

Chemistry

Section I (continued)

Part B – 60 marks

Attempt Questions 16–27

Allow about 1 hour and 45 minutes for this part

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Marks

Question 16 (3 marks)

Radioisotopes are used in industry, medicine and chemical analysis. For ONE of these fields, relate the use of a named radioisotope to its properties.

3

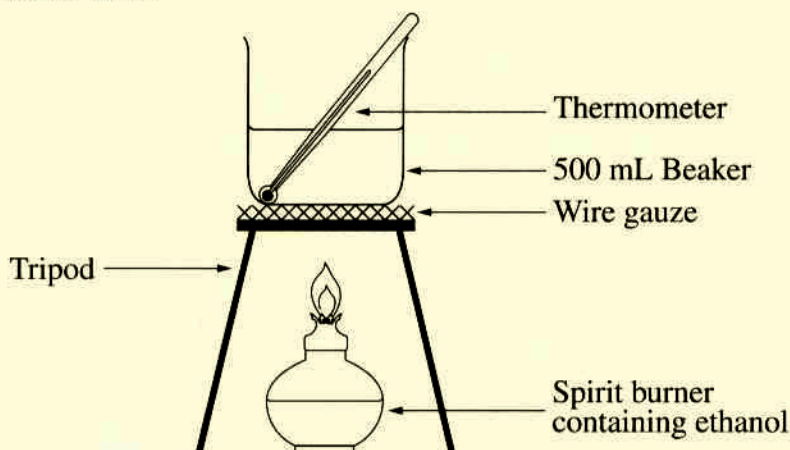
Cobalt-60 is used in medicine for ~~the~~ chemotherapy ^{when treating cancer.} ~~It is used as~~ It is used as a source of γ -rays because it gives this off when undergoing ~~beta~~ beta decay. γ -rays have the ability to kill cancer cells. The half-life of Cobalt-60 is useful because it gives strong enough radiation for treatment ~~while~~ but ~~is~~ is long enough ~~to~~ to last a few years in the machine.

Question 17 (6 marks)

Students were asked to perform a first-hand investigation to determine the molar heat of combustion of ethanol.

The following extract is from the practical report of one student.

Apparatus used:



Lab data:

Mass of water	=	250.0 g
Initial mass of burner	=	221.4 g
Final mass of burner	=	219.1 g
Initial temperature of water	=	19.0°C
Final temperature of water	=	59.0°C

- (a) After completing the calculations correctly, the student found that the answer did not agree with the value found in data books. Suggest ONE reason for this. 1

the ~~beaker~~^{water} was heated in a beaker, which is not a perfect insulator, so some heat may have escaped into the atmosphere.

- (b) Propose TWO adjustments that could be made to the apparatus or experimental method to improve the accuracy of the results. 2

The experiment could use a polystyrene cup with a lid to contain the ~~beaker~~ water being heated. Adjustments could be made to have the flame closer to the water as some heat energy in this design would not be used to heat the water. The thermometer should also not be permitted to rest ^{used to} on the bottom of the beaker.

Question 17 (continued)

- (c) Calculate the molar heat of combustion of ethanol, using the student's data. 3

$$\text{Mass of fuel used} = 221.4 - 219.1 = 2.3 \text{ g} \quad \text{Moles fuel} = \frac{2.3}{46.068}$$

$$\text{Change in temperature} = 59 - 19 = 40^\circ\text{C}$$

$$\text{Mass of water} = 250 \text{ g}$$

$$\text{Heat capacity of water} = 4.18 \times 10^3$$

$$\text{Heat of combustion} = m c \Delta T$$

$$= 0.250 \text{ kg} \times 4.18 \times 10^3 \times 40$$

$$= 41800$$

$$\text{Molar heat of combustion} = \frac{41800}{0.04992} = 837235.8 \text{ J mol}^{-1}$$

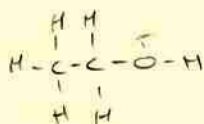
End of Question 17

$$= 837.2358 \text{ kJ mol}^{-1}$$

$$= 837.2 \text{ kJ mol}^{-1} \text{ (rounded)}$$

Please turn over

ethanol

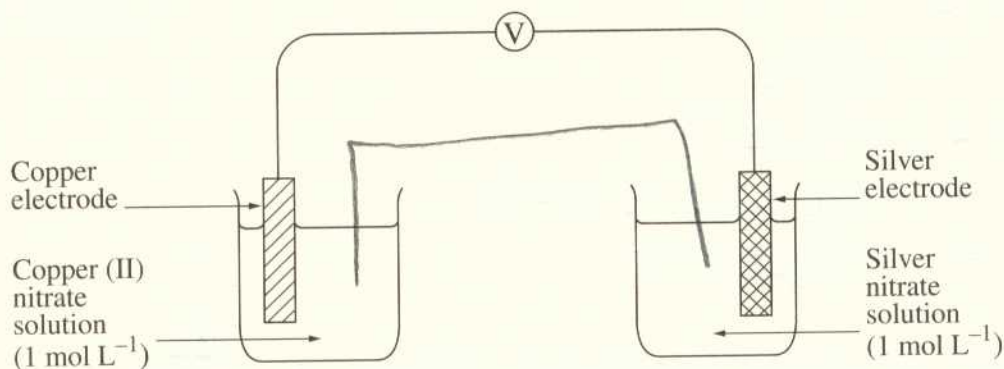


$$46.068 \text{ (FM)}$$

Note: The reaction is exothermic so 837.2 kJ are released per mole of ethanol used.

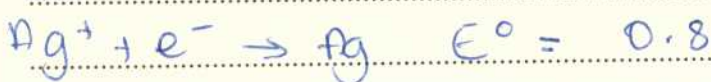
Question 18 (6 marks)

A galvanic cell was made by connecting two half-cells. One half-cell was made by putting a copper electrode in a copper (II) nitrate solution. The other half-cell was made by putting a silver electrode in a silver nitrate solution. The electrodes were connected to a voltmeter as shown in the diagram.



(a) Complete the above diagram by drawing a salt bridge. 1

(b) Using the *standard potentials* table in the data sheet, calculate the theoretical voltage of this galvanic cell. 2



$$\begin{aligned} \text{EMF} &= 0.8 - 0.52 \\ &= 0.28 \text{ V} \end{aligned}$$

(c) A student removes the voltmeter from the circuit and replaces it with an electrical generator. The generator causes the copper electrode to increase in mass. 3

Explain, using an equation, why the copper electrode will increase in mass.

The applied voltage is causing an electrolytic reaction to occur. It is forcing electrons to bring about the reduction of copper ions; $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$. Copper ions will therefore come out of solution and precipitate onto the copper electrode, hence causing it to increase in mass.