand, but try to make use of the 'Shapes' or 'Insert Clipart' functions of MS Word. If you submit this assignment electronically, the filename must be in the following format, "LastnameFirstinitialPerXReadActX-X".