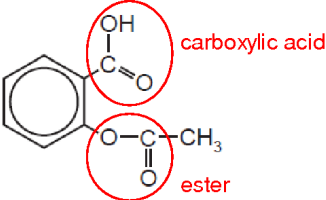
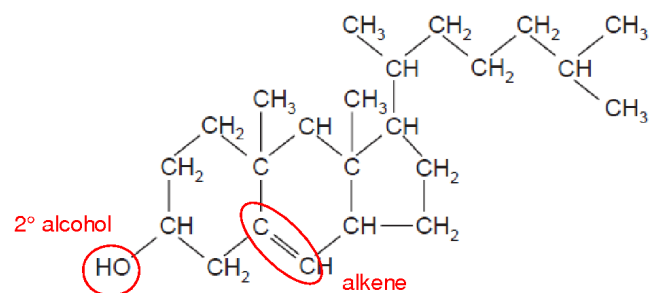


- 1 **D**
 $\text{P}_4\text{O}_{10} + 6\text{CaO} \rightarrow 2\text{Ca}_3(\text{PO}_4)_2$
- 2 **A**
 $m(\text{N}) \text{ in } 14 \text{ g fertiliser} = \frac{15}{100} \times 14 \text{ g}$
 $n(\text{N}) = \frac{15}{100} \times 14 \times \frac{1}{14.0} \text{ mol}$
 $c(\text{N}) = \frac{15}{100} \times 14 \times \frac{1}{14.0} \times \frac{1}{5} = 0.03 \text{ mol dm}^{-3}$
- 3 **A**
 15 p, (32-15) n, (15+3) e⁻
- 4 **A**
 HCHO must use lone pair on O to form H bond. It cannot use its H atoms because both H atoms are bonded to C and not to O. Liquid Y must provide the a H atom to form the H bond to O of HCHO. Only CH₃OH has a suitable H atom to form the H bond because the H atom is bonded to O.
- 5 **C**
 $m(\text{H}_2\text{O}) = 1.00 \text{ g}$ (because density of ice is 1.00 g cm^{-3})
 Use $pV = nRT$
 $V = \frac{mRT}{pM} = \frac{1 \times 8.31 \times 596}{101 \times 10^3 \times 18.0} = 2.72 \times 10^{-3} \text{ m}^3 = 2.72 \text{ dm}^3$
- 6 **D**
 sulfur: covalent bonds between S atoms in S₈ molecule
 chlorine: covalent bond between Cl atoms in Cl₂ molecule
- 7 **D**
 $pV = nRT$; constant n , $T \Rightarrow pV = \text{constant} \Rightarrow$ **A, B, C** wrong
 constant n , $p \Rightarrow V \propto T \Rightarrow$ **D** correct.
- 8 **B**
 1 mol of gaseous I atoms formed
- 9 **C**
 $\Delta H = \Sigma \Delta H_f(\text{products}) - \Sigma \Delta H_f(\text{reactants})$
 $= 2(-110) - (-940) = +720 \text{ kJ mol}^{-1}$
- 10 **C**
 cold pack \Rightarrow endo process; $\Delta H > 0$. Process is spontaneous; $\Delta G < 0$.

- 11 **B**
 $K_c = \frac{[Y]^2[Z]^3}{[W][X]^2}$
 Units: $(\text{mol dm}^{-3})^5 / (\text{mol dm}^{-3})^3 = (\text{mol dm}^{-3})^2 = \text{mol}^2 \text{ dm}^{-6}$
- 12 **C**
 At lower T , peak is higher and shifts to left.
- 13 **A**
 $\text{Na}_2\text{O} + \text{H}_2\text{O} \rightarrow 2\text{NaOH}$
- 14 **A**
 Al³⁺ has the highest charge density. e.g. AlCl₃ is covalent.
- 15 **B**
 $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$
 Total mass of limestone = 1000 + 200 = 1200 million tonnes
 $m(\text{CO}_2) = \frac{44.0}{100.1} \times 1200 = 527 \text{ million tonnes}$
- 16 **C**
 Cl₂ has weaker van der Waals' forces of attraction between Cl₂ molecules. I₂ molecules have more electrons per molecule and so are more polarisable.
- 17 **C**
 Limewater is aqueous Ca(OH)₂, a strong base. Strong bases liberate NH₃ (a weak base) from its salt (NH₄⁺).
- 18 **D**
 The operating temperature of the Haber process is about 500°C. So the hot NH₃ can be used to heat the incoming gases.
- 19 **C**
 $\text{SO}_2 + \text{Ca}(\text{OH})_2 \rightarrow \text{CaSO}_3 + \text{H}_2\text{O}$
- 20 **B**
 alkene + HI is electrophilic addition; hydrolysis of RX is nucleophilic substitution.
- 21 **A**
 C*HBrCl-CBrCl₂ is formed. C* is chiral.
- 22 **A**
 This is an addition reaction to form the PVC polymer. -CH₂CHCl- is the repeat unit. There are no double bonds in the polymer; all the C atoms are sp³ hybridised. Hence all the C-C-C bond angles are 109°.

- 23 **D**
D is a 3° RX and so will react via S_N1 mechanism. A and B are 1° RX; react via S_N2. C is a 2° RX and reacts via competing S_N1 and S_N2 mechanisms.
- 24 **D**
X is an alcohol which undergoes dehydration to give alkenes. Since X cannot be oxidised, it must be a 3° alcohol. Only alkene in D can be formed from a 3° alcohol (add OH and H across double bond to get structure of X).
- 25 **C**
The formula of the product (C₄H₆O₄) has two more O atoms and four fewer H atoms compared to the starting alcohol (C₄H₁₀O₂). So two -CO₂H groups are formed. The two alcohol groups must be 1° alcohols, i.e. -OH groups are attached to the terminal carbon atoms of the four carbon chain.
- 26 **A**
The reaction is a free radical substitution. (CH₃)₄Pb decomposes to form •CH₃ radicals. The increase in the concentration of the methyl free radicals speeds up the reaction.
- 27 **C**
The nucleophile is the hydride ion, H⁻. H⁺ is an electrophile, not a nucleophile. Applying the usual nucleophilic addition mechanism for carbonyl compounds, the nucleophile attacks the electron deficient C atom of the carbonyl group.
- 28 **D**
A and D have acidic -CO₂H groups but only D has a chiral C.
- 29 **C**
The forward reaction I is an intramolecular condensation to form an ester group. Note that the equation is not balanced and does not show the water molecule produced in the forward reaction. The *type* of reaction is condensation (and the reaction can be called an esterification). The reverse reaction is a hydrolysis.
- 30 **C**
X is a 1° alcohol, oxidised to form carboxylic acid Y which reacts with ethanol to form ester Z. Only C and D are esters. C is formed from 6C acid + ethanol. D is formed from CH₃CH₂CO₂H + HO(CH₂)₄CH₃.
- 31 **C**
Write out the balanced equations. Option 1 is wrong
C₂H₅OH + 3O₂ → 2CO₂ + 3H₂O

- 32 **D**
The catalyst speeds up the forward reaction (and also the reverse reaction), so option 1 is correct. Option 2 is wrong since the value of K_p can only change with temperature.
- 33 **C**
Option 1 is wrong. The catalyst has no effect on the average kinetic energy of the reacting particles.
- 34 **C**
Option 1 is wrong. The reaction is exothermic. Option 2 is correct since the [Al(H₂O)₆]³⁺ undergoes hydrolysis to give H⁺. Option 3 is correct. The hydrolysis is an equilibrium, so there is still [Al(H₂O)₆]³⁺ present.
- 35 **B**
Option 1 is correct. Group II metals from Ca downwards react with cold water (Mg reacts vigorously with steam). Option 2 is correct. All Group II metals has +2 oxidation states in their compounds. Option 3 is wrong. Ra should have the lowest IE since IE decreases down a group.
- 36 **C**
Option 1 is wrong. N is reduced because its oxidation state decreases from +3 in NCl₃ to 0 in N₂. Cl is oxidised because its oxidation state increases from -1 in NCl₃ to +1 in NaOCl. Option 2 is correct. Aqueous NaOCl is bleach solution. Option 3 is correct. Cl⁻ ions in solution will react with Ag⁺ to form white ppt of AgCl.
- 37 **C**
- 
- 38 **D**
There are 4C in the starting molecule and 5C in the product. Option 1 is correct. CN⁻ substitutes Cl to form nitrile; alkaline hydrolysis of nitrile gives the carboxylate ion.

39 **B**

Option 1 is correct. 2° alcohol group can form ester.

Option 2 is correct. Alkene group on bromination gives two C* atoms.

Option 3 is wrong. 2° alcohol group is oxidised to ketone, not aldehyde.

40 **A**

Option 1 is correct. The carboxylic acid group will form salt with aq NaOH.

Option 2 is correct. The alkene group can be cleaved with hot acidified conc. KMnO_4 .

Option 3 is correct. The alkene group can undergo electrophilic addition with HBr.