CHEMISTRY 1A (CHEM1101) June 2013

NB These answers have not been checked

2013-J-2

- An ionic bond is the electrostatic attraction between a cation and an anion.

  Because electrostatic attractions are long range and isotropic, large crystals are lower in energy and hence favoured over small molecules.

  The crystal structure (*i.e.* the geometry of the crystal lattice) which determines the Madelung constant; the charges on the cations and the anions; and the radii of the cations and anions.

2013-J-3

- Transient unsymmetrical electron distribution around an atom results in an instantaneous dipole that causes an induced dipole in an adjacent molecule. Dispersion forces are the attractions between the instantaneous dipoles and the induced dipoles.

  Higher than 338 K (actually 457 K). All the molecules are non-polar, so dispersion forces are the only ones relevant. Iodine is the biggest atom with the most electrons and hence its electron cloud is the most polarisable. I_2 therefore has the strongest dispersion forces and the highest boiling point.

- The freezing of water is exothermic and the heat evolved is passed to the surroundings. Because the surroundings are at a lower temperature than the water (else the water would not freeze), the increase is entropy of the surroundings is greater than the decrease in entropy of the water. ($\Delta S = \Delta Q/T$) The net increase in entropy of the universe (system + surroundings) therefore increases, consistent with the Second Law.
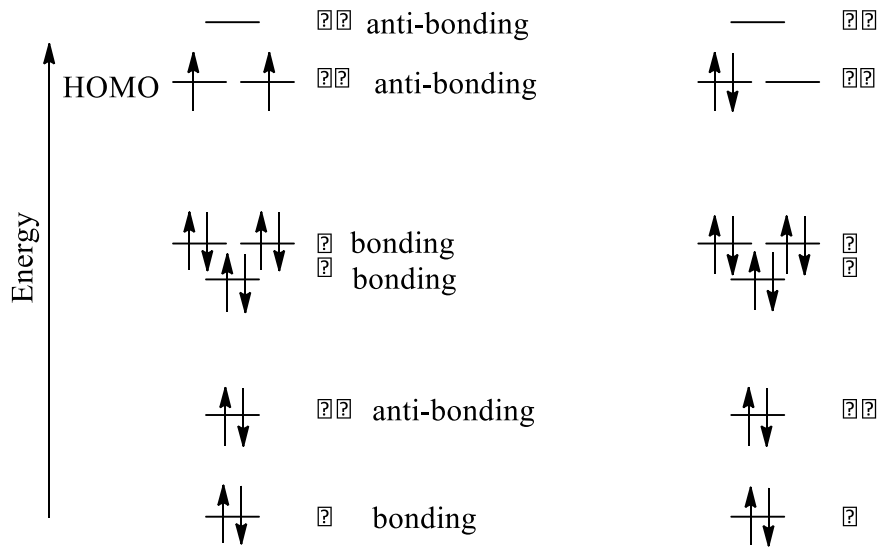
2013-J-4

- [Ar] $4s^1$

  [Ar] $4s^1\ 3d^{10}\ 4p^3$

  [Kr] $5s^2$

  [He] $2s^2\ 2p^1$

  ruthenium

  erbium

- Gamma radiation is more useful as it is more penetrating (so can be detected by detector placed outside the body) and is less damaging to human tissue than alpha radiation.

  Hours. Allows time for production of nuclide, administration to patient, and for it to accumulate in the tissue of interest. Activity is high enough to give good quality image with small amount of nuclide. A long half-life means a lower activity and hence more nuclide needs to be used to generate a quality image.

2013-J-5

- The Periodic Table groups atoms into groups (columns) based on the number of valence electrons they have. Chemical reactivity is based on the number of valence electrons so elements in the same group have similar chemical properties.

- 5.7 g cm^{-3}

2013-J-6

- 12

HOMO $\qquad$ ▢▢ anti-bonding $\qquad$ ▢▢

↑ ↑ ▢▢ anti-bonding ↑↓ $\qquad$ ▢▢

Energy

↑↓ ↑↓ ↑↓ ▢ bonding ▢ bonding

↑↓ ↑↓ ↑↓ ▢ bonding ▢ bonding

↑↓ ▢▢ anti-bonding ↑↓ ▢▢

↑↓ ▢ bonding ↑↓ ▢

Bond order: 2

1270 nm (1.27×10^{-6} m)

NO^-, NF

2013-J-7

-

48	:F: � :F S F: :F F: :F: (SF₆ structure)	octahedral
34	:F: F S: F: :F: (SF₄ structure)	"see-saw"

There is a lone pair of electrons on the S that can participate in reactions for SF_4, but not for SF_6.

2013-J-8

- 2.0 kg

- Natural processes
  Nitrogen fixing bacteria in plants (legumes) and blue-green algae produces NH_3.
  Lightning (high temperatures) causes the reaction of N_2 with O_2 to produce $NO(g)$.
  Human activity
  Haber process produces $NH_3(g)$ from $N_2(g)$ and $H_2(g)$.
  Reaction of N_2 with O_2 in internal combustion engines produces $NO(g)$.

2013-J-9

- 2.12 M

2013-J-10

- -726.7 kJ mol^{-1}

- 82 L

2013-J-11

- $Sn(s) + CO(g) \rightarrow SnO(s) + C(s)$
  $2Al(s) + 3ZnO(s) \rightarrow Al_2O_3(s) + 3Zn(s)$
  No reaction
  $CO(g)$

2013-J-12

- 33 hours

- Transfer of electrons between the two half-cells occurs to try and equalise the concentrations in each half-cell and hence to maximise the entropy.

- $H_2(g) \rightleftharpoons 2H^+(aq) + 2e^-$
  Under acidic conditions, this equilibrium will be pushed to the left due to Le Chatelier's principle. Similarly, it will be pulled to the right under basic conditions as the H^+ ions produced will react with the OH^- ions. Therefore H_2 is a better reducing agent under basic conditions.

2013-J-13

- $NH_4^+(aq)$
  8
  0.84 V
  -650 kJ mol^{-1}
  E_{cell} increases (from Le Chatelier's principle)
  $+1.03$ V