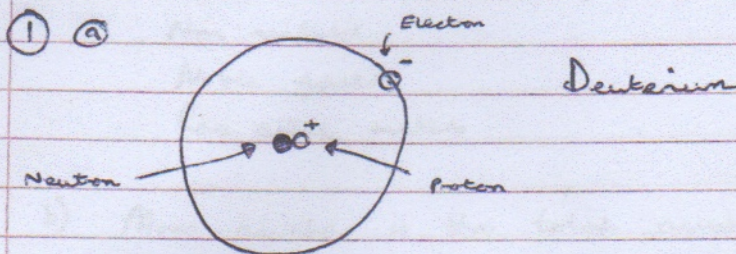


Advanced Chemistry of OME
ACDA 5014

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b) An electron can revolve around the nucleus in certain fixed orbits of definite energy without emission of any radiant energy. These are called stationary orbits.

An electron can make a transition from a stationary orbit of higher energy to a stationary orbit of lower energy and in doing so emits a single photon with a characteristic wavelength.

Only those orbits are allowed for which the angular momentum of the orbit is an integer multiple of $h/2\pi$ where h is Planck's constant.

c) Though a hydrogen atom has only one electron, it contains a large number of shells, so when this single electron jumps from one shell to another a photon is emitted and the energy difference of the shells causes different wavelengths to be released, therefore hydrogen has many spectral lines

⑦

(1)

- (2) a) Hydrogen
Alkali metals
Alkali earth metals
Transition metals
Poor metals
Non metals
Noble gases
Rare earth metals

(1)

b) Mass number is the total number of Protons and Neutrons within the nucleus of an atom. The Atomic number is the number of Protons within the nucleus of an atom.

(2)

c) Nitrogen - 5 outer shell electrons
Oxygen - 6 — " —
Fluorine - 7 — " —
Neon - 8 — " —

(4)

d) Nitrogen Valency - 3
Oxygen Valency - 2
Fluorine Valency - 1
Neon Valency - 0

(3)

e) The closer a valence shell is to being stable the more reactive it is. Fluorine has a valency of 1 meaning it is more reactive than the other elements as it needs to gain just one electron. Oxygen is less reactive as it has a valency of 2 and ~~wants~~ wants to gain 2 electrons. Nitrogen is less reactive than oxygen. Neon has a full outer shell and is the least reactive as it is neither

wants to gain or lose an electron.

4

f) Carbon, Hydrogen, Nitrogen, Oxygen are commonly found in High explosives.

An example of elements used in pyrotechnics are Magnesium, Potassium, strontium.

15

3) a) Stability is how an explosive changes chemically in relation to time.

b) Boltzmann energy distribution is the spread of speeds at which the atoms are moving.

c) Activation energy is the energy required for an explosive to initiate.

d) Nitrocellulose will have more atoms that have more energy than its activation energy, in comparison to RDX, which will have ^{less} of its atoms above its activation energy. This means Nitrocellulose is less stable.

e) Stabilisers can bind with nitrogen oxides to neutralise the decomposition products to extend the life of NC based propellants.

F) Every time reaction rate doubles, the life halves.

20°C — 10 yrs remaining

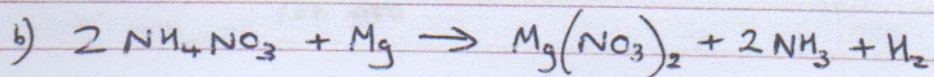
30°C — 5 yrs

40°C — 2.5 yrs

50°C — 1.25 yrs

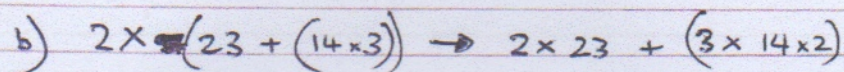
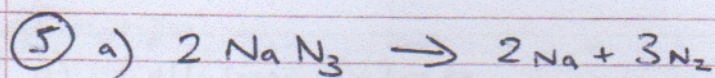
g) It is possible for the stabilisers to have reduced enough for decomposition ~~the~~ rate to increase which could lead to an auto catalytic process.

④ a) Hess' Law states that the change in enthalpy in a chemical reaction is a fixed quantity and is independent of the path of the reaction or the number of steps to obtain the reaction.



c)

d) Heat of reaction is lower than that of TNT.



$130 \rightarrow 46 + 84$

Ans = 84 g of Nitrogen

c) 3 moles of N_2 $\times$ 22.7 L

= 68.1 L

d) $PV = nRT$ $V = \frac{nRT}{P}$

$V = \frac{8.3145 \times 3 \times 373.15}{100000} = 0.09 \text{ m}^3$

e) $P = \frac{nRT}{V} = \frac{3 \times 8.3145 \times 373.15}{0.09 \text{ m}^3}$

= 103418.5 = 103.4 kPa

f)

g) This is ideal where there are no ^{energy} losses. In practice energy will be lost to heat transfer and friction,

⑥ a) Cellulose Nitrate

- b) - Cotton cellulose cleaned and bleached
 - These are mixed with nitrating acid
 - These then go through two further stages of Nitration.
 - Nitrating acid is removed by centrifugation
 - Nitrocellulose is then mixed with water and boiled
 - Pulping, cleaning and packaging

c) Nitric acid gets protonated in sulphuric acid which loses water to form nitronium ions.

d) The peeling process is used to reduce acidity as well as mechanically reducing the cellulose fibres in size.

e) Low Nitrogen NC $< 12.5\%$ Nitrogen content
High Nitrogen NC $> 12.5\%$ Nitrogen content

f) Single base propellants - Nitrocellulose only
Double base propellants - Nitrocellulose and Nitroglycerine
Triple base - NC + NG + Nitroguanidine

Single - SAA propellant

Double - Rocket motors propellants

~~Triple~~ Triple - Artillery gun propellants.

g) Nitroglycerine has a hazardous manufacturing process and increases the erosion due to increased energy.

(2)

h) Nitrocellulose is cheap, easy to manufacture, efficient and easy to ignite.

(2)

~~(16)~~

(7) a) Sensitivity - how easily an explosive will react in its design mode

Sensitiveness - how easily it will react in an accident or when you do not want it to.

(2)

b)

c) Ammonium Nitrate - oxidiser
Oil - fuel

(2)

d) Liquid droplets (oxidisers) suspended in liquid fuel

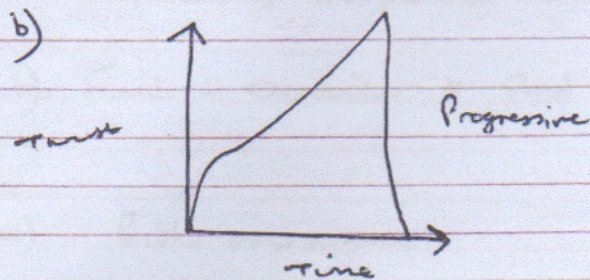
(2)

e) Adiabatic compression of the air in the voids which increases temperature + energy above the activation energy.

(3)

(9)

- ⑧ a) Grain geometry
Design of rocket chamber
Chemistry of the propellant

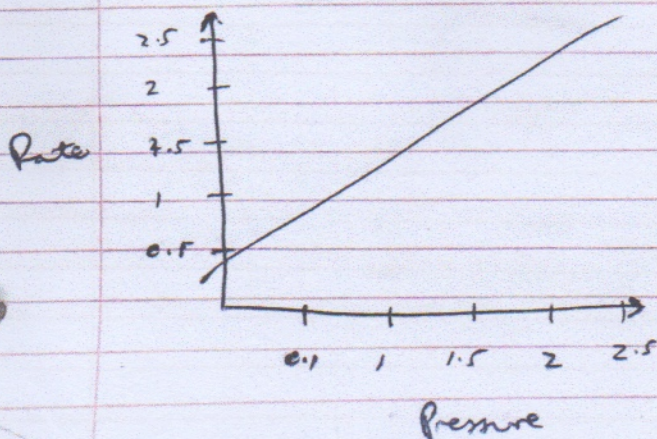


- c) ~~Vielle's~~ Vieille's Law

$$r = \beta p^\alpha$$

r → Burning rate (mm s^{-1})
 β → Burning rate coefficient
 p → Pressure (MPa)
 α → Pressure index

d) $y = 0.9704x + 0.4945$



Burning rate coefficient
 $= \frac{dy}{dx} = 0.97$

9) a) oxidiser reacts with fuel to create heat, The volatile dye boils off to create a vapour. This condenses into a mist of particles suspended in the air.

(4)

b) Fuel + Oxidiser + Red dye

X

c) Risk assessment

(2)

d) Rate of reaction, More material or bigger Smoke generator, chemical composition and geometry of smoke composition

(3)

e) Avoiding too high a rate, which could cause the smoke generator to catch fire and burn.

(1)

f) Gas produced to throw out the dye stuff.

(1)

g) The volume of gas for both reactions is the same.

(1)

12
=