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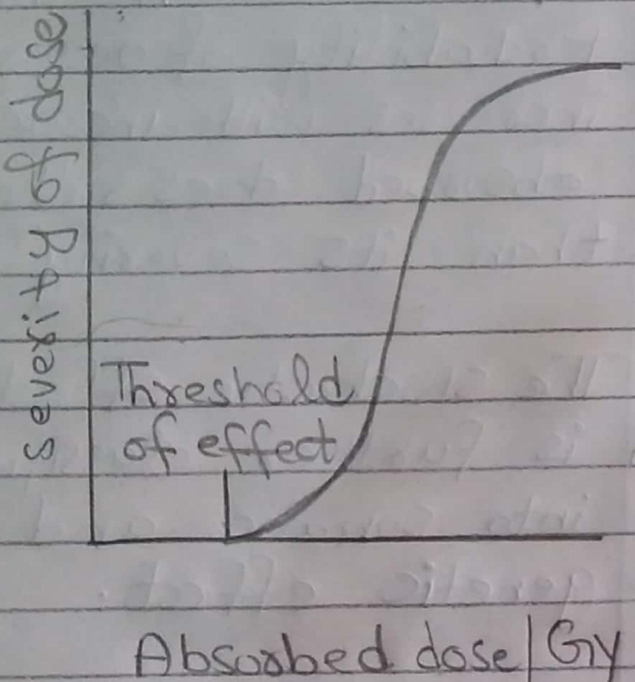
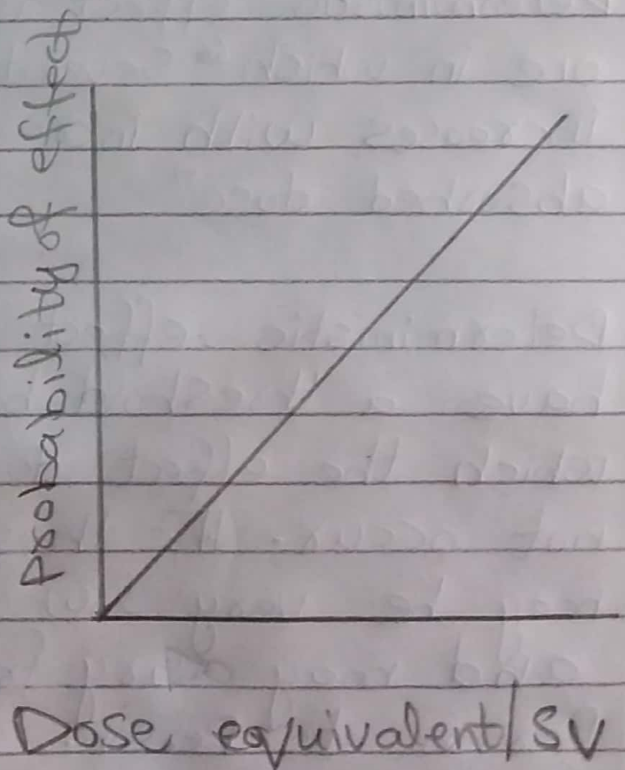
B.S Radiology 4th Semester
Paper: Radiation Protection

Question No:1
Differentiate between deterministic and stochastic effect of radiation?

	Deterministic Effect	Stochastic Effect
1	Deterministic effect is one in which "Severity increases with increasing absorbed dose."	A stochastic effect is one in which "the Probability of occurrence increases with increasing absorbed dose rather than its severity".
2	Deterministic effect have a threshold below which the effect does not occur. The threshold may be very low and may vary from Person to Person.	The stochastic effect is further classified into somatic and genetic effect.
3	Once the threshold has been exceeded, the severity of an effect increases	Stochastic means random and the severity of this effect is independent of the radiation dose.

	with dose.	
4	The main importance of deterministic effect is cell killing.	The main importance of this effect is cell modification.
5	It has threshold dose.	It has no threshold dose.
6	This effect occurs only at high dose.	It occurs at even at low doses.
7	It can be completely avoided.	It can't be completely avoided.
		
	Examples:- Hair loss, Skin reddening, acute radiation syndrome.	Examples:- Cancer, leukaemia, hereditary effec

Question No: 2
Expalin briefly following terms, radiation, radioactivity, non-ionizing radiation ionizing radiation and harmful radiation?

1 **Radiation:-**

Radiation is the emission and Propagation of energy in the form of waves, rays or particles. There are three main types of radiation.

1 Non-ionizing radiation
2 Ionizing radiation
3 Neutrons

Example of Radiation:

Radiation includes emanation of any Portion of the electromagnetic Spectrum, plus it includes the release of Particles.

- A burning candle emits radiation in the form of heat and light.
- The sun emits radiation in the form of light, heat and particles.
- Uranium-238 decaying into Thorium-234 emits radiation in the form of alpha particles.
- Electron dropping from one energy state to a lower state emit radiation in the form of a Photon.

2 **Non-ionizing radiation:**

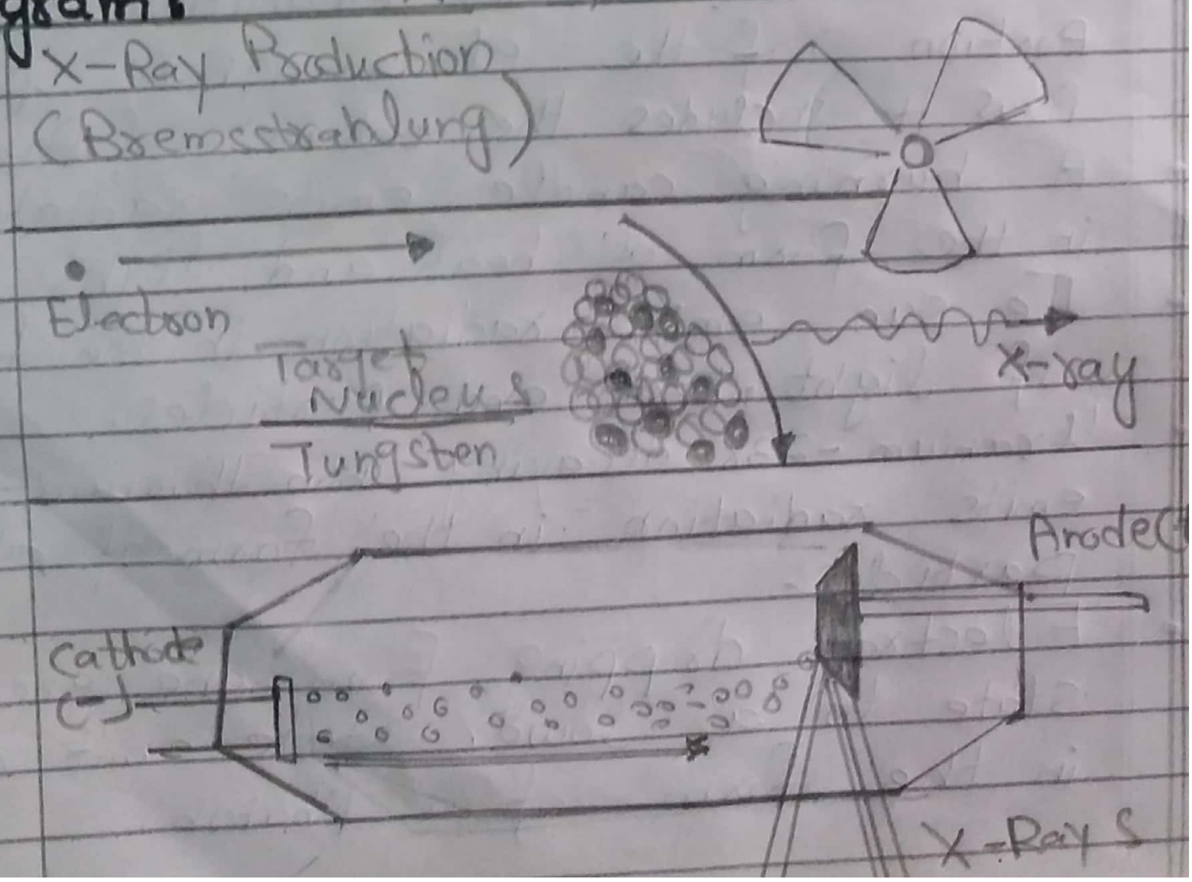
This is the release of energy from the lower-energy region of the electromagnetic spectrum. Source of non-ionizing radiation include light, radio, microwaves, infrared (heat) and ultraviolet light.

3 **Ionizing radiation:**

This is the radiation with sufficient energy to remove an electron from an atomic orbital, forming an ion. Ionizing radiation includes X-ray, gamma rays, alpha particles and beta particles.

Diagram:

X-Rays

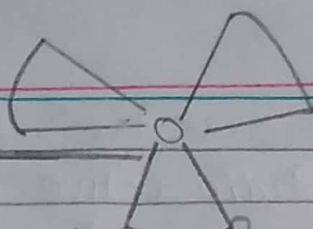


Radioactivity:

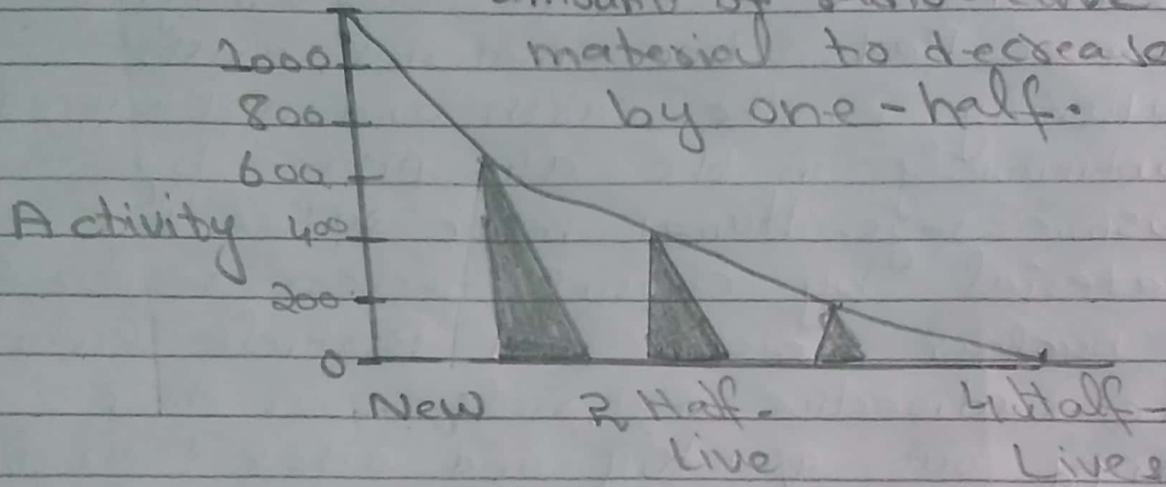
Radioactive atoms contain energy that pours out spontaneously as energetic subatomic particles or electromagnetic waves. Radioactive material exists naturally in the earth and is produced continuously in the atmosphere by cosmic rays. Human make radioactive material by causing nuclear reactions in nuclear reactor and particle accelerators. Some radioactive materials pour their energy out quickly and other pour it out slowly. The rate of energy release is quantified through the material half-life, which is the time after which half of the initial atoms have released their energy.

For example: if you start with 100 radioactive atoms with a half-life of 1 minute, 50 of them will have emitted their energy after 1 minute, After 2 minute there will be 25 left and so on.

Half - life



The time required for the amount of radioactive material to decrease by one - half.



5 Harmful Radiation:-

Harmful radiation damages the cells that make up the human body. Low level of radiation are not dangerous, but medium levels can lead to sickness, headaches, vomiting and a fever. High level can kill you by causing damage to your internal organs. It is difficult to treat high radiation exposure. Exposure to radiation over a long time can cause cancer.

Question No: 3
a) Write two basic Principles of radiation Protection?

* **Radiation Protection:**
Is a term applied to concepts, requirements, technologies and operation related to a Protection of the people against harmful effects of ionizing radiation.

* **Basic Principles of Radiation Protection:**

1. Cardinal Principles of Radiation Protection:
- Time
- Distance
- Shielding

- **Time:**
For People who are exposed to radiation in addition to natural background radiation, limiting or minimizing the exposure time reduces the dose from the radiation source.

- **Distance:** Just as the heat from a fire is less intense the further away you are, so the intensity and dose of radiation decreases dramatically as you increase your distance from the source.

Shielding:-

Barriers of leads, concrete, or water provide protection from penetrating radiation such as gamma rays and neutrons.

System of Radiation Protection:

Justification of Practices:

Any exposure procedures sufficient benefit to offset the radiation harm that it might cause.
As low as Reasonably Achievable

Optimization of Protection:

optimization includes the criterion: does should be as low as reasonably achievable" assuming image quality is adequate for diagnostic purposes.

Limitation of Doses:

The normal exposure of individuals shall be restricted so that neither the total effective dose nor the total equivalent dose to relevant organs or tissues.

B) Write down the names of the radiation protection device?

★ Names Radiation Protection Device:

1. Thyroid shield
2. X-ray Glove
3. X-ray Protection Goggles
4. X-ray Apron
5. X-ray Apron "de Luxe"
6. X-ray Apron "Double Sided"
7. Warming Sign
8. Barrier Tape
9. Mobile Lead Shield
10. Glove Rack
11. Apron Rack Hanger
12. Storage Rack complete
13. Scinti solutions

Question No: 4
What are the features for radiation Protection design? Explain briefly?

★ Features of radiation Protection Designs

1 Protective X-ray Tube Housing:
X-ray tube must be contained within a protective housing that reduces

leakage radiation during use. Leakage radiation must be less than 1 mGya/hr (100 mR/hr) at a distance of 1 m from the protective housing.

2 **Control Panel:**

The control panel must indicate the conditions of exposure and must positively indicate when the x-ray tube is energized. These requirements are usually satisfied with the use of kVp and mA indicators.

3 **Source-to-image Receptor Distance Indicator:-**

A source to image receptor distance (SID) indicator must be provided. This can be as simple as a tape measure attached to the tube housing or as advanced as lasers. Must be accurate to 2% of the indicated SID.

4 **Collimation:**

Ligh-localize, variable aperture rectangular collimators should be provided. The x-ray beam and the light beam must coincide to within 2% of the SID.

5 **Positive - Beam Limitation:**

Automatic, light-localized collimation were required on all but special x-ray imaging system manufacture circa 1974-1994. Must be accurate with in 2% of SID.

6 **Beam Alignment:**

In addition to proper collimation, each radiographic tube should be provided with a mechanism to ensure proper alignment of the x-ray beam and the image receptor.

7 **Filtration:**

Inherent plus added - Total must be at least 2.5 mm above 70 kVp.

8 **Reproducibility:**

Constant output radiation intensity should be constant from one exposure to another. The variation in X-ray intensity should not exceed 5% through same technique.

9 **Linearity:**

Constant output for varied mA settings while time is adjusted to keep mAs the same. Maxim variation is 10% from one mA to adjacent mA station.

10 **Operator Shield:**

It must not be possible to expose in a room outside of the operator booth. Portable x-ray must have >2m either for exposure.

11 **Mobile X-ray Imaging System:-**

The protective lead apron should be assigned to each mobile x-ray imaging system. The exposure switch of such an imaging system. Must allow the operator to remain at least 2m from the x-ray tube during exposure.

Question No: 5

What is GM counter, how it can be used as a radiation protection device?

* **GM Counter:**

The geiger counter is an instrument used for measuring ionizing radiation used widely in such application as radiation dosimeter, radiological protection, experimental physics and the nuclear industry.

- It detects ionizing radiation such as alpha particles, beta particles and gamma rays using the ionization effect produced in a Geiger-Muller tube which gives its name to the instrument.
- In wide and prominent use as a hand-held radiation survey instrument it is perhaps one of the world best known radiation detection instruments.
- There are limitations in measuring high radiation rate and the energy of incident radiation.

* **Basic components:**

- A Geiger counter consists of a Geiger-Muller tube, the sensing element which detects the radiation and the processing electronics, which displays the result.
- The Geiger-Muller tube is filled with an inert gas such as helium, neon or argon at low pressure, to which a high voltage typically

400 - 600 V is applied.

* Principle of operation:

-> When a single gamma or beta ray entering the tube, a small amount of ionization is produced.
-> The electrons are rapidly collected,
-> The center electrode which is at high Positive potential attracts the electrons and gives them energy to produce further ionization until the whole volume contain ion pairs.
-> The voltage on the center electrode drope and the slow positive ions go to the outer wall,
-> After (Dead time) the tube is ready to repeat the process.

* Radiation Protection Used:

-> It is displayed in a unit such as the Sievert which is normally used for measuring gamma or X-ray dose rates.
-> To detect or estimate radioactivity in a tissue or organ.
-> To detect radioactive emission from a biological sample.
-> To estimate or detect radioisotope in metabolites.