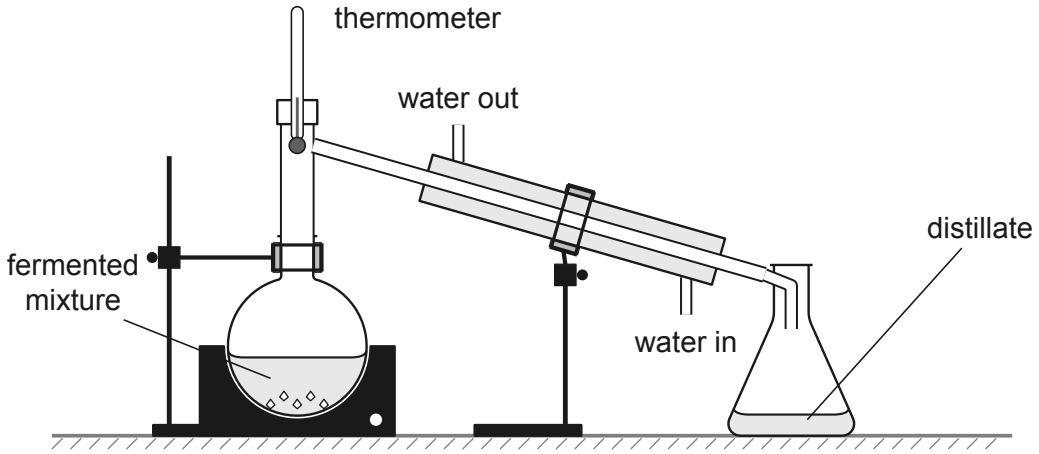
Carbon-based fuels

Student name _____ Answer all questions in the spaces provided.

Question 1 (5 marks)

Bioethanol is a transport fuel that is produced from sugar cane. Yeast is added to glucose that is obtained from the cane, and the mixture that forms is then separated by distillation. A laboratory technician uses the apparatus shown to separate a sample of this mixture.



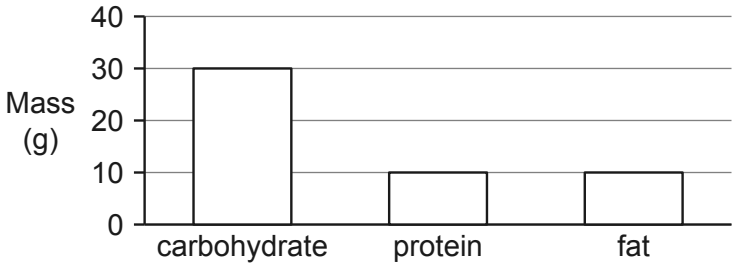
a. State why the distillate contains a higher percentage of ethanol than the fermented mixture in the heated flask does. 1 mark

b. Explain why the bioethanol that is produced from sugar cane is classified as a renewable fuel. Refer to photosynthesis in your answer. 2 marks

c. Yeast carries out cellular respiration when oxygen is present. A sealed container of yeast initially holds 9.00 g of glucose and 6.40 g of oxygen gas. Determine which of these two substances is the limiting reactant in cellular respiration. 2 marks

Question 2 (5 marks)

A student eats a snack bar shortly before a long race, and the graph shows the mass of each fuel source that is present in the bar.



a. Calculate the percentage of the energy available from this bar that the fat supplies. 2 marks

b. The car that follows the race uses bioethanol as its only fuel. Write a balanced thermochemical equation for the complete combustion of liquid ethanol. 2 marks

c. State, with reference to bond breaking and bond making, why this combustion reaction releases energy. 1 mark

End of questions

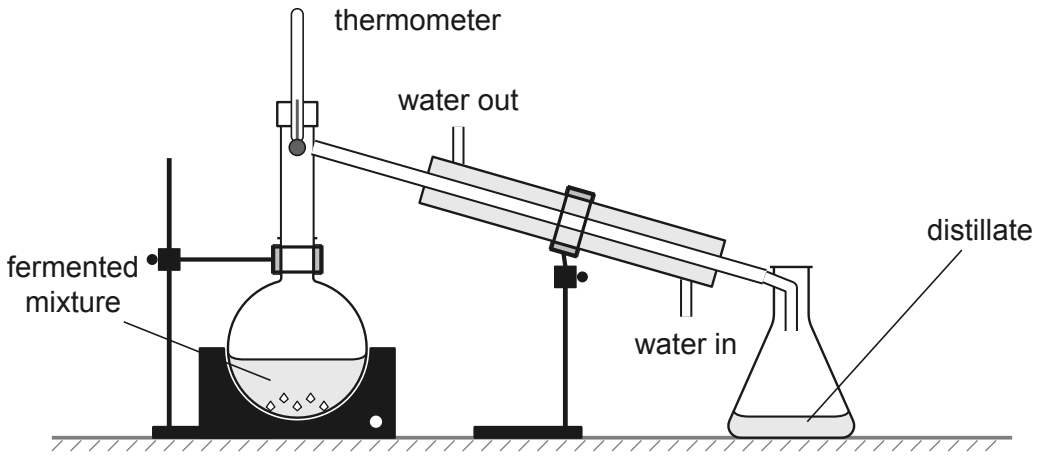
Carbon-based fuels

Solutions

Answer all questions in the spaces provided.

Question 1 (5 marks)

Bioethanol is a transport fuel that is produced from sugar cane. Yeast is added to glucose that is obtained from the cane, and the mixture that forms is then separated by distillation. A laboratory technician uses the apparatus shown to separate a sample of this mixture.



a. State why the distillate contains a higher percentage of ethanol than the fermented mixture in the heated flask does. 1 mark

① Ethanol has a lower boiling point than water, so the vapour that leaves the mixture and condenses contains a higher proportion of ethanol.

b. Explain why the bioethanol that is produced from sugar cane is classified as a renewable fuel. Refer to photosynthesis in your answer. 2 marks

① The glucose forms in the sugar cane by photosynthesis, which uses light energy to convert carbon dioxide and water into glucose and oxygen.

② A new crop of cane grows within about a year, so the fuel is replaced by natural processes within a relatively short time.

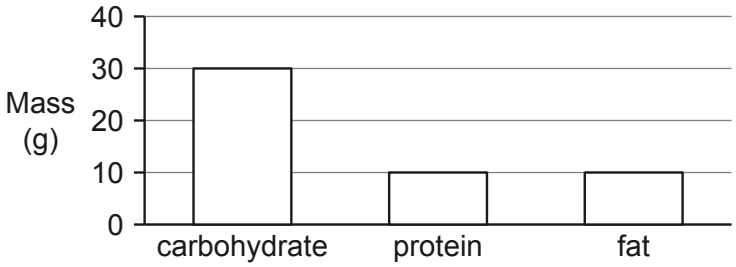
c. Yeast carries out cellular respiration when oxygen is present. A sealed container of yeast initially holds 9.00 g of glucose and 6.40 g of oxygen gas. Determine which of these two substances is the limiting reactant in cellular respiration. 2 marks

① $n(C_6H_{12}O_6) = \frac{m}{M} = \frac{9.00}{180.0} = 0.0500$ mol and $n(O_2) = \frac{m}{M} = \frac{6.40}{32.0} = 0.200$ mol

② $C_6H_{12}O_6(aq) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l)$: $n(O_2)$ needed = 6 × 0.0500 = 0.300 mol, which is more than 0.200 mol, so oxygen gas is the limiting reactant.

Question 2 (5 marks)

A student eats a snack bar shortly before a long race, and the graph shows the mass of each fuel source that is present in the bar.



a. Calculate the percentage of the energy available from this bar that the fat supplies. 2 marks

① E(total) = (30 × 16) + (10 × 17) + (10 × 37) = 1020 kJ

② % of energy from fat = $\frac{10 \times 37}{1020} \times 100 = 36.27\ldots\% = 36\%$

b. The car that follows the race uses bioethanol as its only fuel. Write a balanced thermochemical equation for the complete combustion of liquid ethanol. 2 marks

① $C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$, with states

② ΔH = –1367 kJ (or –2734 kJ if every coefficient is doubled)

c. State, with reference to bond breaking and bond making, why this combustion reaction releases energy. 1 mark

① More energy is released when the bonds in the products form than is absorbed when the bonds in the reactants break.

End of questions