Yaman Lahi Foundation, Inc.
Emilio Aguinaldo College

CULMINATING PERFORMANCE TASK

GEN MATHEMATICS

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RADIOACTIVE SUBSTANCE:

CESIUM-137

HALF-LIFE: 30 YEARS

USES:

- Small amounts of cesium-137 are used to calibrate radiation-detection tools like Geiger-Mueller counters. Cesium-137 is used at larger doses in medical radiation therapy equipment for the treatment of cancer, in industrial gauges that monitor liquid flow via pipelines, and in other industrial equipment to gauge the thickness of materials including paper, photographic film, and metal sheets.
- Cesium-137 can be used as a means of enhancing particular properties of various food commodities by means of sterilization, insect disinfestation, delayed senescence and ripening, and sprout inhibition.
- The cesium-137 used to measure soil erosion in Tunisia comes from atmospheric nuclear weapon tests carried out in the 1950s and early 1960s. Atmospheric circulation and precipitation patterns have made this nuclear fallout present in soils and sediments around the world.

RADIOACTIVE SUBSTANCE:

CESIUM-137

HALF-LIFE: 30 YEARS

EFFECTS:

- Exposure to Cs-137 can increase the risk for cancer because of the presence of high-energy gamma radiation. Internal exposure to Cs-137 through ingestion or inhalation allows the radioactive material to be distributed in the soft tissues, especially muscle tissue, which increases cancer risk.
- External exposure to large amounts of Cs-137 can cause burns, acute radiation sickness and even death. Exposure to such a large amount could come from the mishandling of a strong industrial source of Cs-137, a nuclear detonation or a major nuclear accident. Large amounts of Cs-137 are not found in the environment under normal circumstances.
- Internal exposure to Cs-137, through ingestion or inhalation, allows the radioactive material to be distributed in the soft tissues, especially muscle tissue, exposing these tissues to the beta particles and gamma radiation and increasing cancer risk.

Find an exponential decay model of each radioactive substances.

RADIOACTIVE SUBSTANCE: CESIUM-137
INITIAL AMOUNT: 1,200 GRAMS
HALF-LIFE: 30 YEARS

TABLE OF VALUES

x (years)	*0*	*30*	*60*	*90*	*120*
y (amount of substance)	1,200	600	300	150	75

RADIOACTIVE SUBSTANCE: CESIUM-137
INITIAL AMOUNT: 1,200 GRAMS
EXPONENTIAL DECAY MODEL

HALF-LIFE: 30 YEARS

$$y = 1{,}200\left(\frac{1}{2}\right)^{\frac{x}{30}}$$

Where:

A is the initial amount of the substance
b is 1/2
x is the umber of years over the half time.

RADIOACTIVE SUBSTANCE: CESIUM-137
INITIAL AMOUNT: 1,200 GRAMS

WHAT IS THE REMAINING AMOUNT IN 30 YEARS?

x (years)	*0*	*30*	*60*	*90*	*120*
y (amount of substance)	1,200	600	300	150	75

Remaining amount of cesium-137 in 30 years.

RADIOACTIVE SUBSTANCE:

Sodium-22

HALF-LIFE: 2.6 YEARS

USES:

- Sodium-22 is used in positron emission tomography (PET) scanning. In PET imaging, Na-22 is typically used to generate positron-emitting radiopharmaceuticals like sodium fluoride (NaF-22), which is used for bone imaging. PET scans utilizing Na-22 allow for the detection of bone metastases and assessment of bone health in patients, as demonstrated in research published in the article.
- Sodium-22 is also employed in experiments to study fundamental particles and interactions. Researchers at the Sudbury Neutrino Observatory (SNO) have used Na-22 as part of their investigation into neutrinos and the phenomenon of neutrino oscillation, as documented in the paper.
- Sodium-22 can be utilized in industrial radiography for non-destructive testing. It emits gamma radiation, which can penetrate materials and reveal defects or internal structures in various industrial components. However, its use in industrial radiography has become less common compared to other radioactive isotopes due to safety considerations and regulatory constraints.

RADIOACTIVE SUBSTANCE:

Sodium-22

HALF-LIFE: 2.6 YEARS

EFFECTS:

- Exposure to sodium-22 can be harmful to living organisms. The emitted beta particles can damage tissues and cells, potentially leading to genetic mutations and an increased risk of cancer (Health Physics Society, "Radiation Exposure and Cancer," hps.org). Additionally, the gamma radiation emitted by sodium-22 can further contribute to radiation exposure, making proper safety precautions essential when handling this isotope.
- Sodium-22 can contaminate equipment and materials in nuclear facilities. Its radiation emissions can cause degradation of materials, potentially compromising the structural integrity of equipment and posing challenges for long-term storage and disposal.
- Despite its potential hazards, sodium-22 has applications in industrial radiography and non-destructive testing. Its gamma radiation is used to inspect the integrity of welds and materials in various industries, such as aerospace and manufacturing.

Find an exponential decay model of each radioactive substances.

RADIOACTIVE SUBSTANCE: SODIUM 22

INITIAL AMOUNT:1,500 GRAMS

HALF-LIFE: 2.6 YEARS

TABLE OF VALUES

x (years)	*0*	*2.6*	*5.2*	*7.8*	*10.4*
y (amount of substance)	1,500	750	375	187.5	93.75

RADIOACTIVE SUBSTANCE: SODIUM 22
INITIAL AMOUNT: 1,500 GRAMS
EXPONENTIAL DECAY MODEL

HALF-LIFE: 2.6 YEARS

$$y = 1{,}500\left(\frac{1}{2}\right)^{\frac{x}{2.6}}$$

Where:

A is the initial amount of the substance
b is 1/2
x is the umber of years over the half time.

RADIOACTIVE SUBSTANCE: SODIUM 22
INITIAL AMOUNT: 1, 500

WHAT IS THE REMAINING AMOUNT IN 7.8 YEARS?

x (years)	*0*	*2.6*	*5.2*	*7.8*	*10.4*
y (amount of substance)	1,500	750	375	187.5	93.75

Remaining amount of Sodium-22 in 7.8 years.

RADIOACTIVE SUBSTANCE:

Strontium 90

HALF-LIFE: 28.8 YEARS

USES:

- Cancer Treatment: Strontium-90 is used in radiation therapy to treat certain types of cancer, particularly cancers that affect the eye (e.g., ocular melanoma). It can be delivered via small implants called "strontium-90 plaques" directly to the tumor site. The radiation from Sr-90 helps destroy cancer cells.
- Radiation Contamination: Strontium-90 is one of the radioactive isotopes released into the environment during nuclear weapon tests and nuclear accidents. It can contaminate soil, water, and the food chain. When ingested or inhaled, Sr-90 can pose health risks, as it accumulates in bones and can irradiate nearby tissues. This contamination has been observed in various nuclear accidents, such as the Chornobyl disaster.
- Radioisotope Thermoelectric Generators (RTGs): Strontium-90 is used as a heat source in RTGs. These devices convert the heat generated by the radioactive decay of Sr-90 into electricity. RTGs have been used in space missions, such as those exploring outer planets like Jupiter and Saturn, where solar panels are less effective due to the distance from the Sun.

RADIOACTIVE SUBSTANCE:

Strontium 90

HALF-LIFE: 28.8 YEARS

EFFECTS:

- Prolonged exposure to elevated levels of strontium-90 can increase the risk of bone cancer (osteosarcoma) and other radiation-related cancers.
- Strontium-90 has a strong affinity for bone tissue and can weaken bones, potentially leading to increased risk of fractures.
- Strontium-90 released into the environment can contaminate soil and water, potentially affecting ecosystems and food chains.

Find an exponential decay model of each radioactive substances.

RADIOACTIVE SUBSTANCE: STRONTIUM-90
INITIAL AMOUNT: 800 GRAMS
HALF-LIFE: 28.8 YEARS

TABLE OF VALUES

x (years)	*0*	*28.8*	*57.6*	*86.4*	*115.2*
y (amount of substance)	800	400	200	100	50

RADIOACTIVE SUBSTANCE: STRONTIUM-90
INITIAL AMOUNT: 800 GRAMS
EXPONENTIAL DECAY MODEL

HALF-LIFE: 28.8 YEARS

$$y = 800\left(\frac{1}{2}\right)^{\frac{x}{28.8}}$$

Where:

A is the initial amount of the substance
b is 1/2
x is the umber of years over the half time.

RADIOACTIVE SUBSTANCE: STRONTIUM-90
INITIAL AMOUNT: 800 GRAMS

WHAT IS THE REMAINING AMOUNT IN 115.2 YEARS?

x (years)	*0*	*28.8*	*57.6*	*86.4*	*115.2*
y (amount of substance)	800	400	200	100	50

Remaining amount of strontium-90 in 115.2 years.

CITATION:

Source: **National Cancer Institute - Radiation Therapy for Cancer**: https://www.cancer.gov/about-cancer/treatment/types/radiation
Source: **World Health Organization - Health Effects of the Chernobyl Accident:** https://www.who.int/ionizing_radiation/chernobyl/en/

Source: **NASA - Radioisotope Power Systems**: https://www.nasa.gov/content/radioisotope-power-systems

National Cancer Institute - Radiation and Cancer: https://www.cancer.gov/about-cancer/causes-prevention/risk/radiation

U.S. Environmental Protection Agency (EPA) - Strontium-90: https://www.epa.gov/radiation/radioactive-strontium

International Atomic Energy Agency (IAEA) - Radionuclide Fact Sheet: Strontium-90: https://www.iaea.org/resources/radionuclides/strontium-90

Positron emission tomography in the detection and management of bone metastases," by Fogelman et al. (2001) in the journal Seminars in Nuclear Medicine.

Measurement of the total active 8B solar neutrino flux at the Sudbury Neutrino Observatory with enhanced neutral current sensitivity" by SNO Collaboration (2002), published in Physical Review Letters.

Sodium-22 industrial radiography

CITATION:

International Atomic Energy Agency, "Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards," iaea.org

Nuclear Energy Agency, "Management of Sodium Fast Reactor Fuel: Results of an International Collaborative Study," nea.fr

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Centers for Disease Control and Prevention. Cesium (Cs) - Chemical properties, health and environmental effects. CDC. https://www.cdc.gov/nceh/radiation/emergencies/isotopes/cesium.htm

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Exposure to Cs-137 can increase the risk for cancer because of the presence of high-energy gamma radiation. Internal exposure to Cs-137 through ingestion or inhalation allows the radioactive material to be distributed in the soft tissues, especially muscle tissue, which increases cancer risk. Centers for Disease Control and Prevention. https://www.cdc.gov/nceh/radiation/emergencies/isotopes/cesium.htm

CITATION:

Centers for Disease Control and Prevention. Cesium (Cs) - Chemical properties, health and environmental effects. CDC. https://www.cdc.gov/nceh/radiation/emergencies/isotopes/cesium.htm

U.S. Environmental Protection Agency. Radionuclide Basics: Cesium-137. EPA. https://www.epa.gov/radiation/radionuclide-basics-cesium-137
Centers for Disease Control and Prevention. (Year, Month Day). Cesium (Cs) -

Chemical properties, health and environmental effects. CDC.
https://www.cdc.gov/nceh/radiation/emergencies/isotopes/cesium.htm