Engineering Daily 29 [Set 03] EV - Answer Sheet

Organic Chemistry [Nomenclature + Isomerism + Alkenes, Alkynes + Aromatic Compounds + Polymers]

Total Marks: 50 **Negative Marks:** 0.25 **Time:** 1 Hour

MCQ 50 marks

1. **D. 56%**
Explanation: Here, propane has 6 1° H and 2 2° H
Relative amount of 1-chloropropane = $6 \times 1 = 6$
Relative amount of 2-chloropropane = $2 \times 3.8 = 7.6$
Therefore, 2-chloropropane = $\frac{7.6}{6+7.6} \times 100\% \approx 56\%$

2. **C. 2-Methylbutane**
Explanation: In isomerization, a straight-chain alkane is converted into its branched isomer
$CH_3(CH_2)_3CH_3 \xrightarrow{AlCl_3,\ HCl,\ 300°C} (CH_3)_2CHCH_2CH_3$
Product: 2-methylbutane

3. **B. 2,2,4-Trimethylhexane**
Explanation: Longest chain: from one CH_3 of the tert-butyl group to the terminal CH_3 = 6 carbons, so the parent is hexane
Numbering from the left gives the methyl locant set {2,2,4}, which is the lowest
Therefore, the name is 2,2,4-trimethylhexane

4. **C.** $CH_3CH_2C(CH_3) = C(CH_3)Cl$
Explanation: Condition: each carbon of the double bond must carry two different groups
In $CH_3CH_2C(CH_3) = C(CH_3)Cl$, the left carbon has C_2H_5 and CH_3, the right carbon has CH_3 and Cl
Therefore, the compound shows geometrical isomerism

5. **D. Cyclopentadienyl anion**
Explanation: The cyclopentadienyl anion is planar, cyclic and fully conjugated
π electrons = 4 + 2 (lone pair) = 6
$4n + 2 = 6 \Rightarrow n = 1$ (an integer)
Therefore, it is aromatic

6. **C. Cycloheptatriene**
Explanation: Cycloheptatriene has an sp^3-hybridized CH_2 carbon in its ring
So the ring lacks a fully conjugated cyclic π system
Therefore, it is not aromatic

7. **A. Propane-1,2-diol**
Explanation: Baeyer's reagent adds two −OH groups across the double bond (glycol formation)
$CH_3CH = CH_2 \xrightarrow{KMnO_4} CH_3CH(OH)CH_2OH$
Product: propane-1,2-diol

8. **B. Nitration first, then** $Cl_2/FeCl_3$
Explanation: The $-NO_2$ group is a meta director
Nitration first with concentrated HNO_3 and concentrated H_2SO_4 gives nitrobenzene
Subsequent chlorination with $Cl_2/FeCl_3$ places Cl at the meta position
Product: m-chloronitrobenzene

9. **A. Hexamethylbenzene**
Explanation: Three alkyne molecules cyclize to form a benzene ring (trimerization)
$3CH_3 - C \equiv C - CH_3 \rightarrow C_6(CH_3)_6$
Each ring carbon carries one CH_3, so the product is hexamethylbenzene

10. **B.** +40°
Explanation: $[\alpha] = \frac{\alpha}{l \times c}$
Here, $c = \frac{1.5}{25} = 0.06\ gmL^{-1}$
$l = 20\ cm = 2\ dm$
Therefore, $[\alpha] = \frac{4.8}{2 \times 0.06} = +40°$

11. **A. Propane**
Explanation: In Wolff–Kishner reduction, the C = O group is converted into CH_2
The intermediate hydrazone $(CH_3)_2C = NNH_2$ loses N_2 on heating with KOH
$CH_3COCH_3 \rightarrow CH_3CH_2CH_3$
Product: propane

12. **B. 3-Methylhex-1-en-4-yne**
Explanation: The main chain has 6 carbons and contains both a double and a triple bond
Numbering from the left gives ene = 1, yne = 4, i.e. the lowest locant set {1,4}
The methyl group is on C3

'ene' is written before 'yne' in the name
Therefore, the name is 3-methylhex-1-en-4-yne

13. C. n-Hexane

Explanation: Straight-chain n-hexane has the largest surface area
So the van der Waals (London) attractions between its molecules are the strongest
Therefore, n-hexane has the highest boiling point

14. C. Cyclohexa-1,4-diene

Explanation: In Birch reduction, the benzene ring is partially reduced
Two H atoms add at positions 1 and 4 of the ring
So the non-conjugated cyclohexa-1,4-diene is obtained

15. B. 3 in total, 2 active

Explanation: $CH_3 - CHBr - CHBr - CH_3$ has 2 chiral carbons and two identical halves (symmetric)
Total stereoisomers = $2^{n-1} + 2^{\frac{n}{2}-1} = 2^1 + 2^0 = 3$
Optically active = $2^{n-1} = 2$ (d and l)
The remaining 1 is the meso form, which is optically inactive

16. C. Benzene

Explanation: Soda lime replaces each $-COONa$ group with H (decarboxylation)
$C_6H_4(COONa)_2 + 2NaOH \xrightarrow{CaO,\ \Delta} C_6H_6 + 2Na_2CO_3$
Product: benzene

17. D. Be_2C

Explanation: Be_2C is a methanide carbide
$Be_2C + 4H_2O \rightarrow 2Be(OH)_2 + CH_4$
Therefore, Be_2C produces methane with water

18. C. SO_3

Explanation: The S atom of SO_3 is bonded to three electronegative O atoms, so it is electron-deficient (partially positive)
Hence SO_3 attacks the benzene ring as the electrophile
$C_6H_6 + SO_3 \rightarrow C_6H_5SO_3H$

19. A. m-Cresol

Explanation: Zinc dust replaces the phenolic $-OH$ group with H
$CH_3C_6H_4OH + Zn \rightarrow CH_3C_6H_5 + ZnO$
Therefore, m-cresol gives toluene

20. D. Isooctane

Explanation: On the octane scale, isooctane (2,2,4-trimethylpentane) is assigned an octane number of 100
For example, a petrol with octane number 85 knocks like a mixture of 85% isooctane and 15% n-heptane

21. C. 1,1,2,2-Tetrabromopropane

Explanation: Step 1:
$CH_3C \equiv CH + Br_2 \rightarrow CH_3CBr = CHBr$
Step 2:
$CH_3CBr = CHBr + Br_2 \rightarrow CH_3CBr_2 - CHBr_2$
Product: 1,1,2,2-tetrabromopropane

22. C. $(CH_3)_3C - CHO$

Explanation: Keto–enol tautomerism requires an H on the carbon next to the carbonyl group (α-carbon)
In $(CH_3)_3C - CHO$, the α-carbon is quaternary and has no H
Therefore, it does not show keto–enol tautomerism

23. C. 2-Methylbut-2-ene

Explanation: Saytzeff's rule: H is removed from the β-carbon bearing fewer H atoms
So the more substituted (more stable) alkene is the major product
Therefore, the product is $(CH_3)_2C = CH - CH_3$, i.e. 2-methylbut-2-ene

24. A. $TiCl_3$

Explanation: Propene is polymerized using $TiCl_3$ as catalyst (140 atm, 120°C)
$n\,CH_2 = CH - CH_3 \xrightarrow{TiCl_3} -[CH_2 - CH(CH_3)]_n-$

25. A. $CH_3 - NH - CH_2CH_2CH_3$ **and** $CH_3CH_2 - NH - CH_2CH_3$

Explanation: Metamerism: different distribution of alkyl groups on either side of the same divalent group (e.g. $-O-$, $-NH-$, $-CO-$)
Around $-NH-$, one compound has CH_3 and

C_3H_7, the other has C_2H_5 and C_2H_5
Therefore, the two compounds are metamers

26. B. 6
Explanation: With the two Cl at 1,2: Br can be at 3 or 4 → 2
With the two Cl at 1,3: Br can be at 2, 4 or 5 → 3
With the two Cl at 1,4: Br can be at 2 → 1
Therefore, total isomers = 2 + 3 + 1 = 6

27. B. Butanone
Explanation: By Markovnikov's rule, −OH adds to the internal carbon, giving the enol $CH_3CH_2C(OH) = CH_2$
The enol tautomerizes to a ketone
Therefore, the product is $CH_3CH_2COCH_3$, i.e. butanone

28. B. Ethylene glycol and terephthalic acid
Explanation: Terylene is a polyester (condensation polymer)
Ethylene glycol (ethane-1,2-diol) and terephthalic acid (benzene-1,4-dicarboxylic acid) combine with loss of water to form terylene

29. D. 2,2-Dibromobutane
Explanation: The first HBr adds by Markovnikov's rule:
$CH_3CH_2C \equiv CH \rightarrow CH_3CH_2CBr = CH_2$
The second HBr also adds by Markovnikov's rule, placing Br on the carbon that already carries Br
Therefore, the product is $CH_3CH_2CBr_2CH_3$, i.e. 2,2-dibromobutane

30. B. 4-Methyl-5-oxopentanoic acid
Explanation: −COOH is the principal functional group, so its carbon is C1
C1 (COOH), C2, C3, C4 (bearing CH_3), C5 (CHO); 5 carbons in total
The terminal CHO is named with the prefix 'oxo'
Therefore, the name is 4-methyl-5-oxopentanoic acid

31. A. 9
Explanation: n-Heptane: 1
Methylhexanes (2-, 3-): 2
Dimethylpentanes (2,2-, 2,3-, 2,4-, 3,3-): 4
3-Ethylpentane: 1
2,2,3-Trimethylbutane: 1
Therefore, total = 1 + 2 + 4 + 1 + 1 = 9

32. C. $CH_3 \cdot + Cl\cdot \rightarrow CH_3Cl$
Explanation: In a chain termination step, two free radicals combine to form a stable molecule
$CH_3 \cdot + Cl\cdot \rightarrow CH_3Cl$
No new free radical is formed in this step, so the chain stops

33. D. But-1-yne
Explanation: Terminal alkynes (−C ≡ C − H) have an acidic H
But-1-yne is a terminal alkyne, so it gives a white precipitate of silver alkynide
$CH_3CH_2C \equiv CH \rightarrow CH_3CH_2C \equiv CAg$

34. B. 2-Ethyl-3-methylhex-1-ene
Explanation: Longest chain containing the double bond:
$CH_2 = C - CH - CH_2 - CH_2 - CH_3$, i.e. 6 carbons
Giving the double bond the lowest number: C1=C2
Ethyl on C2 and methyl on C3; ethyl comes first alphabetically
Therefore, the name is 2-ethyl-3-methylhex-1-ene

35. B. To generate the Cl^+ electrophile
Explanation: $FeCl_3$ is a Lewis acid
$Cl_2 + FeCl_3 \rightarrow Cl^+ + FeCl_4^-$
The Cl^+ formed attacks the benzene ring as the electrophile

36. D. 56 kg
Explanation: Molar mass of $CaC_2 = 40 + 2 \times 12 = 64$
128 kg of $CaC_2 = \frac{128}{64} = 2$ kmol
1 mol CaC_2 gives 1 mol C_2H_2, which gives 1 mol C_2H_4
So, $C_2H_4 = 2 \times 28 = 56$ kg
Mass is unchanged on polymerization, so polythene = 56 kg

37. D. Butane
Explanation: In decarboxylation, the −COONa group is replaced by H, so the carbon count drops by 1
$CH_3CH_2CH(CH_3)COONa + NaOH \xrightarrow{CaO,\ \Delta}$

$CH_3CH_2CH_2CH_3 + Na_2CO_3$
Product: butane

38. D. Benzotrichloride ($C_6H_5CCl_3$)
Explanation: With heat and light, the side-chain H atoms are substituted by a free-radical mechanism
$C_6H_5CH_3 \rightarrow C_6H_5CH_2Cl \rightarrow C_6H_5CHCl_2 \rightarrow C_6H_5CCl_3$
With excess Cl_2, the final product is benzotrichloride

39. D. cis-But-2-ene
Explanation: Lindlar's catalyst is partially poisoned, so the reaction stops at the alkene stage
The two H atoms add to the same side of the triple bond (syn addition)
Therefore, the product is cis-but-2-ene

40. B. 2-Methylbut-2-ene
Explanation: Joining the carbonyl carbons of the two products with a double bond gives the original alkene
$(CH_3)_2C = O + O = CH - CH_3 \rightarrow (CH_3)_2C = CH - CH_3$
Therefore, the alkene is 2-methylbut-2-ene

41. D. 116
Explanation: Diamine monomer: hexamethylenediamine $H_2N - (CH_2)_6 - NH_2$, i.e. $C_6H_{16}N_2$
$M = 6 \times 12 + 16 \times 1 + 2 \times 14$
$= 72 + 16 + 28$
$= 116$

42. C. 1-Bromo-2-methylpropane
Explanation: With peroxide, the reaction proceeds by a free-radical mechanism, against Markovnikov's rule
$Br\cdot$ adds to the terminal CH_2 to form the stable 3° radical, which then takes up H
Therefore, the product is $(CH_3)_2CH - CH_2Br$, i.e. 1-bromo-2-methylpropane

43. A. Benzoic acid
Explanation: A strong oxidant oxidizes any side chain bearing a benzylic H completely, regardless of its length
The carbon attached to the ring becomes $-COOH$
$C_6H_5CH_2CH_3 \xrightarrow{KMnO_4} C_6H_5COOH + CO_2$

44. A. 3
Explanation: In the Wurtz reaction of two different alkyl halides, three types of coupling occur
$C_2H_5 + C_2H_5 \rightarrow$ butane
$C_2H_5 + C_3H_7 \rightarrow$ pentane
$C_3H_7 + C_3H_7 \rightarrow$ hexane
Therefore, 3 alkanes in total

45. A. 3-Nitrobenzoic acid
Explanation: $-COOH$ is the principal group, so the parent name is benzoic acid and the carbon bearing $-COOH$ is C1
The $-NO_2$ group then gets the lowest number, 3
Therefore, the name is 3-nitrobenzoic acid

46. B. $-CHO$
Explanation: The $-CHO$ group withdraws electrons from the ring through $-M$ and $-I$ effects
This lowers the electron density most at the ortho and para positions
So the incoming electrophile goes to the meta position, i.e. $-CHO$ is a meta director

47. A. $(CH_3)_2C = C(CH_3)_2$
Explanation: The more alkyl groups on the double-bond carbons, the greater the hyperconjugation and the more stable the alkene
$(CH_3)_2C = C(CH_3)_2$ (tetramethylethylene) has 4 alkyl groups on its double bond
Therefore, it is the most stable

48. A. 291
Explanation: Addition reaction:
$C_6H_6 + 3Cl_2 \xrightarrow{h\nu} C_6H_6Cl_6$ (BHC or gammexane)
$M = 6 \times 12 + 6 \times 1 + 6 \times 35.5$
$= 72 + 6 + 213$
$= 291$

49. D. 2-Bromo-2-methylbutane
Explanation: Markovnikov's rule: H^+ adds to the carbon with more H ($= CH_2$)
This forms the more stable 3° carbocation
Br^- then adds to that 3° carbon
Therefore, the product is 2-bromo-2-methylbutane

50. **A.** $CH_2 = CHCl$

Explanation: The monomer of polyvinyl chloride (PVC) is vinyl chloride ($CH_2 = CHCl$)

$n\,CH_2 = CHCl \rightarrow -[CH_2 - CHCl]_n-$