

Understanding by Design*

The *Understanding by Design* template focuses on the three stages of backward design:

- Identify desired results
- Determine acceptable evidence
- Plan learning experiences

What overarching understandings are desired?

You can increase your enjoyment of sports by understanding the physics of sports.

- A sportscaster requires knowledge of sports as well as language skills and the ability to clearly articulate thoughts and deliver them in an engaging fashion.
- All sports can be explained with the same laws of physics.
- Knowledge of physics can improve sports performance.
- The motion of people and objects in sports are governed by Newton's laws using mass, position, velocity and acceleration and forces.
- Physics can help explain restrictions to movements in sports.
- Sports can be explained in terms of energy transformations.

What are the overarching "essential" questions?

- What does it mean to say that someone runs faster than someone else?
- How can you increase your speed?
- How can you throw an object further?
- What effect does a shoe have on your sports performance?
- Can you become a world record holder in pole-vaulting by merely purchasing a longer pole?

What "essential" questions will focus this chapter?

- How do objects keep moving after the force on them ceases to act?
- How do velocities add?
- What is inertia (mass)?
- What is acceleration?
- How does acceleration depend on the force on an object and on its mass?
- What is weight?
- What is the acceleration due to gravity?
- What determines the range of a thrown object?
- When an object exerts a force on a second object, what force does the second object exert on the first object?
- What is friction? How is it measured? What does it depend on?
- What does the amount of kinetic, gravitational potential, and elastic energy depend on?
- When is energy conserved and what does it mean that energy is conserved?

What will students understand as a result of this chapter?

- Objects at rest remain at rest and objects in motion remain in motion with a constant velocity along a straight line unless acted upon by an outside force.
- The acceleration of an object is proportional to the net force on it and inversely proportional to its mass. $F = ma$.
- Acceleration is a rate of change of velocity. $a = \Delta v / \Delta t$.
- Velocities and forces add as vectors.
- Weight is the force on an object due to the gravitational attraction between that object and Earth.
- All objects on Earth fall with the same acceleration due to gravity = 9.8 m/s^2 (if air resistance is ignored).
- Newton's third law states that every force has an equal and opposite force. The two forces act on different objects.
- Inanimate objects can exert forces.
- Friction is a force. The coefficient of friction is a property of the two surfaces in contact and is related to the weight of the object. $F_f = \mu F_N$, where F_N is the normal force.
- Kinetic energy, gravitational potential energy, and spring potential energy are three forms of energy.
- Energy can be transformed from one form to another, but the energy of a system not acted on by an outside force is conserved.

* Grant Wiggins and Jay McTighe, *Understanding by Design* (Merril/Prentice Hall, 1998), 181.