Chapter 3

What Is Radioactivity?

Preface

- Ch. 2 discussed what is radiation.
- Emission of radiation.
- Decay and half-life.

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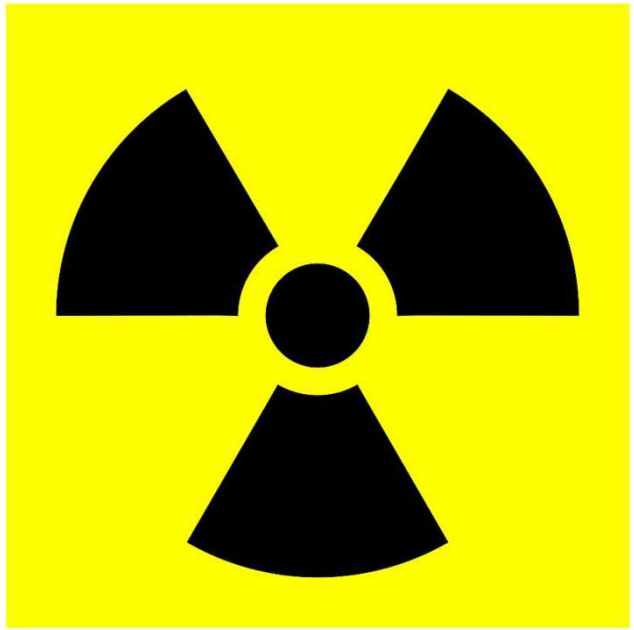
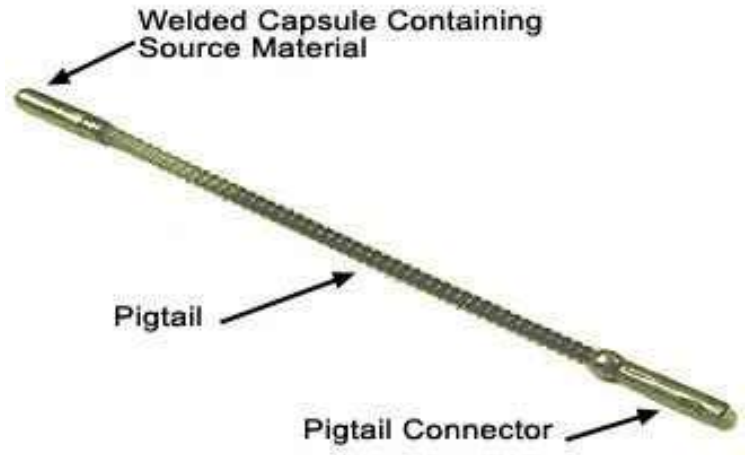


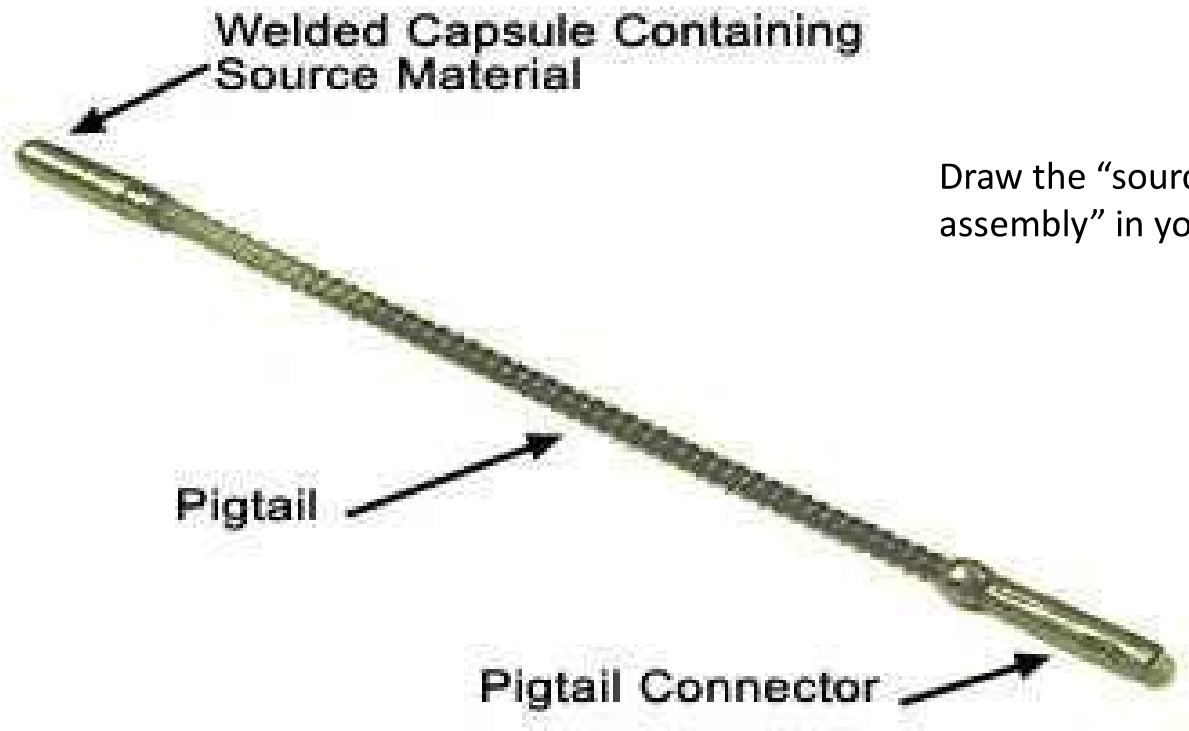
Radioactivity

- The emission of radiation from an unstable atom.
- Shake, snap of atom releasing energy.
- Particulate radiation, gamma rays.



Radioactivity

- Unstable atom.
- Decay process.
- Expends energy.
- Becomes stable.



Draw the “source assembly” in your notes.

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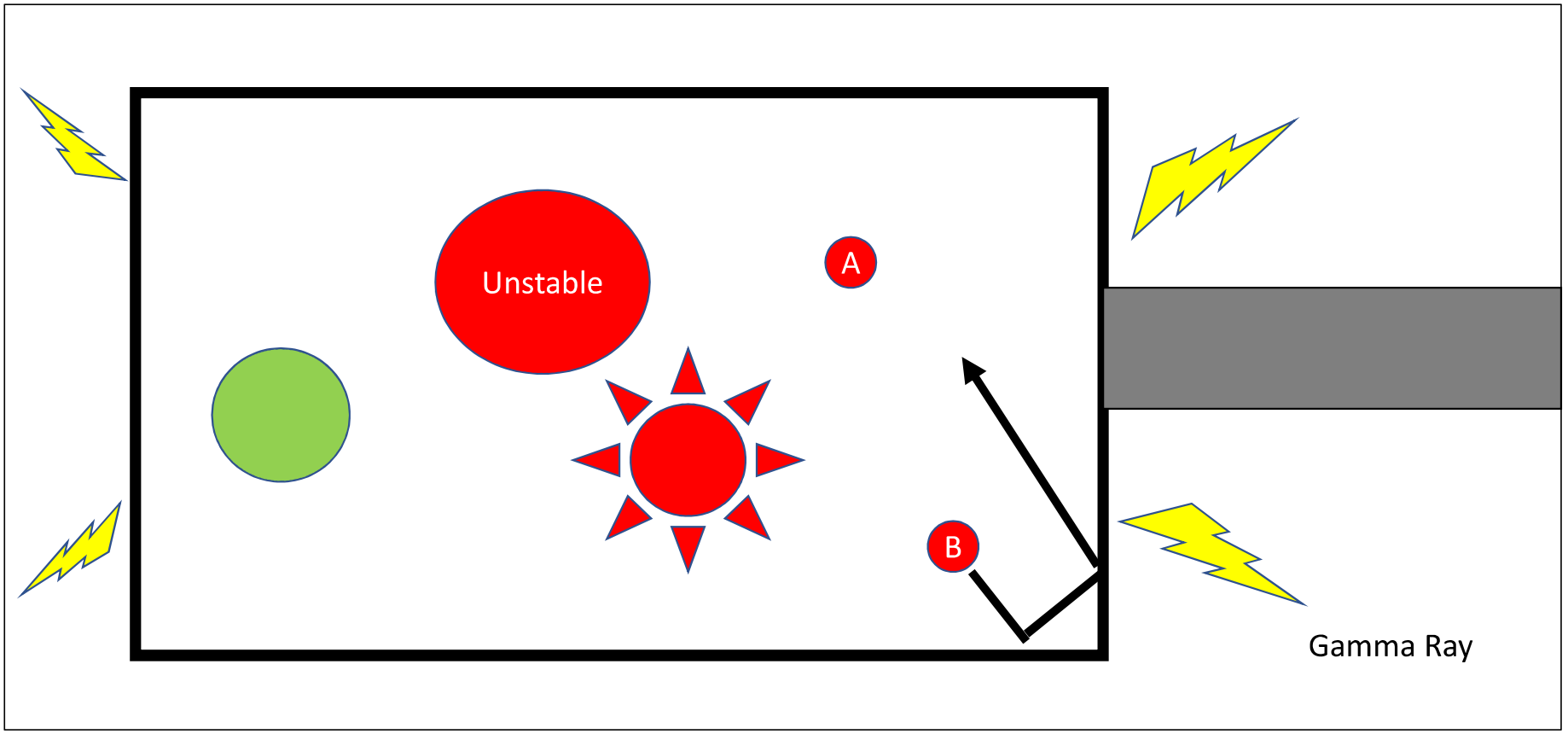
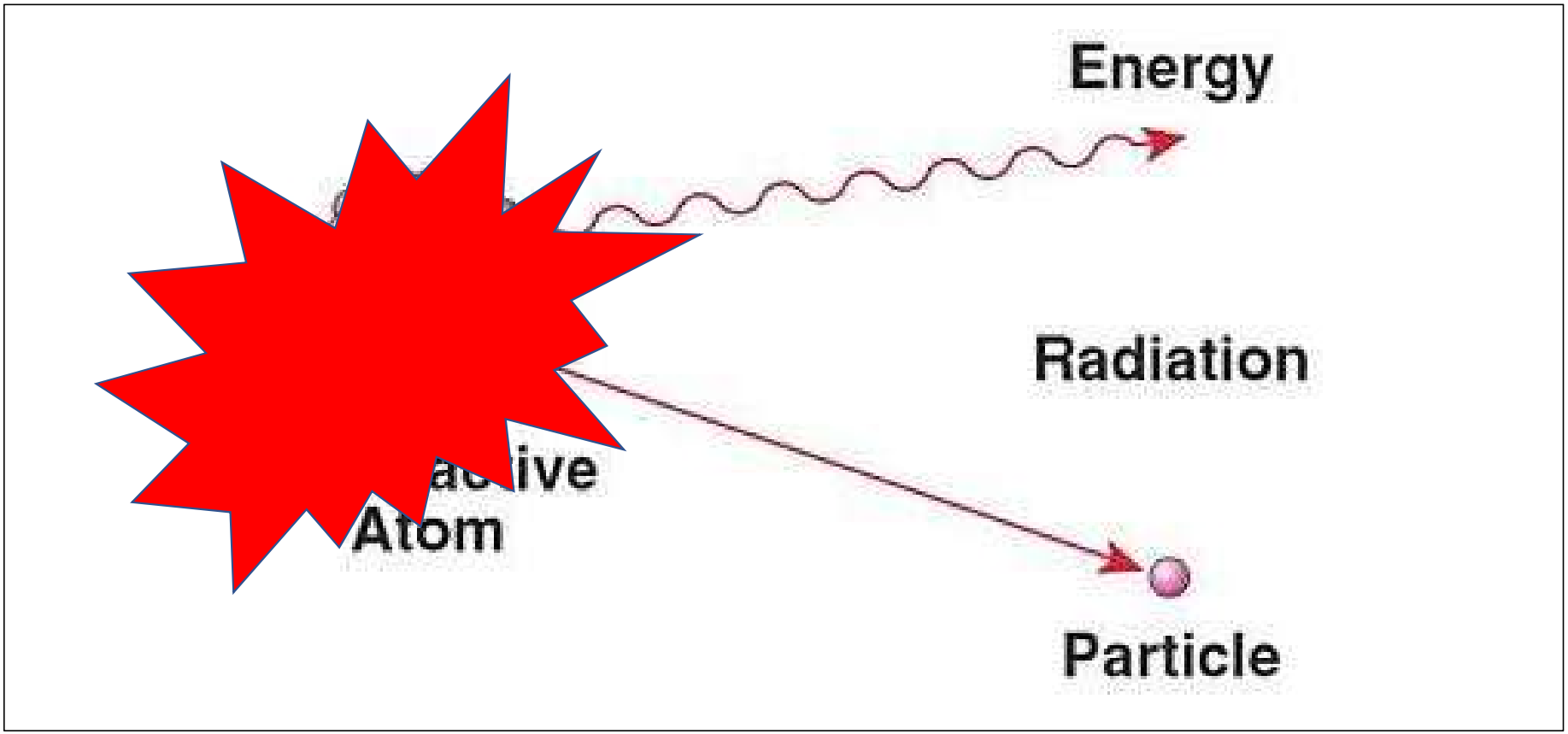
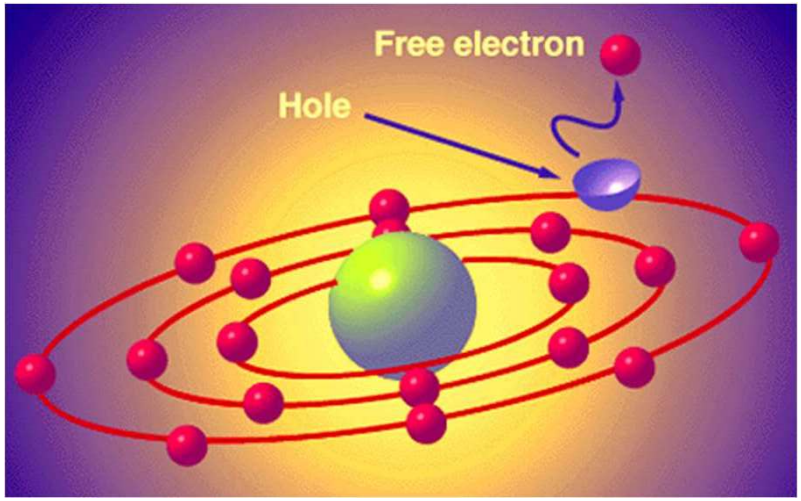
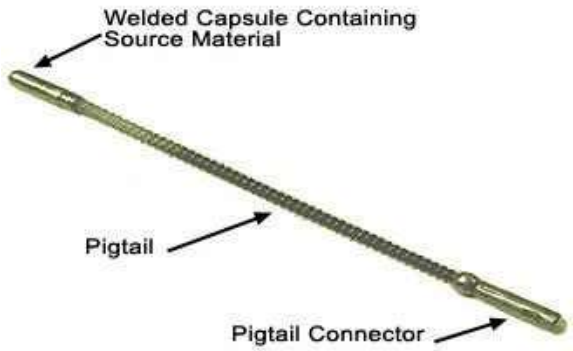



Energy
Radiation
Atom
Particle



Radioactivity

- Or radiation generated from X-ray machines.

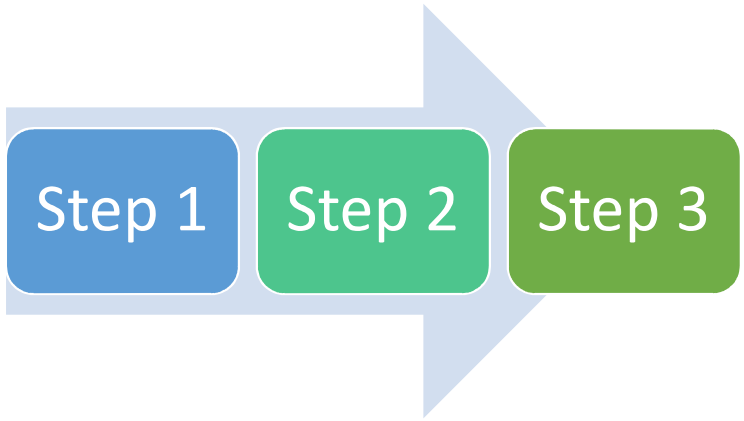


The difference?

- Gamma – radiation derived from a radioactive isotope.
- X-radiation – radiation is derived from X-ray tube, control panel, and power source. (no isotope).

Regulations?

- Gamma – regulated by the US NRC and Agreement States.
- X-radiation – regulated by the state in which the X-ray machine is used.



X-ray Machines

- Free electrons produced.
- Magnetism draws electrons toward target material.
- X-rays produced.

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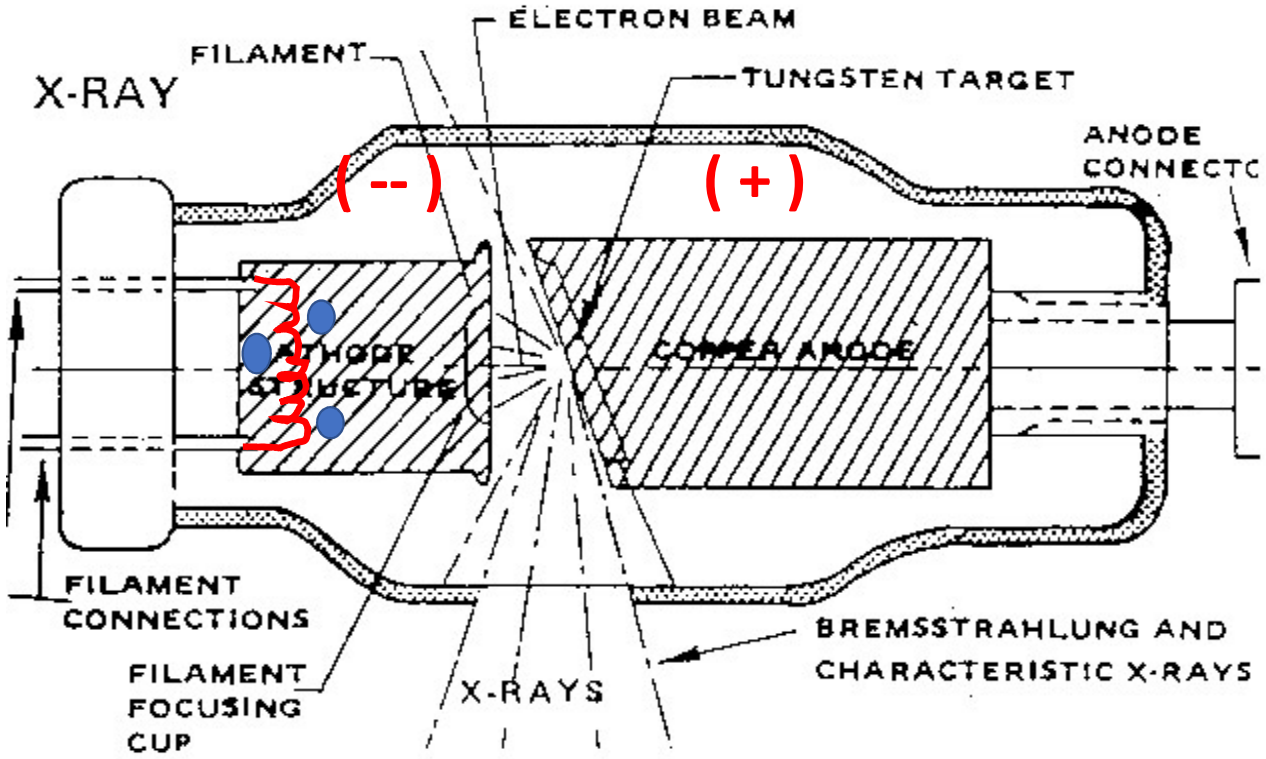
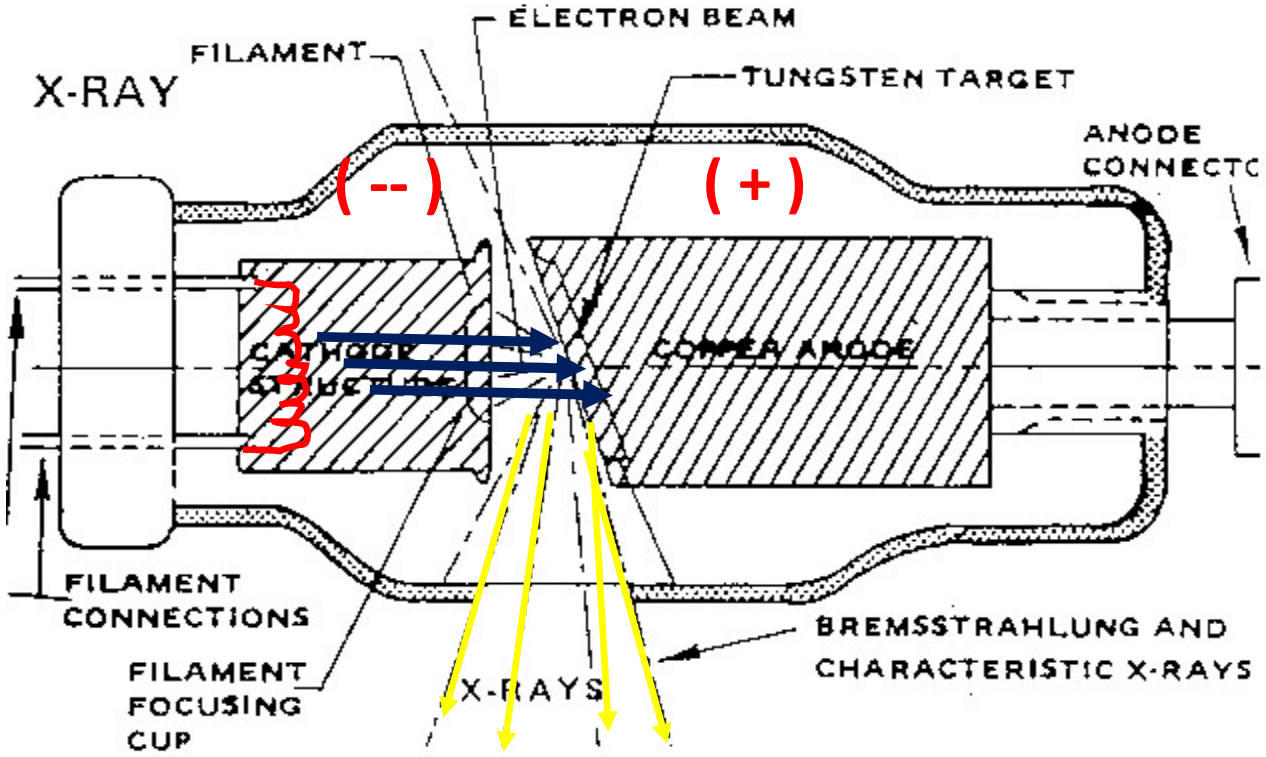

X-RAY
FILAMENT
ELECTRON BEAM
TUNGSTEN TARGET
ANODE
CONNECTO
(--)
(+)
CATHODE
STRUCTURE
COPPER ANODE
FILAMENT
CONNECTIONS
FILAMENT
FOCUSING
CUP
X-RAYS
BREMSSTRAHLUNG AND
CHARACTERISTIC X-RAYS


CONTROL PANEL
On
Off
kV
mA
POWER
HONDA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CONTROL PANEL
On
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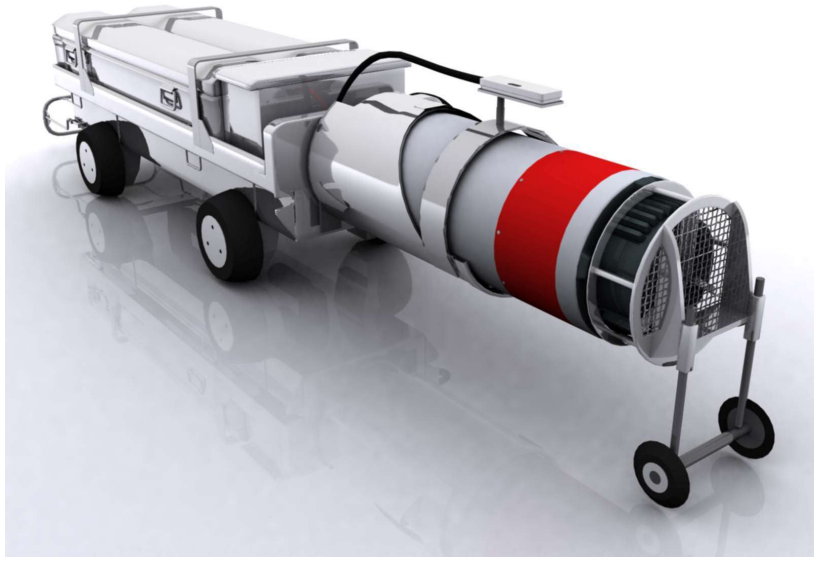
Xray Tube Ratings

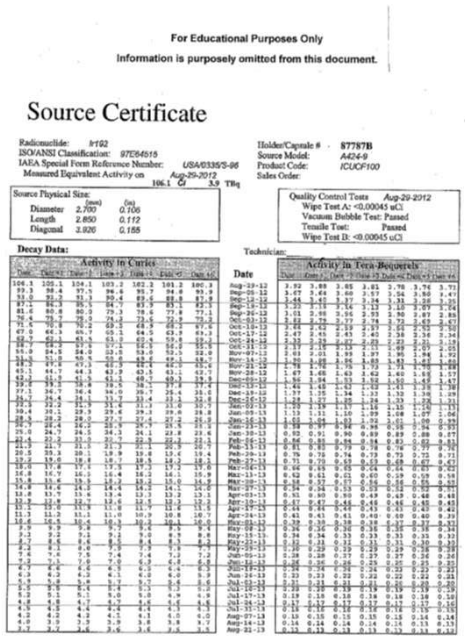
- 100 kV
- 150 kV
- 200 kV
- 225 kV
- 250 kV
- Etc…

The higher the kV enables increase of the penetration power from the X-ray tube.



Tube Pre-Heat

- kV is increased a bit, then exposure.
- kV is increased a bit, then another exposure.
- kV is increased bit by bit so X-ray tube reaches production temp.



For Educational Purposes Only

Information is purposely omitted from this document.

Source Certificate

(Click picture to see decay chart)

Radioactive Decay

- The disintegration or breaking up of an unstable atom with the emission of radiation.
- High to low activity sources.

Measures of Radioactivity

Activity: The quantity of radioactive material present at a given time:

- Curie (Ci) : 3.7×10^{10} disintegration per second (dps)

or

- Becquerel (Bq): 1 dps

Activity

- The strength of a radioactive source.
- High activity.
- Low activity.

Activity

- Sources that are not useful…what do you think happens to those sealed sources?

Pop Quiz

- Cs-137 contaminates Chernobyl. It's estimated to be 20,000 years before the area is habitable again. Why?

Iridium-192

30 Curies

40 curies

70 Curies

Total Curies= **140**

Iridium-192

30 Curies

Total Curies=

30

Iridium-192

15 curies

15 Curies

Total Curies=

30

Pop Quiz:

What benefit is present if sources were combined during an exposure?

More curies equals lower exposure time.

Iridium-192

30 Curies

Total Curies=

30

Cobalt-60

30 Curies

Total Curies=

30

Iridium-192

Curies

Cobalt-60

Curies

Energies are NOT the same. Energy from Cobalt-60 is about 2.5 times greater than Iridium-192.

Iridium-192

\# Curies

5900 mR/hr at 1 foot.

Cobalt-60

\# Curies

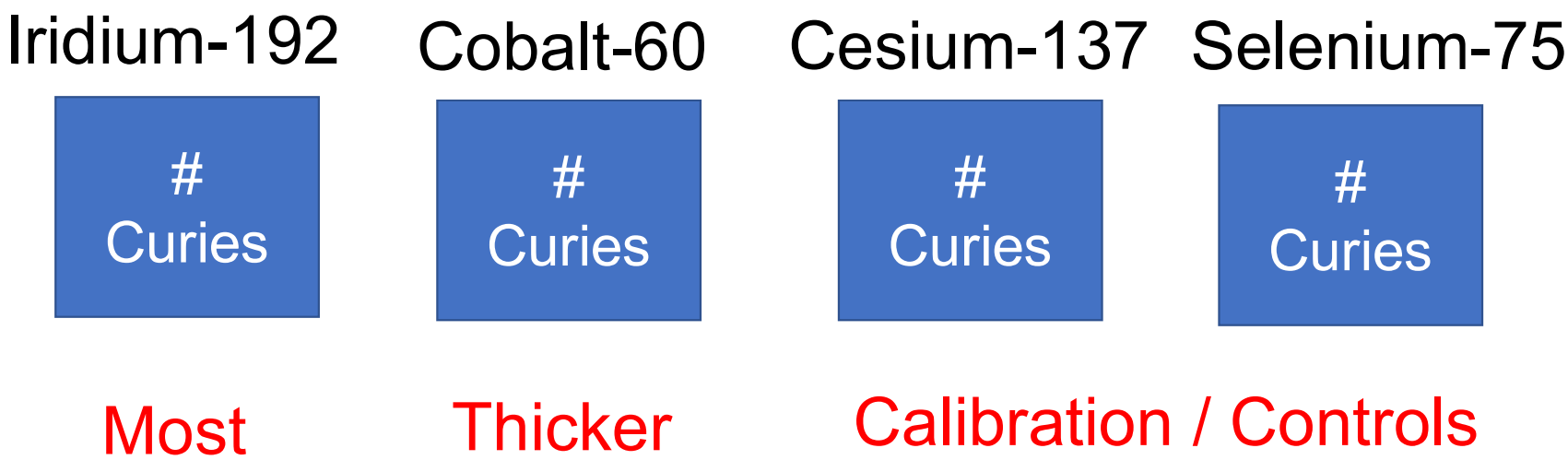
14,500 mR/hr at 1 foot.

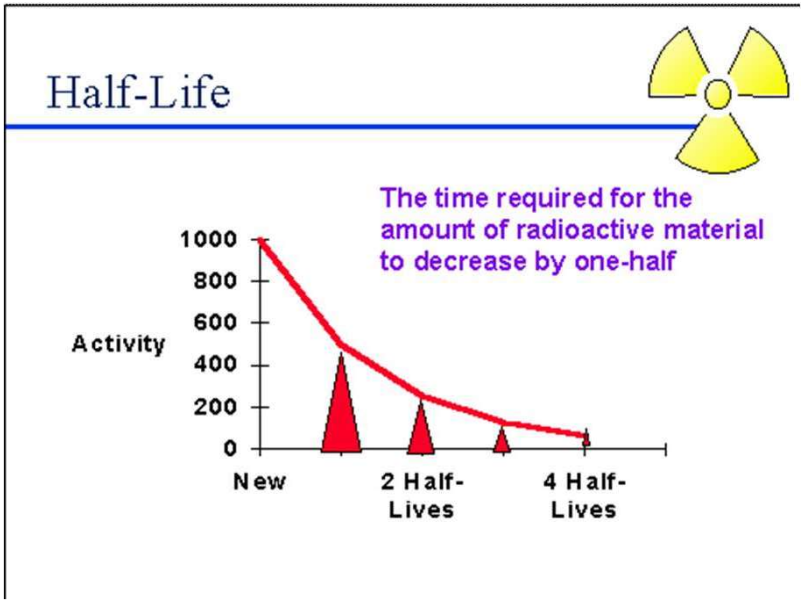
Iridium-192

Used for most Industrial Radiography applications.

Cobalt-60

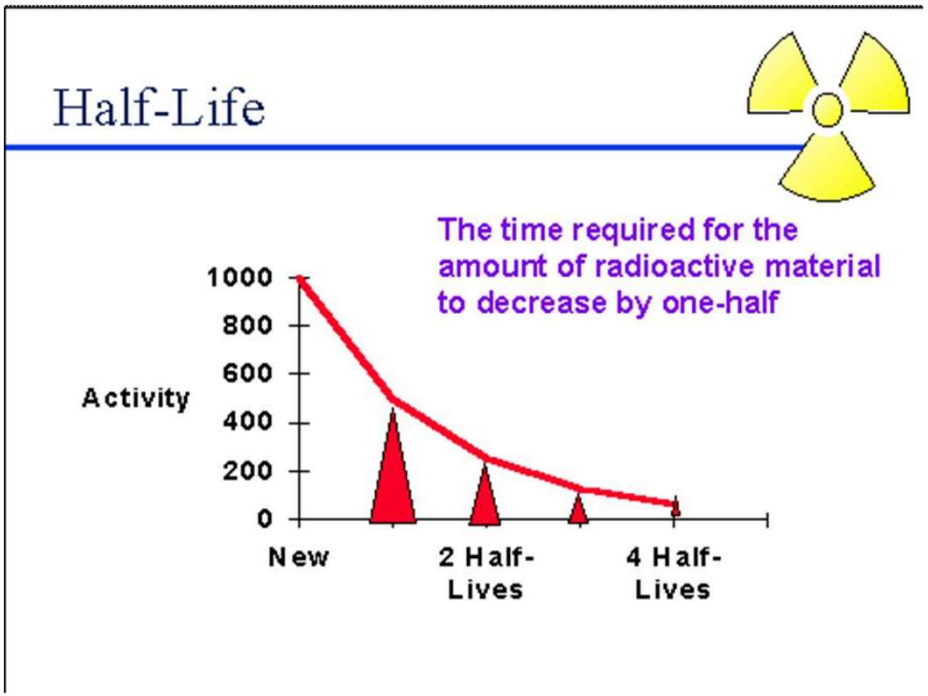
Used to inspect thicker material.

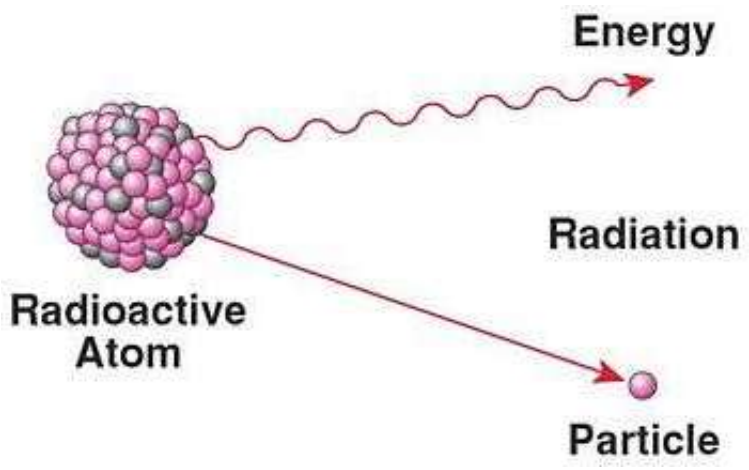

Iridium-192
Curies
Cobalt-60
Curies
Cesium-137
Curies
Selenium-75
Curies
Most
Thicker
Calibration / Controls



Half Life

- The time required for one half of the unstable atoms of a radioactive isotope to decay.
- If half the atoms are present, then the radiation emission is reduced by half.


Half-Life
The time required for the amount of radioactive material to decrease by one-half
Activity
1000
800
600
400
200
0
New
2 Half-Lives
4 Half-Lives

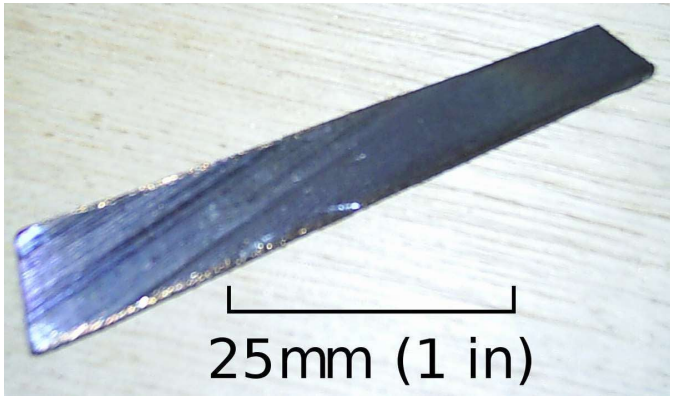


Half Life

- Each isotope has a constant half life.
- Iridium-192 has a half life of approximately 74 days.

Radioisotope	Half Life
Iridium 192	74 days
Cobalt 60	5.3 years
Cesium 137	30.2 years
Selenium 75	120 days
Radium 226	1,580 years

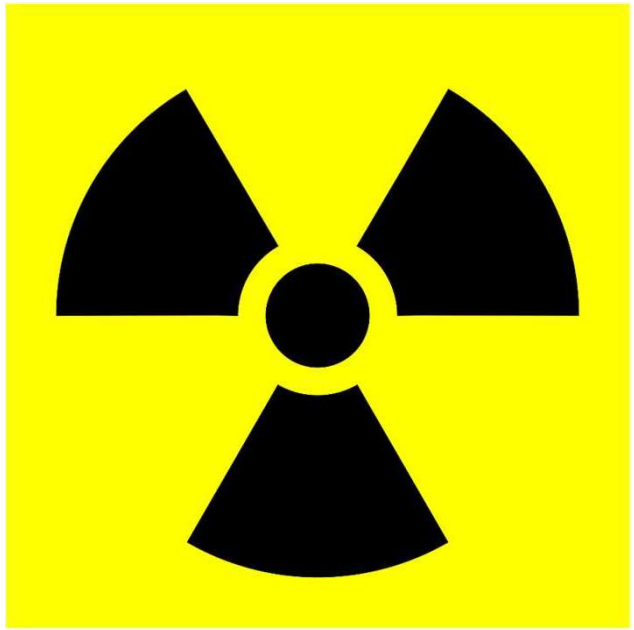
Did you know?



Uranium-238, the most prevalent isotope in uranium ore, has a half-life of **about 4.5 billion years**; that is, half the atoms in any sample will decay in that amount of time.

Radioisotope	Half Lives (days)	Activity
Iridium 192	0	100 ci.
	1 (74 days)	50 ci.
	2 (74 days)	25 ci.
	3 (74 days)	12.5 ci.
	4 (74 days)	6.25 ci.

Radioisotope	Half Lives (years)	Activity
Cobalt 60	0	100 ci.
	1 (5.3 years)	50 ci.
	2 (5.3 years)	25 ci.
	3 (5.3 years)	12.5 ci.
	4 (5.3 years)	6.25 ci.



Can Radiography Sealed Sources Make Things Radioactive?

- No – source material is sealed in capsule.
- Radioactive contamination.

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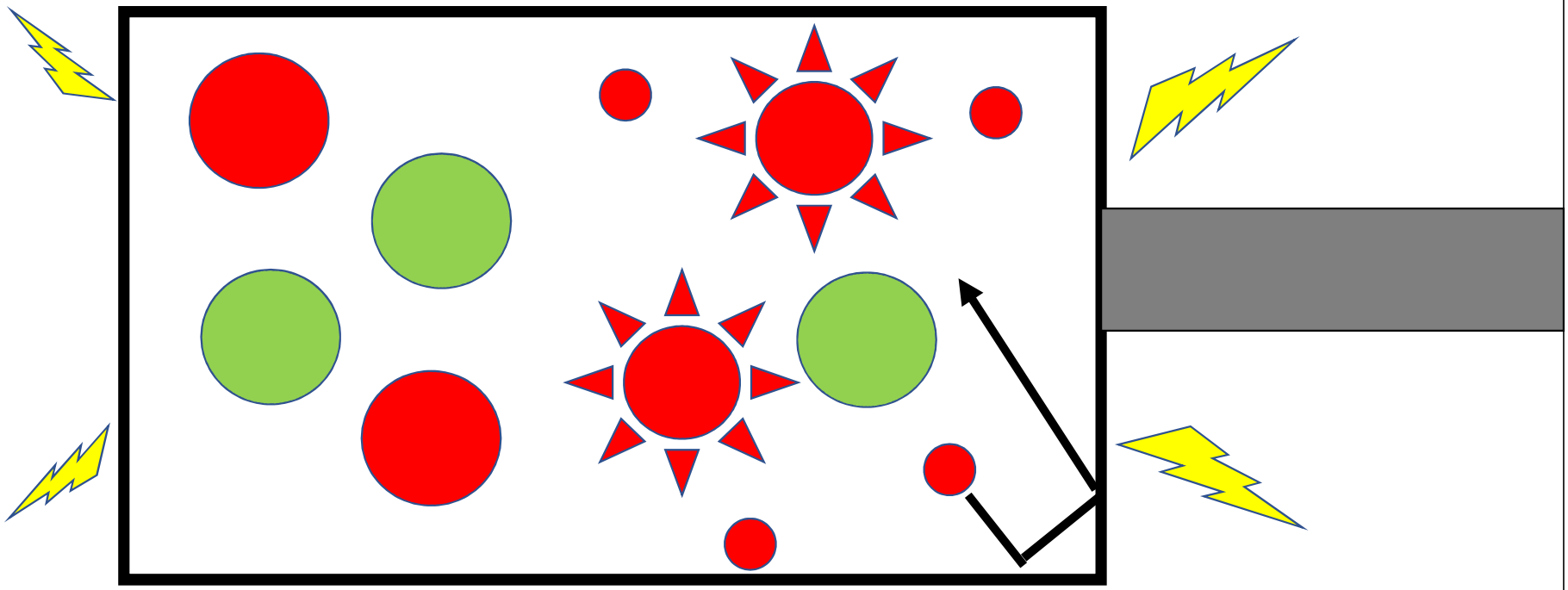

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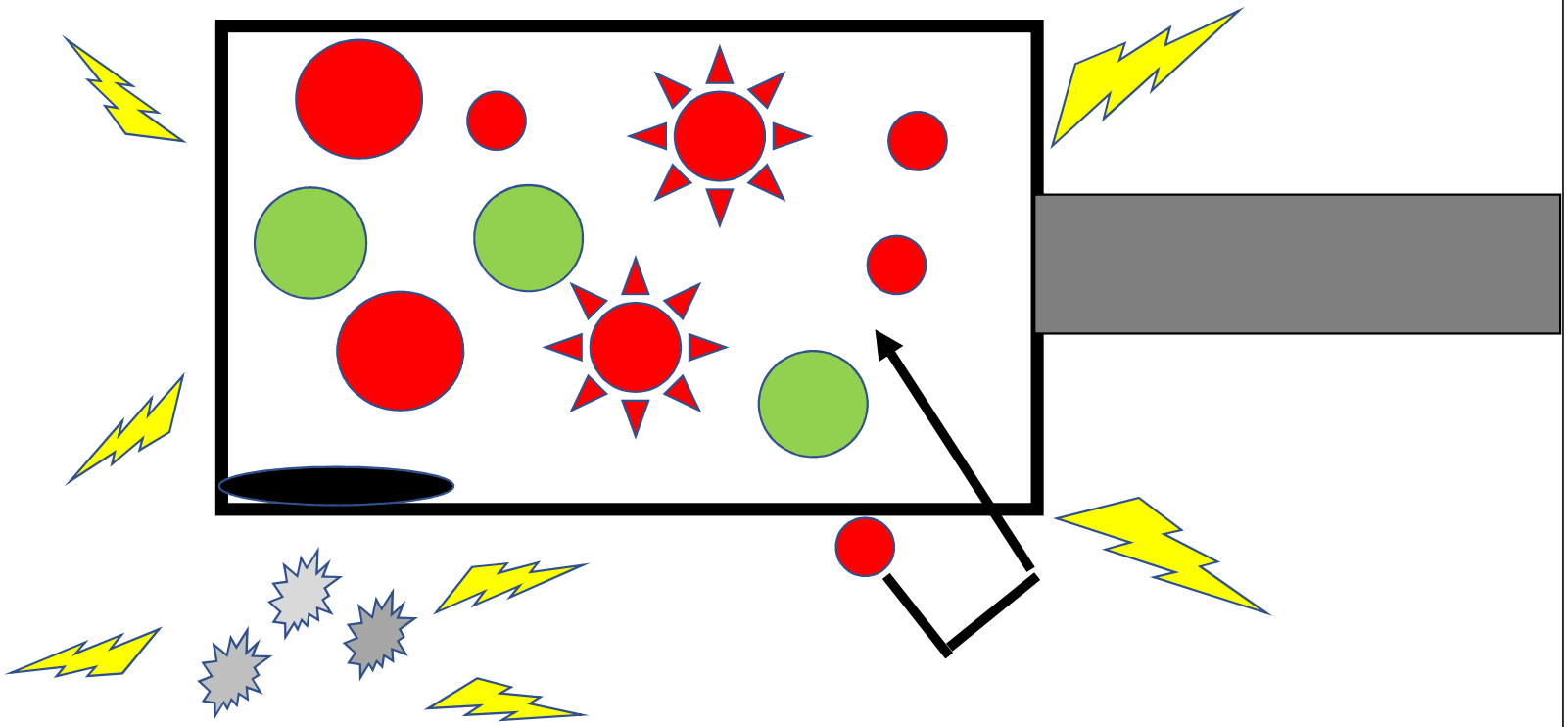
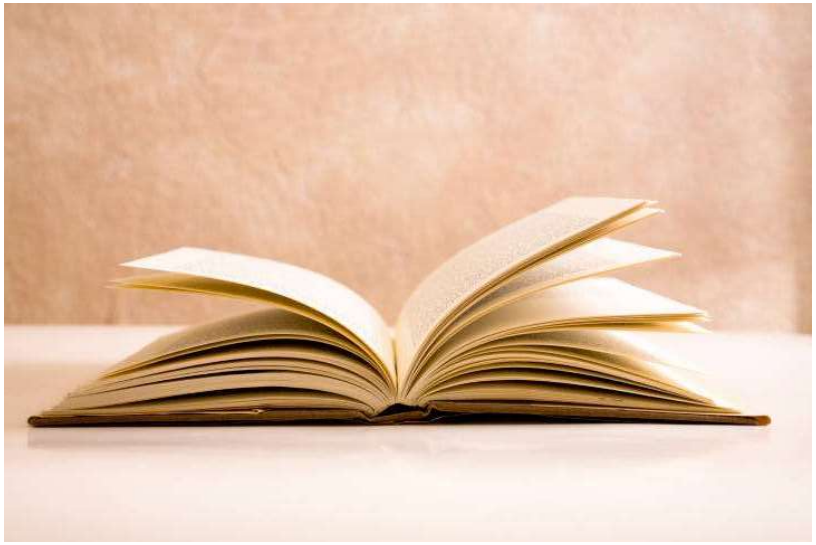


Radioactive Contamination



Making Sense of It All

- What is radioactivity?
- X-ray machines.
- Isotopes and radioactive decay.
- Half-life.
- Residual radiation?
- Contamination.

Quiz 1 of 8:

What is radioactivity?

The emission of radiation from the decay of an unstable atom.

Quiz 2 of 8:

Do X-ray machines contain a radioisotope?

No. X-radiation is created by bombarding a target material with an electron beam. Unlike gamma sources of radiation, X-ray machines can be turned on/off and intensity adjusted via rheostats.

Quiz 3 of 8:

Licensees are required to conduct test for radioactive contamination. What is this test called?

Leak or wipe tests.

Quiz 4 of 8:

When mentioning half life and 74 days, which radioisotope am I referring?

Iridium 192.

Quiz 5 of 8:

Is it possible to speed up or slow down a radioisotope's half-life?

No. Heat, cold, or chemical induction will not slow or speed up the half life.

Quiz 6 of 8:

There are 2 radioactive sources placed next to each other. One has 30 curies and the other has 50 curies. What is the total output?

80 curies output.

Quiz 7 of 8:

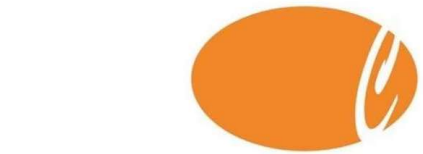
What is *radiation contamination*?

The presence of radioactive material spread on surfaces where it is not supposed to be.

Quiz 8 of 8:

Which rheostat on a X-ray machine control panel controls electron beam acceleration?

The rheostat controlling kilovolts (kV).



End of Chapter 3

What Is Radioactivity?