Student #: _____ Student Name: _____

Physics 11 Homework Unit 5: Energy Transformation

(Plus questions from Unit 4)

1. How can a $\$10$ compact fluorescent light bulb $(15\,\text{W})$ be an overall money saver compared to an incandescent light bulb $(60\,\text{W})$ that costs only $\$0.50$?

2. You have just finished taking notes for one hour in class and you think you have accomplished a lot of work. Explain why you have accomplished very little work in a physical sense.

3. How can you determine the efficiency with which the mechanical energy of a pendulum is conserved?

4. If equal amounts of heat are added to equal masses of silver and copper, both at the same initial temperature, which will reach the higher final temperature? Explain your answer. The specific heat capacity of silver is $0.235\,\text{J/g}\cdot{}^\circ\text{C}$ and that of copper is $0.385\,\text{J/g}\cdot{}^\circ\text{C}$.

5. A $20\,\mathrm{kg}$ block is being pushed forward on a flat surface with a force of magnitude $45\,\mathrm{N}$ against a frictional force of $13\,\mathrm{N}$.
   (a) What is the net force acting on the block?
   (b) What is the change in kinetic energy after the force has pushed the block for $4.0\,\mathrm{m}$?
   (c) If the block started from rest, how much work would it take to stop the block?

6. Your friend comes across a "good deal" to purchase a silver ring. She asks you for advice and for you to test the ring. The ring has a mass of $4.540\,\mathrm{g}$. When you heat the ring with $13.97\,\mathrm{J}$ of energy, its temperature rises from $23.05\,^{\circ}\mathrm{C}$ to $47.55\,^{\circ}\mathrm{C}$. Would you advise your friend that she is getting a good deal? Explain. The specific heat capacity of silver is $0.235\,\mathrm{J/g}\cdot{}^{\circ}\mathrm{C}$.

7. A swimming pool hold $1.1\times10^{8}\,\mathrm{kg}$ of water. First thing in the morning, the temperature of the pool was $20\,^{\circ}\mathrm{C}$. When the temperature was checked in the afternoon, it has risen to $23\,^{\circ}\mathrm{C}$. How much energy was required to raise the temperature of the water?

8. A $450\,\text{ml}$ cup of coffee is too hot to drink at $91\,^\circ\text{C}$, so $100\,\text{ml}$ of cold water at $6.5\,^\circ\text{C}$ is added to cool it off.
   (a) What is the final temperature of the drink?
   (b) What assumptions did you have to make when solving this problem?

9. A large nuclear power plant is powered by enriched uranium ($3\,\%$ U-235). If the thermal power in the reactor core is $4200\,\text{MW}$ and $1300\,\text{MW}$ of electricity is generated,
   (a) What is the efficiency of the nuclear reactor?
   (b) If each fission event generates $2.0 \times 10^8\,\text{eV}$, and $1\,\text{eV} = 1.6 \times 10^{-19}\,\text{J}$, find the rate that the atoms are splitting.

10. Washing the evening dishes required $55.5\,\text{kg}$ of water. Tap water is at a temperature of $4.0\,^\circ\text{C}$ and the dishwater's preferred water temperature is $45.0\,^\circ\text{C}$. Find the amount of energy that is required to heat the water. Calculate the electrical cost if Toronto Hydro charges $\$0.132$ per kilowatt-hour during evening "mid-peak" hours. $1.0\,\text{kW}\cdot\text{h} = 3.6 \times 10^6\,\text{J}$)

11. A small well-insulated shed is heated by a single $100\,\text{W}$ light bulb.
    (a) If the shed has $10.4\,\text{kg}$ of air, how long, in minutes, would it take the light bulb to raise the air temperature from $-8.0\,^\circ\text{C}$ to $2.0\,^\circ\text{C}$ Assume that *all* of the bulb's energy is converted to thermal energy.
    (b) Is your answer to (a) reasonable? What assumption could you improve?

12. A $500\,\text{g}$ piece of silver at $150\,^\circ\text{C}$ is submerged in $1000\,\text{g}$ of water at $5\,^\circ\text{C}$ to be cooled. Determine the final temperature of the silver and water. (The specific heat capacity of silver is $0.235\,\text{J/g}\cdot{}^\circ\text{C}$ and the specific heat capacity of water is $4.186\,\text{J/g}\cdot{}^\circ\text{C}$.)

____ 13. A boy pushes on a car to slow it down while the car is rolling horizontally down the road. If the boy pushes backwards on the car with $10\,\text{N}$ of force as the car rolls forward $3.0\,\text{m}$, the amount of work done by the boy is:
    (a) $-30\,\text{J}$
    (b) $0\,\text{J}$
    (c) $3.3\,\text{J}$
    (d) $30\,\text{N}\cdot\text{m}$
    (e) $300\,\text{J}$

____ 14. A $300\,\text{N}$ force is applied horizontally to a $50\,\text{kg}$ crate, originally at rest, pushing it $2\,\text{m}$. The friction force between the crate and the floor is $200\,\text{N}$. The final kinetic energy of the crate is:
    (a) $0\,\text{J}$
    (b) $200\,\text{J}$
    (c) $400\,\text{J}$
    (d) $600\,\text{J}$
    (e) $300\,000\,\text{J}$

____ 15. A small rocket engine generates a thrust of $21.0\,\text{N}$ *vertically* to a $0.500\,\text{kg}$ toy rocket. Assuming that air resistance ("drag") is negligible for the first $50.0\,\text{cm}$ of flight, find the kinetic energy gained by the rocket in the first $50.0\,\text{cm}$ of takeoff.

(a) $4.0\,\text{J}$
(b) $8.05\,\text{J}$
(c) $10.5\,\text{J}$
(d) $21\,\text{J}$
(e) $32\,\text{J}$

____ 16. If a $1000\,\text{kg}$ car accelerates from $10\,\text{m/s}$ to $20\,\text{m/s}$, the amount of work done is:

(a) $112\,500\,\text{J}$
(b) $10\,000\,\text{J}$
(c) $150\,000\,\text{J}$
(d) $5000\,\text{J}$
(e) $0\,\text{J}$

____ 17. If mechanical energy is conserved, then

(a) the sum of the kinetic energy and gravitational potential energy remains constant.
(b) the amount of kinetic energy is constant.
(c) thermal energy losses due to friction are constant.
(d) the amount of gravitational potential energy is constant.
(e) none of the above.

____ 18. The amount of energy required to raise a $12\,\text{kg}$ toddler onto a high chair $1.25\,\text{m}$ off the ground is approximately:

(a) $30\,\text{J}$
(b) $7.8\,\text{N}$
(c) $15\,\text{J}$
(d) $150\,\text{J}$
(e) $0\,\text{J}$ (no work is done)

____ 19. The temperature $273.15\,\text{K}$ is equivalent to:

(a) absolute zero
(b) $0\,^\circ\text{C}$
(c) $20\,^\circ\text{C}$
(d) $273\,^\circ\text{C}$
(e) $273\,^\circ\text{F}$

____ 20. A professional cyclist during a bike race has $6.4\,\text{kJ}$ of kinetic energy. If the combined mass of the bicycle and cyclist is $82\,\text{kg}$, he is travelling at a speed of:

(a) $100\,\text{km/h}$
(b) $45\,\text{km/h}$
(c) $12.5\,\text{km/h}$
(d) $156\,\text{m/s}$
(e) $0\,\text{m/s}$

____ 21. The rated power output of an engine is $10\,\text{hp}$ (horse power) which is approximated to be $7460\,\text{W}$. How much energy would it produce in $10\,\text{min}$?

(a) $0\,\text{J}$
(b) $100\,\text{J}$
(c) $74\,600\,\text{J}$
(d) $4.5\,\text{MJ}$
(e) $746\,\text{MJ}$

____ 22. An electrical hair dryer consumes $90\,\text{kJ}$ in one minute. What is the power used by this hair dryer?

(a) $90\,\text{W}$
(b) $100\,\text{W}$
(c) $1500\,\text{W}$
(d) $5.4\,\text{kW}$
(e) $1\,\text{hp}$

____ 23. A solar panel is exposed to $55\,\text{W}$ of sunlight and produces $590\,\text{J}$ of electrical energy in 1min. What is the efficiency of this panel?

(a) $100\,\%$
(b) $93\,\%$
(c) $18\,\%$
(d) $10\,\%$
(e) $9.3\,\%$

____ 24. Which of the following samples has the highest specific heat capacity?

(a) $100\,\text{kg}$ of "material A" requires $13\,000\,\text{J}$ to increase its temperature by $1\,\text{K}$
(b) A $50\,\text{g}$ sample of "material B" releases $1050\,\text{J}$ as it cools by $5\,^\circ\text{C}$
(c) A $2\,\text{kg}$ sample of "material C" receives $2340\,\text{J}$ of thermal energy as it warms from $20\,^\circ\text{C}$ to $23\,^\circ\text{C}$
(d) All the samples above have the same specific heat
(e) It is impossible to compare the specific heat of the materials from the information given

____ 25. Which of the following energy transformations best describes the operation of a solar powered battery charger? (Radiant energy is the energy of electromagnetic wave.)

(a) electrical energy $\longrightarrow$ thermal energy $\longrightarrow$ kinetic energy
(b) nuclear energy $\longrightarrow$ potential energy $\longrightarrow$ chemical energy
(c) thermal energy $\longrightarrow$ elastic potential energy $\longrightarrow$ electrical energy
(d) radiant energy $\longrightarrow$ electrical energy $\longrightarrow$ chemical potential energy
(e) radiant energy $\longrightarrow$ thermal energy $\longrightarrow$ electrical energy