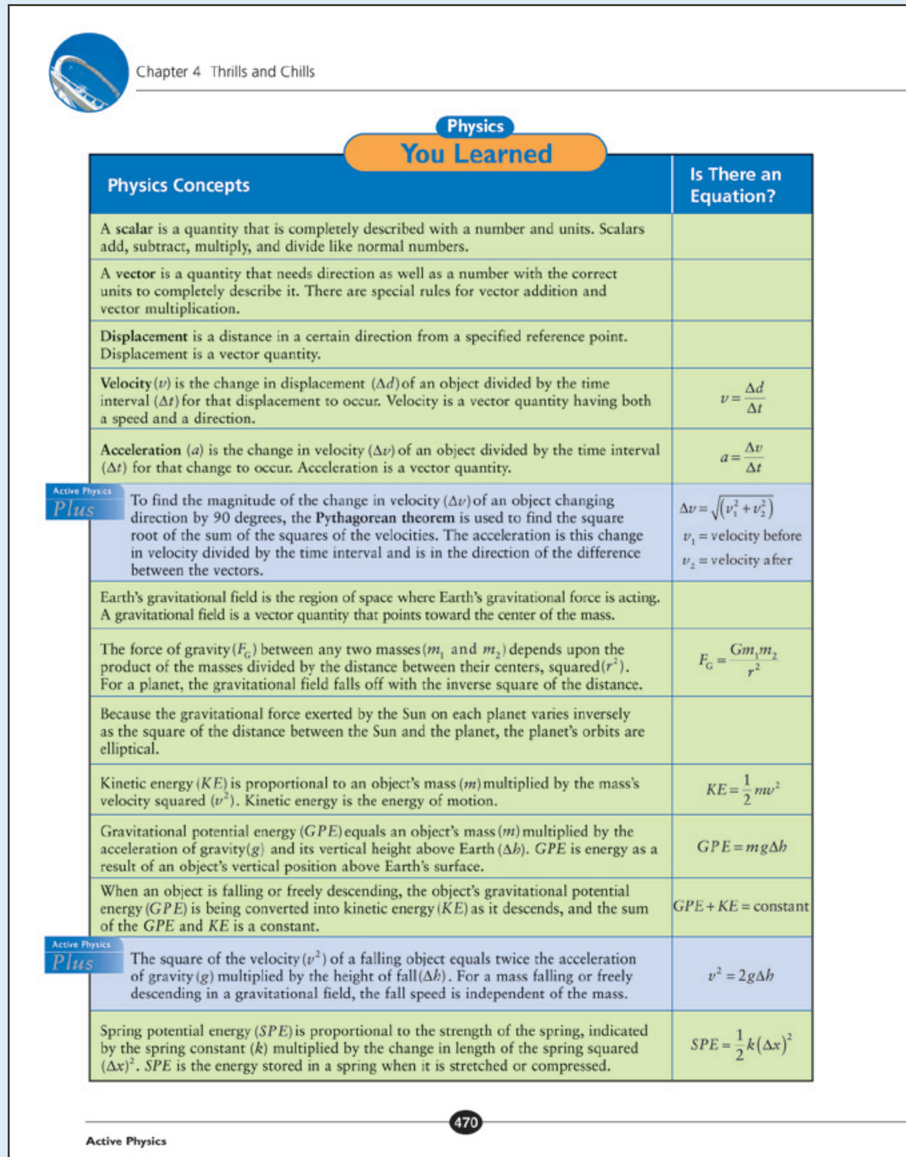
Chapter Assessment

Physics You Learned

The *Physics You Learned* table can be used as a quick reference for prior physics concepts as students acquire additional knowledge of physics while progressing from one section to the next. For a more detailed study of this section, students review the physics concepts they have just learned in *Thrills and Chills*. A brief summary of each concept is presented so that students have time to ponder, analyze, and integrate what they have learned. If a physics concept carries an equation, then that equation is listed in the adjacent column of the table, so that students can immediately access the connection between a concept and its mathematical expression.



Chapter 4 Thrills and Chills

Physics You Learned

Physics Concepts	Is There an Equation?
A **scalar** is a quantity that is completely described with a number and units. Scalars add, subtract, multiply, and divide like normal numbers.	
A **vector** is a quantity that needs direction as well as a number with the correct units to completely describe it. There are special rules for vector addition and vector multiplication.	
Displacement is a distance in a certain direction from a specified reference point. Displacement is a vector quantity.	
Velocity (v) is the change in displacement (Δd) of an object divided by the time interval (Δt) for that displacement to occur. Velocity is a vector quantity having both a speed and a direction.	$v = \frac{\Delta d}{\Delta t}$
Acceleration (a) is the change in velocity (Δv) of an object divided by the time interval (Δt) for that change to occur. Acceleration is a vector quantity.	$a = \frac{\Delta v}{\Delta t}$
Active Physics Plus: To find the magnitude of the change in velocity (Δv) of an object changing direction by 90 degrees, the **Pythagorean theorem** is used to find the square root of the sum of the squares of the velocities. The acceleration is this change in velocity divided by the time interval and is in the direction of the difference between the vectors.	$\Delta v = \sqrt{(v_1^2 + v_2^2)}$ v_1 = velocity before v_2 = velocity after
Earth's gravitational field is the region of space where Earth's gravitational force is acting. A gravitational field is a vector quantity that points toward the center of the mass.	
The force of gravity (F_G) between any two masses $(m_1$ and $m_2)$ depends upon the product of the masses divided by the distance between their centers, squared (r^2). For a planet, the gravitational field falls off with the inverse square of the distance.	$F_G = \frac{Gm_1m_2}{r^2}$
Because the gravitational force exerted by the Sun on each planet varies inversely as the square of the distance between the Sun and the planet, the planet's orbits are elliptical.	
Kinetic energy (KE) is proportional to an object's mass (m) multiplied by the mass's velocity squared (v^2). Kinetic energy is the energy of motion.	$KE = \frac{1}{2}mv^2$
Gravitational potential energy (GPE) equals an object's mass (m) multiplied by the acceleration of gravity (g) and its vertical height above Earth (Δh). GPE is energy as a result of an object's vertical position above Earth's surface.	$GPE = mg\Delta h$
When an object is falling or freely descending, the object's gravitational potential energy (GPE) is being converted into kinetic energy (KE) as it descends, and the sum of the GPE and KE is a constant.	$GPE + KE = \text{constant}$
Active Physics Plus: The square of the velocity (v^2) of a falling object equals twice the acceleration of gravity (g) multiplied by the height of fall (Δh). For a mass falling or freely descending in a gravitational field, the fall speed is independent of the mass.	$v^2 = 2g\Delta h$
Spring potential energy (SPE) is proportional to the strength of the spring, indicated by the spring constant (k) multiplied by the change in length of the spring squared $(\Delta x)^2$. SPE is the energy stored in a spring when it is stretched or compressed.	$SPE = \frac{1}{2}k(\Delta x)^2$

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Active Physics

Once students reach the end of the chapter, consider asking them to prepare a poster of important equations, along with the accompanying concepts and post it on the wall of their classroom. The concepts of motion and energy that are applied in this chapter can be reviewed in a class discussion or in groups of four or five students. Each group member can be assigned a portion of the physics concepts they have just learned and then they can share their knowledge with other members of their group. Sharing information enables students to retain concepts as they are engaged in the process of asking questions or answering them.

Consider asking the students to formulate several questions that could possibly be included in the *Physics Practice Test*, using either the concepts or the equations. By posing questions and responding to answers, students have the opportunity to consolidate their knowledge of newly acquired physics concepts. The most important part of this exercise is that it provides a review for the *Physics Practice Test*.

	For a system that uses spring potential energy (like a pop-up toy), the sum of the *SPE*, *KE*, and *GPE* is a constant. The law of conservation of energy states that for a closed system where no outside energy is added or subtracted, the total energy of the system remains the same, although it may switch forms.	$GPE + KE + SPE = \text{constant}$
	The weight of an object (F_w) equals the object's mass (m) multiplied by the strength of the gravitational field at that point (g). Different planets will have different values for g.	$F_w = mg$
	The spring force (F_s) equals the spring constant (k) multiplied by the change in length of the spring (Δx), and is in the direction opposite the change in length.	$F_s = -k\Delta x$
	The net force on an object is found by adding the vectors of all the forces acting on the object.	
	Newton's first law states an object traveling with constant speed without direction change has no net force acting upon it.	$F_{net} = 0$
	The acceleration of an object (a) equals the net force acting on the object (F_{net}) divided by the object's mass.	$a = \frac{F_{net}}{m}$
Active Physics Plus	Inertial mass and gravitational mass are equal quantities.	
Active Physics Plus	The centripetal acceleration (a_c) equals the square of the velocity (v^2) divided by the radius of the circle (r) and points toward the center of the circle.	$a_c = \frac{v^2}{r}$
	For an object to travel in a circle, a net force toward the center of the circle, called the centripetal force, is required.	
Active Physics Plus	The centripetal force (F_c) acting on an object equals the object's mass multiplied by its centripetal acceleration. The centripetal force on a roller-coaster car may come from a perpendicular force provided by the track (the normal), the car's weight, or a combination of the two forces.	$F_c = \frac{mv^2}{r}$
	The apparent weight of a rider on a roller coaster is the normal force provided by the seat.	
	Work (W) equals the force (F) acting in the direction of motion multiplied by displacement of the object (d).	$W = F \cdot d$
	The work done on an object increases the object's energy. This increase can be in any form: *KE*, *GPE*, or *SPE*.	$W = \Delta KE + \Delta GPE + \Delta SPE$
	Power (P) equals the work done (W) divided by the time required to do the work (Δt). Power is measured in watts (J/s).	$P = \frac{W}{\Delta t}$