

Chemistry 1Adv/1SSP (Chem1901/1903) June 2008

2008-J-2

- a) An orbital with a nodal plane perpendicular to the bond.
b) The study of radiation emitted as an atom or molecule relaxes from an initial excited state.
c) The time required for a material to decay to half its initial amount.
d) The energy gap between the valence and conductance bands in a solid.
e) The attraction arising between fluctuating dipoles.
f) A "bond" between two atoms consisting of 1 σ -bond and 2 π -bonds.

2008-J-3

- Below the critical mass, so many neutrons are lost from the material that a chain reaction cannot be sustained.
- 120 years
- ${}^{13}_7\text{N}$ - Positron emitter, non-toxic and has sufficiently long half life to be chemically incorporated.
 ${}^{32}_{15}\text{P}$ - This nuclide is a β -emitter (ie ${}^1_0n \rightarrow {}^1_1p + {}^0_{-1}\beta$)
 ${}^{33}_{17}\text{Cl}$ - it has the shortest half-life.

2008-J-4

- 2 0 0 2 0
3 N_2
0.5 B_2^+ F_2^-
- 3 15
 $1s^3 2s^3 2p^8$
The difference would be greater because of the increase in number of electrons in the s orbital shielding the nucleus.

2008-J-5

- **A** 2 2 bent
B 0 4 tetrahedral
C 0 2 linear

2008-J-6

- Squaring Moseley' relationship gives $\frac{1}{\lambda} = (kZ)^2$

The energy of an X-ray with wavelength λ is given by $E = \frac{hc}{\lambda}$

Substituting in Moseley's value for $1/\lambda$ gives $E = hc(kZ)^2$

For a hydrogen like atom, an electron in an orbital with quantum number n has energy $E = -Z^2 E_R (\frac{1}{n^2})$ where E_R is the Rydberg constant.

The energy *emitted* when an electron moves from an orbital with quantum number $n = 2$ to an orbital with quantum number $n = 1$ is:

$$E = -Z^2 E_R (\frac{1}{2^2}) - (-Z^2 E_R (\frac{1}{1^2})) = Z^2 E_R (\frac{3}{4})$$

Equating these two expressions of E gives $hc(kZ)^2 = Z^2 E_R (\frac{3}{4})$

Rearranging for k gives: $k = \sqrt{\frac{3E_R}{4hc}}$

2008-J-7

- 1. Solid N_2 is denser than liquid N_2 . Solid water is less dense than liquid water.
- 2. Liquid N_2 has a much lower b.p. than liquid water (due to the latter's H-bonds).
- Classical theory held that a negatively charged particle orbiting a positive one would lose energy continuously. In quantum theory, the energy of the electrons is quantised and only certain values are allowed.
- $NF_3 < CH_3Cl < CH_3F$

2008-J-8

- (i) $2C_7H_5N_3O_6(s) \rightarrow 12CO(g) + 3N_2(g) + 5H_2(g) + 2C(s)$
- (ii) $2C_7H_5N_3O_6(s) + \frac{21}{2}O_2(g) \rightarrow 14CO_2(g) + 5H_2O(g) + 3N_2(g)$

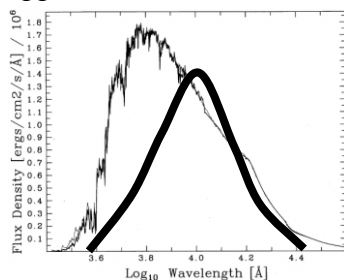
In the combustion reaction, the oxidant comes from an external source (air). In the explosion, the oxidant is contained in the explosive material.

(i) 10 (ii) 5.75

(ii) the combustion

2008-J-9

- approx 4600 - 4800 K



2008-J-10

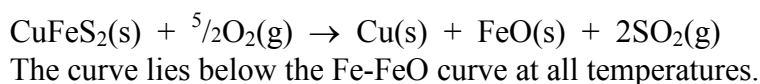
- 82 J K^{-1} (78 J K^{-1} if you fail to realise the density of water is 0.997 g cm^{-3} at $25 \text{ }^\circ\text{C}$)
 $[\text{Ag}^+(\text{aq})] = 1.6 \times 10^{-11} \text{ M}$ $[\text{Br}^-(\text{aq})] = 0.031 \text{ M}$
 $+85 \text{ kJ mol}^{-1}$

2008-J-11

- $2\text{NiO}(\text{s}) + \text{C}(\text{s}) \rightleftharpoons 2\text{Ni}(\text{l}) + \text{CO}_2(\text{g})$
Spontaneous between 400 and 950 K. Below 400 K, NiO is not reduced.
Above 950 K the product is CO.
Above 1450 K. Mn, Al or Ca

2008-J-12

~1100 atm



2008-J-13

- 0 V
 $[\text{Zn}^{2+}(\text{aq})] = 1.5 \text{ M}$ $[\text{Cu}^{2+}(\text{aq})] = 2.2 \times 10^{-38} \text{ M}$

2008-J-14

- $[\text{H}^+(\text{aq})]$ in water is 10^{-7} M , not 1 M , and there is a very high overpotential for the formation of $\text{H}_2(\text{g})$
- In any spontaneous process, the entropy of the universe always increases.
A closed system can exchange heat or work with its surroundings. An exothermic reaction releases heat, q , into the surroundings: $\Delta S_{\text{surr}} = q_{\text{out}} / T > 0$
The enthalpy of reaction defines the heat released into or absorbed from the surroundings at constant temperature and pressure.

$$\Delta S^\circ_{\text{univ}} = -31 + 7800/T \text{ J K}^{-1} \text{ mol}^{-1}$$

As T increases, $\Delta S^\circ_{\text{univ}}$ goes from positive value (ie spontaneous process) to negative value (non-spontaneous). Therefore warming the solution decreases the solubility.