C7F Organic Chemistry: Foundation Tier Practice

AQA 8462 · Calculator allowed · about 90 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Alkanes are a homologous series of hydrocarbons found in natural gas and crude oil fractions.

(a) Give the general formula for the alkane homologous series. **(1)**

(Total for Question 1 is 1 mark)

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2 Name the following organic molecules represented by their condensed formulas.

(a) Name: CH3CH2CH2CH3 **(1)**

(b) Name: CH3CHO **(1)**

(Total for Question 2 is 2 marks)

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3 A student burns methane in a laboratory Bunsen burner with a good supply of oxygen.

(a) Write the word equation for the complete combustion of methane. **(2)**

(Total for Question 3 is 2 marks)

4 A petrol fraction contains hydrocarbons of about 7 to 10 carbon atoms. Larger hydrocarbons are found in diesel and heavy fuel fractions.

(a) State whether hydrocarbons with 8 carbon atoms have higher or lower boiling points than hydrocarbons with 16 carbon atoms, and give a simple reason. **(2)**

(b) Give one common use of the petrol fraction. **(1)**

(Total for Question 4 is 3 marks)

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5 Alkenes are hydrocarbons that contain a carbon-carbon double bond and can undergo addition reactions.

(a) Give the functional group that identifies an alkene. **(1)**

(b) Name the alkene with two carbon atoms. **(1)**

(Total for Question 5 is 2 marks)

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6 A student cracks a sample of a long-chain hydrocarbon (decane) using a catalyst and heat, producing useful shorter hydrocarbons, one of which is an alkane and one of which is an alkene.

(a) State the general name for the process that breaks large hydrocarbon molecules into smaller, more useful molecules. **(1)**

(b) Give one safety precaution the student should follow when heating the hydrocarbon sample using a Bunsen burner, and explain why this precaution is needed. **(2)**

(Total for Question 6 is 3 marks)

7 Polymers are long chains of repeating units. Poly(ethene) is made from ethene monomers.

(a) Describe, in simple terms, how many small ethene molecules join together to make poly(ethene). **(2)**

(b) Give one everyday use for poly(ethene). **(1)**

(Total for Question 7 is 3 marks)

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8 A student burns a small sample of a hydrocarbon fuel in a Bunsen burner and wants to test the gases produced to confirm which products form during complete combustion.

(a) Describe how you could test the gas produced for carbon dioxide, and state the result of a positive test. **(2)**

(b) Suggest how you could show that water is also produced by the combustion, and state what you would observe. **(2)**

(Total for Question 8 is 4 marks)

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9 Extended response: Ethanol can be produced by fermentation of sugars using yeast, or by hydration of ethene using steam and a catalyst. Compare these two methods as ways to produce ethanol for use as a fuel or a solvent. In your answer discuss starting materials, conditions, relative speed, and whether the ethanol is renewable.

(Total for Question 9 is 6 marks)

10 A student cracks 71.0 g of decane using a catalyst and heat. The cracking reaction produces octane and ethene in a 1:1 mole ratio: C10H22 -> C8H18 + C2H4. Mr values: decane C10H22 = 142, octane C8H18 = 114. The actual yield of octane obtained is 72% of the maximum possible mass.

(a) Calculate the maximum theoretical mass of octane that could be produced from 71.0 g of decane (before yield). **(2)**

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(b) Using the 72% yield, calculate the actual mass of octane produced. **(2)**

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(Total for Question 10 is 4 marks)

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11 Hydrocarbons can be separated by fractional distillation. A student distils a mixture and collects two fractions. Fraction A boils at about 40 degrees C and Fraction B boils at about 180 degrees C.

(a) Suggest which fraction (A or B) contains smaller hydrocarbon molecules and explain your reasoning. **(2)**

(b) Give one industrial product that would be expected to have a boiling point near 180 degrees C and be found in the heavier fractions. **(2)**

(Total for Question 11 is 4 marks)

12 Some car exhaust emissions contain nitrogen oxides NO and NO2, formed in engines from nitrogen and oxygen in the air. A catalytic converter reduces these nitrogen oxides back to nitrogen gas using a catalyst and carbon monoxide as a reducing agent. Write a simple word equation for the reduction of nitrogen monoxide using carbon monoxide and state why a catalyst is needed in a catalytic converter.

(a) Write the word equation for the reaction of nitrogen monoxide with carbon monoxide to form nitrogen and carbon dioxide. **(2)**

(b) State why a catalyst is needed in a catalytic converter. **(2)**

(Total for Question 12 is 4 marks)

Mark scheme · C7F Organic Chemistry: Foundation Tier Practice

Question 1

- (a) **B1** general formula CnH2n+2 cao
- **(a) Answer: CnH2n+2**

Question 2

- (a) **B1** butane cao
- **(a) Answer: Butane**
- (b) **B1** ethanal (accept acetaldehyde) cao
- **(b) Answer: Ethanal**

Question 3

- (a) **M1** correct reactants and products named: methane + oxygen -> carbon dioxide + water
- (a) **A1** word equation presented correctly with reactants and products in the correct order using -> or gives, cao
- **(a) Answer: Methane + oxygen -> carbon dioxide + water**

Question 4

- (a) **M1** states lower boiling point for C8 than for C16
- (a) **A1** reason: smaller molecules have weaker van der Waals forces due to less surface area/fewer electrons, oe
- **(a) Answer: Lower boiling point, because smaller molecules have weaker van der Waals forces due to less surface area and fewer electrons.**
- (b) **B1** use as fuel for petrol engines/cars cao
- **(b) Answer: Fuel for car engines (petrol).**

Question 5

- (a) **B1** carbon-carbon double bond (C=C) cao
- **(a) Answer: Carbon-carbon double bond (C=C).**
- (b) **B1** ethene cao
- **(b) Answer: Ethene**

Question 6

- (a) **B1** cracking cao
- **(a) Answer: Cracking.**
- (b) **M1** states a valid precaution such as wear eye protection, keep the flame away from the flammable hydrocarbon sample and vapour, or work in a well-ventilated area/fume cupboard
- (b) **A1** gives a reason linked to the precaution: e.g. hydrocarbons and their vapours are flammable and could ignite, or fumes could be harmful if inhaled, oe
- **(b) Answer: Keep the flame away from the flammable hydrocarbon sample and work in a well-ventilated area, because hydrocarbon vapours are flammable and could ignite or be harmful if inhaled.**

Question 7

- (a) **M1** states that many ethene monomers join together in a repeating chain (polymerisation)
- (a) **A1** refers to the breaking of the double bond and joining of carbon atoms to make a long chain, oe
- **(a) Answer: Many ethene monomers join together by opening their C=C double bonds and linking the carbon atoms into a long repeating chain.**
- (b) **B1** e.g. plastic bags, plastic bottles, packaging, containers, oe
- **(b) Answer: Plastic bags or packaging.**

Question 8

- (a) **M1** states the method: bubble/pass the gas produced through limewater
- (a) **A1** states the positive result: the limewater turns cloudy (milky) if carbon dioxide is present, oe
- **(a) Answer: Bubble the gas through limewater; the limewater turns cloudy (milky) if carbon dioxide is present.**
- (b) **B1** holds a cool, dry surface (e.g. a cool glass or metal spoon) above the flame, oe
- (b) **B1** droplets of water/condensation form on the cool surface, showing water vapour is a product, oe
- **(b) Answer: Hold a cool, dry surface above the flame; droplets of water (condensation) form on it, showing that water is produced by the combustion.**

Question 9

- **Level 3** (5-6): Detailed comparison. Discusses both fermentation and hydration with several accurate points about starting materials, conditions, speed, yield and renewability. Draws a supported conclusion about which method is more suitable in a given context.
- **Level 2** (3-4): Some comparison. Mentions both methods and at least two correct points such as different starting materials and one difference in conditions or speed. Limited conclusion or justification.
- **Level 1** (0-2): Simple statements or description of one method only, or brief, largely factual points without comparison or judgement.
- **Indicative content:**
  - Fermentation: starting material is sugar (glucose) from biomass; hydration: starting material is ethene from crude oil (non-renewable).
  - Fermentation conditions: yeast, warm (about 30-40 degrees C), anaerobic, relatively low temperature and pressure; hydration conditions: steam, high temperature and pressure and acid catalyst, industrial conditions.
  - Speed and yield: fermentation is slower, gives lower concentration of ethanol (often 10-15% in batch) and requires distillation to purify; hydration is faster, continuous process and can give higher yields and purer product.
  - Renewability: fermentation uses renewable biomass (sugars); hydration uses ethene derived from fossil fuels so is non-renewable unless ethene from bio-ethanol cracking is used.
  - Uses and choice: for renewable fuel fermentation may be preferred despite lower yield; for large-scale pure ethanol for industry hydration may be preferred. Conclude with a justified statement comparing suitability for fuel or solvent.

Question 10

- (a) **M1** calculates moles of decane: 71.0 / 142 = 0.500 moles
- (a) **A1** correct theoretical mass: mass = moles x Mr = 0.500 x 114 = 57.0 g cao
- **(a) Answer: 57.0 g**
- (b) **M1** applies yield: actual mass = 57.0 x 0.72
- (b) **A1** 41.0 g cao
- **(b) Answer: 41.0 g**

Question 11

- (a) **M1** identifies Fraction A as smaller molecules
- (a) **A1** reason relates lower boiling point to smaller molecules having weaker intermolecular forces/less surface area, oe
- **(a) Answer: Fraction A contains smaller hydrocarbon molecules, because its lower boiling point indicates weaker intermolecular forces associated with smaller molecules.**
- (b) **B1** diesel fuel, kerosene, or heavy fuel oil as an example located in heavier fractions
- (b) **B1** accept naming diesel or heavy fuel oil as a single example cao
- **(b) Answer: Diesel fuel (a heavy fraction).**

Question 12

- (a) **M1** correct reactants and products named: nitrogen monoxide + carbon monoxide -> nitrogen + carbon dioxide
- (a) **A1** equation presented correctly using -> or gives cao
- **(a) Answer: Nitrogen monoxide + carbon monoxide -> nitrogen + carbon dioxide**
- (b) **B1** catalyst speeds up the reaction without being used up, allowing reactions to occur at lower temperatures or faster rates
- (b) **B1** specifically allows harmful gases to be converted to less harmful ones quickly as exhaust passes through, oe