IB CHEMISTRY YEAR 2 - Unit 6

Teacher(s)	IB Chemistry PLC	**Subject Group and Course**	Group 4 - Chemistry		
Course Part and Topic	Energy and Fuels IB Chemistry Option Topic C	**SL or HL / Year 1 or 2**	SL Year 2	**Dates**	March - April 2024
Unit Description and Texts		**DP Assessment(s) for Unit**			
• Murphy et al. *Oxford IB Diploma Programme: Chemistry Course Companion*, 2014 edition. • Brown and Ford. *Pearson Baccalaureate Standard Level Chemistry*, 2nd edition.		• Practice Paper 3 (Unit Exam)			

INQUIRY: establishing the purpose of the unit

Transfer Goals

List here one to three big, overarching, long-term goals for this unit. Transfer goals are the major goals that ask students to "transfer" or apply their knowledge, skills, and concepts at the end of the unit under new/different circumstances, and on their own without scaffolding from the teacher.

Phenomenon: Utilizing bioethanol in internal combustion engines showcases the renewable and carbon-neutral nature of biofuels, providing a cleaner and more sustainable alternative to fossil fuels.

Statement of Inquiry: Energetics allows us to investigate the exchange and transformation of energy within chemical reactions, leading to a deeper understanding of the factors influencing enthalpy changes and their applications in real-world processes.

1. **Students can** determine the energy density, specific energy, and efficiency of energy transfer processes using relevant data, enthalpies of combustion, densities, and molar masses of fuels. They will apply these skills to evaluate different energy sources based on their characteristics.

2. **Students can** synthesize information and evaluate the advantages and disadvantages of various energy sources and processes. They will analyze factors such as fuel properties, reaction mechanisms, and environmental impacts to make informed decisions.

3. **Students can** apply scientific concepts to real-world scenarios, such as calculating carbon footprints, constructing nuclear equations, and explaining molecular mechanisms.

ACTION: teaching and learning through inquiry

Content / Skills / Concepts - Essential Understandings	**Learning Process** *Check the boxes for any pedagogical approaches used during the unit. Aim for a variety of approaches to help facilitate learning.*
Students will UNDERSTAND the following CONTENT: • **A useful energy source releases energy at a reasonable rate and produces minimal pollution.** • **The quality of energy is degraded as heat is transferred to the surroundings.** • **Energy and materials go from a concentrated into a dispersed form. The quantity of the energy available for doing work decreases.** • **Renewable energy sources are naturally replenished. Non-renewable energy sources are finite.** • **Energy density = energy released from fuel / volume of fuel consumed .** • **Specific energy = energy released from fuel / mass of fuel consumed .** • **The efficiency of an energy transfer = useful output energy / total input energy x 100%.** • **Fossil fuels were formed by the reduction of biological compounds that contain carbon, hydrogen, nitrogen, sulfur and oxygen.** • **Petroleum is a complex mixture of hydrocarbons that can be split into different component parts called fractions by fractional distillation.** • **Crude oil needs to be refined before use. The different fractions are separated by a physical process in fractional distillation.** • **The tendency of a fuel to auto-ignite, which leads to "knocking" in a car engine, is related to molecular structure and measured by the octane number.** • **The performance of hydrocarbons as fuels is improved by the cracking and catalytic reforming reactions.** • **Coal gasification and liquefaction are chemical processes that convert coal to gaseous and liquid hydrocarbons.** • **A carbon footprint is the total amount of greenhouse gases produced during human activities. It is generally expressed in equivalent tons of carbon dioxide.** • **Light nuclei can undergo fusion reactions as this increases the binding energy per nucleon.** • **Fusion reactions are a promising energy source as the fuel is inexpensive and abundant, and no radioactive waste is produced.** • **Absorption spectra are used to analyse the composition of stars.** • **Heavy nuclei can undergo fission reactions as this increases the binding energy per nucleon.** • **^{235}U undergoes a fission chain reaction: $^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{236}_{92}U \rightarrow X + Y +$ neutrons.** • **The critical mass is the mass of fuel needed for the reaction to be self sustaining.** • **^{239}Pu, used as a fuel in "breeder reactors", is produced from 238U by neutron capture.** • **Radioactive waste may contain isotopes with long and short half-lives.** • **Half-life is the time it takes for half the number of atoms to decay.**	Learning experiences and strategies/planning for self-supporting learning: ☒ Lecture □ Socratic seminar ☒ Small group/pair work ☒ PowerPoint lecture/notes ☒ Individual presentations ☒ Group presentations ☒ Student lecture/leading □ Interdisciplinary learning Details: *Students will learn through a combination of presentations, small group work, and practice problems.* ☒ Other(s): *practice problems* **Formative assessment(s):**

- **Light can be absorbed by chlorophyll and other pigments with a conjugated electronic structure.**
- **Photosynthesis converts light energy into chemical energy: $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$**
- **Fermentation of glucose produces ethanol which can be used as a biofuel: $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$**
- **Energy content of vegetable oils is similar to that of diesel fuel but they are not used in internal combustion engines as they are too viscous.**
- **Transesterification between an ester and an alcohol with a strong acid or base catalyst produces a different ester: $RCOOR_1 + R_2OH \rightarrow RCOOR_2 + R_1OH$**
- **In the transesterification process, involving a reaction with an alcohol in the presence of a strong acid or base, the triglyceride vegetable oils are converted to a mixture mainly comprising of alkyl esters and glycerol, but with some fatty acids.**
- **Transesterification with ethanol or methanol produces oils with lower viscosity that can be used in diesel engines.**
- **Greenhouse gases allow the passage of incoming solar short wavelength radiation but absorb the longer wavelength radiation from the Earth. Some of the absorbed radiation is re-radiated back to Earth.**
- **There is a heterogeneous equilibrium between concentration of atmospheric carbon dioxide and aqueous carbon dioxide in the oceans.**
- **Greenhouse gases absorb IR radiation as there is a change in dipole moment as the bonds in the molecule stretch and bend.**
- **Particulates such as smoke and dust cause global dimming as they reflect sunlight, as do clouds.**

<u>Students will DEVELOP the following SKILLS:</u>

- **Discussion of the use of different sources of renewable and non-renewable energy.**
- **Determination of the energy density and specific energy of a fuel from the enthalpies of combustion, densities and the molar mass of fuel.**
- **Discussion of how the choice of fuel is influenced by its energy density or specific energy.**
- **Determination of the efficiency of an energy transfer process from appropriate data.**
- **Discussion of the advantages and disadvantages of the different energy sources.**
- **Discussion of the effect of chain length and chain branching on the octane number.**
- **Discussion of the reforming and cracking reactions of hydrocarbons and explanation how these processes improve the octane number.**
- **Deduction of equations for cracking and reforming reactions, coal gasification and liquefaction.**
- **Discussion of the advantages and disadvantages of the different fossil fuels.**
- **Identification of the various fractions of petroleum, their relative volatility and their uses.**
- **Calculations of the carbon dioxide added to the atmosphere, when different fuels burn and determination of carbon footprints for different activities.**
- **Construction of nuclear equations for fusion reactions.**
- **Explanation of fusion reactions in terms of binding energy per nucleon.**
- **Explanation of the atomic absorption spectra of hydrogen and helium, including the relationships between the lines and electron transitions.**
- **Deduction of nuclear equations for fission reactions.**
- **Explanation of fission reactions in terms of binding energy per nucleon.**
- **Discussion of the storage and disposal of nuclear waste.**
- **Solution of radioactive decay problems involving integral numbers of half-lives.**
- **Identification of features of the molecules that allow them to absorb visible light.**
- **Explanation of the reduced viscosity of esters produced with methanol and ethanol.**
- **Evaluation of the advantages and disadvantages of the use of biofuels.**

Short closer quizzes for each lesson
Daily formative checks

Summative assessments:

Exam consisting of Paper 3 questions

Differentiation:

☒ Affirm identity - build self-esteem

☒ Value prior knowledge

☒ Scaffold learning

☒ Extend learning

Details:

- *SWD/504 – Accommodations Provided*
- *ELL – Reading & Vocabulary Support*
- *Intervention Support*
- *Extensions – Enrichment Tasks and Project*

• **Deduction of equations for transesterification reactions.** • **Explanation of the molecular mechanisms by which greenhouse gases absorb infrared radiation.** • **Discussion of the evidence for the relationship between the increased concentration of gases and global warming.** • **Discussion of the sources, relative abundance and effects of different greenhouse gases.** • **Discussion of the different approaches to the control of carbon dioxide emissions.** • **Discussion of pH changes in the ocean due to increased concentration of carbon dioxide in the atmosphere.**	

Approaches to Learning (ATL)

Check the boxes for any explicit approaches to learning connections made during the unit. For more information on ATL, please see the guide.

□ Thinking

□ Social

☒ Communication

☒ Self-management

□ Research

Details:

Students will communicate their findings to their peers in the form of small-group presentations.

Students must use self-management skills to complete work in a timely and accurate manner.

Language and Learning	**TOK Connections**	**CAS Connections**
Check the boxes for any explicit language and learning connections made during the unit. For more information on the IB's approach to language and learning, please see the guide.	*Check the boxes for any explicit TOK connections made during the unit*	*Check the boxes for any explicit CAS connections. If you check any of the boxes, provide a brief note in the "details" section explaining how students engaged in CAS for this unit.*

☒ Activating background knowledge ☒ Scaffolding for new learning ☒ Acquisition of new learning through practice ☒ Demonstrating proficiency Details: *Content and vocabulary introduced in previous science courses will be used in this unit.* *Students will acquire new vocabulary.* *Students will continually demonstrate proficiency with chemistry vocabulary in class discussions and group work.*	□ Personal and shared knowledge ☒ Ways of knowing □ Areas of knowledge □ The knowledge framework Details: *TOK knowledge questions will be included as discussion options for each lesson.*	□ Creativity □ Activity □ Service Details: N/A
Resources *List and attach (if applicable) any resources used in this unit*		
● Textbooks (Oxford and Pearson - see page 1) ● Online notes and videos (Schoology)		

REFLECTION: considering the planning, process, and impact of the inquiry

What worked well *List the portions of the unit (content, assessment, planning) that were successful*	**What didn't work well** *List the portions of the unit (content, assessment, planning) that were not as successful as hoped*	**Notes / Changes / Suggestions** *List any notes, suggestions, or considerations for the future teaching of this unit*
●	●	●