Hydrocarbons

Standard difficulty · 20 questions · 40 marks · Time: 36 minutes

Name: _____ Date: _____ Score: ____ / 40

Show your working for Sections B and C. Answers are on the last page — try every question first!

Section A — Choose the correct answer 8 × 1 = 8 marks

1. The general formula of alkanes is:
(a) C_nH_{2n-2} **(b)** C_nH_n **(c)** C_nH_{2n} **(d)** C_nH_{2n+2}

2. But-1-ene reacts with HBr in the presence of a peroxide. The main product is:
(a) 1-bromobutane **(b)** ethanal (two molecules)
(c) propanone and methanal **(d)** methanal (two molecules)

3. An open-chain hydrocarbon C_5H_8 has at most one multiple bond. It is an:
(a) arene **(b)** alkene **(c)** alkyne **(d)** alkane

4. In electrophilic substitution of a benzene ring carrying $–NH_2$, the group is:
(a) meta (activating) **(b)** ortho and para (deactivating)
(c) ortho and para (activating) **(d)** meta (deactivating)

5. Which of these is aromatic?
(a) Pyridine **(b)** The cyclopentadienyl cation
(c) Cyclopenta-1,3-diene **(d)** Cyclooctatetraene

6. Ethanol is treated with concentrated H_2SO_4 at 443 K. The product is:
(a) ethyne **(b)** propene
(c) but-2-ene (main product) **(d)** ethene

7. Which of these shows cis–trans (geometrical) isomerism?
(a) propene **(b)** but-2-ene
(c) 2-methylbut-2-ene **(d)** pent-1-ene

8. Assertion (A): The addition of water (acid catalyst) to 2-methylpropene gives mainly 2-methylpropan-2-ol.
Reason (R): In the addition to an unsymmetrical alkene, H^+ adds first to the carbon with fewer hydrogens.
(a) Both A and R are true, and R is the correct explanation of A.
(b) Both A and R are true, but R is not the correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

Section B — Short answer 8 × 2 = 16 marks

9. State Markovnikov's rule, with an example.

10. Write the balanced equation for the complete combustion of methane. How many moles of oxygen are needed to burn 1 mol of it?

11. What happens when 2-methylpropene reacts with ozone, then zinc and water? Name the product and give its formula.

12. Name the products of ozonolysis (ozone, then zinc and water) of pent-2-ene.

13. Benzene is treated with Br_2 with anhydrous $FeBr_3$. Name the reaction and the product, and give the electrophile.

14. Complete and name: ethene + H_2 over nickel at 523 K → ?

15. 28 g of ethene (C_2H_4) burns completely. Find the masses of carbon dioxide and water formed. (Atomic masses: H = 1 u, C = 12 u, O = 16 u)

16. A mixture of $CH_3CH_2CH_2Br$ and C_2H_5Br is heated with sodium in dry ether. Which alkanes are formed? Why is this not a good way to make one pure alkane?

Section C — Word problems — 4 × 4 = 16 marks

17. Describe three methods of preparing alkanes, with equations.

18. An alkene A gives propanone and ethanal on ozonolysis. (a) Identify A and write its structure. (b) What is the main product when A reacts with HBr? (c) What is it with HBr in the presence of a peroxide?

19. 105 g of propene is burnt completely in oxygen. (a) Write the balanced equation. (b) Find the mass of oxygen used. (c) Find the masses of carbon dioxide and water formed. (d) Check that mass is conserved. (Atomic masses: H = 1 u, C = 12 u, O = 16 u)

20. How will you obtain the following? Give the reagents and conditions. (a) ethylbenzene from benzene; (b) benzene from ethyne; (c) nitrobenzene from benzene

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Answer key

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Q	Answer	Working
1	**(d) C_nH_{2n+2}**	—
2	**(a) 1-bromobutane**	anti-Markovnikov (peroxide effect)
3	**(c) alkyne**	C_nH_{2n-2}
4	**(c) ortho and para (activating)**	it releases electrons into the ring
5	**(a) Pyridine**	pyridine: 6 π electrons, cyclic, planar and conjugated (4n + 2)
6	**(d) ethene**	acidic dehydration
7	**(b) but-2-ene**	each carbon of the C=C must carry two different groups
8	**(c) A is true, but R is false.**	A is true: the main product is 2-methylpropan-2-ol. R is false.
9	**When HX adds to an unsymmetrical alkene, the negative part (X) goes to the carbon with fewer hydrogen atoms. $CH_3CH{=}CH_2$ + HBr → $CH_3CHBrCH_3$ (2-bromopropane).**	—
10	**$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$; 2 mol**	balance C, then H, then O
11	**Propanone and methanal: CH_3COCH_3 + HCHO**	ozonolysis breaks the C=C into two C=O
12	**ethanal and propanal**	each C=C carbon becomes C=O
13	**Bromination; bromobenzene; electrophile Br^+**	electrophilic substitution
14	**Ethane (catalytic hydrogenation)**	—
15	**88 g CO_2; 36 g H_2O**	$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$; 1 mol of C_2H_4
16	**butane, pentane, hexane; three products form, and they are hard to separate**	any two alkyl groups can join
17	**From alkenes and alkynes by hydrogenation over Ni, Pt or Pd: $CH_2{=}CH_2 + H_2 \rightarrow CH_3CH_3$. From alkyl halides by the Wurtz reaction: $2CH_3Br + 2Na \rightarrow C_2H_6 + 2NaBr$ (dry ether). From carboxylic acid salts by decarboxylation with soda lime: $CH_3COONa + NaOH \rightarrow CH_4 + Na_2CO_3$; or by Kolbe's electrolysis.**	—
18	**(a) 2-methylbut-2-ene; (b) 2-bromo-2-methylbutane; (c) 2-bromo-3-methylbutane**	join the carbonyl carbons with a double bond; Markovnikov without peroxide

Q	Answer	Working
19	**(a) $2C_3H_6 + 9O_2 \rightarrow 6CO_2 + 6H_2O$; (b) 360 g; (c) 330 g CO_2, 135 g H_2O; (d) 465 g on each side**	2.5 mol of C_3H_6
20	**(a) Treat benzene with C_2H_5Cl with anhydrous $AlCl_3$; (b) Pass ethyne through a red-hot iron tube at 873 K; (c) Treat benzene with concentrated HNO_3 and concentrated H_2SO_4**	electrophilic substitution for groups on the ring

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