

GET1024 / GEC1036 : Radiation – Scientific Understanding and Public Perception

Tutorial 3

Note from the lecturer

One of the intended learning outcomes of this module is the ability to understand popular and as well as more technical documents in the press, magazine and Internet after learning the basic science of radiation. The Term Tests may also have questions based on articles extracted from various sources which will be reproduced in the paper. As such, part of this tutorial is based on information given in the Material Safety Data Sheet (MSDS) of cobalt-60. MSDS are important documents which many of you will encounter in your future working life.

Please also attempt the questions from past tests that I have also posted under the folder “Past Term Tests”. You may omit Qns 17 – 20 of the 2019 paper as these deal with medical applications of radiation which will be covered in later lectures. I will post the answers to the test papers later. Your tutor will discuss some of the questions from these papers during the tutorial too.

Dosage and Units

- 1) A hospital worker is preparing a sample of ^{99m}Tc ($A = 2 \text{ GBq}$) in a glass vial for a bone scan of a patient. What is the dose rate at his fingers if he is using a 30 cm long clamps with no additional shielding? Data given: ^{99m}Tc source of 1MBq activity in a glass vial gives dose rate of $2.2 \times 10^{-2} \mu\text{Sv/h}$ at 1 m
- 2) When describing human exposure to external sources of radiation, the unit grays is typically used interchangeably with sieverts. Why is this the case? Hint: the unit grays are typically not used interchangeably with sieverts when describing exposure to internal source of radiation.

Detection, Measurement and Identification

- 1) A scientist was tasked with proving to a farmer living near a nuclear power plant that it was safe to live there and his crops were safe to eat. Explain what kind of analysis or monitoring the scientist would need in order to do so.
- 2) A worker is investigating a site that has been contaminated with radioactive materials from a spillage. What kind of radiation detector(s) and personal dosimeter(s) should he bring?

Material Safety Data Sheet (MSDS)

Using the information given in the MSDS of Co-60, RSDSCo60.pdf, answer the following questions:

1. Consider a 10 μCi cobalt-60 source. As the maximum range for the Co-60 beta particles in air is 74 cm, we will neglect any contribution due to beta particles in all remaining questions. For (a) and (b) below, you may also assume that the source has just been acquired, i.e., neglect any decay that may have already taken place.
 - a. What is the dose rate (due to gamma rays) at the working distance of 75 cm from the source if there is no shielding?
 - b. Roughly how thick must the lead shield be in order that behind the shield, the dose rate is less than 0.1 $\mu\text{Sv/h}$ at the distance of 75 cm from source? (Note: HVL = **half-value layer** or **half-value thickness**, is the thickness of the material at which the intensity of radiation entering it is reduced by 50%.)
 - c. If the source was acquired in Feb 2020. What is its activity now? If we do not want to use this source anymore, how long must we keep it so that its activity level is below the exemption quantity?
2. Suppose you worked with a 1 μCi Co-60 source in an experiment. The experiment lasted for 3 hours.
 - a. Estimate the dose you will get from this experiment. Make appropriate approximation to any values you need.
 - b. Estimate also the possible range of dose that you may get.
 - c. Suggest steps that you can take to reduce the exposure?