

# UBC Physics 102

## *Lecture 2*

Rik Blok



# Outline

- ▷ Radioactivity
- ▷ Alpha decay
- ▷ Beta decay
- ▷ Gamma decay
- ▷ Rate of decay
- ▷ Half-life
- ▷ Activity
- ▷ Radioactive dating
- ▷ End

# Radioactivity [Text: Sect. 42-3]

- **Definition:** *Radioactivity*
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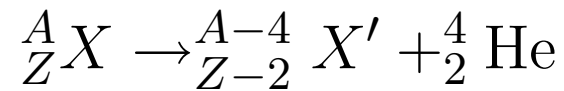
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$\gamma$ (gamma)	photon	none	<u>very</u> light

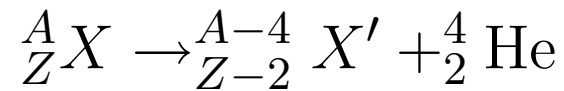
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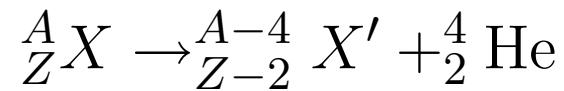


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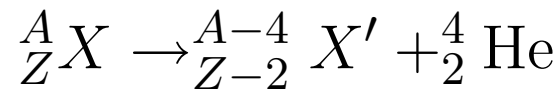
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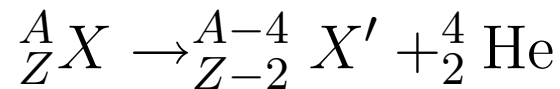
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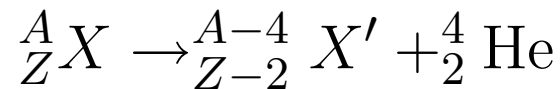
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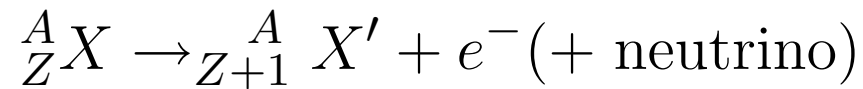
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- Smoke interrupts current to trip alarm.

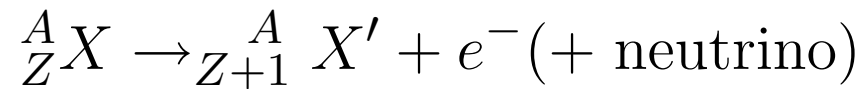
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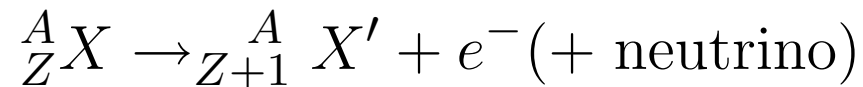
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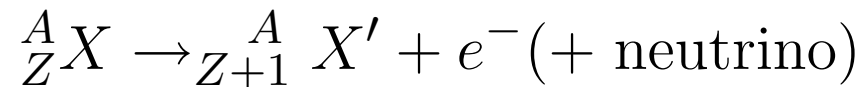
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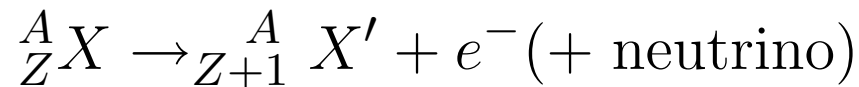


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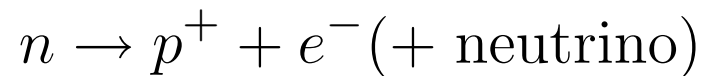


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- Produced by decay of neutron:



# Gamma decay [Text: Sect. 42-6]

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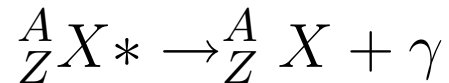
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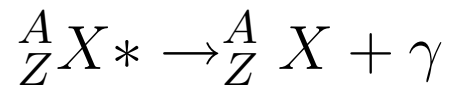


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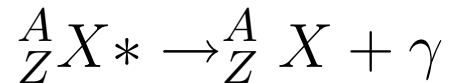
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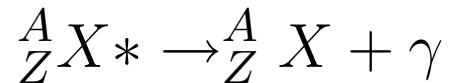
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## ● Interactive Quiz: PRS 02a

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- $\lambda$  (lambda) is proportionality constant that sets rate.
- Can integrate to find how much material remains after time  $t$ ,

$$N(t) = N_0 e^{-\lambda t}.$$

# Half-life [Text: Sect. 42-8]

- **Derivation: Half-life,  $T_{1/2}$**

- The time it takes for half the original amount of isotope to decay. Is solution to

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- **Interactive Quiz: PRS 02b**
- **Definition: *Half-life*,  $T_{1/2}$**

$$T_{1/2} = \frac{\ln 2}{\lambda}$$

# Activity [Text: Sect. 42-8]

- **Definition:** *Activity*,  $\left| \frac{dN}{dt} \right|$ 
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- **Example:**

- $^{31}\text{Si}$  has a half-life of 2.62 hr. What will the activity of a 1 g sample be after 1 week?

# Activity, contd

## • Solution:

• We know  $N(t) = N_0 e^{-\lambda t}$ . Then

$$\left| \frac{dN}{dt} \right| = \lambda N_0 e^{-\lambda t}.$$



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- Need to calculate  $N_0$ ,  $\lambda$ , and  $t$ . First,  $t$  (in hours) is  $t = 1 \text{ wk} = 168 \text{ hr}$ .

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- Need to calculate  $N_0$ ,  $\lambda$ , and  $t$ . First,  $t$  (in hours) is  $t = 1 \text{ wk} = 168 \text{ hr}$ .
- Now, use half-life,  $T_{1/2} = \frac{\ln 2}{\lambda}$  to get  $\lambda$ ,

$$\begin{aligned} \lambda &= \frac{\ln 2}{T_{1/2}} = \frac{0.693}{2.62 \text{ hr}} \\ &= 0.265 \text{ hr}^{-1}. \end{aligned}$$

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- So activity is

$$\begin{aligned} \left| \frac{dN}{dt} \right| &= \lambda N_0 e^{-\lambda t} \\ &= (0.265 \text{ hr}^{-1})(1.94 \times 10^{22} \text{ part.}) e^{-(0.265 \text{ hr}^{-1})(168 \text{ hr})} \\ &= 238 \text{ particles/hr.} \quad \square \end{aligned}$$

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## ● Discussion: Carbon dating

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- $N_0$  can be determined from total number of carbon atoms in sample.
- Measure activity to get current  $N$ , from  $\left| \frac{dN}{dt} \right| = \lambda N$ .



# End

## ● Practice Problems:

- Ch. 42: Q. 7, 13, 19, 21, 25
- Ch. 42: Pr. 35, 37, 39, 43, 45, 47, 49, 55, 63, 65

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## ● Interactive Quiz: Feedback

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## ● Interactive Quiz: Feedback

## ● Tutorial Question: tut02