

Name _____ Section _____

Activity 11: Ionizing Radiation II

11.1 Additional Sources of Ionizing Radiation

1) Cosmic Rays

Your instructor will show you radiation events in a cloud chamber. Look for vapor trails that do not seem to come from one of the radioactive sources.

What could be the source for events that occur away from any of the radioactive sources?

2) X-Rays

a) What are X-rays?

b) How are X-rays produced?

c) How do we know that X-rays are a form of ionizing radiation?

d) How does ionizing radiation differ from other types of radiation, such as microwaves, infrared radiation, or visible light?

11.2 How Are All Types of Ionizing Radiation Detected?

3) Detection of ionizing radiation

a) What do film badges do?

b) List three ways we've seen in class to detect ionizing radiation.

11.3 What Is the Strength of Ionizing Radiation?

4) The strength of ionizing radiation

a) Use the Geiger counter and a timer to find the background radiation in the room by counting the number of Geiger counter clicks per minute. _____

b) What is the source of this background radiation?

- c) Your instructor will bring you a weak radioactive source. Attach the Geiger counter detector to a ring stand. Place the source 10 cm from the open side of the detector and record the number of counts per minute. _____
How many counts per minute result from this source? _____
- d) Place the source 20 cm from the detector and record the number of counts per minute. _____ How many counts per minute result from this source? _____
- e) Place the source 40 cm from the detector and record the number of counts per minute. _____ How many counts per minute result from this source? _____
- f) What effect does increasing the distance have on the count?

5) The Penetrating ability of ionizing radiation

Test the penetrating ability of beta and gamma sources by placing the sources, one at a time, approximately 10 cm from the open side of the Geiger counter detector. Try shielding each source with pieces of cardboard, aluminum, and lead. Write "yes" or "no" in the table below to indicate which materials shielded each source.

Does the shielding material significantly reduce the ionizing radiation recorded?

Shielding material	alpha	beta	gamma
a) cardboard	_____	_____	_____
b) one aluminum sheet	_____	_____	_____
c) multiple aluminum sheets	_____	_____	_____
d) one lead sheet	_____	_____	_____
e) multiple lead sheets	_____	_____	_____

- f) Compare the penetrating ability and the ionizing ability of alpha, beta, and gamma radiation.

11.4 What Are Natural Sources of Radioactivity?

6) Radiation exposure

- a) What factors determine the extent of our exposure to ionizing radiation?
- b) What is the average person's annual dose of ionizing radiation? _____
- c) How does the radiation exposure of a typical chest X-ray compare to the average annual exposure?

7) Radioactivity in household products

Your instructor will show you some natural and man-made radioactive sources.

- a) Describe the results when you place a Geiger counter detector near each source.
 - i) Potassium iodide (salt substitute)
 - ii) Smoke detector
 - iii) Uranium and thorium ores
 - iv) Radium paint on clock
 - v) Fiestaware

- b) Does your exposure to these products constitute a danger to your health?

- c) The radiation exposure from an old orange Fiestaware plate is about 0.002 mrem/hour. Estimate the annual radiation exposure of a person who ate 3 meals a day using a Fiestaware plate. What percent is this exposure from the plate of the 200 mrem annual exposure of the average person?

8) Radiation or phosphorescence?

Watch the flash bulb/glow-in-the-dark stickers demonstration.

- a) Are glow-in-the dark stickers radioactive? _____
- b) What makes them glow?

- c) How are glow-in-the-dark stickers different from radium glow-in-the-dark clocks manufactured years ago?

9) Radon

- a) What is radon?

- b) What is a "radioactive daughter"?

- c) Radon-222 ($^{222}_{86}\text{Rn}$) decays by emitting an alpha particle (^4_2He). Write the reaction that occurs when radon-222 decays.

- d) How long do you have to leave a radon test kit in a location to determine if you have a radon problem? _____
- e) Can you use a Geiger counter or similar device to check if you have a radon problem? Why or why not?
- f) Why are radon daughters dangerous?
- g) Why is radon of particular concern in locations like central Ohio?
- h) What can be done to correct a radon problem in a building?

11.5 A Model of Radioactive Decay

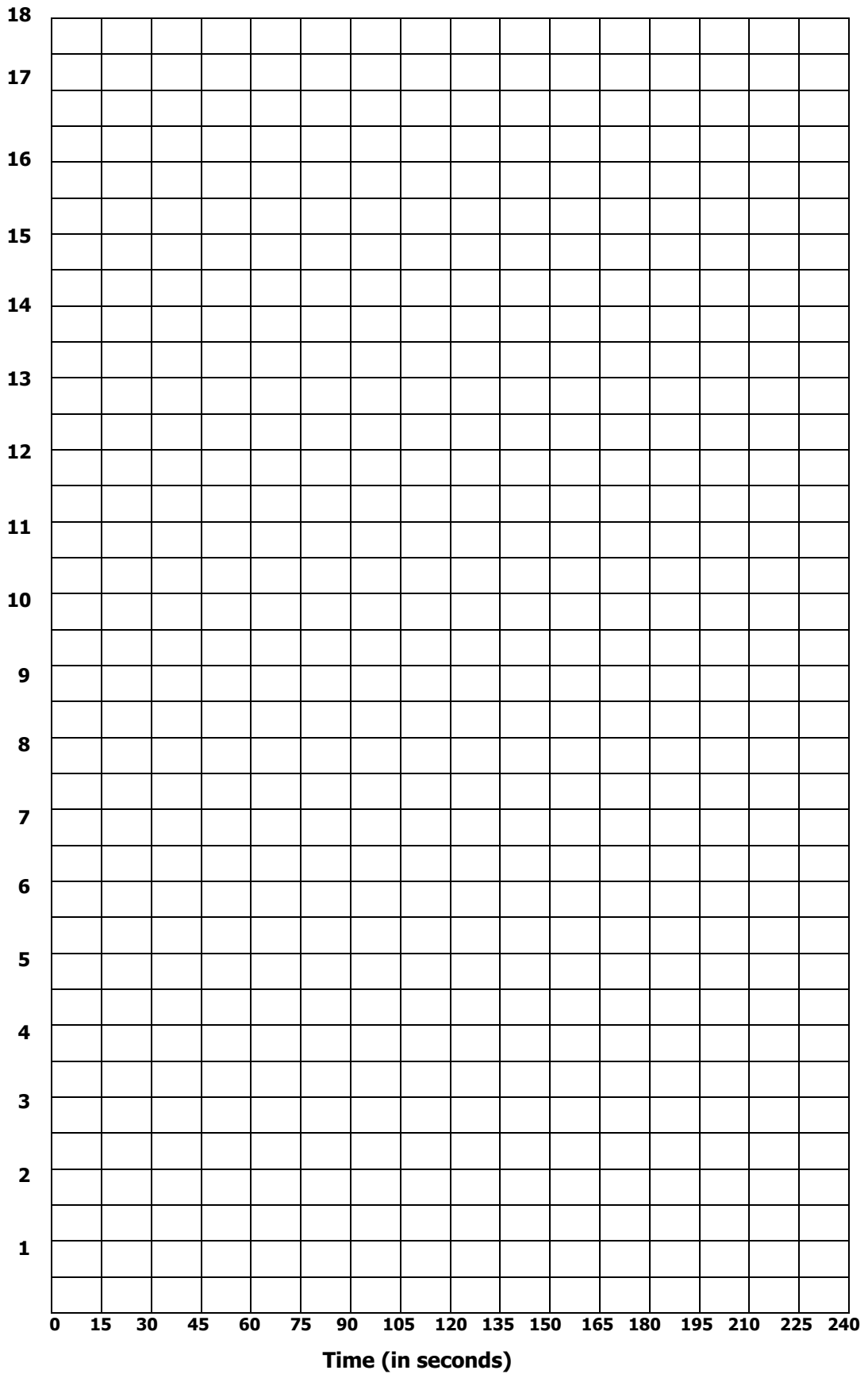
Your instructor will explain how to use a board that simulates radioactive decay with circuit elements and a capacitor.

10) Finding the half-life of a radioactive source

- a) What is the half-life of a radioactive source?
- b) After charging the capacitor, flip the switch to the right to allow the capacitor to discharge through the resistor. At the same time, start the timer. Measure the voltage with a multimeter set to measure DC voltage (V $\overleftarrow{=}$) every 15 seconds for four minutes. Record your measurements in the table below.

Time elapsed (Min: Sec)	Voltage (volts)	Time elapsed (Min: Sec)	Voltage (volts)
0:00		2:15	
0:15		2:30	
0:30		2:45	
0:45		3:00	
1:00		3:15	
1:15		3:30	
1:30		3:45	
1:45		4:00	
2:00			

- c) Make a graph on the grid below of the voltages you measured versus time elapsed.



- d) What is the smallest voltage reading you obtained? _____
- e) What does this voltage represent? Why didn't your graph decrease further?
- f) Would your graph decrease below this voltage if you had measured the voltage for a longer time? Why or why not?
- g) From your graph, find the half-life represented by the capacitor's discharge. To do so, you must subtract the background radiation (the background voltage), find the time for the radiation (the voltage) to decrease by $\frac{1}{2}$, and then add in the background radiation (background voltage).

11.6 Radiocarbon Dating

11) Carbon-14

- a) What common radioactive isotope is used for archeological dating? _____
- b) Why is this isotope unstable?
- c) What change to a $^{14}_6\text{C}$ nucleus would make it a more stable nucleus?
- d) Write a nuclear equation to show how a $^{14}_6\text{C}$ nucleus decays to become a more stable nucleus. What type of ionizing radiation is emitted during this decay?
- e) Where does carbon-14 come from? Write a nuclear reaction to show the formation of $^{14}_6\text{C}$.

12) Carbon Dating

- a) How long does it take for one-half of the carbon-14 nuclei in a sample to decay?
- b) How can the half-life of carbon-14 allow us to determine the age of an archeological object?
- c) A sample of bone from an archeological site was found to contain only one-sixty fourth ($\frac{1}{64}$) the amount of carbon-14 that would have been present in living bone at the time this organism was alive. What is the age of this bone?
- d) Group Discussion Question: An archeological team works in a dig they believe to be around one million years old. Would carbon-14 dating be appropriate to determine the age of this site? Why or why not?