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VCE Chemistry $\frac{3}{4}$
Fuels [1.5]
Homework

Homework Outline:

Compulsory Questions	Pg 2 - Pg 13
Supplementary Questions	Pg 14 - Pg 25



Section A: Compulsory Questions (61 Marks)

Sub-Section [1.5.1]: Explain the Production of Biofuels (Biogas, Bioethanol & Biodiesel)



Question 1 (4 marks)



- a. State the two gases produced in biogas. (2 marks)

- b. Write the balanced equation for the fermentation of glucose to produce bioethanol. (2 marks)

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Question 2 (4 marks)


- a. Explain the anaerobic process through which biogas is formed, identifying the role of bacteria. (2 marks)

- b. Amber is interested in producing bioethanol.

- i. State the conditions required for bioethanol production. (1 mark)

- ii. State the role that yeast plays in producing bioethanol. (1 mark)

Question 3 (6 marks)


- a. Explain the transesterification process used to produce biodiesel, including the key reactants and byproducts. (3 marks)

- b. Compare biogas, bioethanol, and biodiesel in terms of their production processes and main components.
(3 marks)

<u>Name of Fuel</u>	<u>Fuel Comparison</u>
Biogas	
Bioethanol	
Biodiesel	

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Sub-Section [1.5.2]: Identify & Explain Differences Between Fossil Fuels & Biofuels With Reference to Renewability

Question 4 (3 marks)



- a. Define a renewable fuel and provide one example. (1 mark)

- b. Provide two examples of fossil fuels and explain why these fuels are classified as non-renewable. (2 marks)

Question 5 (4 marks)



- a. Provide and justify an example of a fuel which is considered carbon neutral. (2 marks)

- b. Compare the carbon emissions from burning coal and biofuels. (2 marks)


Question 6 (5 marks)

- a. Bhuvi is comparing the heat of combustion of bioethanol and petrol. State and justify the difference in energy content between petrol and bioethanol. (3 marks)

- b. Provide two practices in farming which reduce the carbon neutrality of biofuels. (2 marks)

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Sub-Section [1.5.3]: Write Cellular Respiration & Photosynthesis Equations

Question 7 (3 marks)



- a. Write the equation for cellular respiration. (1 mark)

- b. Write the equation for photosynthesis. (1 mark)

- c. Identify the energy source required for photosynthesis. (1 mark)

Question 8 (4 marks)



- a. Explain how photosynthesis and cellular respiration are interconnected. (2 marks)

- b.** Identify the products of photosynthesis and state how they are used in cellular respiration. (2 marks)

Question 9 (7 marks)



- a.** Write the balanced chemical equations for both cellular respiration and photosynthesis, highlighting the relationship between each of the equations. (2 marks)

- b.** If 2 moles of glucose undergo cellular respiration, calculate:

- i.** The moles of carbon dioxide produced. (1 mark)

- ii.** The moles of water produced. (1 mark)

- c. Explain why photosynthesis is classified as an endothermic process, while cellular respiration is classified as an exothermic process. Provide one example of energy transformation in each. (3 marks)

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Sub-Section [1.5.4]: Calculate Energy Obtained From Foods

Question 10 (3 marks)



- a. Calculate the energy obtained from 10 g of carbohydrates, given that carbohydrates release 16 kJ/g. (1 mark)

- b. Arjun is comparing the energy content of fats and proteins. State and justify which macromolecule produces more energy. (2 marks)

Question 11 (2 marks)



- a. A food sample contains 5 g of fat and 8 g of carbohydrates. Calculate the total energy content. (1 mark)

- b. Explain why fats provide more energy per gram than carbohydrates. (1 mark)

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Question 12 (7 marks)

- a. A sample of food contains 25 g of carbohydrates, 15 g of proteins, and 30 g of fats. Calculate the total energy released from this food. (2 marks)

- b. Explain why cellulose cannot be used to provide energy by humans. (2 marks)

- c. A person consumes a salad meal that contains 30 g of carbohydrates, 10 g of protein, 15 g of fats, and 20 g of cellulose. Calculate the total energy content of the meal. (3 marks)

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Sub-Section: The 'Final Boss'

Question 13 (9 marks)



- a. Describe the processes used to produce biogas, bioethanol, and biodiesel. Compare their main components and identify which of these biofuels is the most carbon neutral. (3 marks)

- b. A 50 g sample of salad contains 20% (*m/m*) fat, 10% (*m/m*) protein, 50% (*m/m*) carbohydrates, 20% (*m/m*) of which is cellulose. Calculate the total energy released from the salad. (3 marks)

- c. Write the balanced equations for photosynthesis and cellular respiration and explain how they are linked in the production and use of energy. (3 marks)

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Section B: Supplementary Questions (64 Marks)

Sub-Section [1.5.1]: Explain the Production of Biofuels (Biogas, Bioethanol & Biodiesel)



Question 14 (4 marks)



- a. Describe one method through which biogas production helps reduce greenhouse gas emissions. (2 marks)

- b. State how the breakdown of glucose by yeast results in a usable fuel source. (2 marks)

Question 15 (4 marks)



- a. Discuss why anaerobic digestion is more sustainable than landfill decomposition for waste management. (2 marks)

- b. Propose how agricultural residues could be converted into bioethanol and explain the advantage of this approach. (2 marks)

Question 16 (5 marks)


- a. Explain why glycerol is produced during the synthesis of biodiesel, and suggest one industrial use for this byproduct. (2 marks)

- b. Compare the feedstocks for producing biogas, bioethanol, and biodiesel, and evaluate which feedstock has the least environmental impact. (3 marks)

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Question 17 (7 marks)

Evelyn is experimenting with methane.

- a. She is interested in the methods to source methane. Her friend suggests using crude oil as a source of methane. State another 3 non-renewable methods of obtaining methane. (2 marks)

- b. Deciding on crude oil, Evelyn is unsure of how to obtain methane from crude oil. State the process used in this separation and how it works. (3 marks)

- c. State and explain an alternative renewable method of obtaining methane gas. (2 marks)

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Sub-Section [1.5.2]: Identify & Explain Differences Between Fossil Fuels & Biofuels With Reference to Renewability

Question 18 (4 marks)



- a. Define "renewable fuel" and explain why firewood from a sustainably managed forest fits this definition. (2 marks)

- b. Name two fossil fuels and explain why their rate of consumption exceeds their natural replenishment rate. (2 marks)

Question 19 (4 marks)



- a. Justify why bioethanol derived from sugarcane is often labelled "carbon neutral," referencing photosynthesis and combustion. (2 marks)

- b.** Discuss how the heat of combustion differs between fossil fuels and biofuels, considering the molecular composition of each. (2 marks)

Question 20 (4 marks)



- a.** Contrast the carbon emission profiles of burning natural gas versus biogas. (2 marks)

- b.** List two factors during biofuel production that compromise its carbon neutrality and suggest solutions to mitigate these effects. (2 marks)

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Question 21 (6 marks)

- a. Compare and justify the rate of replenishment of biofuels and fossil fuels. State the relationship between a renewable resource and its rate of replenishment. (4 marks)

- b. Fossil fuels and biofuels both release CO_2 when burned. Despite this, why are biofuels considered more environmentally friendly in terms of CO_2 emissions? (2 marks)

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Sub-Section [1.5.3]: Write Cellular Respiration & Photosynthesis Equations

Question 22 (1 mark)



State how sunlight can be absorbed in photosynthesis.

Question 23 (2 marks)

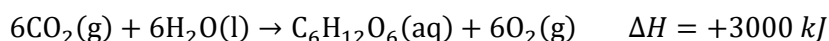


Angela is talking with her classmates and overhears that “in cellular respiration, energy is absorbed.” Evaluate this statement.

Question 24 (5 marks)



During photosynthesis, plants undergo the following reaction:



- a. If **75.0 L of carbon dioxide** is absorbed, what is the mass of glucose produced during photosynthesis? (3 marks)

b. How much energy is absorbed during this process? (2 marks)

Question 25 (7 marks)



a. Write the balanced chemical equations for aerobic respiration and fermentation in yeast and explain the key differences between the two processes. (3 marks)

b. If 4 moles of glucose undergo fermentation in yeast, calculate:

i. The moles of ethanol ($\text{C}_2\text{H}_5\text{OH}$) produced. (1 mark)

ii. The moles of carbon dioxide produced. (1 mark)

c. Compare and justify the energy output of aerobic respiration and fermentation. (2 marks)

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Sub-Section [1.5.4]: Calculate Energy Obtained From Foods

Question 26 (2 marks)



Fill in the table below.

<u>Food</u>	<u>Heat of combustion (kJg^{-1})</u>
Fats and oils	
Protein	
Carbohydrate	

Question 27 (2 marks)



Julian is looking at food labels and notices that kJ/g rather than kJ/mol to describe the heat of combustion of foods. Justify this observation.

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Question 28 (3 marks)


Emma is investigating the effect of ingestion of fibres such as cellulose in the body. State and justify what happens to cellulose during digestion.

Question 29 (4 marks)


The label on a packet of some biscuits, which has a serving size of **60.0 g**, has the following composition:

- **Protein:** 8.25 g
- **Fats:** 2.10 g
- **Carbohydrates – sugars and starches:** 42.0 g
- **Carbohydrates – cellulose fibre:** 4.65 g

a. Calculate the total possible energy available to the body per gram of biscuit. (3 marks)

- b. A sample of biscuit is combusted in a calorimeter to determine its energy value. The result obtained indicates that the energy content of the biscuit is **19 kJ/g**. Explain why there is a difference between this answer and the value obtained in **part.a**. (1 mark)

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