Neutron Capture Processes

on the Partial Chart of the Nuclides

Start at the endpoint of fusion: ^{56}Fe

Choose how long it takes a nucleus to capture a neutron in your simulation (more/faster neutrons -> shorter time)

- To simulate slow-neutron-capture ("s-process"): capture one neutron every **10 years**
- To simulate rapid-neutron-capture ("r-process"): capture one neutron every **100 ms**

} *mark paths in different colors*

For your starting isotope, and each isotope you make afterwards:

- **Decide whether your isotope will decay first (half-life shorter than capture time) or last long enough to capture a neutron!**
- **Use a marker to draw an arrow from your starting isotope to the created isotope (legend at far right shows which direction)**
- *Advanced: if your isotope's half-life is close to the capture time (one-half to two times), try **both** decay and capture paths!*

Keep capturing/decaying until you reach the finish line (the heaviest isotope of strontium (Sr) you create)!

Advanced: all neutron-rich nuclei will eventually decay back to stability. Use a different color to draw arrows to stable isotopes made.

Isotope name: Element Mass Number

Naturally-occurring abundance of this isotope (only for **stable** isotopes, black boxes)

Half-life/typical decay time (only for **unstable** isotopes, boxes with colored shapes)

s = seconds m = minutes
h = hours d = days y = years
ms = milliseconds
ns = nanoseconds

B 10 20%	Stable, no decay
Li 11 0.009s	Beta-minus decay (lose a neutron, gain a proton)
O 15 0.122s	Beta-plus decay (lose a proton, gain a neutron)

Neutron capture

Beta minus decay

Beta plus decay

Finish?

						^{73}Sr >25 ms	^{74}Sr >1.5us	^{75}Sr 88 ms	^{76}Sr 7.89 s	^{77}Sr 9 s	^{78}Sr 2.6 m	^{79}Sr 2.25 m	^{80}Sr 1.77 h	^{81}Sr 22.3 m	^{82}Sr 25.36 d	^{83}Sr 1.35 d	^{84}Sr 0.56%	^{85}Sr 64.85 d	^{86}Sr 9.9%	^{87}Sr 7.0%	^{88}Sr 82.6%	^{89}Sr 50.53 d	^{90}Sr 28.79 y	^{91}Sr 9.63 h	^{92}Sr 2.66 h	^{93}Sr 7.43 m	^{94}Sr 1.25 m	^{95}Sr 23.9 s	^{96}Sr 1.07 s	^{97}Sr 429 ms	^{98}Sr 653 ms	^{99}Sr 269 ms	^{100}Sr 202 ms	^{101}Sr 113.8 ms
							^{73}Rb <30 ns	^{74}Rb 64.78 ms	^{75}Rb 19 s	^{76}Rb 36.5 s	^{77}Rb 3.78 m	^{78}Rb 17.66 m	^{79}Rb 22.9 m	^{80}Rb 33.4 s	^{81}Rb 4.57 h	^{82}Rb 1.27 m	^{83}Rb 86.2 d	^{84}Rb 32.82 d	^{85}Rb 72.2%	^{86}Rb 18.64 d	^{87}Rb 27.8%	^{88}Rb 17.77 m	^{89}Rb 15.15 m	^{90}Rb 2.63 m	^{91}Rb 58.4 s	^{92}Rb 4.49 s	^{93}Rb 5.84 s	^{94}Rb 2.7 s	^{95}Rb 377.7 ms	^{96}Rb 201 ms	^{97}Rb 169.1 ms	^{98}Rb 114 ms	^{99}Rb 54 ms	^{100}Rb 48 ms
		^{69}Kr 27.4 ms	^{70}Kr 52 ms	^{71}Kr 100 ms	^{72}Kr 17.16 s	^{73}Kr 27.3 s	^{74}Kr 11.5 m	^{75}Kr 4.29 m	^{76}Kr 14.8 h	^{77}Kr 1.24 h	^{78}Kr 0.35%	^{79}Kr 1.46 d	^{80}Kr 2.3%	^{81}Kr 229 ky	^{82}Kr 11.6%	^{83}Kr 11.5%	^{84}Kr 57.0%	^{85}Kr 10.78 y	^{86}Kr 17.3%	^{87}Kr 1.27 h	^{88}Kr 2.84 h	^{89}Kr 3.15 m	^{90}Kr 32.32 s	^{91}Kr 8.57 s	^{92}Kr 1.84 s	^{93}Kr 1.29 s	^{94}Kr 212 ms	^{95}Kr 114 ms	^{96}Kr 80 ms	^{97}Kr 62.2 ms	^{98}Kr 42.8 ms	^{99}Kr 40 ms		
			^{69}Br <24 ns	^{70}Br 79.1 ms	^{71}Br 21.4 s	^{72}Br 1.31 m	^{73}Br 3.4 m	^{74}Br 25.4 m	^{75}Br 1.61 h	^{76}Br 16.2 h	^{77}Br 2.38 d	^{78}Br 6.45 m	^{79}Br 50.7%	^{80}Br 17.68 m	^{81}Br 49.3%	^{82}Br 1.47 d	^{83}Br 2.4 h	^{84}Br 31.76 m	^{85}Br 2.9 m	^{86}Br 55.1 s	^{87}Br 55.65 s	^{88}Br 16.29 s	^{89}Br 4.4 s	^{90}Br 1.91 s	^{91}Br 541 ms	^{92}Br 343 ms	^{93}Br 102 ms	^{94}Br 70 ms	^{95}Br >300ns	^{96}Br >300ns	^{97}Br >300ns	^{98}Br >400ns			
^{64}Se >180ns	^{65}Se 33 ms	^{66}Se 33 ms	^{67}Se 133 ms	^{68}Se 35.5 s	^{69}Se 27.4 s	^{70}Se 41.1 m	^{71}Se 4.74 m	^{72}Se 8.4 d	^{73}Se 7.15 h	^{74}Se 0.89%	^{75}Se 119.78 d	^{76}Se 9.4%	^{77}Se 7.6%	^{78}Se 23.8%	^{79}Se 335 ky	^{80}Se 49.6%	^{81}Se 18.45 m	^{82}Se 8.7%	^{83}Se 22.3 m	^{84}Se 3.26 m	^{85}Se 31.7 s	^{86}Se 14.3 s	^{87}Se 5.5 s	^{88}Se 1.53 s	^{89}Se 410 ms	^{90}Se 210 ms	^{91}Se 270 ms	^{92}Se >300ns	^{93}Se >300ns	^{94}Se >300ns	^{95}Se >400ns			
	^{64}As 40 ms	^{65}As 170 ms	^{66}As 95.77 ms	^{67}As 42.5 s	^{68}As 2.53 m	^{69}As 15.2 m	^{70}As 52.6 m	^{71}As 2.72 d	^{72}As 1.08 d	^{73}As 80.3 d	^{74}As 17.77 d	^{75}As 100%	^{76}As 1.08 d	^{77}As 1.62 d	^{78}As 1.51 h	^{79}As 9.01 m	^{80}As 15.2 s	^{81}As 33.3 s	^{82}As 19.1 s	^{83}As 13.4 s	^{84}As 4.02 s	^{85}As 2.02 s	^{86}As 945 ms	^{87}As 610 ms	^{88}As 270 ms	^{89}As >150ns	^{90}As >300ns	^{91}As >300ns	^{92}As >300ns						
^{62}Ge 129 ms	^{63}Ge 142 ms	^{64}Ge 1.06 m	^{65}Ge 30.9 s	^{66}Ge 2.26 h	^{67}Ge 18.9 m	^{68}Ge 270.93 d	^{69}Ge 1.63 d	^{70}Ge 20.6%	^{71}Ge 11.43 d	^{72}Ge 27.4%	^{73}Ge 7.8%	^{74}Ge 36.5%	^{75}Ge 1.38 h	^{76}Ge 7.7%	^{77}Ge 11.21 h	^{78}Ge 1.47 h	^{79}Ge 18.98 s	^{80}Ge 29.5 s	^{81}Ge 8 s	^{82}Ge 4.56 s	^{83}Ge 1.85 s	^{84}Ge 954 ms	^{85}Ge 540 ms	^{86}Ge 219 ms	^{87}Ge >300ns	^{88}Ge >300ns	^{89}Ge >300ns	^{90}Ge >400ns						
^{61}Ga 168 ms	^{62}Ga 116.12 ms	^{63}Ga 32.4 s	^{64}Ga 2.63 m	^{65}Ga 15.2 m	^{66}Ga 9.3 h	^{67}Ga 3.26 d	^{68}Ga 1.13 h	^{69}Ga 60.1%	^{70}Ga 21.14 m	^{71}Ga 39.9%	^{72}Ga 14.1 h	^{73}Ga 4.86 h	^{74}Ga 8.12 m	^{75}Ga 2.1 m	^{76}Ga 32.6 s	^{77}Ga 13.2 s	^{78}Ga 5.09 s	^{79}Ga 2.85 s	^{80}Ga 2.03 s	^{81}Ga 1.22 s	^{82}Ga 599 ms	^{83}Ga 308.1 ms	^{84}Ga 85 ms	^{85}Ga 93 ms	^{86}Ga >300ns	^{87}Ga >400ns								
^{60}Zn 2.38 m	^{61}Zn 1.48 m	^{62}Zn 9.19 h	^{63}Zn 38.47 m	^{64}Zn 49.2%	^{65}Zn 243.93 d	^{66}Zn 27.7%	^{67}Zn 4.0%	^{68}Zn 18.4%	^{69}Zn 56.4 m	^{70}Zn 0.61%	^{71}Zn 2.45 m	^{72}Zn 1.94 d	^{73}Zn 23.5 s	^{74}Zn 1.59 m	^{75}Zn 10.2 s	^{76}Zn 5.7 s	^{77}Zn 2.08 s	^{78}Zn 1.47 s	^{79}Zn 995 ms	^{80}Zn 550 ms	^{81}Zn 304 ms	^{82}Zn 228 ms	^{83}Zn 127 ms	^{84}Zn >400ns	^{85}Zn >400ns									
^{59}Cu 1.36 m	^{60}Cu 23.7 m	^{61}Cu 3.33 h	^{62}Cu 9.67 m	^{63}Cu 69.2%	^{64}Cu 12.7 h	^{65}Cu 30.9%	^{66}Cu 5.12 m	^{67}Cu 2.58 d	^{68}Cu 30.9 s	^{69}Cu 2.85 m	^{70}Cu 44.5 s	^{71}Cu 19.4 s	^{72}Cu 6.63 s	^{73}Cu 4.2 s	^{74}Cu 1.63 s	^{75}Cu 1.22 s	^{76}Cu 637.7 ms	^{77}Cu 467.9 ms	^{78}Cu 335 ms	^{79}Cu 220 ms	^{80}Cu 210 ms	^{81}Cu >400ns	^{82}Cu >400ns											
^{58}Ni 68.1%	^{59}Ni 101 ky	^{60}Ni 26.2%	^{61}Ni 1.1%	^{62}Ni 3.6%	^{63}Ni 101.2 y	^{64}Ni 0.93%	^{65}Ni 2.52 h	^{66}Ni 2.27 d	^{67}Ni 21 s	^{68}Ni 29 s	^{69}Ni 11.5 s	^{70}Ni 6 s	^{71}Ni 2.56 s	^{72}Ni 1.57 s	^{73}Ni 840 ms	^{74}Ni 680 ms	^{75}Ni 341 ms	^{76}Ni 236 ms	^{77}Ni 124 ms	^{78}Ni 140 ms	^{79}Ni >400ns													
^{57}Co 271.74 d	^{58}Co 70.86 d	^{59}Co 100%	^{60}Co 5.27 y	^{61}Co 1.65 h	^{62}Co 1.54 m	^{63}Co 26.9 s	^{64}Co 300 ms	^{65}Co 1.16 s	^{66}Co 194 ms	^{67}Co 329 ms	^{68}Co 200 ms	^{69}Co 227 ms	^{70}Co 112.7 ms	^{71}Co 80 ms	^{72}Co 59.9 ms	^{73}Co 41 ms	^{74}Co 30 ms	^{75}Co 30 ms	^{76}Co >400ns															
^{56}Fe 91.8%	^{57}Fe 2.1%	^{58}Fe 0.28%	^{59}Fe 44.49 d	^{60}Fe 2.62 My	^{61}Fe 5.98 m	^{62}Fe 1.13 m	^{63}Fe 6.1 s	^{64}Fe 2 s	^{65}Fe 810 ms	^{66}Fe 351 ms	^{67}Fe 394 ms	^{68}Fe 188 ms	^{69}Fe 110 ms	^{70}Fe 77 ms	^{71}Fe 28 ms	^{72}Fe >300ns	^{73}Fe >400ns	^{74}Fe >400ns	^{75}Fe >620ns															

Protons (Elements)

P

26

Start! 30

N Neutrons (Isotopes)