Lesson 1 – Energy Consumption and Non-Renewable Resources

General

1. What are the first and second law of thermodynamics? Give an example of each.

	What is it?	Example
First Law of Thermodynamics		
Second Law of Thermodynamics		

2. How is electricity generated? Use specific vocabulary including turbine and generator.

3. What are the main sources of energy and what percent do each provide commercially?

4. What types of energy resource provides 85% of all commercial energy in the world?

5. What is the general relationship between per capita GNP and per capita energy use?

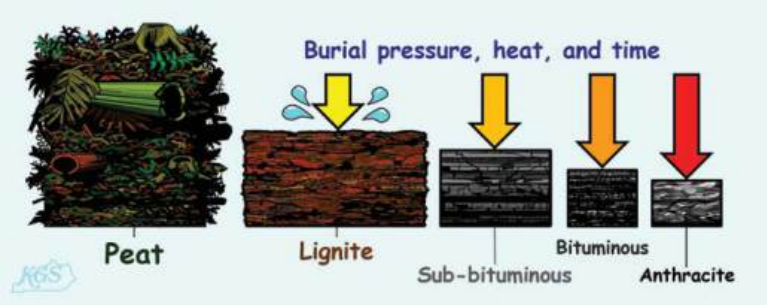
6. Describe why current energy technologies are so inefficient. Start with the coal powerplant as an example.

Non-renewable Energies

7. How is coal formed?

8. Where are most of the coal powerplants in the US?

9. What are the major types of coal and rank each in terms of purity relative to each other.



10. What are the advantages to using coal as a fuel?

11. Describe the disadvantages to coal including…be specific for each
    a. Mining practices
    c. Wet deposition of mercury
    b. Acid rain formation (know specific pollutants)
    d. Emissions

12. What technologies does “clean coal” implement? Is there such a thing as clean coal?

13. What is crude oil (petroleum) and how is it formed?

14. What components can crude be refined into? How is this done?

15. What are the advantages and disadvantages of oil?

Advantages	Disadvantages

16. Why is the process of tar sands extraction particularly harmful and how does the Kestone XL pipeline relate to tar sands extraction?

17. What is natural gas? How is it formed?

18. How is natural gas extracted? How are its global supplies being expanded?

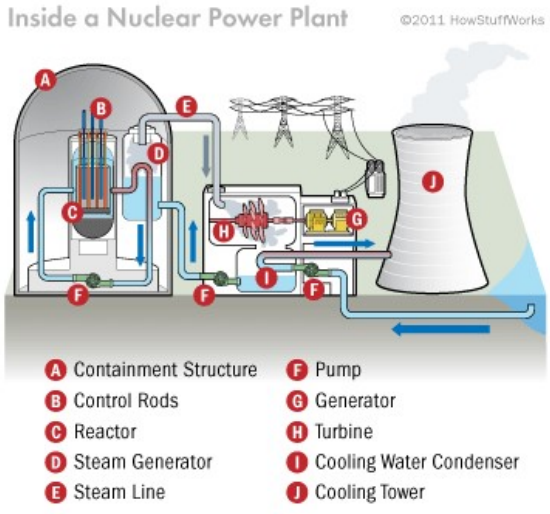
19. What are the advantages and disadvantages to natural gas?

Advantages	Disadvantages

20. What was the context in which nuclear power was invented as a viable fuel?

21. What is the main nuclear fuel and what does enrichment refer to?

22. How does a nuclear fission reactor work and what are its major safety features? Label the diagram below.



	Label	Description
#B		
#C		
#G		
#H		
#J		

23. Describe some of the consequences of the Chernobyl, Three Mile Island, and the Fukishima nuclear power plant accidents.

24. What are the major advantages and disadvantages of relying on the nuclear fuel cycle as a way to produce electricity?

Advantages	Disadvantages

25. How do nuclear power plant operators store highly radioactive spent fuel rods now?

26. What site has been heavily researched as a site for long-term storage of radioactively spent rods?

27. What is nuclear fusion and what is its potential as an energy resource?

28. Which countries…
    a. Has the highest percent nuclear energy use?_____
    b. Uses the most total energy?_____
    c. Has the highest per capita energy use?_____
    d. Has the most coal reserves?_____
    e. Oil reserves?_____
    f. Natural gas reserves? _____

Lesson 2 – Energy Conservation and Renewable Resource

1. Describe or draw how each of the following renewable energies works and list the pros and cons of each.

Passive Solar **Pros** **Cons** **World Leader?**	**Active Solar – Photovoltaic PV** **Pros** **Cons** **World Leader?**
Active Solar – Concentrated Solar **Pros** **Cons** **World Leader?**	**Wind** **Pros** **Cons** **World Leader?**

Geothermal	Tidal and Wave
Pros **Cons** **World Leader?**	**Pros** **Cons** **World Leader?**
Biofuels	**Hydrogen Fuel Cells**
Pros **Cons** **World Leader?**	**Pros** **Cons** **World Leader?**

Increasing Conservation

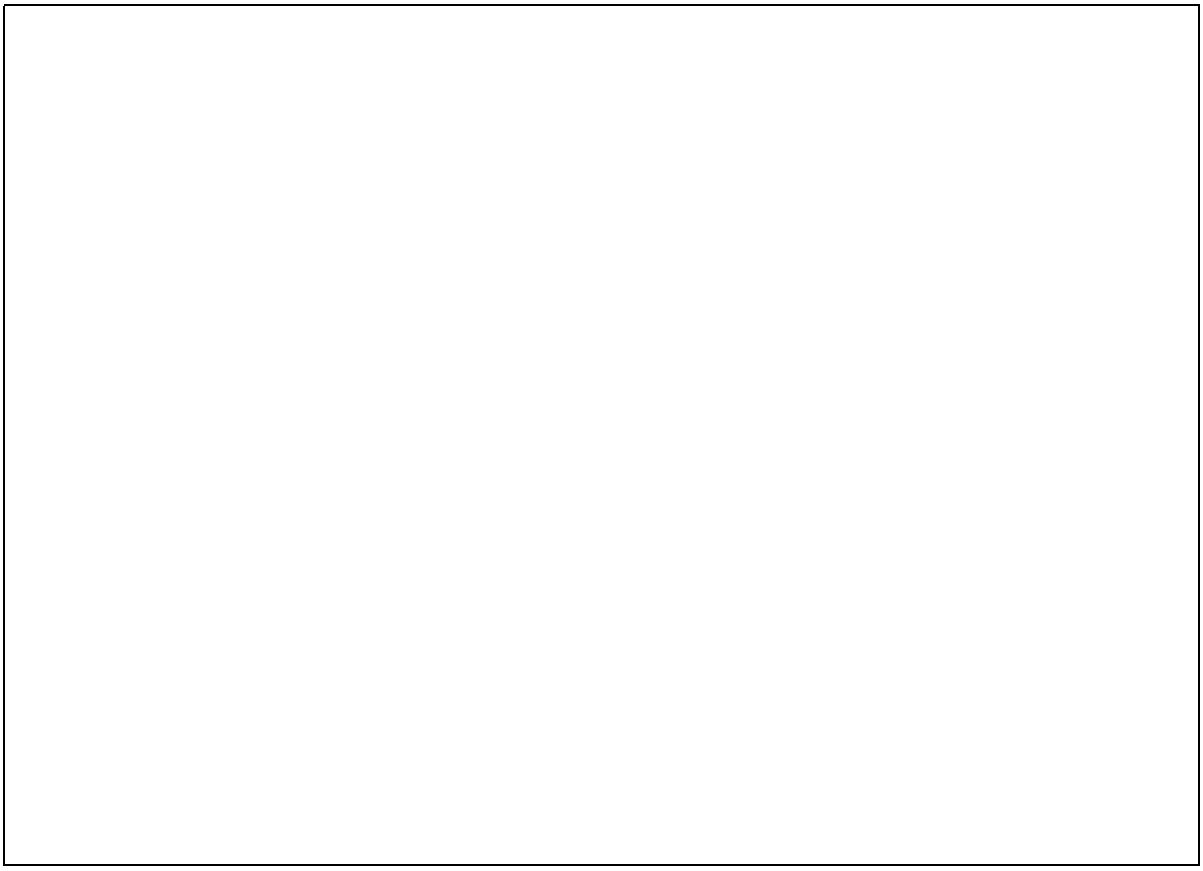
1. What is a **smart grid** and why is it important?

2. Describe the trends in fuel efficiency in the United States since the 1970s. Be sure to explain **CAFÉ standards**

3. What are the **environmental advantages and disadvantages to hybrid and electric cars**?

4. Identify and contrast the efficiency of **incandescent, compact fluorescent, and LED light bulbs**.

5. What are specific attributes of energy efficient buildings? Draw one below with all the bells and whistles.



6. What is cogeneration and how can it increase energy efficiency?

7. What is the largest source of energy in developing countries?

Lesson 3 – Energy Calculations

Nuclear Decay

1. If 100.0 g of carbon-14 decays until only 25.0 g of carbon is left after 11 460 y, what is the half-life of carbon-14?

2. What is the half-life of a 100.0 g sample of nitrogen-16 that decays to 12.5 g of nitrogen-16 in 21.6 s?

3. A 208 g sample of sodium-24 decays to has a half life of 25 days. How much of the sample is left after 200 days?

Other

Energy: The basic unit of energy is a Joule (J). Other units are calorie, kilojoule, British Thermal Unit (BTU), and therm.

1000J = 1 kJ 1000cal = 1kcal 1 cal = 4.184 J 1 BTU = 1.05 kJ 1 therm = 100,000 BTU

Power: Power is the rate at which energy is used. **(P = E/t)** Unit: Watt

1W = 1J/s (1Watt = 1 Joule per second)

4. A 100 Watt bulb uses 100 J/sec of electrical energy. If it is 20% efficient, then the bulb converts 20% of the electrical energy into light and 80% is wasted by being transformed into heat (ever felt a hot light bulb?).

a) What is the example of the First Law of Thermodynamics above?

b) What is the example of the Second Law of Thermodynamics above?

5. How much energy, in kJ, does a 75 Watt light bulb use then it is turned on for 25 minutes?

112.5 kJ

The Kilowatt Hour, or kWh, is not a unit of power but of energy. Notice that kilowatt is a unit of power and hour is a unit of time. E = P x t (rearranged from above). A kilowatt hour is equal to 1 kW delivered continuously for 1 hour (3600 sec).

1 kWh = $\frac{1000\ J}{s}$ x 3600 sec = 3.6 x 10^6 J = 3600 kJ

6. Assume your electric bill showed you used 1355 kWh over a 30-day period.

a.) Find the energy used, in kJ, for the 30 day period.

4,878,000 kJ

b.) Find the energy used in J/day.

1.626 x 10^8 J/day

c) At the rate of $.0749/kwh, what will your electric bill be for this month?

$101.49

7. A 100 Watt light bulb is 20% efficient. **100 W= 100 J/s**

a.) How much energy does it use in 12 hours of operation?

4.32 x 10^6 J

b.) How much energy does the bulb convert to light during 12 hours?

864,000 J light

c.) Convert total energy use to kWh

1.2 kWh

8. (This question is extracted word for word from the 1998 APES exam) The environmental impact of washing a load of dirty dishes in an electric dishwasher differs from that of washing them by hand in a sink. Use the information and data below to answer thee questions that follow. Show your calculations.

Assume:

i. The dishes all fit in one load.
ii. The water coming into the water heater for the sink and into the water heater in the dishwasher is at 50^{o} F.
iii. The water heaters for the sink and the dishwasher are both 100% efficient.
iv. In one complete cycle, the electric dishwasher uses 10 gallons of water heated to 140^{o} F and the dishwasher also
uses 0.500 kWh of electrical energy for its mechanical operation.

v. Washing the dishes by hand requires 20 gallons of water heated to 110^{o} F.

Other Information:

1 gallon of water = 8 lb. water

1 BTU = the amount of energy needed to raise the temperature of 1 pound of water by 1^{o} F.

1 kWh = 3400 BTUs.

a. Calculate the total energy (in BTU's) used both to heat the water and run the electric dishwasher to wash a load of dishes.

b. Calculate the energy (in BTU's) used to heat the water for washing the load of dishes by hand.

c. Discuss the economic and environmental costs and benefits of

i. using the electric dishwasher (including its manufacture and disposal)

ii. washing the dishes by hand

9. AP Practice

(1998) If an incandescent light bulb used for lighting has an efficiency rating of 5 percent, then for every 1.00 joule of electrical energy consumed by the bulb, which of the following is produced?

a) 1.05 joules of light energy

b) 1.05 joules of heat energy

c) 0.95 joule of light energy

d) 0.05 joule of light energy

e) 0.05 joule of heat energy

(2003) The combustion of one gallon of automobile fuel produces about 5 pounds of carbon (in CO_2). Two autos are making a trip of 600 miles. The first auto gets 20 miles per gallon, and the second gets 30 miles per gallon. Approximately how much less carbon (in CO_2) will be produced by the second auto on this trip?

a) 300 lbs b) 150 lbs c) 100 lbs d) 75 lbs
e) 50 lbs

(2003) If the annual consumption of petroleum in the United States is about 23 barrels per capita, the total annual consumption of petroleum in the United States is closest to

a) 12 million barrels

b) 240 million barrels

c) 120 billion barrels

d) 6 billion barrels

e) 10 billion barrels

(2003) Uranium-235 has a half-life of 710 million years. If it is determined that a certain amount of stored U-235 will be considered safe only when its radioactivity has dropped to 0.10 percent of the original level, approximately how much time must the U-235 be stored securely to be safe?

a) 7.1×10^6 years

b) 7.1×10^7 years

c) 7.1×10^8 years

d) 7.1×10^9 years

e) 7.1×10^{10} years

(2017) Plutonium-239 has a half life of 24,000 years. How much of a 1.0g sample will remain after 96,000 years?

a) 1 gram b) 0.5 grams c) 0.25 grams d) 0.125grams e) 0.062 grams.