

# Tutorial Questions

for Tutorial at 1 pm on August 14 and repeated at 2 pm on August 15

## ENERGY: Fossil Fuels, Nuclear Fuel and Solar Cells

### Energy: Fossil Fuels

1. Define an endothermic reaction? Show schematically an energy profile for an endothermic reaction. Is the combustion of coal endothermic or exothermic?
2. Discuss in a paragraph the composition of the three fossil fuels and give examples of combustion reactions and the heat of combustion for each of the three fossil fuels.
3. List four negative environmental impacts of fossil fuel usage.
4. The oxidation of sulfide containing minerals, such as pyrite ( $\text{FeS}_2$ ) in the tailings and within underground mines, can cause significant damage to surrounding areas, particularly in the surrounding water. Show mechanisms for the oxidation then hydrolysis reactions of ferrous sulfide to ferric hydroxide. The addition of limestone can neutralize the acid produced during these reactions. Show the reaction mechanisms for this.
5. Urea can be used for the removal of a high percentage of the nitrous oxides from the flue stacks associated with the burning of fossil fuels. Show the chemistry involved in the use of urea to remove the nitrous oxides.
6. In a brief paragraph define surfactant and describe the procedure in which the surfactant functions to allow the dispersion of oil spills on water.

### Energy: Nuclear Fuel

7. Define radiation, including in your definition the difference between ionising and non-ionising radiation.
8. Describe the three main types of ionising radiation.
9. Balance the following decay mechanisms:  
$${}_{90}^{234}\text{Th} \rightarrow {}_{91}^{234}\text{Pa} +$$
$${}_{90}^{230}\text{Th} \rightarrow {}_{88}^{226}\text{Ra} +$$
$${}_{83}^{210}\text{Bi} \rightarrow {}_{81}^{206}\text{Tl} +$$
10. With a half-life of 3.823 days, how long will it take for a 5 kg radon-222 sample to reach a tenth of its original activity?
11. The decay series of uranium-238 involves a number of transformations, how is such a decay series different to the fission of uranium-235?
12. What is the difference between controlled and uncontrolled fission? Which is used in nuclear power generators?
13. If you were trying to convince fellow Australians of the benefits of nuclear power, what evidence would you provide to back-up your argument?
14. Which 2 elements (include isotope) are commonly used as nuclear fuel?
15. List the 6 stages in the nuclear fuel cycle. Which stage(s) of the nuclear fuel cycle does Australia contribute to?
16. List the different ways uranium can be mined.

17. In a brief paragraph describe the chemistry involved in the milling of uranium, including reaction mechanisms where appropriate.
18. Why is uranium oxide commonly converted to uranium hexafluoride? Describe the chemistry of the conversion process.
19. What % of U is generally required as  $^{235}\text{U}$  for fuel in a nuclear power reactor?
20. What chemical form of uranium is generally used in nuclear power fuel rods?
21. List the four grades of radioactive waste. What level radioactive waste requires the greatest skill in handling?
22. Describe two techniques to immobilise high level waste, highlighting any difference between the two.
23. Look at the epa website (see lecture notes) and summarise the properties of radioactive radon and uranium.
24. Why were the radionuclides dispersed in the atmosphere during the Chernobyl accident a threat to humans and animals? Which radionuclides in particular were many people exposed to? Describe the radionuclide pathways between the atmosphere and human body.
25. The ionisation of water results in the formation of radicals. Show the reaction mechanisms for these processes.

#### Energy: Solar Cells

26. Describe the differences in energy transformation between solar thermal, solar thermal electrical and solar electrical.
27. What is the function of a photovoltaic device?
28. In a brief paragraph, describe how electrical current is obtained from a crystalline silicon cell, including how the electric field is obtained. Also include definitions of doping and band-gap in your explanation.
29. How has nanotechnology improved the performance of the dye-sensitised solar cell?
30. Describe how electrical current is obtained from a dye-sensitized solar cell. A diagram may be helpful.
31. How is the conversion efficiency of photovoltaic devices calculated?
32. List in point form advantages and disadvantages of using solar cells as energy sources.