08 Energy production questions

Sources and production

1. Real thermodynamic processes are not 100% efficient. Some of the energy becomes spread and is less useful. This non-recoverable energy is referred to as degraded energy?

(a) Draw a labeled diagram of a wind generator.

(b) Construct a Sankey (energy flow) diagram for a wind generator and identify the points where energy is degraded.

(c) If the air density is 1.25 kgm^{-3} and the wind speed is 10ms^{-1} what power is available to a wind turbine of blade length 20m?

2. The table shows energy density of potential fuels: (http://en.wikipedia.org)

Fuel	Used in	Specific energy obtained (MJ/kg)
Deuterium-Tritium mix	Nuclear fusion	567,000,000
Enriched Uranium (3.5% U-235)	Nuclear fission	3,456,000
Zip fuel (/wiki/Zip_fuel)	Jet engines	70
Kerosene	Jet engine	45
Coal	Power stations	30

Use the data to answer the following questions.

(a) Why, given the difficult technological barriers, is there still much interest and investment in nuclear fusion:

(b) Why, despite the risks, are many countries developing nuclear fission reactors?

(c) It takes approximately 33MJ/kg to put a satellite into orbit. Why does this make it worthwhile developing Zip fuels with higher specific energies than Kerosene?

(d) How many kg of coal does a 1000 MW **coal** plant that averages 750 MW of production over the course of day use in one day?

3. Nuclear fission:

(a) Construct a Sankey (energy flow) diagram for a nuclear power station treating the power station as a single process.

(b) Identify a process within the power station where the most is energy degraded?

(c) Explain how control rods and moderators help the nuclear chain reaction propagate safely in a nuclear reactor.

(d) To keep the risk of contamination low the water that powers the turbines does not enter the reaction chamber. State which device is used to transfer the energy from the reaction chamber to the water.

4. What environmental problems are caused by the burning of fossil fuels?
5. Draw a labeled diagram of a photo-voltaic cell.
6. Draw a labeled diagram of a solar heating panel.

7. Water power:
   Draw diagrams to show the differences between the following hydro-electric power schemes.

(a) water storage in lakes
(b) tidal water storage
(c) pumped water storage and give an advantage and disadvantage for each one.

Thermal energy transfer

The sun has a luminosity of 3.8×10^{26} W. 1 AU = $1.5\text{x}10^{11}$ m. Radius of Earth = 6380km

1. (a) Calculate the intensity of sunlight incident on the Earth
   (b) Calculate the total solar power reaching the Earth.
   (c) Define albedo.
   (d) State what meterological features increase the albedo of the Earth.
   (e) The average albedo is 0.3. Calculate the energy absorbed in 24 hours.

2. The average temperature of the Earth is 15^0C and its emissivity is approximately 0.6.
   (a) Calculate the power of radiation emitted from the surface of the Earth.
   (b) Explain, in terms of variation of absorbencies with wavelength of radiation, why "greenhouse" gases act to insulate the Earth.

3. The level of carbon di-oxide in the atmosphere is increasing. (a) What activities of humans have been directly increasing the amount in the atmosphere? (b) Explain how deforestation also increases the amount of carbon dioxide in the atmosphere.

4. The thermos flask on the right is designed to prevent heat transfer. Explain how the different insulating elements help to reduce the heat transfer. Use the words conduction, convection and thermal radiation in your answer.