CHEMISTRY 1B (CHEM1102) - November 2012

NB These answers have not been checked

2012-N-2

- 8.88

  $1.3 \times 10^4 : 1$

2012-N-3

- One answer is 0.13 L of 1.0 M $NaC_6H_7O_7$ and 0.87 L of 1.0 M $Na_2C_6H_6O_7$.

  There is an infinite number of correct answers - the critical point was to finish with a ratio of $[C_6H_6O_7^{2-}] / [C_6H_7O_7^{-}] = 10^{0.82} = 6.61$. The actual amounts of these species are not relevant. The easiest approaches are to:

  a) use different volumes of equimolar solutions
  b) use different concentrations of equal volume
  c) begin with $NaC_6H_7O_7$ solution and add the required amount of NaOH

2012-N-4

- solid

  liquid

  gas

  supercritical fluid

  triple point

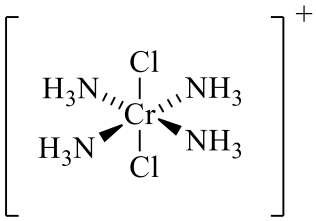
  critical point

  It has a viscosity similar to that of a liquid, but it can expand and contract like a gas filling its container. It's a good solvent.

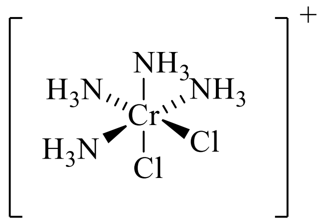
  The density of liquid CO_2 and solid CO_2 are almost the same. Neither is easily compressed.

2012-N-5

- geometrical isomerism

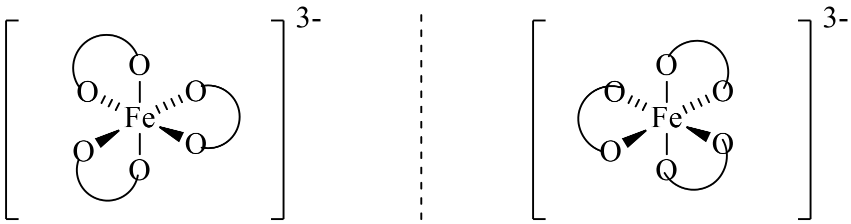


trans- isomer



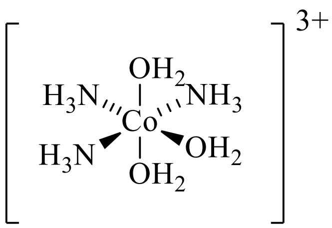
cis- isomer

optical isomerism (enantiomers)



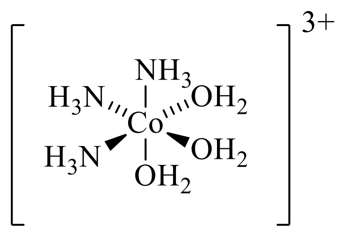
mirror

geometrical isomerism



mer- isomer

the OH_2 ligands lie along a meridian



fac- isomer

the OH_2 ligands define a face of an octahedron

- caesium hexafluoridoplatinate(IV)

  diamminebis(ethylenediamine)cobalt(III) bromide

2012-N-6

- Diamond is a covalent network solid with each carbon bonded to 4 others in a tetrahedral arrangement. Graphite consists of sheets of sp^2 hybridised carbons, each bonded to 3 others in a trigonal planar arrangement.

  Diamond is very hard as each atom is firmly bonded into its place in the crystal. Graphite is very soft and has a greasy feel as the sheets of carbon atoms are free to slide over one another.

  Diamond is an insulator. Graphite can conduct a current in the plane of the sheets as the electrons in the unhybridised *p* orbitals are completely delocalised.

  They have different appearances (diamond is colourless, graphite is black) due to their different electronic arrangements.

- Atomic radius decreases across a period and increases down a group. The numbers of protons and electrons increase as you move across a row. Electrons in s or p orbitals are not shielded from the increasing nuclear charge and hence the effective nuclear charge (Z_{eff}) is increasing. This results in smaller orbitals and decreasing atomic radius. At the end of the row, the next electron goes into an *s* orbital of greater *n*. This orbital is shielded by electrons in the lower energy orbitals and there is a consequent big drop in Z_{eff}. The atomic radius thus increases going down a group.

  Ionisation energies increase across a row as the atoms become smaller. The smaller the atom, the more strongly the outer electrons are attracted to the nucleus and hence the higher the ionisation energy. Similarly, ionisation energies decrease down a group as the atoms become larger.

2012-N-7

- $H_3AsO_4 < H_2SeO_4 < HBrO_4$

  The acidic protons are all bonded to an O atom that in turn is bonded to the As, Se or Br. The more electronegative the central atom, the more electron density is drawn out of the O–H bond and the weaker this bond becomes. The weaker this bond, the stronger the acid. Acid strength therefore follows the electronegativity of the central atoms: Br > Se > As.

  $HClO < HClO_2 < HClO_3 < HClO_4$

  All are structurally H–O–Cl(O)$_x$, where x is 0, 1, 2 or 3. Oxygen is a very electronegative atom and pulls electron density towards itself. The more O's bonded to the chlorine, the more pronounced this effect and the weaker the O–H bond becomes. The weaker this bond, the stronger the acid.

- A_3B There are 8 corners of the cube, each containing $^1/_8$ of a B atom.
  There are 6 faces of the cube, each containing ½ of an A atom.

2012-N-8

- 1.6×10^{-7} g / 100 mL
- $\Delta G = \Delta H - T\Delta S$
  Any process is spontaneous if $\Delta G < 0$, *i.e.* if $T\Delta S > \Delta H$.
  For the melting of ice, both ΔS and ΔH are positive, so this process is spontaneous at higher temperatures.
  Conversely, for the freezing of water, both ΔS and ΔH are negative, so this process is spontaneous at lower temperatures.

2012-N-9

- Rate = k[A][B]^2
  $k = 50.0\ \text{L}^2\ \text{mol}^{-2}\ \text{s}^{-1}$

2012-N-10

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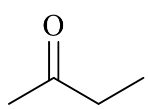

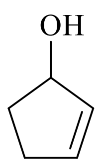

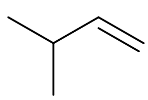

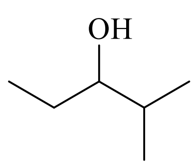

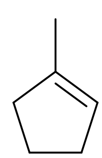

$SOCl_2$

2012-N-11

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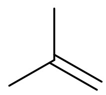

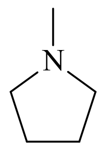

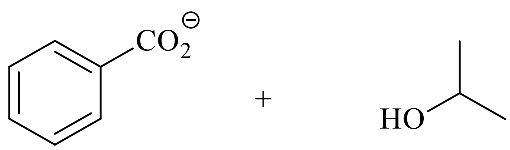

2012-N-12

• (*R*)-3-methyl-1-pentene

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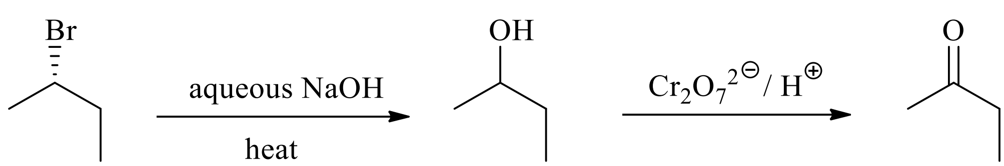

2012-N-13

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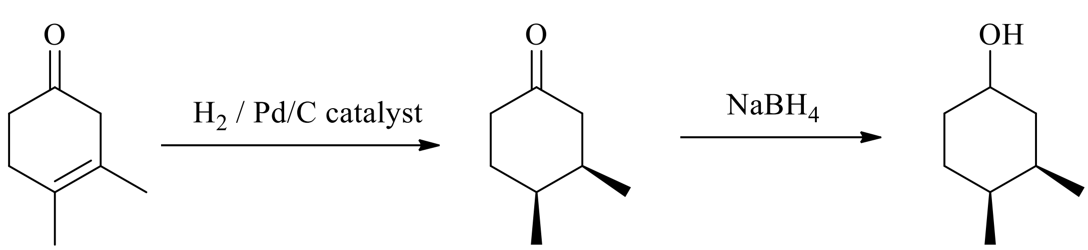
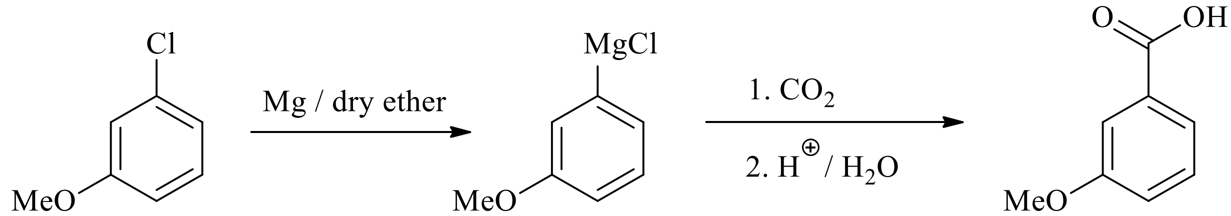


2012-N-13 (cont.)



2012-N-14

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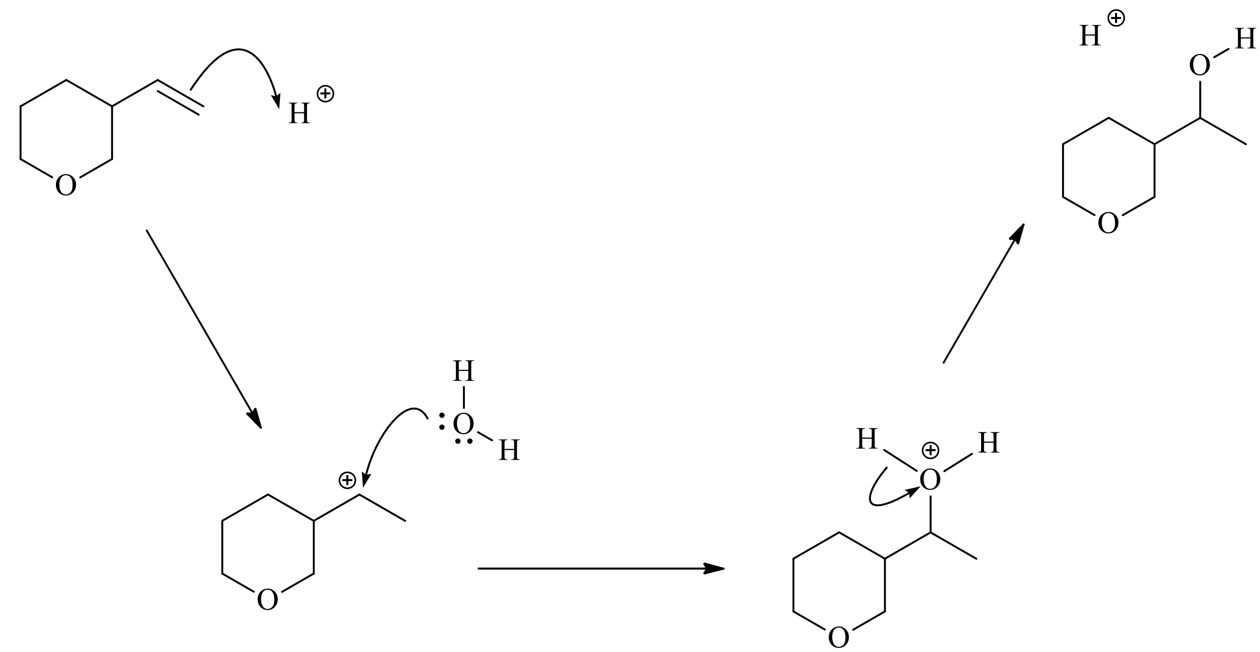

2012-N-15

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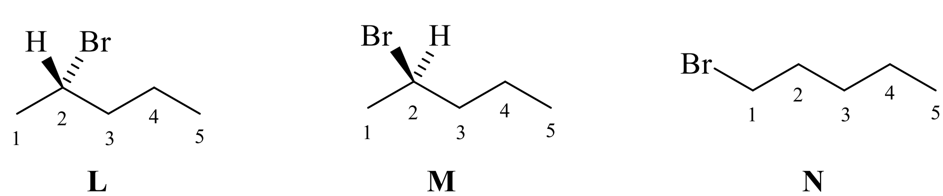

Electrophilic addition of H^+ to the double bond gives 2 possible carbocations. The more stable carbocation leads to the major products **L** and **M**, which are formed in equal amounts as attack by Br^- ion on the planar carbocation is equally likely from either top or bottom. The minor product, **N**, comes from the less stable carbocation.