S.5 CHEMISTRY DISCUSSION ITEMS PHASE TWO

1. A rural community is planning to test bore hole water for contamination.

A volunteer chemistry student learns that radioactive isotopes of certain elements can be used to trace water pollution sources

Task

a) Define what an isotope is and explain how isotopes of an element differ from each other
b) The isotope oxygen -18 (O-18) is often used to track water movement. Compare this isotope to the more common oxygen -16 (O-16) in terms of atomic mass and structure
c) Discuss how knowing the isotopic composition of elements in water can help identify pollution and suggest one way to educate the community on this tool's use.

2. In a nearby forest, families produce charcoal for cooking. A student observes that the smoke contains carbon particles and other pollutants. She reads that carbon exists in several isotopic forms such as carbon -12 and carbon -14

Task

a) Define atomic mass and explain how it is calculated from isotopes
b) Carbon's atomic mass is listed as 12.01 on the periodic table. What does this suggest about the relative abundance of carbon isotopes?
c) Explain how an understanding of carbon isotopes might help scientists study the long-term environmental effects of deforestation and charcoal burning

3. A company is comparing ethanol and methanol as fuels. The direct measurement of enthalpy of formation of ethanol is not possible, but the following enthalpy changes are known:

- Combustion of ethanol $-1367kj/mol$
- Formation of carbon dioxide $-394kj/mol$
- Formation of water $-286kj/mol$

Similary, the following data shows the enthalpy of formation of methanol

Task

a) State Hess's law
b) Using the above data and Hess's law, calculate the standard enthalpy of formation of ethanol and methanol
c) Discuss how this calculation helps the company decide between ethanol and methanol as a commercial fuel

4. A self –heating food container contains chemicals that release heat when mixed. A cooling pack by contrast, absorbs heat when activated

Task

a) Define the term enthalpy change of a reaction
b) Explain with reference to bond energies, why one reaction releases heat and the other absorbs it.
c) The self-heating reaction is an exothermic reaction. Sketch and label an energy profile diagram for this reaction clearly indicating ,reactants, products , activation energy and enthalpy change
d) Explain why an understanding of enthalpy change is important when designing temperature-sensitive packaging

5. An industrial chemist is designing a reaction to take place at low temperature to reduce energy costs.

Task

a) Explain what is meant by activation energy
b) Draw an energy profile diagram to show how a catalyst affects a reaction including both the catalyzed and uncatalyzed pathways
c) Suggest and explain one reason why lowering activation energy is desirable in industrial chemical processes

5. Polonium (210, 84) decays with emission of an alpha particle to lead (206, 82) with a half-life of 138.4 days. If 1.0g of polonium -210 is placed in a sealed tube, how much helium will accumulate in 69.2 days? Express the answer in cm^3 at s.t.p

6. The beta activity from 1 g of carbon from wood that was cut recently was registered 0.204 counts/ second. 1 g of the specimen of carbon prepared from

wood taken from a long strip gave 0.177 counts per second. Estimate the age of the strip to the nearest 50 years. (Half-life of carbon is 5580 years)

6. 9.2g of ethanol and 12.0 g of ethanoic acid were mixed in a stoppered flask with $20cm^3$ of 1M hydrochloric acid as catalyst at $20℃$. The mixture was left for a week to attain equilibrium and then titrated with $137cm^3$ of 0.1M sodium hydroxide solution (of the total volume of the base used, only $20cm^3$ were used to react with hydrochloric acid)

a) Work out the concentrations of the equilibrium mixture
b) Calculate the value of equilibrium constant Kc

7. a group of farmers in Iganga bought two different types of fertilizers labeled " **contains Nitrogen -14 and Nitrogen -15 isotopes"** they want to know which fertilizer delivers more nitrogen per mole for better crop yield

Task

a) Identify what isotopes are and how they differ in nitrogen atoms
b) Calculate the relative atomic mass of the nitrogen in the fertilizer, given that 90% is Nitrogen -14 and 10% is Nitrogen -15
c) Explain why knowing the atomic mass of nitrogen is important when calculating how much nitrogen is delivered per kilogram of fertilizer.

8. A break-in at a pharmacy in Kampala leads police to test some powder left behind. Scientists use a mass spectrometer to identify the substances based on its isotopic pattern

Task

a) Describe how a mass spectrometer separates isotopes of an element
b) Calculate the relative atomic mass of the element using the following from the spectrum
    - Peak 1: 75% abundance , mass = 20
    - Peak 2: 25% abundance , mass = 22
c) Explain one way mass spectrometry is useful in health, security or agriculture