

U1T2 – L2 STABILITY OF THE ATOM

LEARNING GOALS

- Explain the stability of a nuclide in terms of:
 - the operation of the strong nuclear force over very short distances
 - electrostatic repulsion
 - the relative number of protons and neutrons in the nucleus
- Explain natural radioactive decay in terms of stability.

RETRIEVAL PRACTICE

1. **Describe** the nuclear model of the atom.

Nucleus in the middle of the atom

Electron cloud surrounding the nucleus

Nucleus contains protons and neutrons.
Protons repel each other through
electrostatic forces, but strong nuclear
forces keep nucleus intact.

Electron cloud consists of electrons orbiting
the nucleus.

2. **Explain** why protons in the nucleus repel each other.

Electromagnetism says that things with the same charge repel each other.

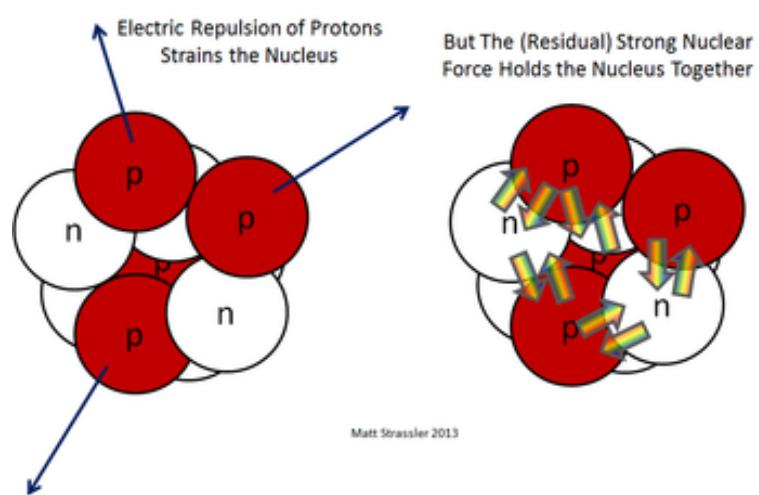
Protons are positively charged, so they repel each other with electrostatic forces.

3. **Define** the term 'strong nuclear force'.

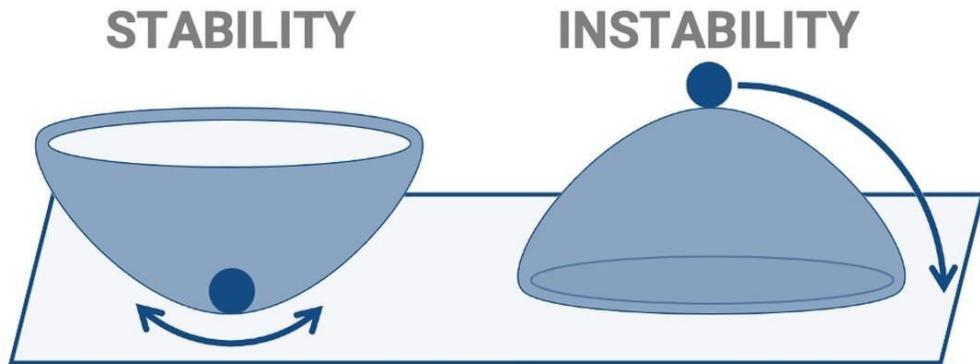
TASK 1: WHICH IS STABLE AND WHY?



THE TWO TYPES OF FORCES



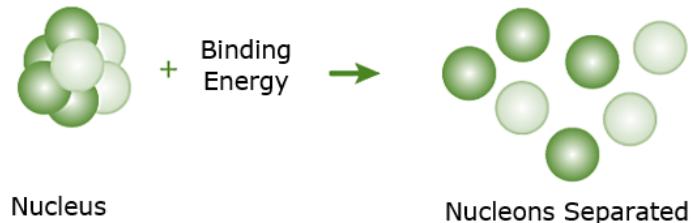
STABILITY AND ENERGY



How is the energy required to keep the ball fixed in place within the two locations?

If $F_{strong} > F_{repulsion}$:

If $F_{strong} < F_{repulsion}$:



Binding energy is:

Amount of energy to break apart nucleus

The higher the binding energy per nucleon:

The more energy required to break nucleus

SPONTANEOUS DECAY

Nuclear decay: Needs input energy.

Spontaneous decay: Doesn't require input energy.

TASK 3: UNSTABLE PARTICLES AND SPONTANEOUS DECAY

- Spontaneous decay can occur when an atom has:

	Excess Mass	Unstable ratio	Excess energy
Caused by	Excess protons and neutrons (High surface area to volume ratio)	Excess protons or neutrons (High coulomb repulsion or particle asymmetry)	Nucleus being in an excited state (Not related to binding energy)
Description	An abundance of particles ($Z > 82$) creates a nucleus with a diameter larger than the range of the SNF. Particles closer to the surface are easy to remove.	The ratio of protons to neutrons varies with isotopes. Too many protons or too many neutrons causes instability.	During decay, when a nucleus emits a particle, the daughter nucleus is left in an excited state.
To increase stability	The nucleus must expel mass to reduce its size.	The nucleus must transform either protons (positive charge) into neutrons or vice versa.	Emits energy (similar to electrons jumping to lower energy states).
Type of decay	Alpha decay	Beta decay	Gamma radiation

We'll learn more about types of decay in another lesson.

Predict an element that will undergo spontaneous decay – you can use the simulation from task 2 if needed.

TASK 4: FILL IN THE BLANKS

Excess Protons AND Neutrons

- An excess of protons and neutrons ($Z > 82$) increases the size of the nucleus such that it creates an unstable surface area
- The particles closer to the surface are only weakly held onto by the strong nuclear force
- The nuclide must undergo alpha decay to release excess protons and neutrons to reduce its surface area, becoming more stable.

Excess Protons

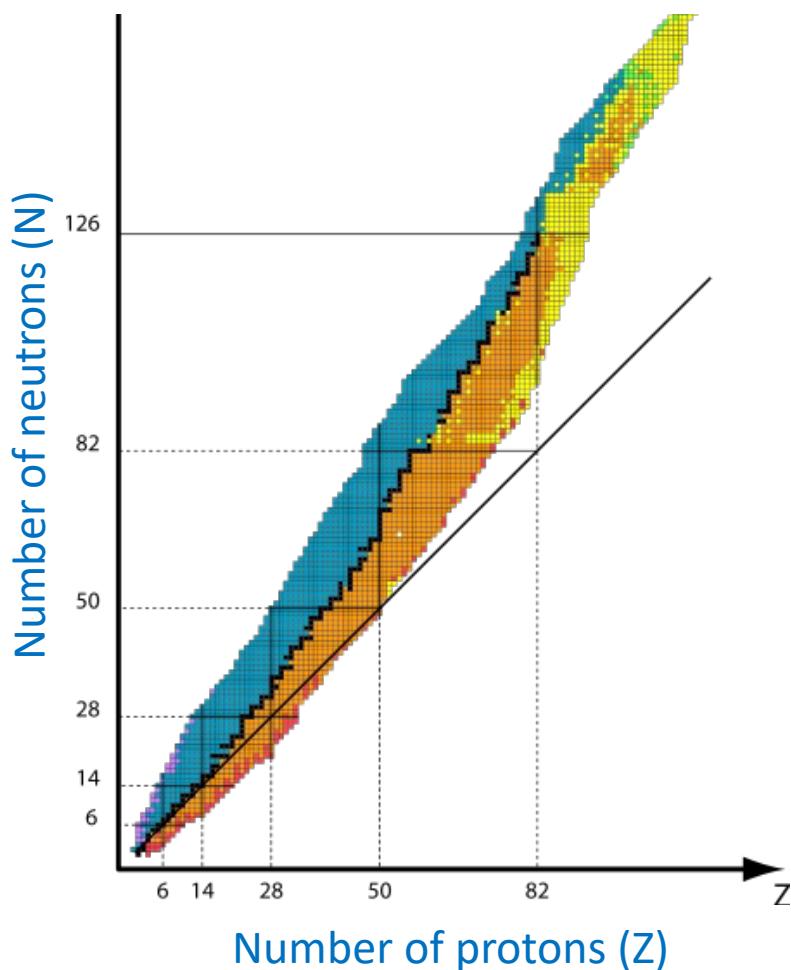
- An excess of protons in the nucleus increases the repulsion acting on the nucleons.
 - This creates an imbalance between the kinetic energy of the particles and the nucleus.
- strong force in the

- The nuclide must undergo radioactive decay to reduce the neutrons to protons in the nucleus to reduce the number of protons , becoming more stable.

Excess Neutrons

- An excess of neutrons in the nucleus creates an _____ causing the nucleons to become too _____
- This creates an imbalance between the kinetic energy of the particles and the _____ in the nucleus.
- The nuclide must undergo radioactive decay to reduce the ratio of _____ in the nucleus to create a stable ratio of nucleons present.

SEGRE CHART



TASK 5:

- Ruthenium 101 and Ruthenium 102 are stable isotopes, but Ruthenium 103 is not.
1. Present the three isotopes of Ruthenium using atomic notation.
 2. Explain why Ruthenium 103 is unstable.

TASK 6: FACTS AND FIBS

For each of the statements below about nuclear stability, identify whether it is a fact or a fib.
If it is a fib, rewrite it so that it becomes a fact.

- A stable nucleus always has equal ratios of protons and neutrons. FALSE

A stable nucleus always has *roughly* equal ratio of protons and neutrons.

- At very high atomic numbers (83 or greater), there are no stable isotopes. TRUE
- Too many protons in the nucleus creates an excess of electrostatic repulsion.

TR UE

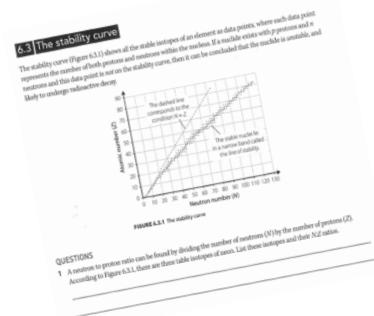
- Too many neutrons in the nucleus creates an excess of the strong-nuclear force.

FALSE

Too many neutrons in the nucleus does... idfk

TASK 7: PRACTICE – GO TO QLEARN DOWNLOAD

- Access the Worksheet "WS 1.2.2 Stability Curve"
- Start now, finish for homework



CONCEPT CHECK

Can you:

- ✓ **Explain** the stability of a nuclide in terms of:
 - ✓ the operation of the strong nuclear force over very short distances
 - ✓ electrostatic repulsion
 - ✓ the relative number of protons and neutrons in the nucleus
- ✓ **Explain** natural radioactive decay in terms of stability.

HOME WORK

- Complete the Stability Curve Worksheet - WS 1.2.2 Stability Curve