**PHYSICS 2021 - 22 December 6, 2021**

**Today’s Agenda (Day 68)**

1. HOUSEKEEPING ITEMS

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1. HOMEWORK CHECK:

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1. CLASS ACTIVITY

🡪 BEGIN: Chapter 12 PPT Review

1. Section 12.1 -Temperature, Heat and Thermal Energy
2. Section 12.2 – Changes of state and Thermodynamics

HOMEWORK:

* READ: Chapter 11 – Energy and Its Conservation
* READ: Chapter 12 – Thermal Energy
* STUDY: Chapter 11 Vocabulary AND Test

<http://glencoe.mheducation.com/sites/0078807220/student_view0/self-check_quizzes.html>

Chapter 11: Energy and Its Conservation

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| --- | --- | --- | --- | --- |
| Rotational kinetic energy | Gravitational potential energy | Elastic potential energy | Law of conservation of energy | Inelastic collision |
| Potential energy | Reference level | Thermal energy | Mechanical energy | Elastic collision |

Chapter 12: Thermal Energy

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| --- | --- | --- | --- | --- | --- |
| Conduction | Thermal equilibrium | Heat | Convection | Radiation | Specific heat |
| Heat of fusion | Heat of vaporization | First law of thermodynamics | Heat engine | Entropy | Second law of thermodynamics |

REMINDERS:

* **TEST: Ch 11 & Vocab🡪 Dec. 7**
* **TEST: Ch 12 & Vocab 🡪 Dec. 9**
* Mini-Lab: Stair Climbing and Power – Dec. 10
* **Midterm Exam:** Chapters 1 - 12

**PHYSICS 2021 - 22** CHAPTER REVIEW

**PRACTICE PROBLEMS 11.1**

1. A 52.0 kg skater moves at 2.5 m/s and glides to a stop over a distance of 24.0 m. Find the skater’s initial kinetic energy. How much of her kinetic energy is transformed into other forms of energy by friction as she stops? How much work must she do to speed up to 2.5 m/s again?
2. An 875.0 kg sub-compact car speeds up from 22.0 m/s to 44.0 m/s. What are the initial and final kinetic energies of the car? How much work is done on the car to increase its speed?
3. A comet with a mass of 7.85 x 1011 kg strikes Earth at a speed of 25.0 km/s. Find the kinetic energy of the comet in joules, and compare the work that is done by Earth in stopping the comet to the 4.2 x 1015 J of energy that was released by the largest nuclear weapon ever exploded.
4. A 2 kg wheel rolls down the road with a linear speed of 15 m/s. Find its translational and rotational kinetic energies. (Hint: I = mr2)
5. If you slowly lower a 20.0 kg bag of sand 1.20 m from the trunk of the car to the driveway, how much work do you do?
6. A worker picks up a 10.1 kg box from the floor and sets it on a 1.1 m high table. He slides the box 5.0 m along the table and then lowers it back to the floor. What were the changes in the box-earth system’s energy, and how did the system’s total energy change? (Ignore friction.)
7. You get a spring-loaded jumping toy ready, compressing the spring. The toy then flies straight up. Draw bar graphs that describe the forms of energy present in the following instances. Assume the system includes the spring toy and earth.
8. The toy is pushed down thereby compressing the spring.
9. The spring expands and the toy jumps
10. The toy reaches the top of its flight.
11. A 90.0 kg rock climber climbs 45.0 m upward, then descends 85.0 m. The initial height is the reference level. Find the potential energy of the climber-earth system at the top and at the bottom. Draw bar graphs for both situations.

**PRACTICE PROBLEMS 11.2**

1. A bike rider approaches a hill at a speed of 8.5 m/s. The combined mass of the bike and the rider is 85.0 kg. Choose a suitable system. Find the initial kinetic energy of the system. The rider coasts up the hill. Assuming friction is negligible, at what height will the hike come to rest?
2. A skier starts from rest at the top of 45.0 m high hill, skis down a 30⁰ incline into a valley, and continues up a 40.0 m high hill. The heights of the both hills are measured from the valley floor. Assume that friction is negligible and ignore the effect of the ski poles.
3. How fast is the skier moving at the bottom of the valley?
4. What is the skier’s speed at the top of the second hill?
5. Do the angles of the hill affect your answers?
6. In a belly-flop diving contest, the winner is the diver who makes the biggest splash upon hitting the water. The size of the splash depends not only on the diver’s style, but also on the amount of kinetic energy the diver has. Consider a contest in which each diver jumps from a 3.00m platform.

One diver has a mass of 136 kg and simply steps off the platform. Another diver has a mass of 100 kg and leaps upward from the platform. How high would the second diver have to leap to make a competitive splash?

1. The spring in a pinball machine exerts an average force of 2N on a 0.08 kg pinball over 5 cm. As a result, the ball has both translational and rotational kinetic energy. If the ball is a uniform sphere (I = 5/2 mv2), what is its linear speed after leaving the spring? (Ignore the table’s tilt.)
2. An 8.00 g bullet is fired horizontally into a 9.00 kg block of wood on an air table and is embedded in it. After the collision, the block and bullet slide along the frictionless surface together with a speed of 10.0 cm/s. What is the initial speed of the bullet?
3. A 91.0 kg hockey player is skating on ice at 5.50 m/s. Another hockey player of equal mass, moving at 8.1 m/s in the same direction, hits him from behind. They slide together.
4. What are the total mechanical energy and momentum of the system before the collision?
5. What is the velocity of the two hockey players after the collision?
6. How much was the system’s kinetic energy decreased in the collision?
7. A child jumps on a trampoline. Draw bar diagrams to show the forms of energy present in the following situations.
8. The child is at the highest point.
9. The child is at the lowest point.
10. As shown in Figure 14, a child slides down a playground slide. At the bottom of the slide, she is moving at 3.0 m/s. How much energy was transformed by friction as she slid down the slide?



**PHYSICS 2021 - 22** MINI-LAB

**Stair Climbing and Power**

**MATERIALS**

**• Avoid wearing loose clothing.**

• meterstick (or metric tape measure)

• stopwatch

•bathroom scale

**Background:** Can you estimate the power you develop as you climb a flight of stairs? Climbing stairs requires energy. As your body moves up through a distance, work is done. Power is a measure of the rate at which work is done. In this activity you will try to maximize the power you develop as you move up a flight of stairs.

**Question**

*What can you do to increase the power you develop as you climb a flight of stairs?*

**Objectives**

◼ Predict the factors that affect power.

◼ Calculate the power developed.

◼ Define power operationally.

◼ Interpret force, distance, work, time and power data.

◼ Make and use graphs of work versus time, power versus force, and power versus time.

**Procedure**

1. C10-10P-845813-ARead the procedure and the safety information and complete the lab form.
2. Measure and record the mass of each person in your group using a bathroom scale. If the scale does not have kilogram units, convert the weight in pounds to kilograms. Recall that   
   2.2 lbs = 1 kg.
3. Measure the vertical displacement from the floor to the top of the flight of stairs you will climb. Record it in the data table.
4. Have each person in your group climb the flight of stairs in a manner that he or she thinks will safely maximize the power developed.
5. Use your stopwatch to measure the time it takes each person to perform this task. Record your data in the data table.

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| --- | --- | --- | --- | --- | --- |
| Data Table | | | | | |
| Mass  (kg) | Weight  (N) | Distance  (m) | Work Done  (J) | Time  (s) | Power  Generated  (W) |
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|  |  |  |  |  |  |
|  |  |  |  |  |  |
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Analyze Your Data

1. Calculate each person’s weight in newtons and record it in the data table.
2. Calculate the work done by each person and record it in the data table.
3. Calculate the power developed by each person in your group as he or she climbs the flight of stairs and record it in the data table.
4. Use the data you calculated to draw a graph of work versus time and draw the best-fit line.
5. Draw a graph of power versus work and draw the best-fit line.
6. Draw a graph of power versus time and draw the best-fit line.

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Graph 1 Graph 2 Graph 3

Conclude and Apply

1. Did each person in your group have the same power rating? Why or why not?

1. Which graph(s) showed a definite relationship between the two variables?

1. Explain why this relationship exists.
2. Write a definition of power.

Going Further

1. What three things can be done to increase the power you develop while climbing the flight of stairs?

1. Why were the fastest climbers not necessarily the ones who developed the most power?

1. Why were the members of your group with more mass not necessarily the ones who developed the most power?

1. Compare and contrast your data with those of other groups in your class.
2. Which of your group members demonstrated a greater thermal energy? The least? How do you know? Explain.

**Real-World Physics**

1. Research a household appliance that has a power rating equal to or less than the power you developed by climbing the stairs.
2. Suppose an electric power company in your area charges $0.06/kWh. If you charged the same amount for the power, you develop climbing stairs, how much money would you earn by climbing stairs for 1 h?
3. If you were designing a stair climbing machine for the local health club, what information would you need to collect? You decide that you will design a stair climbing machine with the ability to calculate the power developed. What information would you have the machine collect to let the climber know how much power he or she developed?

**PHYSICS 2021 - 22** CHAPTER REVIEW

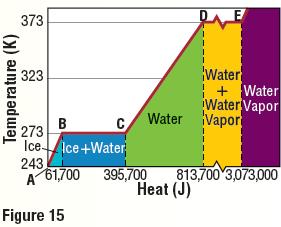
**CH 12 PRACTICE PROBLEMS**

SECTION 12.1

1. When you turn on the hot water to wash dishes, the water pipes heat up. How much heat is absorbed by a copper water pipe with a mass of 2.3 kg when its temperature is raised from 20.0⁰C to 80.0⁰C?
2. Electric power companies sell electrical energy by the kWh, where 1 kWh = 3.6 x 106 J. Suppose that it costs $0.15 per kWh to run an electric water heater in your neighborhood. How much does it cost to heat 75 kg of water from 15⁰C to 43⁰C to fill a bathtub?
3. A car engine’s cooling system contains 20.0 L of water (1 L of water has a mass of 1 kg).
4. What is the change in the temperature of the water if 836.0 kJ of thermal energy is added?
5. Suppose that it is winter and the car’s cooling system is filled with methanol. The density of methanol is 0.80 g/cm3. What would be the increase in temperature of the methanol if it absorbed 836.0 kJ of thermal energy?
6. Which coolant, water or methanol, would better remove thermal energy from the car engine? Explain.
7. Three metal fishing weights, each with a mass of 1.00 x 102 g and at a temperature of 100.0⁰C, are placed in 1.00 x 102 g of water at 35.0⁰C. The final temperature of the mixture is 45.0⁰C. What is the specific heat of the metal in the weights?
8. A 2.00 x 102 g sample of water at 80.0⁰C is mixed with 2.00 x 102 g of water at 10.0⁰C in a calorimeter. What is the final temperature of the mixture?
9. Could the thermal energy of a bowl of hot water equal that of a bowl of cold water? Explain your answer.
10. If you take a plastic spoon out of a cup of hot cocoa and put it in your mouth, you are not likely to burn your tongue. However, you could very easily burn your tongue if you put the hot cocoa in your mouth. Why?
11. As water heats in a pot on a stove, it might produce some mist above its surface right before the water begins to roll. What is happening?

SECTION 12.2

1. How much thermal energy is absorbed by 1.00 x 102 g of ice at -20.0⁰C to become water at 0.0⁰C?
2. Use the graph in Figure 15 to calculate the heat of fusion and heat of vaporization of water.



1. A steel plant operator wishes to change 100 kg of 25⁰C iron into molten iron (melting point = 1538⁰C). How much thermal energy must be added?
2. A gas balloon absorbs 75 J of thermal energy. The balloon expands but stays at the same temperature. How much work did the balloon do in expanding?
3. A drill bores a small hole in a 0.40 kg block of aluminum and heats the aluminum by 5.0⁰C. How much work did the drill do in boring the hole?
4. How many times would you have to drop a 0.50 kg bag of lead shot from a height of 1.5 m to heat the shot by 1.0⁰C?
5. When you stir a cup of tea, you do about 0.050 J of work each time you circle the spoon in the cup. How many times would you have to stir the spoon to heat a 0.15 kg cup of tea by 2.0⁰C?
6. Describe the energy transformations and transfers made by a heat engine, and explain why operating a heat engine causes an increase in entropy.