

Part I – Short Answer

Choose a letter to fill in the blanks. Use choices as many times as you wish. Only one choice is needed per blank. All are 3 points each.

1. First set.

- | | |
|---------------------------|------------------|
| A. hydrogen-1 | D. all of these |
| B. hydrogen-2 (deuterium) | E. none of these |
| C. hydrogen-3 (tritium) | |

- _____ Which of these isotopes has the greatest mass?
_____ Which of these isotopes also is a type of electromagnetic radiation?
_____ Which of these isotopes has an atomic number of 2?
_____ Which of these isotopes is naturally occurring?

2. Next set, and again there is only one correct choice.

- | | |
|-----------------|------------------|
| A. carbon-14 | D. plutonium-239 |
| B. cesium-137 | E. uranium-235 |
| C. strontium-90 | F. None of these |

- _____ Which of these has 14 protons?
_____ Which one of these is not a metal?
_____ Which of these mimics iodine in the body?
_____ Which of these occurs as a +1 ion?
_____ Which of these is a product in the natural decay series of uranium?

3. Final set. **HINT: see Table 5.6 of ions on page 7**

- | | | |
|-----------------------------|---------------------------|------------------|
| A. CaCO_3 | D. Na_2O | G. All of these |
| B. $\text{Ca}(\text{OH})_2$ | E. Na_2OH | H. None of these |
| C. KNO_3 | F. O_2 | |

- _____ Which chemical formula is incorrectly written?
_____ Which chemical formula represents an element?
_____ Which of these contains the oxide ion?
_____ Which of these contains the potassium ion?

Part II – Radioactivity!

Here is a table from your textbook

Type	Symbol	Composition	Charge	Change to the Nucleus That Emits It
Alpha	${}^4_2\text{He}$	2 protons 2 neutrons	2+	Mass number decreases by 4. Atomic number decreases by 2.
Beta	${}^0_{-1}\text{e}$	an electron	1-	Mass number does not change. Atomic number increases by 1.
Gamma	${}^0_0\gamma$	a photon	0	No change in either the mass number or the atomic number.

1. (4 points) This table states that an alpha particle is made of neutrons and protons. Neutrons and protons are similar in that _____.
One way in which they differ is _____.

2. (4 points) The table uses these terms. Explain each in 10 words or less.

atomic number

mass number

3. (4 points) With beta particle emission, the table reports that “the atomic number increases by one.” Offer an explanation as to what might be occurring.

4. (4 points) Speaking of beta emission, cobalt-60 (Co-60) is a beta emitter with an accompanying gamma ray. Write the nuclear equation. No partial credit here.

5. (4 points) Speaking of Co-60, this radioisotope is used in the gamma knife. Explain why 200 beams of radiation are used rather than a single beam.

Part III – The Priscilla Shot

Here is Figure 7.5 from Chemistry in Context. The nuclear test “Priscilla” was exploded on a dry lake bed northwest of Las Vegas in 1957



1. (2 points) The nuclear process that released the energy shown here is called _____.

2. (3 points) The most abundant isotope of uranium in nature is U-238.

This radioisotope could NOT have fueled this nuclear explosion because:

3. (6 points) Actually Priscilla was fueled with an isotope of plutonium.

Humans produced plutonium on our planet using U-238 as a starting material. The first step was to make neptunium. Explain with an equation how humans can produce neptunium from U-238. No gamma rays are produced.

Hint: you did something analogous in the lab.

4. (7 points) Neptunium-239 has a half-life of 2.4 days. Construct a graph that shows the decay of Np-239 over time. Start with 100 atoms of Np-239, and let the time run about 10 days. Label your axes!

Part IV – Radiation and people

Here is another table.

Table 7.4		Physiological Effects of a Single Dose of Radiation
Dose (rem)	Dose (Sv)	Likely Effect
0–25	0–0.25	No observable effect
25–50	0.25–0.50	White blood cell count decreases slightly
50–100	0.50–1.00	Significant drop in white blood cell count, lesions
100–200	1.00–2.00	Nausea, vomiting, loss of hair
200–500	2.00–5.00	Hemorrhaging, ulcers, possible death
>500	>5.00	Death

1. (6 points)

This table uses the unit of **rem**.

We also used the unit **curie** in class.

Fill in the blanks:

The **curie** and **rem** are units that both relate to radioisotopes, but are VERY different.

The **curie** focuses on the radioisotope and is a measure of _____.

In contrast, the **rem** focuses on what happens when ionizing radiation hits tissue, and **rems = Q x rads**, where a **rad** measures the dose of energy deposited in a tissue.

The factor **Q** takes into account the fact that _____.

2. (6 points) A dose of ionizing radiation >100 rem can cause radiation sickness.

Mark true statements with an **X**:

- _____ Muscle cells, such as those in your heart, are especially sensitive to radiation.
- _____ If damaged, your DNA usually repairs itself within a few hours.
- _____ Radiation sickness primarily is caused by damaged cells that live and reproduce, rather than the damaged cells that die.

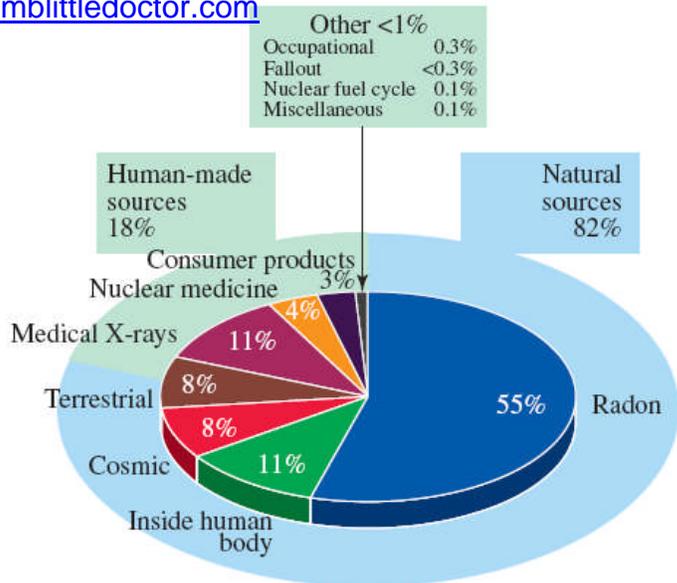
3. (4 points) After Hiroshima, radiation sickness was most acute approximately 2 weeks after the large dose of radiation received from the atomic explosion. Explain the delay in 25 words or less.

4. (6 points) In addition to these two, list 3 more questions that you need answers to in order to assess the hazard of a radioisotope. NOTE: “Is it dangerous?” or “Is it toxic?” are both too vague.

1. **Is the radioisotope inside or outside of your body?**
2. **What is the chemical form of the radioisotope?**
- 3.
- 4.
- 5.

Part V – Radioactivity On Our Planet

Yep, our planet contains radioactive substances. The figure to the right is taken from Chemistry in Context.



1. (3 points) This figure is missing its caption. What should it be?

2. (12 points) In the pie chart, 11% refers to “inside human body.”

a. Radioactive potassium (K-40) is found inside your body. Explain why (<15 words).

b. This potassium is not in the form of potassium metal. Explain why (<15 words).

c. Eating bananas (potassium-rich) does not increase the amount of K-40 in your body. Explain why (<15 words).

3. (9 points) In the pie chart, fallout is estimated at <0.3%

a. What is fallout?

b. Why isn't radon-222 included as a part of fallout?

c. If not from fallout, where does radon-222 come from?

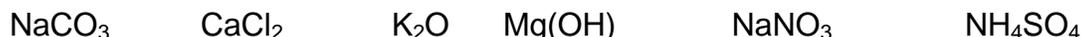
Part VI – Ions and Ionizing Radiation

Here are the chemical formulas of some polyatomic ions, taken from your textbook.

Table 5.6		Common Polyatomic Ions	
Name	Formula	Name	Formula
acetate	$C_2H_3O_2^-$	nitrite	NO_2^-
bicarbonate*	HCO_3^-	phosphate	PO_4^{3-}
carbonate	CO_3^{2-}	sulfate	SO_4^{2-}
hydroxide	OH^-	sulfite	SO_3^{2-}
hypochlorite	ClO^-	ammonium	NH_4^+
nitrate	NO_3^-		

If an ion is used below and not listed here, you are expected to know it.

1. (6 points) Circle the chemical formulas with errors and write the correct formula below. Assume that the polyatomic ions are only the ones listed in Table 5.6.



2. Students in past years have had trouble with the term “**ionizing radiation.**”

a. (6 points) Part of the confusion is the word “radiation.” First explain these 2 terms.

nuclear radiation:

electromagnetic radiation:

b. (4 points) Now explain **ionizing radiation.** You may have 15 words.

3. (4 points) The early radiologists lost their hands (and sometimes their lives) while doing their job.

a. Their skin cells were damaged by **nuclear electromagnetic** radiation.
(circle one)

b. The name of the type of radiation involved was _____.

4. Here is an equation that we discussed in lecture.



a. (3 points) Two species in this equation have “dots.” What does the dot mean?

b. (4 points) In the context of nuclear radiation, explain the implications of this equation at the cellular level.