No formal report

Lab #1 monday.

Activated Aluminum Half-Life Measurement

Objective:

In this laboratory you'll be given a thin aluminum foil that has been activated in the OSU TRIGA Reactor. Your objective is to familiarize yourself with the laboratory equipment (with Dr. Farsoni's assistance) and to determine the half-life of the radioactive isotope of aluminum using the activated foil.

Procedure:

1. Set up the GM counter and its supporting electronics so that it is ready for use as a scalar (counter).
2. Confirm that the GM is operating properly and collect any preliminary data that you might need.
3. Set the dual counter/timer to the aluminum-lab counting time (hint: perform this sequence on the counter/time to find the preset program: Mode "Config Module" => scroll to "recall" => scroll to "AL-LAB" => Mode "Oper". At this setting, the counter/time will automatically count for 12 seconds, rest for 48 seconds, and count again in this pattern until stopped.)
4. Aluminum foils (1 cm diameter x 56 micron thickness) will be exposed to a thermal neutron flux of $1x10^9$ n s^{-1} cm^{-2} for 60 seconds. After a 5-minute cool-down period, the foils will be brought to the lab.
5. When the aluminum source is in place, start the timer and record each 12-second count for a total of at least 15 trials. Note the time (relative to the end of the irradiation time) that your first count begins.
6. Determine the decay constant and calculate the half-life.

Questions:

1. Considering dead-time correction, determine the decay constant (λ) from your graph and calculate the half-life of the appropriate aluminum isotope.
2. Why is it important to include the effects of dead time?
3. What is the known radio-aluminum half-life and how different (%) is the known from your calculated half-life?
4. Estimate the activity of the foil (assume pure aluminum) when it emerged from the reactor and at the beginning of your first count. Estimate both the intrinsic and the absolute efficiency of your GM detector.

$$A_t = \phi N \sigma (1-e^{-\lambda t})(e^{-\lambda t_c})$$

A Brief Introduction to Neutron Activation Analysis

Why NAA?

Applications

- Archaeology
- Geology
- Environmental Analysis
- Semiconductor
- Epidemiology
- Forensics

Advantages

- Non-destructive
- Time efficient
- Multi-element
- Not limited by chemical form

Why NAA?

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Why NAA?

- Archaeology
- Geology
- Enviro
- Semic
- Forens

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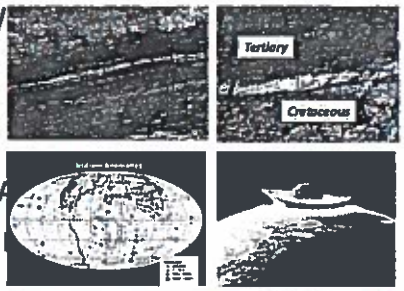
- Archaeology
- Geology
- Environmental A

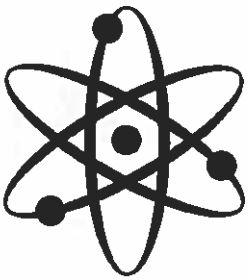


- Iridium is a metal which has very low abundance on earth
- Excess iridium in K-T band is attributed to an impact of a 10-kilometer diameter asteroid

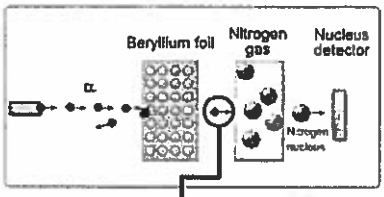
Why N

- Epidemiology
- Forensics

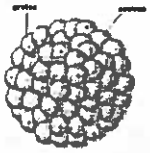
Structure of Atoms



Structure of Atoms



James Chadwick



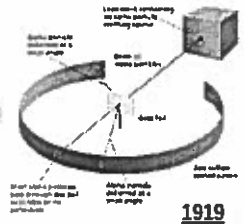
Carries no charge – neutral
Similar mass as proton

Neutron

1932

Structure of Atoms

"It was almost as incredible as if you fired a 15-inch shell at a piece of tissue paper and it came back and hit you."



1911

Ernest Rutherford
1871-1937

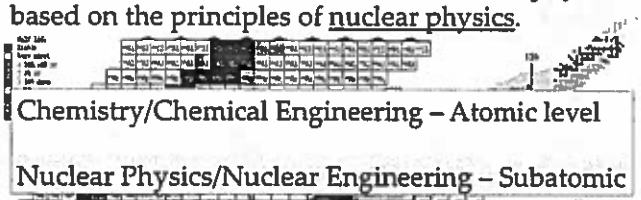
Nucleus
Proton
Electron

1919

Hydrogen nucleus is present in other nuclei

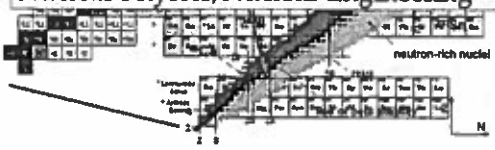
Proton

Nuclear Engineering is the branch of engineering concerned with the application of the breakdown of atomic nuclei and/or other sub-atomic physics, based on the principles of nuclear physics.



Chemistry/Chemical Engineering – Atomic level

Nuclear Physics/Nuclear Engineering – Subatomic



Structure of Atoms

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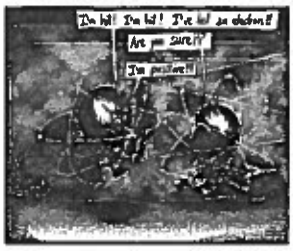


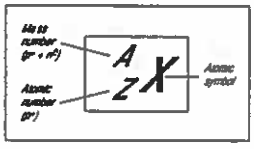
1911

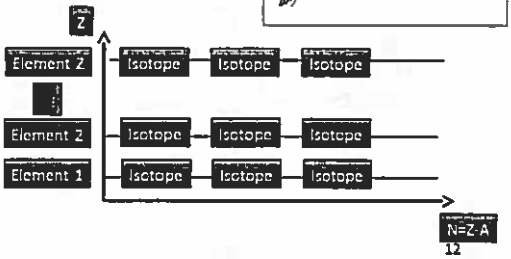
Ernest Rutherford
1871-1937

Nucleus
Proton
Electron

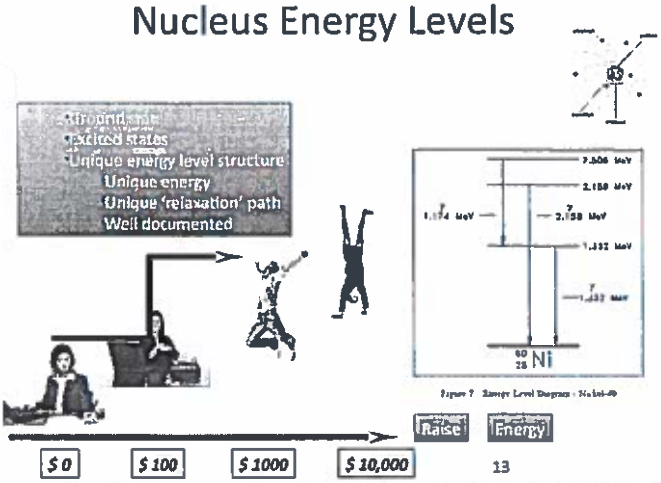
Proton

Isotope vs. Element





Nucleus Energy Levels



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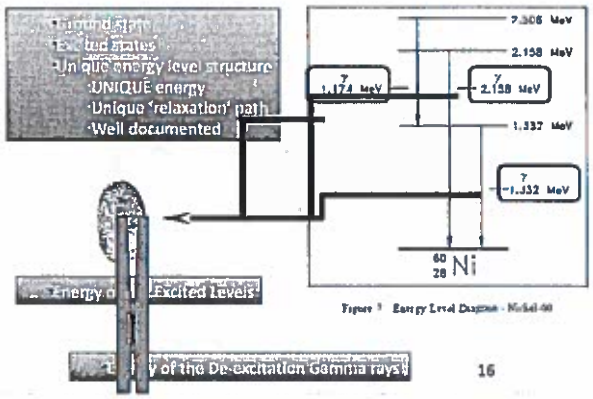
Origin of Gamma-rays



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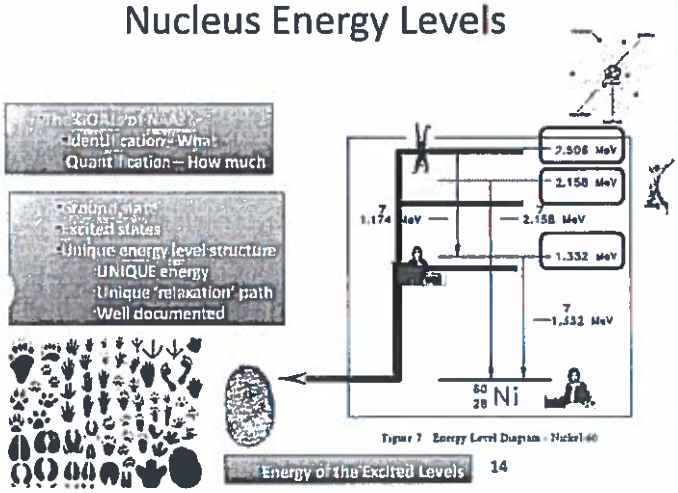
Nucleus Energy Levels



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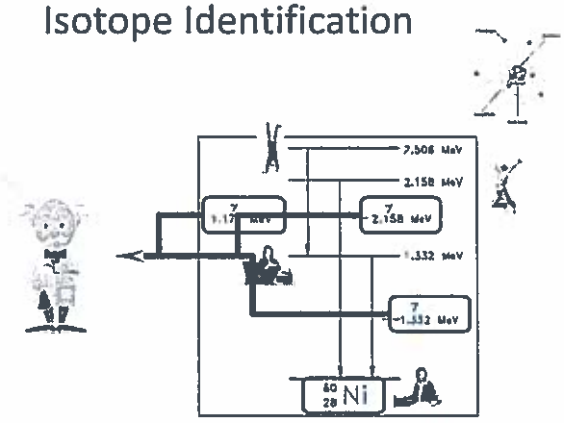
Isotope Identification



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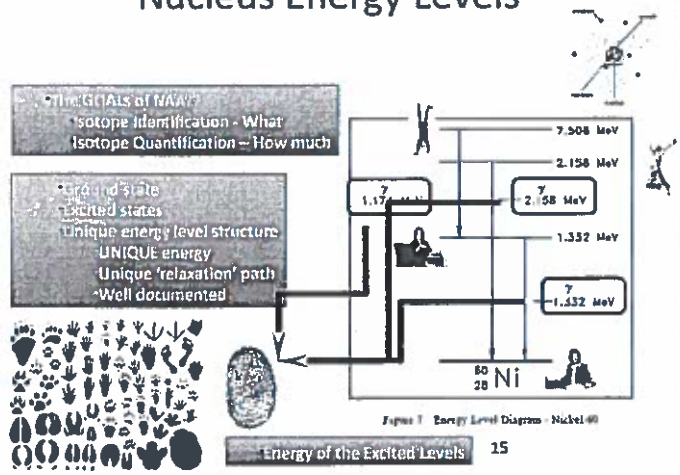
Nucleus Energy Levels



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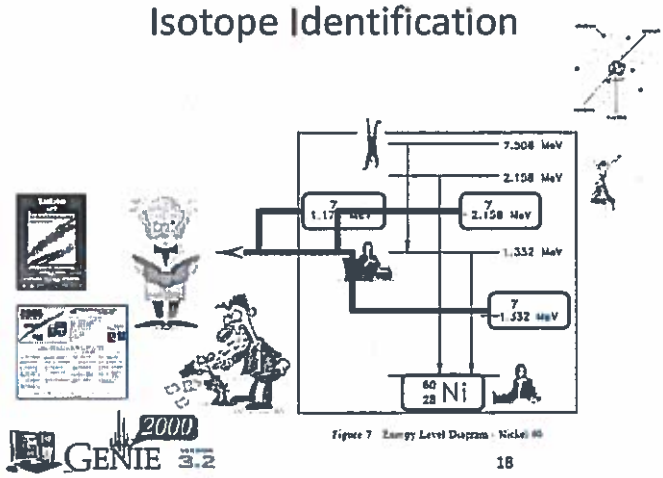

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Isotope Identification

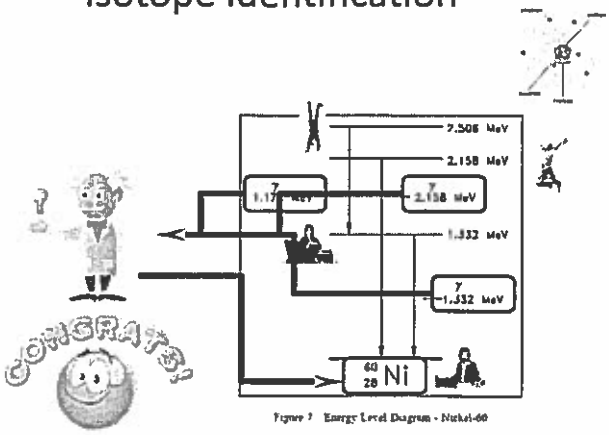


Figure 7 Energy Level Diagram - Nickel-60

Al Lab

What is the activity of Al-28 after and irradiation period of t?

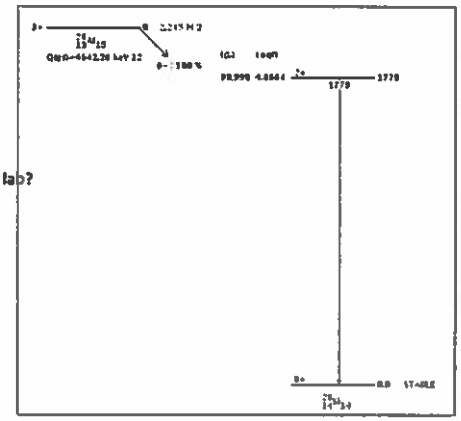
Balance equation of # of Al-28 nuclei
Increase rate:
$\Phi N_P \sigma$
Decrease:
λN_d
Rate of change:
$dN_d/dt = \Phi N_P \sigma - \lambda N_d$
Initial condition:
$N_d(0) = 0$

Activity
$A_t = \lambda N_d(t) = \Phi N_P \sigma(1-e^{-\lambda t})$

Al Lab

$^{27}Al + n \rightarrow {}^{28}Al^*$
$^{27}Al^* \rightarrow {}^{28}Al + \gamma$
$^{28}Al \rightarrow {}^{28}Si^* + \beta$
$^{28}Si^* \rightarrow {}^{28}Si + \gamma$

What could be measured in the lab?

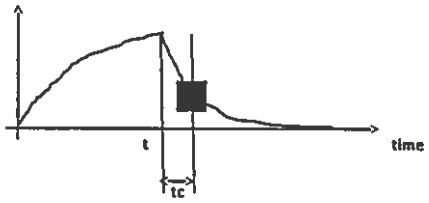


Al Lab

What is the activity of Al-28 after and irradiation period of t?

$A_t = \lambda N_d(t) = \Phi N_P \sigma(1-e^{-\lambda t})$

What is the activity after cooling time tc?



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$^{28}Al \rightarrow {}^{28}Si^* + \beta$
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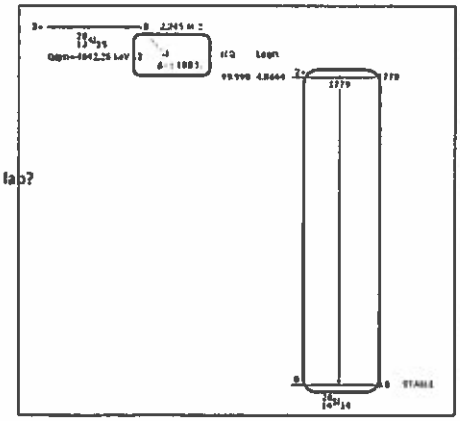
What could be measured in the lab?
- Beta particle
- Gamma ray

What is the half life of Al-28?



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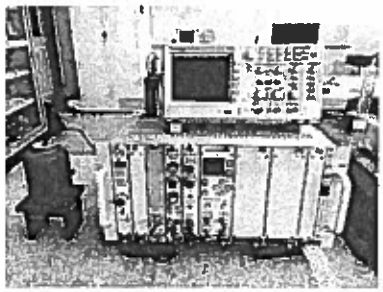
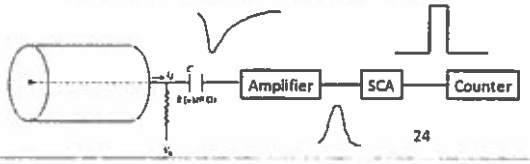




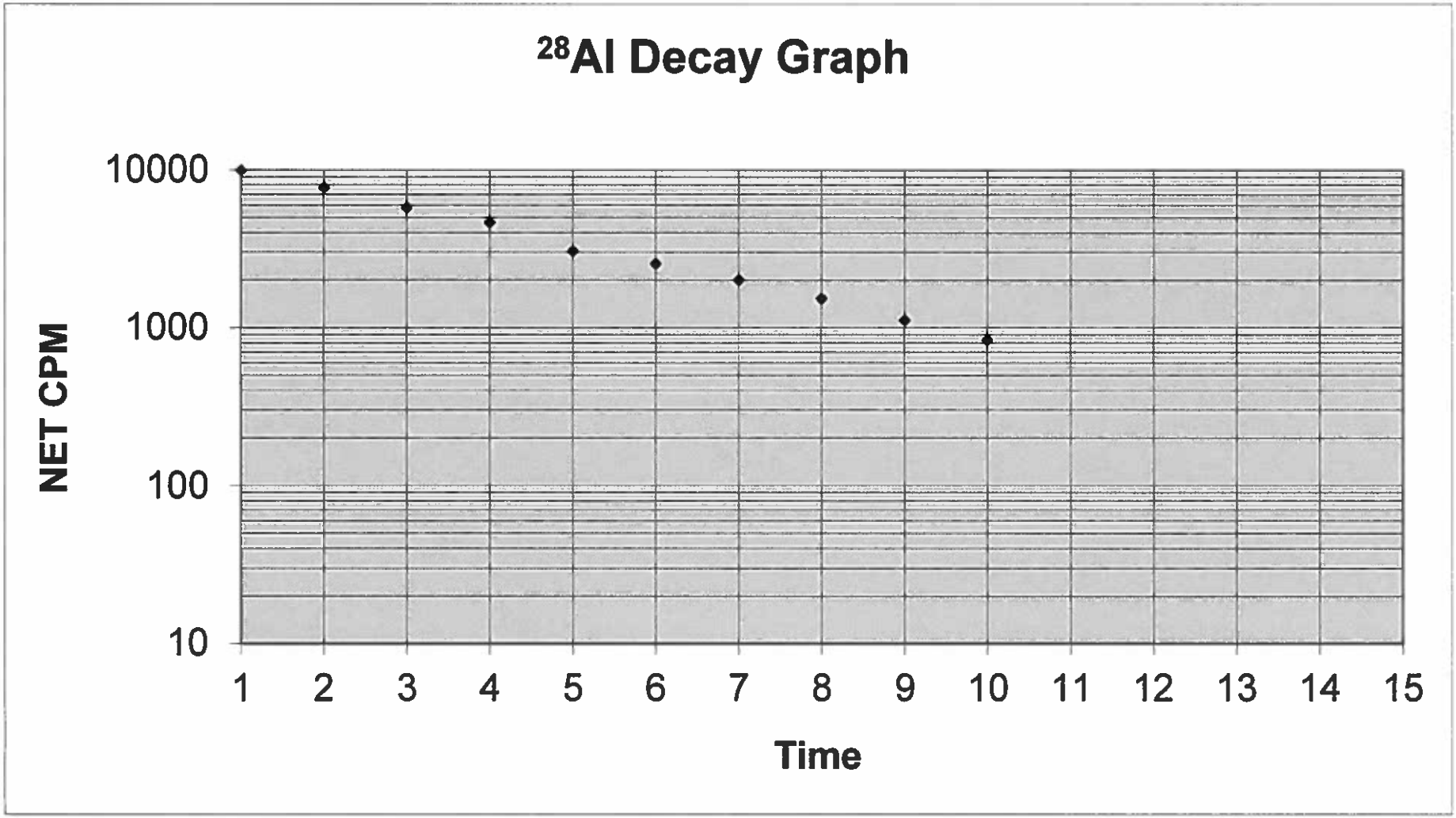
) $t_{1/2} = \frac{\ln 2}{\lambda} = \ln 2$

[5th lab don't need]

Aluminum Lab Worksheet

Background Counts
Background CPM 0

Time	Gross Counts	Δt (min)	Gross CPM	NET CPM
1	1981	0.2	9905	9905
2	1527	0.2	7635	7635
3	1149	0.2	5745	5745
4	923	0.2	4615	4615
5	607	0.2	3035	3035
6	503	0.2	2515	2515
7	399	0.2	1995	1995
8	304	0.2	1520	1520
9	222	0.2	1110	1110
10	166	0.2	830	830
11		0.2	0	0
12		0.2	0	0
13		0.2	0	0
14		0.2	0	0
15		0.2	0	0


28Al Decay Graph
NET CPM
10000
1000
100
10
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Time