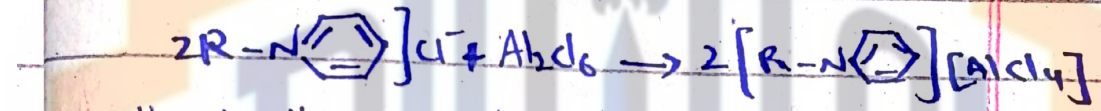
2K19

**Give example of molten salt that can be used at room temp?**

Some salts are liquid at or near room temprature. For example, If alkylpyridinium chlorides are added to aluminium chloride, the resultant compound is very similar to alkali metal tetra-chloroaluminates.



Although the chloroaluminates are the best known room temprature molten salts.

If we mixes the crystalline solid tri-ethyl ammonium chloride & copper chloride, an endothermic reaction take place to form light green oil.

$$[Et_3NH]Cl + CuCl \longrightarrow [Et_3NH][CuCl_2]$$

$$[CuCl_2] + CuCl \rightleftharpoons [Cu_2Cl_3]^-$$

$$2[CuCl_2] \rightleftharpoons [Cu_2Cl_3]^- + Cl^-$$

$$[CuCl_2]^- + Cl^- \rightleftharpoons [CuCl_3]^{2-}$$

**Relationship b/w half life period & decay constant :-**

It is evident from definition that an expression for half life period can be obtained by putting $t = t_{0.5}$ & $N = N_0/2$ in eqn (A) or B

$$N = N_0 e^{-kt}$$

$$\frac{N_0}{2} = N_0 e^{-k t_{0.5}}$$

$$\frac{1}{2} = e^{-k t_{0.5}}$$

$$\ln \frac{1}{2} = \ln (e^{-k t_{0.5}}) = -k t_{0.5}$$

$$\ln \frac{1}{2} = -k t_{0.5}$$

$$2.303 \log_{10} \left(\frac{1}{2}\right) = -k t_{0.5}$$

$$-2.303 \log_{10} \frac{1}{2} = k t_{0.5}$$

$$2.303 \log_{10} 2 = k t_{0.5}$$

$$\frac{2.303 \log_{10} 2}{k} = t_{0.5}$$

$$\boxed{t_{0.5} = \frac{0.693}{k}}$$

## Role of artificial transmutation in daily life:-

Artificial transmutation reaction have been used to prepare many radioactive isotopes, which have been used as radioactive tracers in various process met with in medical field, agriculture, industry, analytical chemistry and can contribute to waste managements treatment.

$$^{23}_{11}Na + {}^{2}_{1}H \longrightarrow {}^{24}_{11}Na + {}^{1}_{1}H$$

$$^{27}_{13}Al + {}^{1}_{0}n \longrightarrow {}^{24}_{11}Na + {}^{4}_{2}He$$

$$^{32}_{16}S + {}^{1}_{0}n \longrightarrow {}^{32}_{15}P + {}^{1}_{1}H$$

$$^{14}_{7}N + {}^{1}_{0}n \longrightarrow {}^{14}_{6}C + {}^{1}_{1}H$$

2k19

## Why $SO_3$ & $SiO_2$ tend to form polymerize?

More than one structural form is possible for $SO_3$, because the linking bonds to the two coordinate oxygen atom may either be turned inward to give cyclic oligomers, or outward to give chain polymer. These different forms are often termed polymorphs of $SO_3$. Since they have different crystal lattice types. perhaps they should be called polymerization isomers.

Silicon in the $SiO_2$ structural units has two vacant coordination site, it is likely to polymerize to a greater extant than $SO_3$, forming two links per structural units, and giving each bonding oxygen atom a coordination no 2.

## Give advantages & disadvantages by using liq. $NH_3$ as solvent?

On other hand liq. $NH_3$ is better solvent than water for iodine compound & non-polar compound. Liq $NH_3$ dissolves alkali metals without apparent chemical reaction but water does not.

$M + H_2O \rightarrow MOH + H_2\uparrow$

Liq. $NH_3$ has little solvolytic tendency than $H_2O$ towards the dissolved solute.

Disadvantages ⇒ Elaborate equipment & special techniques are required to carry out the chemical reaction in liq. $NH_3$ bcz of its physical properties.

⇒ Liq. $NH_3$ is extremly hygroscopic care must taken to exclude some moisture from $NH_3$ sys.

## Levelling effect of Solvent :-

In a solvent acid of different strengths are added & the solvent bring them to one level so, solvent levelling.

Strong acid or base available in a given protonic solvent is that which result the self-ionization.

Ionization → basicity of solvent → effective (greater) strength → high proton affinity

Relative permittivity ↑ → solvating ability

$H_2O + H_2O \longrightarrow H_3O^+ + OH^-$ $\quad\quad$ $NH_3 + NH_3 \longrightarrow NH_4^+ + NH_2^-$

$CH_3COOH + CH_3COOH \longrightarrow CH_3COOH_2^+ + CH_3COO^-$

## Example of complex formation reaction in $BrF_3$ :

preparation of $AuF_3$ :

$$Au + 2BrF_3 \longrightarrow [BrF_2^+ \cdot AuF_4^-] \xrightarrow{120^\circ C} AuF_3 + BrF_3$$

preperation of $[NO]_2[SnF_6]$ :

$$2NOCl + SnF_4 \longrightarrow [NO]_2[SnF_6]$$

preperation of $K[RuF_6]$

$$Ru + KCl \longrightarrow K[RuF_6]$$

## 5 Spinals & Its magnetic properties :-

An imp class of mixed metal oxide is spinals $AB_2O_4$. In spinels the oxide ions are ccp.

The spinels exibit two most common form of cooperative magnetic properties, ferromagnetism & antiferromagnetism. Among the mixed metal spinels, $MnFe_2O_4$ & $CoFe_2O_4$ are antiferromagnetic while only $FeFe_2O_4$ show the property of ferromagnetism. Macroscopic crystals of magnetite have been found in no of different living organi including bacteria, Pigeons & Salmon.

## 6 Applications of Artificial transmutation :-

- Preparation of various isotopes
- Release of atomic energy in nuclear fission & fusion reactions.
- Discovery of new fundamental particals & their uses

$$^{14}_{7}N + {}^{4}_{2}He \longrightarrow {}^{17}_{8}O + {}^{1}_{1}H$$

$$^{9}_{4}Be + {}^{4}_{2}He \longrightarrow {}^{12}_{6}C + {}^{1}_{0}n$$

$$^{27}_{13}Al + {}^{4}_{2}He \longrightarrow {}^{30}_{15}P + {}^{1}_{0}n$$

$$^{30}_{15}P \longrightarrow {}^{30}_{14}Si + {}^{0}_{+1}e$$

ozone – upper atm → UV rays → Preventing from reaching it on earth → cause cancer & genetic mutation

# Environmental issue caused by oxide of Nitrogen.

⇒ Nitric acid & $NO_2$ are involved in several environmental issues. $NO_2$ react with $H_2O$ to to produce nitric acid. The reaction occur in atm as a major source of acid rain.

⇒ Nitric oxide is known to catalyze the destructive reaction of ozone with atomic oxygen.

$NO + O_3 \rightarrow NO_2 + O_2$ $\quad$ $NO_2 + O \rightarrow NO + O_2$

⇒ In lower atmosphere, $NO_2$ is involved in the complex series of reaction with sunlight, volatile organic compound. These reaction produce aldehydes, & organic nitrates (PAN) & (PBN) which are powerful eye irritant & are quite damaging to vegitation.

2K20

(1)

| Natural Radioactivity | Artificial Radioactivity |
|---|---|
| Natural Radioactivity is a spontaneous process. In which the nuclei of heavy atom disintegrate acc to own & give more slighter & stable product. By emitting $\alpha, \beta$ & $\lambda$ rays. | It is unspontaneous process. Since int the nuclei of heavy atom is bombarded by fast moving particals like $\alpha$, $\beta$, neutron & proton. |
| It is uncontrollable process. | It is controlable process |
| Shown by heavy elements. | Shown by lighter elements. |

E.g: $^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}He$

$^{226}_{88}Ra \rightarrow {}^{222}_{86}Rn + {}^{4}_{2}He$

$^{27}_{13}Al + {}^{4}_{2}He \rightarrow {}^{30}_{15}P + {}^{1}_{0}n$

$^{30}_{15}P \rightarrow {}^{30}_{14}Si + {}^{0}_{+1}e$

(2) **Relationship b/w activity & no of half lives.**

Activity of substance is defined as $A = kN$

no of disintegration undergo by x gram of substance in time t: $kNt = \frac{0.693}{t_{0.5}} \times \frac{6.022 \times 10^{23} \times \text{mass no}}{\text{mass}} \times t$

$= \frac{0.693}{t_{0.5}} \times \frac{6.022 \times 10^{23} \times x}{8} \times t$

We already shown that

$t = \frac{2.303}{k} \log_{10} \frac{\text{Activity shown by substance in the begning}}{\text{Activity shown by substance after time t}}$

$t = \frac{2.303}{k} \log_{10} \frac{A_0}{A}$

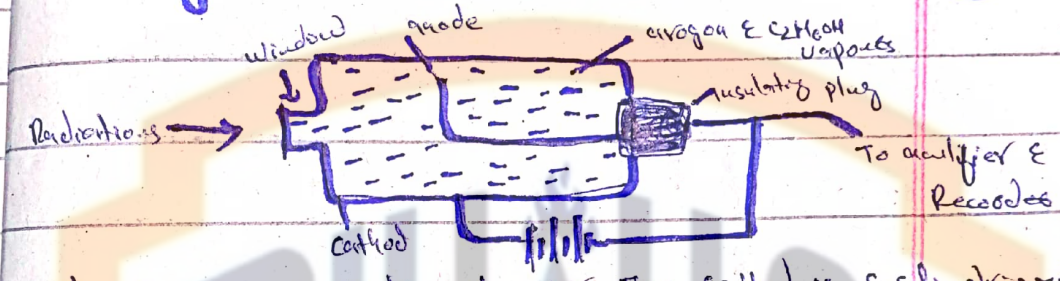
$A = A_0 e^{-kt}$

$A = A_0 \left(\frac{1}{2}\right)^n$

In eqn (iv) the 'n' is the no of half lives ($t_{0.5}$) of which the total time is composed

$$t = n \times t_{0.5} \quad , \quad n = t/t_{0.5}$$

## Geiger muller counter method: (3)




It is an ionization chamber. The cathod is cylindrical & thin wire act as anode. when radiation enter into the chamber through small window called mica which is filled with argon gas at low pressure. A working potential of 1200 V is applied the radiation interact with the filled gas & produce +ve charge ion & electron. The counter generate a pulse, clicking a sound on loudspeaker or activate the digital activator which register the amount of radiation entering the chamber. A chart recorder is also display attached to the circuit, give graphic display of intensity of radiation verse time

## Example of neutralization reaction in HF: (4)

H like $H_2O$, $NH_3$ and so, undergo autoionization to give $Hf^{2-}$ & $H^+$.

The neutralization reaction use carried out in HF:

$$SbF_6 + HF \longleftrightarrow [SbF_6]^- + H^+$$

$$AsF_5 + HF \longleftrightarrow [AsF_6]^- + H^+$$

(5) **Complex formation reaction occurring in liq $NH_3$:**

The possibility of complex formation in liq. $NH_3$ has been studied extensively. Some example are given below.

$$ZnCl_2 + 2KOH \longrightarrow Zn(OH)_2 + 2KCl$$

$$Zn(OH)_2 + 2KOH \longrightarrow K_2[Zn(OH)_4]$$

$$ZnCl_2 + 2KNH_2 \longrightarrow Zn(NH_2)_2 + 2KCl$$

$$Zn(NH_2)_2 + 2KNH_2 \longrightarrow K_2[Zn(NH_2)_4]$$

Al salt react with $KNH_2$ & give Al-complex in $NH_3$.

$$AlCl_3 + 3KNH_2 \longrightarrow Al(NH_2)_3 + 3KCl$$

$$Al(NH_2)_3 + KNH_2 \longrightarrow K[Al(NH_2)_4]$$

(6) **Prove that angular momentum remain constant when β-partical is emitted from nucleus:**

Angular momentum remain constant when β-Particle is emitted from nucleus. For example:

$$^{24}_{11}Na_{13} \longrightarrow {}^{24}_{12}Mg_{12} + {}^{0}_{-1}e + {}^{0}_{0}\nu$$

when a neutron is converted into proton, β-Particles is released $\quad {}^{1}_{0}n \longrightarrow {}^{1}_{1}p + {}^{0}_{-1}e + {}^{0}_{0}\nu$

Eqn is balanced is so for the value of angular momentum of different particals shown below

Eqn: $\quad {}^{1}_{0}n \longrightarrow {}^{1}_{1}H + {}^{0}_{-1}e + {}^{0}_{0}\nu$

Angular momentum: $\quad +\frac{h}{4\pi} \quad . \quad +\frac{h}{4\pi} \quad -\frac{h}{4\pi} \quad +\frac{h}{4\pi}$

If $\nu_e$ is not supposed to be emitted from the above eqn the angular momentum value is not balanced as shown below

Eqn: $^{1}_{0}n \longrightarrow {}^{1}_{1}p + {}^{0}_{-1}e$

Angular momentum: $\frac{+h}{4\pi}$ $\quad$ $\frac{+h}{4\pi}$ $\quad$ $\frac{-h}{4\pi}$

So the angular momentum doesn't remain constant.

## Uses of MgO & $TiO_2$ in industry :- (7)

**MgO :-** Their very high melting points & & low volatility make them useful as refractories for providing surfaces capable of withstanding very high temp. MgO not only used to line furnaces but to cover the heating elements of electric ranges. Since it conduct heat more readily than electricity.

**$TiO_2$ :-** $TiO_2$ is used extensively for its intense whitness when cold (in white paints). Naturally occuring $TiO_2$ is used for the detection of different impurities in the reaction performed by different industries for different purpose. The $TiO_2$ normally get darkened with impurities.

**Environmental issue cause by Sulphur oxide :-**

Acid Rain

2k21

(1) What is meant by self-ionization of solvent

Self-ionization is an important property of $H_2O$ & aqueous solns in which involve the loss of proton from the water molecule, leaving behind a hydroxide ion. Spontaneous reaction of the hydrogen nucleus with another water molecule produce the hydronium ion, $H_3O^+$

$2H_2O \rightleftharpoons H_3O^+ + OH^-$ $\quad 2NH_3 \rightleftharpoons NH_4^+ + NH_2^-$

$2H_2SO_4 \rightleftharpoons H_3SO_4^+ + HSO_4^-$

(2) Dielectric constant, effect on solubility:-

Dielectric constant of a substance is a measure of its ability to store electrical energy.

$H_2O = 81.7$

$NH_3 = 22$

Dielectric constant is the ratio of a material permittivity of free space $F = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2} \propto \frac{1}{D}$

Its Effect on solubility:-

Greater the $\varepsilon_0$ of a coordinated solvent, more the lattice energy will be reduced & solubility will be increased. Slightly polar, non polar & covalent compound show high solubility in $CH_3COOH$.

(3) Write down eqn to show what happen when $BrF_3$ & EtOH dissolve in liq. HF ?

when EtOH is dissolve in HF. The chemical compound is protonated in HF.

$C_2H_5OH + HF \longrightarrow C_2H_5OH^{2+} + F^-$

when $BrF_3$ dissolve in HF than.

$BrF_3 + HF \longrightarrow [BrF_2]^+ + [HF_2]^-$

$BrF_3$ act as

**What are the benifit of liq. $NH_3$** (4)

Repeated q/5 21k19

**Natural radioactive series** **Artificial radioactive series** (5)

The series obtained by the emission of $\alpha$ & $\beta$ particals from $^{232}_{90}Th$, $^{238}_{92}U$ & $^{235}_{92}U$ are called natural radio-active series. This series is represented as, Thorium-232 or 4n, Uranium-238 or 4n+2, Uranium-235 or 4n+3 series.

The series which is obtained by the emission of $\alpha$ & $\beta$ particals from artificialy prepared $^{237}_{93}Np$ isotope. This series is also represented as Neptunium-237 or (4n+1).

**Differentiate b/w partic & A partic** (6)

Solvent :-

| Protic solvent | A-protic solvent |
| --- | --- |
| These solvent either lose proton or gain them or show both the tendencies | These solvent neither lose nor gain proton. |
| These have three types. | Examples :- |
| Acidic solvent: $HF, H_2SO_4, HCN$ | $C_6H_6, CHCl_3$ |
| Basic solvent: $NH_3, N_2H_4$ | $CH_2Cl_2, CCl_4$ |
| Amphoteric solvent: $H_2O + H_2O \rightleftharpoons H_3O^+ + OH^-$ | |
| These solvent are also known as protonic solvent. | These are also known as non-protic & non-protonic. |
| • High dielectric constant. | low dielectric constant. |
| • Hydrogen bonding present. | H-Bonding absent. |

## (7) Role of radio-active isotopes in medicine

Radio-active isotopes are an essential part of radio-pharmaceuticals, which are used to detect (diagnosis) & treat cardiovascular diseases & cancer.

Iodine-131 is used in medicine to diagnose & treat cancer of thyroid gland.

Thallium-201 : Used in imaging - to detect the location of damaged heart

muscle.

Nuclear medicine uses small amount of radiation to provide information about a person body & the functioning of specific organs, or the disease state of a specific illness.

## Four hazardous effects of oxide :- 8

- Elevated level of $NO_2$ can cause damage to the human respiratory tract and increase person vulnerability and the respiratory infections & asthma.
- long term exposur can cause chronic lung disease.
- The increase/higher conc of oxide of C lead to an increased respiratory rate, cardiac arrhythmeris & impaired consciousness.
- Sulphur dioxide can cause bronchitis, can irritate your nose, throat & lungs it may cause coughing wheezing & asthma attack.

## What is inverse spinels? 9

Unlike the normal spinel, the inverse spinel structure has all the A cation & half of the B cations occupy tetrahedral sites.

The common example of inverse spinel structure is $Fe_3O_4$.

| Ferromagnetism | Antiferromagnetism |
| --- | --- |
| Ferromagnetism is the presence of magnetic domains that are aligned in the same direction in magnetic materials. | Antiferromagnetism is the presence of magnetic domains that are aligned in opposite direction in magnetic material. |
| Exhibit strong net magnetization due to parallel alignment of magnetic moments | Net magnetization is usually weaker due to unequal distribution of magnetic moment. |
| Ex Iron, nickel, cobalt | Magnetite ($Fe_3O_4$) & ferrite compounds |

Feson has inverse spinel structure where $Fe^{3+}$ cations occupy a quarter of the tetrahedral A sites and $Fe^{3+}$ & $Fe^{2+}$ cations occupy half of the octahedral B sites.

10

| Ferromagnetism | Antiferromagnetism |
| --- | --- |
| Ferromagnetism is the presence of magnetic domains that are aligned in the same direction in magnetic materials. | Antiferromagnetism is the presence of magnetic domains that are aligned in opposite direction in magnetic material. |
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| E.x Iron, nickel, cobalt | Magnetite ($Fe_3O_4$) & ferrite compounds |

11 $AB_2O_4$ type spinel (notes)

12 Activity & no of half lives (Repeated)

13 Example of metal oxide that can be used at high temp super conductor

From notes [$YBa_2Cu_3O_7$]

14 Magnetic properties of mixed metal oxid?

Magnetic properties of Spinels

2k22

## Hazardous effects of non-metal oxides :-

Air pollution is caused by dust, sulphur oxides, nitrogen oxide & hydrogen sulphide. oxide of S cause acid rain. non-metal oxide also lower soil pH, damage plants & corrodes metal & buildings. $SO_2$ & $NO_x$ can also combine with smoke & $H_2O$ vapours to form smog, which affects the respiratory system, when inhaled increasing incident of asthma & lung infections. These gases also irritate the skin & eye.

| low temp Superconductor | High temp Superconductor |
|---|---|
| It has low $T_c$ (<20k) | It has high $T_c$ (>100k) |
| Super conduction is due to the cooper pairs. | Super conduction is due to the hole states. |
| Explained by BCS theory | Explained by RVB theory |
| It is not very useful for due to its low maintance temp. It is called n-type Superconductor. | very useful for commercial & engineering purposes. It is called p-type super conductor. |

) Paramagnetism :-

It is one of the property of magnetism form whereby some materials are weekly attracted by an externally applied magnetic field, and induced form field in the direction of M.F.

Causes :- This is due to the presence of unpaired electron in material, so most of atoms with incomplete filled atomic orbital, are paramagnetic.

) Mixed metal oxide used as catalyst, examp

ZnO & $TiO_2$ are the most prominent metal oxide for their use as photocatalyst to treat waste water $TiO_2$ has the ability to harness the energy of Sunlight to promote the oxidation in air of almo any organic vapours. $TiO_2$ is most widely used in photocatalyst digs, photochemical stability, relative abundance. $TiO_2$ have high photo reactivity.

| Nuclear fission | Nuclear fusion reaction |
| --- | --- |
| This is the process in which the nucleus of an atom convert into smaller nuclei. | The process in which smaller nuclei join to form heavier nuclei. |
| This type of reaction is not occur naturally. | This type of fusion reaction is found in sun. |
| Working Principle of the atomic bomb. | working principle of hydrogen bomb. |
| Used for the generation of electricity. | For the generation of electricity. |
| The fuel used in nuclear fission reaction is Uranium. | Fuel used is deutrium tritium fuel. |

## Radio-active equilibrium:- (6)

Let a radio-active substance disintegrate to form a product B which further distingerate to produce C.

$$A \longrightarrow B \longrightarrow C$$

$N_A \quad N_B \quad N_C$

$k_A \quad k_B \quad k_C$

$(t_{0.5})_A \quad (t_{0.5})_B \quad (t_{0.5})_C$

The stage at which the rate of decay of A is equal to the rate of decay of B, and the rate of decay

of B equal to C is called radio-active equilibrium. At this stage the amount of B in the sample remain constant.

Rate of decay of A = Rate of decay of B = Rate of decay of C

$k_A N_A = k_B N_B = k_C N_C$

## (7) Major classification of Solvent:-

⇒ First classification:- Based on the proton donating & proton accepting ability.

(i) Protic-solvent: lose or gain proton or show both tendencies.

Acidic solvent :- lose proton [HF, $H_2SO_4$]

Basic solvent :- gain proton [$NH_3$, $NH_4OH$]

amphoteric solvent :- $H_2O + H_2O \rightleftharpoons H_3O^+ + OH^-$

(ii) Non protic :- neither lose or gain [$C_6H_6$]

⇒ Second classification:- Based upon the Polar & non polar nature of solvent.

Ionizing / polar solvent — Non-ionizing / non polar solvent

## (8) How reaction in Molten salt can be studied?

Reaction in molten salt can be studied by following method.

- Cryoscopic method
- Phase diagram

Spectroscopic method • Electric conductivities

**Role of $BrF_3$ in determination of oxygen in metal oxide :-** (9)

It can be done by dissolution of metal oxides in $BrF_3$. The metal oxides release oxygen quantitatively in $BrF_3$, which is collected & measured by some specific method.

$$SeO_2 + 2BrF_3 \longrightarrow SeF_6 + Br_2 + O_2$$

$$U_2O_5 + 2BrF_3 \longrightarrow 2UOF_2 + OF_2 + 2O_2$$

It gives the good test for the determination of direct oxygen.

**Two reaction in liq. $SO_2$ for complex formation :-** (10)

They are analogous to aqueous medium

$$SbCl_3 + 3KCl \longrightarrow K_3[SbCl_6]$$

$$K_3[SbCl_6] + 3SbCl_5 \longrightarrow 3K[SbCl_5] + SbCl_3$$

Similarly :

$$2SbCl_5 + 3SOCl_2 \longrightarrow [SO]_3[SbCl_6]_2$$

$$SbCl_5 + NOCl \longrightarrow [NO][SbCl_6]$$

**Spinels ?** (11)

Repeated

(12) Explain the units to measure Radioactivity?

The standard units of radio-activity is curie which is defined as the mass of radio-active element which produces $3.7 \times 10^{10}$ disintegration per-second. Millicurie & micro curie are the masses of element produce $\frac{3.7 \times 10^{10}}{10^6} = 10^4$ & $\frac{3.7 \times 10^{10}}{10^3} = 10^7$ disintegration per sec

Another Unit: Rutherford (r) is defined as the mass of radioactive substance produce $10^6$ disintegration per sec.

⇒ Relation: $1c/1r = 3.7 \times 10^{10}/10^6$ or $1c = 3.7 \times 10^4 r$

(13) Advantages of using liq $NH_3$ as solvent

Repeated.

(14) Activity & related with half lives?

Repeated

(15) Radio-activity is detected by any method?

Geiger muller method (Repeated)