C.1 Energy Sources

1. Other than the fact that it should be cheap, plentiful and easily accessible, state two essential characteristics for a useful energy source.

2. Wood is essentially composed of cellulose, hemicelluloses, and lignin. Different types of wood have different calorific values but the average energy density of wood is about 15 000 kJ kg^{-1}. Good quality anthracite contains about 95% carbon and 3% hydrogen by mass. The standard enthalpies of combustion of carbon and hydrogen are -394 and -286 kJ mol^{-1} respectively.

(a) Calculate the energy density of good quality anthracite in kJ kg^{-1} (assuming that only the carbon and hydrogen content of the anthracite undergoes combustion).

(b) Compare and contrast anthracite and wood as energy sources.

3. A 60 W incandescent light bulb emits 800 lumens of light. I lumen represents 1/683 W of energy at a wavelength of 555 nm (i.e. the middle of the visible region of the spectrum). For an incandescent light bulb to be illuminated it requires a prime energy source producing 188 J s^{-1}.

(a) Calculate the energy efficiency of this transfer of energy.

(b) If the prime energy source comes from a coal-fired power plant list five separate stages during the energy transfer process that account for the low energy efficiency.

4. Hexane and methanol are being considered as liquid fuels for a model rocket.

FUEL	Density (gcm^{-3})	Enthalpy of Combustion ($kJmol^{-1}$)
hexane	0.655	-4,163
methanol	0.792	-726

a) ***Determine*** the specific energy of each fuel.

b) ***Determine*** the energy density of each fuel.

c) ***State***, with a reason, which fuel would be the best choice based on your calculations.

d) ***Give*** two other factors to consider when choosing the fuel.

5. A large power station supplies electrical energy at a rate of 4,000 MJ every second from burning powdered coal. (1 MJ = 1,000,000 J).

   The efficiency of energy transfer for the power station is 30%. The specific energy for this coal is 24 $MJkg^{-1}$.

   a) ***Define*** '*efficiency of energy transfer*' and '*specific energy*'.

   b) ***What*** mass of coal is burnt each second by the power station?