Week 4

Detailed learning goals

By completing this topic, you should be able to:

- Define and explain some of the many forms of energy
- Explain the concept of a system
- Explain energy transformations within a system
- Explain work as a transfer of energy and net work as the work done by the net force
- Explain the work-energy theorem
- Explain how an object must be displaced for a force on it to do work
- Explain how relative directions of force and displacement determine whether the work done is positive, negative, or zero
- Calculate the kinetic energy of an object moving at a constant velocity
- Explain gravitational potential energy in terms of work done against gravity
- Calculate the gravitational potential energy of an object of mass at height on Earth
- Use knowledge of the potential energy to simplify calculations and explain physical phenomena
- Explain the potential energy of a spring in terms of its compression when Hooke's law applies
- Calculate the elastic potential energy stored in an ideal spring
- Explain the law of the conservation of energy
- Use the work-energy theorem to solve problems involving mechanical energy
- Calculate power by calculating changes in energy over time
- Calculate power consumption and the cost of energy consumed.

Prescribed readings for SLE123 content

Please read the following sections from Giambattista Physics (5th ed.). New York: McGraw-Hill:

- Section 4.4 Interaction Pairs.
  - just the sub-section on Defining a System.
- Section 6.1 The Law of Conservation of Energy.
- Section 6.2 Work Done by a Constant Force.
- Section 6.3 Kinetic Energy.
- Section 6.4 Gravitational Potential Energy and Mechanical Energy.
- Section 6.7 Elastic Potential Energy.
- Section 6.8 Power.

Tutorial problems:

1. A force of 20 N acts on an object over 5m. How much work is done on the object by the force?

2. What is the kinetic energy of a 1500 kg car travelling at a speed of 30 m/s?

3. Which has the larger kinetic energy, a 10 g bullet fired at 500 m/s or a 10 kg bowling ball sliding at 10 m/s?

4. An object of mass 10 kg is suspended at 5 m. What is its gravitational potential energy?

5. If the object in q4 loses 40% of its energy in heat when it falls, how fast will it be travelling when it hits the ground?

6. A spring with a constant 20 N/m is stretched 4 mm. What is the force required? What is the stored energy?

7. A group of muscles fibres (acting like a spring) need 100 N to stretch 0.1 mm. What is the equivalent spring constant of the muscle fibres?

8. Estimate the work done and the energy required for the following tasks (refer to table below):

ACTIVITY	Metabolic power (W)
Standing	125
Walking at 6 km/h	450
Running	800

   a. Standing relaxed for 5 minutes
   b. Walking for 1 hour at 6 km/h
   c. Running for 1 hour

9. Estimate how many kms could a jogger run at 10 km/h to use up the energy obtained from eating an energy bar containing 1000 kJ of energy (assume running at 10 km/hr uses 1200 W).

10. A 1000 kg sports car accelerates from 0 to 30 m/s in 10 s. What is the average power of the engine?