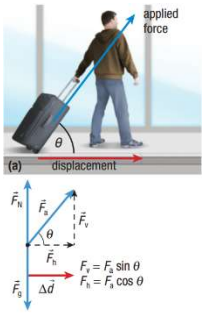
SPH3U 5.1 Work

1. Work done by a constant force

Mechanical work:	
equation	
theta	
special case	

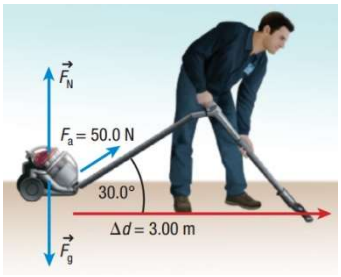


How much mechanical work does a person do on a shopping cart if they apply a force of 25 N in the forward direction, and displace the cart 3.5 m in the same direction?

A curler applies a force of 15.0 N on a curling stone and accelerates the stone from rest to a speed of 8.00 m/s in 3.50 s. Assuming that the ice surface is level and frictionless, how much mechanical work does the curler do on the stone?

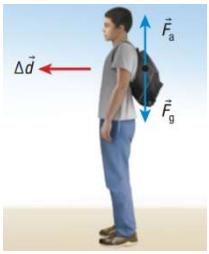
2. Work done when force and displacement are in different directions

Calculate the mechanical work done by a custodian on a vacuum cleaner if the custodian exerts an applied force of 50.0 N on the vacuum hose and the hose makes a 30.0° angle with the floor. The vacuum cleaner moves 3.00 m to the right on a level, flat surface.



3. Special cases

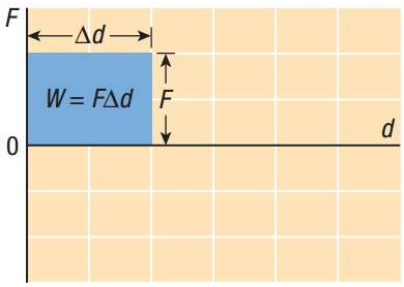
Ranbir wears his backpack as he walks forward in a straight hallway. He walks at a constant velocity of 0.8 m/s for a distance of 12 m. How much mechanical work does Ranbir do on his backpack?

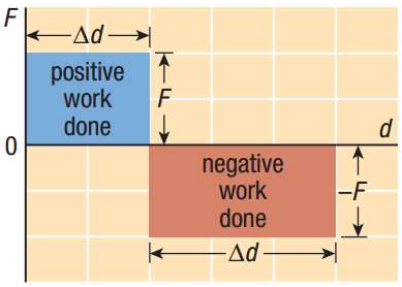


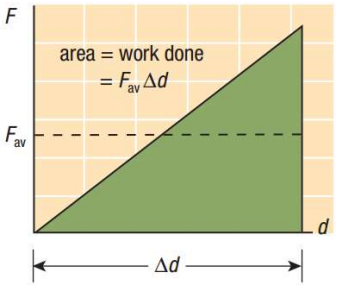
How much mechanical work is done on a stationary car if a student pushing with a 300 N force fails to displace the car?

A shopper pushes a shopping cart on a horizontal surface with a horizontal applied force of 41.0 N for 11.0 m. The cart experiences a force of friction of 35.0 N. Calculate the total mechanical work done on the shopping cart.

4. Graphing work done







Homework: page 229: #1-3, 5-6, 9

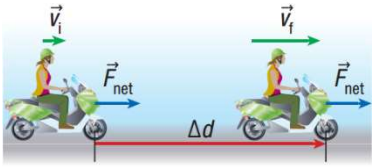
SPH3U 5.2 Energy

5. Kinetic energy

Energy:	
kinetic energy	
equation	

Where does this value come from? Consider the amount of work it takes to change speeds.

Imagine a motorcycle moving at a constant speed, which then accelerates to a new speed. To accelerate, it must have a force acting on it. What is the work done by this force? Assume that all you know is the mass of the motorcycle, its initial speed, and its final speed.



How much work is done to accelerate from rest to some final speed ($v_i = 0$)?

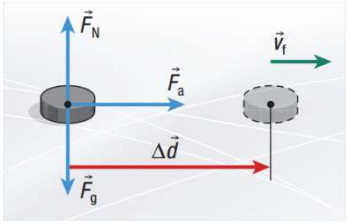
Calculate the kinetic energy of a 150 g baseball that is traveling toward home plate at a constant speed of 35 m/s.

6. The relationship between mechanical work and kinetic energy

What is the work done to change from one speed to another?

This is called the **work-energy principle**.

A 165 g hockey puck initially at rest is pushed by a hockey stick on a slippery horizontal ice surface by a constant horizontal force of magnitude 5.0 N (assume that the ice is frictionless). What is the puck's speed after it has moved 0.50 m?



7. Gravitational potential energy: A stored type of energy

Potential energy:	
gravitational potential energy	
equation	
reference level	

Where does this value come from? Consider the amount of work it takes to lift something.

Imagine lifting a textbook off your desk at a constant speed (not accelerating). Remember, this means that forces are balanced ($F_{net} = 0$). How much work is done by the applied force?

What is the gravitational potential energy of a 48 kg student at the top of a 110 m high drop tower ride relative to the ground?

8. Mechanical energy

Mechanical energy:	

Homework: page 235: #1-3, 5

SPH3U 5.3 Types of Energy and the Law of Conservation of Energy

9. Types of energy

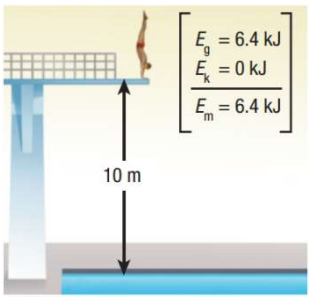
Form of Energy	Type of Energy	Description
Potential and Kinetic		Gravity + kinetic
		Electromagnetic fields
		Flowing charges
		Randomly moving molecules
		Oscillating molecules
Potential		Gravity
		Static charges
		Protons and neutrons
		Stretched materials
		Molecular bonds

Energy transformation:	
example	

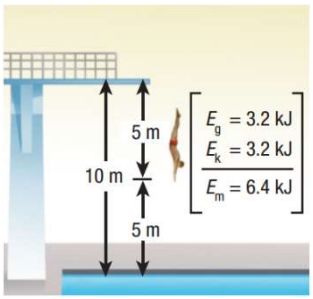
10. The law of conservation of energy

Law of conservation of energy:	

A 65.0 kg diver dives from a 10.0 m high platform into the water below. What is his mechanical energy when he is on the platform (before diving)?



What is his mechanical energy when he is halfway to the water?



What is his mechanical energy when he reaches the surface of the water?

11. Applying the law of conservation of energy

A 1.1 kg camera slips out of a photographer's hands while he is taking a photograph. The camera falls 1.4 m to the ground below.

a. What is the camera's gravitational potential energy relative to the ground when it is in the photographer's hands?

b. Using the law of conservation of energy, determine the camera's kinetic energy at the instant it hits the ground.

c. Use the camera's kinetic energy to determine its speed when it hits the ground.

Homework: page 241: #1-4

SPH3U 5.4 Efficiency, Energy Sources, and Energy Conservation

1. Efficiency

Efficiency:	
equation	

A firefly's body transforms chemical energy in food into radiant energy to glow. What is a firefly's efficiency if its body transforms 4.13 J of chemical energy into 3.63 J of radiant energy?

What is the efficiency of a rope-and-pulley system if a painter uses 1.93 kJ of mechanical energy to pull on the rope and lift a 20.0 kg paint barrel at constant speed to a height of 7.5 m above the ground?

2. Improving the efficiency of energy transformations

Device or Process	Transformation	Waste Energy	Efficiency
gas-powered vehicle			
electric vehicle			
bicycle			
speakers			
electric heater			

Device or Process	Transformation	Waste Energy	Efficiency
hydroelectric power plant			
nuclear power plant			
solar cell			
photosynthesis			
animal muscles (including human)			

3. Sources of energy

Type	Resources	Pros	Cons
Renewable			
Non-Renewable			

Homework: page 249: #1-4

SPH3U 5.5 Power

12. Power

Power:	
equation	

How much power does a swimmer produce if she transforms 2.4 kJ of chemical energy (in food) into kinetic energy and thermal energy in 12.5 s?

A 64 kg student climbs from the ground floor to the second floor of his school in 5.5 s. The second floor is 3.7 m above the ground floor. What is the student's power?

The student runs back down the stairs in 2.25 s. What is the student's power?

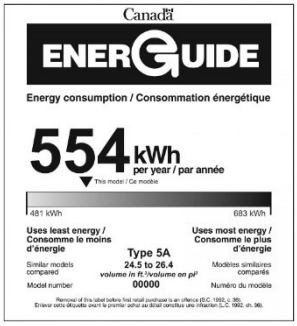
13. Electrical power

Power rating:	
energy transformed	

What is the power of an electric elevator motor if it uses 2.9×10^5 J of electrical energy to lift an elevator car 12 m in 16 s?

Appliance	Power Rating (W)	Appliance	Power Rating (W)	Appliance	Power Rating (W)
laptop		microwave		fridge	
vacuum		dishwasher		stove	

Electricity metres:	
EnerGuide:	



What is the cost of operating a 25 W light bulb 4.0 h a day for 6.0 days if the price of electrical energy is 5¢/kWh?

Twenty incandescent light bulbs are turned on for 12 h a day for an entire year to light up a store. Each bulb has a power rating of 100.0 W. The average cost of electricity is 6.0¢/kWh.

Calculate the cost of lighting the store for a year.

How much money could be saved by using CFLs, if they have a power rating of 23 W?

Homework: page 254: #1-2, 4-5

SPH3U 5.5 Power

14. Power

Power:	
equation	

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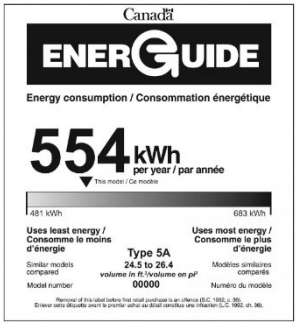
vacuum		dishwasher		stove	

Electricity metres:	
EnerGuide:	



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Homework: page 254: #1-2, 4-5