SAC 1 Key Knowledge Checklist

N.B: This checklist is just a guide and by no means exhaustive.

Key Knowledge	Success Criteria
Topic 1: REDOX Reactions ➢ redox reactions as simultaneous oxidation and reduction processes, and the use of oxidation numbers to identify the reducing agent, oxidising agent and conjugate redox pairs ➢ the writing of balanced half-equations (including states) for oxidation and reduction reactions, and the overall redox cell reaction in both acidic and basic conditions	➢ Identify oxidising agent and reducing agent in a reaction and justify using oxidation numbers ➢ Write and balance simple and complex half-equations for oxidation and reduction reactions o Acidic (KOHES) o Basic (KOHES + OH-)
Topic 2: Galvanic Cells ➢ the common design features and general operating principles of non-rechargeable (primary) galvanic cells converting chemical energy into electrical energy, including electrode polarities and the role of the electrodes (inert and reactive) and electrolyte solutions (details of specific cells not required) ➢ the use and limitations of the electrochemical series in designing galvanic cells and as a tool for predicting the products of redox reactions, for deducing overall equations from redox half-equations and for determining maximum cell voltage under standard conditions ➢ the application of Faraday's Laws and stoichiometry to determine the quantity of galvanic or fuel cell reactant and product, and the current or time required to either use a particular quantity of reactant or produce a particular quantity of product	➢ Recall and explain the importance of the key design features of galvanic cells. o Salt bridge o Electrolyte o External circuit o Electrode ➢ Use your understanding of the above to explain key design features of batteries (primary galvanic cell). ➢ Identify the direction of electron flow and ion flow in galvanic cells ➢ Describe the importance of separating two half-cells to facilitate the transformation of chemical energy into electrical energy in a galvanic cell ➢ Explain the role of inert and reactive electrodes and electrolyte solutions ➢ Use Faraday's Laws: o $Q = I \times t$ o $Q = n(e^-) \times F$ ➢ Compare the relative strengths of reducing agents and oxidising agents ➢ Predict the products, and therefore the overall equation, of a redox reaction in a galvanic cell

	➢ Use the electrochemical series to calculate the maximum cell voltage generated under standard laboratory conditions (1M, 25°C, 1atm)
<u>Topic 3: Commercial Cells</u> ➢ the common design features and general operating principles of fuel cells, including the use of porous electrodes for gaseous reactants to increase cell efficiency (details of specific cells not required) ➢ contemporary responses to challenges and the role of innovation in the design of fuel cells to meet society’s energy needs, with reference to green chemistry principles: design for energy efficiency, and use of renewable feedstocks	➢ Compare the similarities and differences between galvanic cells and fuel cells ➢ Identify and describe the common design features of fuel cells o Role of electrolyte o Porous and catalytic electrodes ➢ Determine half and overall equations based on question and diagram ➢ Explain the importance of key design features in terms of reaction efficiency o Porous and catalytic electrodes ➢ Describe green chemistry principles **(Table 26 ii)** that enhance the sustainability of fuel cells Example: o renewable feedstocks o catalysis ➢ Describe UN Sustainable Development Goals **(Table 26 i)** that enhance the sustainability of fuel cells Example: o Goal 7: Affordable and clean energy o Goal 9: Industry, innovation and infrastructure o Goal 11: Sustainable cities and communities ➢ Compare and contrast energy from fuel cells vs traditional combustion reactions or energy from coal o Energy efficiency o Source of fuel (renewable v non-renewable) o Carbon neutrality

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<u>Topic 4: Fuels</u>

- the definition of a fuel, including the distinction between fossil fuels (coal, natural gas, petrol) and biofuels (biogas, bioethanol, biodiesel) with reference to their renewability (ability of a resource to be replaced by natural processes within a relatively short period of time)
- photosynthesis as the process that converts light energy into chemical energy and as a source of glucose and oxygen for respiration in living things: $6CO_2(g) + 6H_2O(l) \rightarrow C_6H_{12}O_6(aq) + 6O_2(g)$
- production of bioethanol by the fermentation of glucose, $C_6H_{12}O_6(aq) \rightarrow 2C_2H_5OH(aq) + 2CO_2(g)$, and subsequent distillation to produce a more sustainable transport fuel

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- Define ‘fossil fuels’, biofuels’, ‘renewable’, ‘non-renewable’, ‘sustainable’ and ‘carbon neutrality’
- Compare and contrast the different types of fossil fuels and biofuels / renewable fuels
Example:
    - Methane from biogas vs methane from fossil fuel
    - Bioethanol vs ethanol from fossil fuel
    - Biodiesel vs petrodiesel
    - Hydrogen from electrolysis using solar vs hydrogen from fossil fuel
- Describe <u>using equations,</u> the process of producing bioethanol from crops
    - Photosynthesis equation
    - Fermentation of glucose equation
    - Distillation of aqueous bioethanol to pure ethanol
- Explain the advantages and disadvantages of fossil fuels and biofuels.
    - Link this to ‘sustainability’, Green Principles **(Table 26 ii)** and United Nations Sustainable Goals **(Table 26 i)**
- Describe using equations, the process of photosynthesis and cellular respiration
- Compare and contrast the similarities and differences of photosynthesis and cellular respiration

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<u>Topic 5: Energy from Fuels</u>

- fuel sources for the body measured in $kJ\ g^{-1}$: carbohydrates, proteins and lipids (fats and oils)
- energy from fuels and food:
    - calculation of energy transformation efficiency during combustion as a percentage of chemical energy converted to useful energy
    - comparison and calculations of energy values of foods containing

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- Use **Table 12** to calculate the energy content for food
    - Make sure to look out for
1. Serving size
2. Question
3. Dietary fiber
- Use $q = mC\Delta T$ and $q = \frac{energy\ loss\ from\ food\ combustion}{change\ in\ mass\ of\ food}$
- Calculate % efficiency and % heat loss
- Evaluate precision vs accuracy

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carbohydrates, proteins and fats and oils ➢ oxidation of glucose as the primary carbohydrate energy source, including the balanced equation for cellular respiration: $C_6H_{12}O_6(aq) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l)$	➢ Identify ways in experimental design to improve % efficiency (or minimize % heat loss) ➢ Explain using equation the oxidation of glucose as the carbohydrate energy source : $C_6H_{12}O_6(aq) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l)$
<u>**Topic 5 : Energy from Fuels**</u> • comparison of exothermic and endothermic reactions, with reference to bond making and bond breaking, including enthalpy changes (ΔH) measured in kJ, molar enthalpy changes measured in kJ mol^{-1} and enthalpy changes for mixtures measured in kJ g^{-1}, and their representations in energy profile diagrams • combustion (complete and incomplete) reactions of fuels as exothermic reactions: the writing of balanced thermochemical equations, including states, for the complete and incomplete combustion of organic molecules using experimental data and data tables	➢ Draw a detailed energy profile diagram for exothermic and endothermic reactions. Make sure the following is labelled: ○ Reactants / products ○ Activation energy ○ ΔH ➢ Use **ΔH = Hproducts – H reactants** ➢ Calculate average Bond Enthalpy (B.E) of reactants and products using **Table 10 and 11** of data booklet **Refer to p 115 - 116 of booklet** ○ Use **ΔH = B.E reactants – B.E products** ➢ Compare complete and incomplete combustion reactions of fuels ➢ Calculate energy from blended fuel using density equation ($d = \frac{mass}{volume}$) (e.g. 85% ethanol and 15% octane) ➢ Unit conversions! (e.g. kJ to MJ) ➢ Explain why blended fuels cannot be expressed in kJ/mol ➢ Determine the balanced thermochemical equation for complete and incomplete combustion of organic molecules ○ States ○ ΔH
• the use of specific heat capacity of water to approximate the quantity of heat energy released during the combustion of a known mass of fuel and food	➢ Use q = mCΔT and q = $\frac{energy\ loss\ from\ fuel\ combustion}{n\ of\ fuel}$ ➢ Calculate % efficiency and % heat loss ➢ Evaluate precision vs accuracy