IB Physics Topic 8 – Energy Production. Name _____

1. Classify the following energy sources as **Non-renewable (N)** or **Renewable (R)**.
   a. Coal ___ b. Hydro (water) ___ c. Natural Gas ___ d. Uranium-235 ___ e. Wind ___
   f. Crude Oil ___ g. Geothermal ___ h. Biomass ___ i. Sun (solar) ___ j. Wave & Tidal ___

   Ans: NRNNRNRRRR

   Practice: Put the **steps in order from beginning to end** to describe the origin of fossil fuels.
   ___ Biomass buried under great pressure and heat.
   ___ Coal, oil and natural gas are extracted.
   ___ Sun makes biomass through photosynthesis.
   ___ Coal, oil and natural gas are used as fuels.
   ___ Biomass gathers and grows over time.
   ___ Biomass becomes coal, oil and natural gas over eons. Ans: 351624

2. **Specific Energy (E_{SP})** - is the number of Joules that can be released by each kg of fuel. **Unit: J/kg**
   Energy Density ($E_D=E_{SP}xD$) - is the number of Joules that can be released from 1 m^3 of fuel. **Unit: J/m^3**

   Ex. A fossil-fuel power plant has an efficiency of about 28% and generates 1500 MW of useful electrical power. Given that the Specific Energy of the fossil fuel is 52 MJ/kg, calculate the mass of fuel consumed each second.
   a. 92 kg/s b. 103 kg/s c. 110 kg/s Ans: b

   Ex. When a camping stove that burns petrol is used, 65% of the energy of the fuel reaches the cooking pot. Given that the Energy Density of petrol is 35 GJ/m^3, calculate:

   (i) The energy needed to raise the temperature of 1.0 L of water in the pot from 15°C to 100°C. (Ignore the specific heat capacity of the pot, and use 4.2 kJ/kg·K as the specific heat capacity of the water.)
   a. .48 MJ b. .31 MJ c. .36 MJ Ans: c

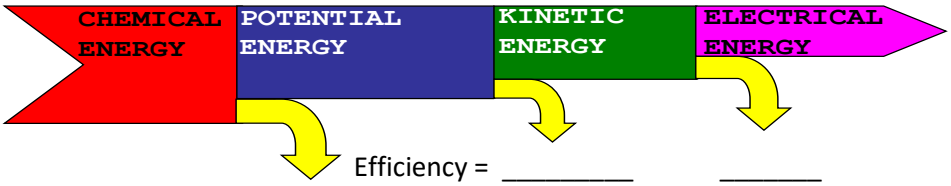
   (ii) The volume of petrol needed.
   a. $1.6x10^{-5}$ m^3 b. $2.3x10^{-5}$ m^3 c. $3.63x10^{-5}$ m^3

   Ans: a

   (iii) Estimate the volume of petrol needed for a weekend camping trip. Assume that 2 L of water are needed for each meal, and that there will be 5 cooked meals over the weekend.
   a. 200 mL b. 1 L c. 2 L

   Ans: a

3. Sankey diagrams. show the efficiency of a number of energy conversions.
Suppose the actual energy values are given: Chem. (100 MJ, P.E. (80 MJ), K.E. (70 MJ), Electrical (50 MJ).
Since Efficiency = Output/Input, find the Efficiency of each conversion.



Efficiency = _____ _____

Efficiency = _____ Ans: 80%, 87.5%, 71.4%

What is the overall Efficiency? _____ Ans: 50%

4. Describing fossil fuel power stations.

The most common way to generate electrical power is the coal-burning power plant. Put the following steps in order from beginning to end.

___ Electrical power is produced.
___ Steam rotates a generator.
___ Chemical energy in coal is released by burning.
___ The generator turns a coil of wire in a magnetic field.
___ Heat boils water. Ans: 53142

Ex. A power plant contains a number of generators. Each one rotates 50.0 m of wire in a magnetic field of 2.0 T at 100.0 m/s.

(a) Calculate the resulting Emf. Ans: 10 kV

(b) Find the current produced if the resulting voltage is produced in distribution wire of resistance of 5.0 kΩ.

Ans: 2.0 A

(c) Find the electrical power in MW if the plant has 10 such generators. Ans: .20 MW

5. **Describing wind turbines.** Another way to generate electrical power is from a wind turbine.
In the simplest case, we assume that the (air) wind kinetic energy is completely converted into mechanical energy.
Formula derivation: Given a rotor blade radius of r.

The volume of air that moves through the blades in a time t is given by, $V = Ad = Avt$, where v is the speed of the air and $A = \pi r^2$. The mass of air, m, is thus $m = \rho V = \rho Avt$. The density of air is about $\rho = 1.2$ kg/m^3.

Therefore, the kinetic energy $E_K = (1/2)mv^2 = (1/2)\rho Avtv^2 = (1/2)\rho Av^3t$.

Power is E_K/t so that $P = (1/2)A\rho v^3$.

Ex. Given a turbine having a blade length of 12 m, a wind speed of 15 m/s and an efficiency of 45%, find the power output.

Ans: 412 kW