

definition of fuel, origin & renewability. Combustion of fuel, energy transformations, efficiency, enthalpy change

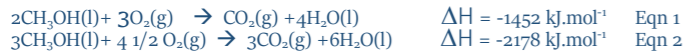
Definitions: fuel _____renewability

Fuel	Origin	Renewable	Energy transformations	Efficiency	kJ.g^{-1}	kJ.mol^{-1}	MJ/tonne
coal							
natural gas							
biogas							
petrol							
LPG							
bioethanol							
petrodiesel							
biodiesel							

Fuel	complete combustion	incomplete combustion
methane		
ethane		
methanol		
ethanol		

- the writing of balanced thermochemical equations, including states, for the complete and incomplete combustion of hydrocarbons, methanol and ethanol, using experimental data and data tables*

6. Provide an explanation for why the heat of combustion of methanol in the first thermochemical equation differs to the second. (p42)



7. When a Bunsen burner is lit the flame is yellow and leaves black soot on the outside of a container. Give the equation for this reaction and explain how a cleaner burning flame could be achieved. (p47)

8. Explain why water is written in the liquid state in a thermochemical equation for the heat of combustion of a fuel. (p50)

9. Explain why it is not possible to determine the heat of combustion in $\text{kJ}\cdot\text{mol}^{-1}$ for petrol and petrodiesel.

the definition of gas pressure including units, the universal gas equation and standard laboratory conditions (SLC) at 25 °C and 100 kPa

$$PV = nRT \quad n = \frac{V}{V_m}$$

10. How many moles of carbon dioxide are generated when 12 moles of butane are burned completely in oxygen?

11. Calculate the volume of carbon dioxide, in L, produced when 1.50 kg of methane is burned completely in oxygen. The gas volume is measured at SLC.

calculations related to the combustion of fuels including use of stoichiometry in calculations of enthalpy change to determine heat energy released, reactant and product amounts and net volume of greenhouse gases at a given temperature and pressure released per MJ of energy obtained

12. Calculate the heat energy released, in MJ, when 12.0 kg of octane undergoes complete combustion.



13. Calculate volume of CO₂ produced per kg of ethanol when it undergoes complete combustion at SLC. (p93 – 95)

use of specific heat capacity of water to determine the approximate amount of heat energy released in the combustion of a fuel

14. The thermochemical equation for combustion of CH_4 is:

$$\text{CH}_{4(g)} + 2\text{O}_{2(g)} \rightarrow \text{CO}_{2(g)} + 2\text{H}_2\text{O}_{(g)} \quad \Delta H = -802.4 \text{ kJ}\cdot\text{mol}^{-1}$$
 What is the final temperature of 1000 g water, initially at 20.0°C , if it is heated by burning 0.600 g methane?
15. Methanol, 0.355 g, underwent complete combustion in a spirit burner and was used to heat 100 mL of water. The temperature of the water rose from 20.24°C to 37.65°C . Calculate the heat of combustion of methanol in $\text{kJ}\cdot\text{mol}^{-1}$.

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redox reactions with reference to electron transfer, reduction and oxidation reactions, reducing and oxidising agents, and use of oxidation numbers to identify conjugate reducing and oxidising agents

23. Complete the mnemonic for redox reactions.

O I L R I G

24. Complete the rules for determining oxidation numbers.

- free elements - ON =
- monoatomic ions - ON =
- list the fixed ON =
- calculation of ON for polyatomic ions -

25. Determine the oxidation number of the elements in bold. a. Al_2O_3 b. $\text{Cr}_2\text{O}_7^{2-}$
26. Assign oxidation numbers to the following reaction, and hence determine whether it is a redox reaction.
- $$2\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$$

the writing of balanced half-equations for oxidation and reduction reactions and balanced ionic equations, including states, for overall redox reactions

27. Complete the mnemonic for complex redox reactions.

28. Write the half equations and the overall equation for the reaction between permanganate ions and ethanol. The skeletal equations are: $\text{MnO}_4^- \rightarrow \text{Mn}^{2+}$, $\text{C}_2\text{H}_5\text{OH} \rightarrow \text{CH}_3\text{COOH}$

galvanic cells as primary cells and as portable or fixed chemical energy storage devices that can produce electricity including common design features (anode, cathode, electrolytes, salt bridge and separation of half-cells) and chemical processes (electron and ion flows, half-equations and overall equations)

28. Draw a representation of the following galvanic cell; a. Ag/Ag^+ and Ni/Ni^{2+} . Write the half equations and overall equations and label the anode, cathode, direction of electron flow and ion movement in the salt bridge. List any visible changes which would take place in the cells.

the comparison of the energy transformations occurring in spontaneous exothermic redox reactions involving direct contact between reactants (chemical energy to heat energy) compared with those occurring when the reactants are separated in galvanic cells (chemical energy to electrical energy)

29. Write the half-cell equations and overall equation for the exothermic redox reaction between zinc and oxygen. Identify the energy transformation that occurs during this reaction.

30. Compare the reaction in Q29 with the galvanic cell with half cells, Zn/Zn^{2+} and O_2/OH^- . Write the half equations, overall equation and identify the energy transformation that occurs.

the use of the electrochemical series in designing and constructing galvanic cells and as a tool for predicting the products of redox reactions, deducing overall equations from redox half-equations and determining maximum cell voltage under standard conditions

31. What half cells could you use to build a battery with a maximum cell potential of 2.12 V?

32. Predict the products of mixing the reactants a. $\text{Cu}^{2+}_{(\text{aq})}$ with $\text{Mg}_{(\text{s})}$ and b. $\text{B}_{2(\text{l})}$ with $\text{Fe}_{(\text{s})}$

common design features of fuel cells including use of porous electrodes for gaseous reactants to increase cell efficiency

33. Draw a diagram of an alkaline fuel cell which requires inputs of H_2 and O_2 gas. (p153) Label the anode, cathode, reactants, products and electrolyte. Write the half-equations for the reactions occurring at the anode and cathode.

comparison of the use of fuel cells and combustion of fuels to supply energy with reference to their energy efficiencies, safety, fuel supply (including storage of H_2), production of greenhouse gases and applications

35. Methanol can be used in a fuel cell to generate electrical energy or combusted to produce heat energy. Compare the chemical reactions, the energy efficiencies and safety of these two processes. (p154, 159)

36. Discuss the advantages and limitations of using hydrogen as a fuel source.
(p156)

comparison of fuel cells and galvanic cells with reference to their definitions, functions, design features, energy transformations, energy efficiencies and applications

35. Complete the table to compare fuel cells with galvanic cells.

	fuel cell	galvanic cell
definition		
design features		
energy transformation		
energy efficiency		
applications: example cells		