http://trending.ly/entertainment/18-amazing-chemical-reaction-gifs/?sid=247&utm_campaign=mhAI2uvo&utm_medium=&utm_source=exp

In a periodic table, the greater number is mass number, smaller number is atomic number

| Subatomic particles | Relative charge | Relative mass | Location in atom | Adding/removal from an atom will change... | Role/function in atom |
|---|---|---|---|---|---|
| Proton | +1 | 1 | Nucleus | Identity | Gives identity |
| Neutron | 0 | 1 | Nucleus | Mass of atom | Stability of nuclei and mass |
| Electron | -1 | 1/1840 or something like that | Around the nucleus inside the shell | Change the charge | Determines the reaction |

If there are too many neutrons, the nucleus will be 'overcrowded' so the neutrons/protons will decay and become radioactive. (and they will start singing)

Arrangement of electrons = electronic configuration

# Isotopes:

Uses: kill cancer cells, used in radioactive explosion stuff (unstable atoms)
~~nuclear explosions, x-men first class them launching the missiles GAMMA RADIATION TURNS BANNER INTO HULK. IM RADIOACTIVE RADIOACTIVE lol no im not~~
~~Nuclear force holds protons 2gedere. It is *together* you uncultured earth apple~~
Hydrogen with 2 neutrons is called Deuterium. 3 neutrons is called Triterium
Properties

- Similar chemical properties
  - Same no of valence electrons.
  - Valence electrons participate in the reaction, cause the reaction to occur.
- Different physical properties
  - eg. melting point, boiling point, mass, density

ALL ELEMENTS HAVE ISOTOPES (just whether they are unstable or not, most radioactive isotopes are man-made, we make the dangerous ones, nature makes the safe ones)

Radioisotopes

- Good and Bad
- Manmade
  - More unstable and suicidal, BOOM BOOM BOOM
- Natural
- Effects
  - long-term, will go into sea, air. Uranium and plutonium - very deadly and harmful. Iodine-137 and caesium-137 is manmade and HIGHLY SOLUBLE IN WATER
  - People in Russia and Fukushima are still battling effects (**WARNING: GRAPHIC**)

http://www.idph.state.ia.us/eh/common/pdf/radiological_health/radioisotopes.pdf

Calculating relative atomic mass

Uranium has 3 common isotopes if the abundance of $^{234}U$ is 0.01%, the abundance of $^{235}U$ is 0.71% and the abundance of $^{238}U$ is 99.28%, what is the average atomic mass of Uranium?

no.

(0.01% x 234 + 0.71% x 235 + 99.28% x 238) / 100 = 238 (3sf)

average atomic mass of Cl is 35.5

2 isotopes: $^{35}Cl$ and $^{37}Cl$

Let x be the abundance of $Cl^{35}$ and 100-x be the abundance of $Cl^{37}$

35.5=(x/100 x 35) + (100-x)/100 x 37

SOLVE.

**QUANTUM MECHANICS (A level let's go)**
**Quantum mechanical model has 90% probability of finding the electron within this space what is this**

Bohr: Proposed idea of quantised energy levels and 'allowed orbits' for the hydrogen atoms. In his model, he placed each electron in a specific energy level. His model was too simplistic and worked well for hydrogen but not for other more complex atoms. http://tinyurl.com/ofam2qp

Limitations of Bohr's model
Works well for atoms with only 1 electron eg. hydrogen

TIME FOR A NEW MODEL WEWEWEWEWEW
*PLAYS DRAMATIC MUSIC*
Quantum mechanics model (1926 was it?)
By Erwin Schrodinger
Solved the problem with bohr's model and was able to apply it to all atoms
This guys work was based on a mathematical equation D: IT'S SUPER ABSTRACT ERGARSH

$$i\hbar\frac{\partial}{\partial t}\Psi = \hat{H}\Psi$$

$$\left(E + \frac{e^2}{r}\right)^2 \psi(x) = -\nabla^2\psi(x) + m^2\psi(x).$$

$$E\Psi(\mathbf{r}) = \left[\frac{-\hbar^2}{2m}\nabla^2 + V(\mathbf{r})\right]\Psi(\mathbf{r})$$

$$i\hbar\frac{\partial}{\partial t}\Psi(\mathbf{r},\, t) = -\frac{\hbar^2}{2m}\nabla^2\Psi(\mathbf{r},\, t) + V(\mathbf{r})\Psi(\mathbf{r},\, t).$$ WOOD YOU LOOK AT THAT BEAUTY


Develops mathematical equation to describe the motion of electrons in atoms.

Proposed electron cloud model which is used today (in A level pfft)

As it moves further away from the nucleus, it moves faster. For an electron to move further away, energy has to be supplied.

It's a region. Just a region. The denser the region, the higher the probability of locating an electron. There are 3 axis (THE THIRD DIMENSION :O)
Another version: red dot with many speckles. The red dot is the nucleus and the speckles is the trail left behind by moving electrons, resembling a 'cloud'. Therefore the probability of the electron being there at that moment in time.
Analogy: I want to find a chicken in a sea of ducks. The more chickens there are (denser region), the higher the probability of finding the chicken. unless you are just plain unlucky.

Other more boring analogy: more substrate and enzyme and formation of E-S complex

Differences between Bohr's model and Quantum Mechanics model

| Bohr | Quantum Mechanics |
|---|---|
| Limit as to how much the electrons can jump around (the shell) | |
| Electrons are treated as particles orbiting around nucleus in a fixed path | |
| 1D model, using 1 quantum number. | 3D model, using 3 quantum numbers to describe the distribution of electrons |
| | |

Similarities between Bohr's model and Quantum Mechanics model
1. The nucleus is always in the middle.

**ANALOGY TIME**
Bohr's model: I am staying at Choa Chu Kang.
QM's mode: I am staying at Choa Chu Kang, St 64, Blk 20.

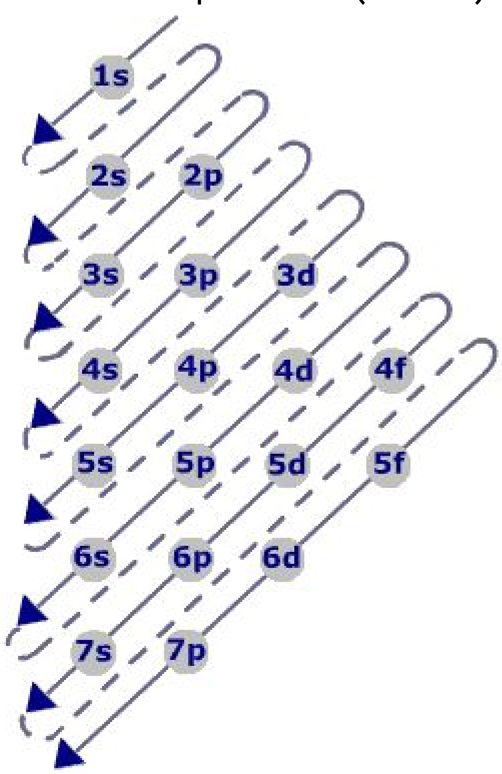
Orbitals: The region of space of high probability (approx. 95%)
Each atomic orbital is described using three quantum numbers: n, l and $m_l$.

We're focusing on the ENERGY LEVEL of the electrons

Orbitals

Some cool interactive thing: http://intro.chem.okstate.edu/WorkshopFolder/Electronconfnew.html

**S**harp
**P**rinciple
**D**iffuse (scattered)
**Fundamental**
**^ Done in Mass-spectrometer (Chem H3)**




n: electron shell number
l: shape of orbital
$m_l$: no. of orbitals

| Value of *l* | 0 | 1 | 2 | 3 |
| --- | --- | --- | --- | --- |
| Letter used | s | p | d | f |

Magnetic quantum number, $m_l$, (-*l* to *l*)
orbitals in subshell: s, p, d, f
When n=1, 2 or 3
Value of *l* is based on alphabet

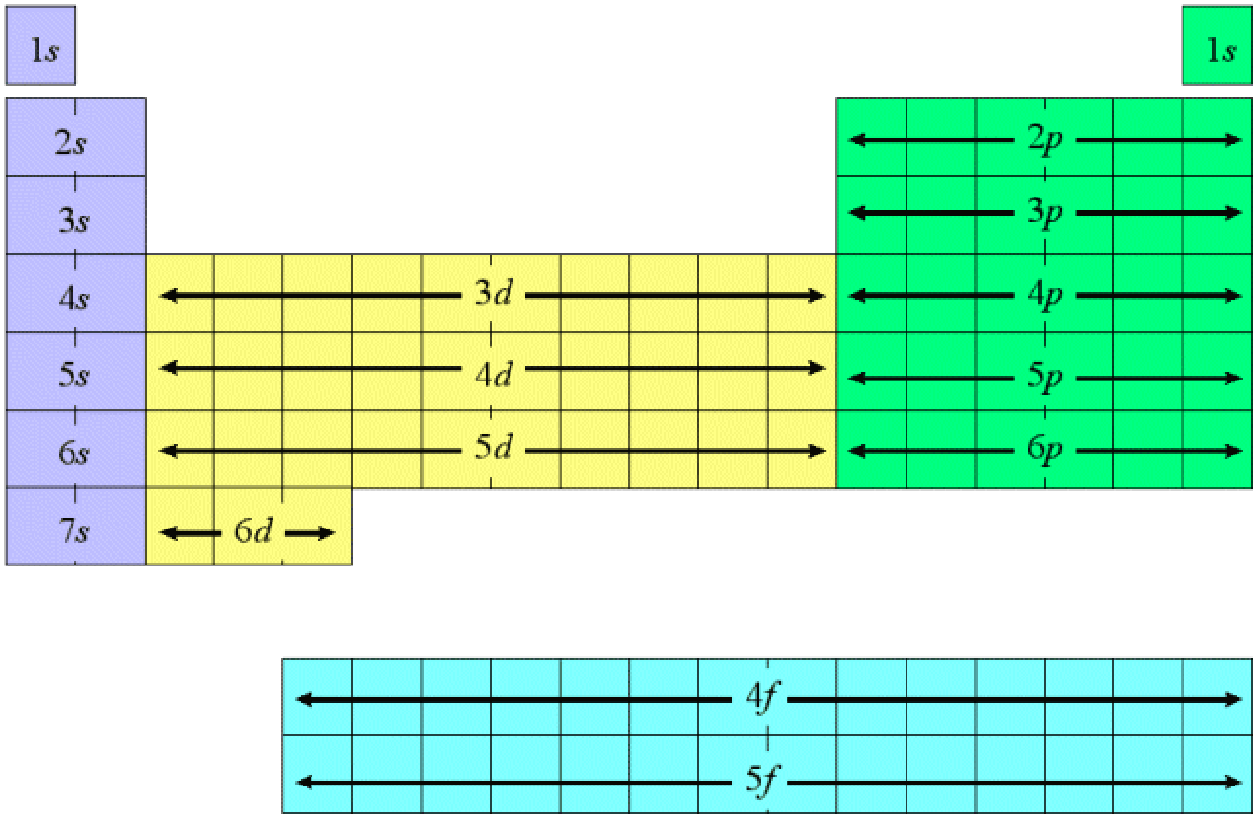
| n | 1 | 2 | 3 | 4 |
| --- | --- | --- | --- | --- |
| *l* | s | s, p | s, p, d | s, p, d, f |
| Range | 0 | -1, 0, 1 | -2, -1, 0, 1, 2 | -3, -2, -1, 0, 1, 2, 3 |
| $m_l$ | 1 | 3 | 5 | 7 |
| Number of electrons | 2 | 6 | 10 | 14 |

| n | l | orbital name | $m_l$ |
| --- | --- | --- | --- |
| 1 | 0 | s | 0 |
| 2 | 0 | s | 0 |
| | 1 | p | 1, 0, 1 |
| 3 | 0 | s | 0 |
| | 1 | p | -1, 0, 1 |
| | 2 | d | -2, -1, 0, 1, 2 |
| 4 | 0 | s | 0 |
| | 1 | p | -1, 0, 1 |
| | 2 | d | -2, -1, 0, 1, 2 |
| | 3 | f | -3, -2, -1, 0, 1, 2 |

30 electrons:

$1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ $4s^2$ $3d^{10}$

Periodic table can determine electron configuration




Do not leave out Hydrogen and Helium:

Same period: Same horizontal row eg. 3s and 3p (Same number of electron shells)

Same group: Same number of electrons in the last shell (Add all the superscript numbers in the last shell)

Same block: Same letter (s, p, d or f)

Electron arrangement in an atom

- Electron configuration: the way electrons are arranged in various orbitals around the nuclei of atoms
- Ground state: electrons are always arranged in a way that the total energy of the atom is as low as possible
  - UNLESS there is thermal energy which makes the electrons excited → reaction to overcome activation energy
- 3 rules:
  1. Aufbau principle (sheep are lazy)
  2. Pauli Exclusion principle (sheep are shy)
  3. Hund's rule (sheep are unfriendly)

Analogy:
Me boarding a double-decker bus: Occupy first deck first, definitely occupy an empty row instead of sitting next to someone

3d is an anomaly (not normal)

When we remove electrons, we attack the outer shell (for ions). So if the ion is a +, and it is $[Ar]3d^{10}4s^2$, it becomes $3d^{10}4s^1$ not $3d^9 4s^2$.
WRITE out neutral atom before removing electrons.
this needs a pic. i'll do it later. hue hue hue

Ionisation Energy (IE)
Definition: Energy required to remove 1 mole of electron from 1 mole of gaseous atom or ion.
Unit: kJ/mol eg. 2000kJ/mol = requires 2000kJ of energy to remove 1 mol of electron
Measures the ease of an atom losing an electron (in chemical reactions)
Questions
1. Why is energy needed for ionisation to occur
    - There is an attraction between the protons and electrons, so energy (eg. heat from heating) is required to overcome the attractive force
    - Might cause a drop in temperature of surroundings
2. Is there an IE for non-metal elements?
    - Yes. But it is not worth it removing electrons from non-metals and value will be much higher than metals
3. Is there a 2nd IE for Na?
    - Yes. It can go up to 11.
4. Is there a 2nd IE for every element?
    - Nope, unless you somehow give hydrogen an electron.
5. Why must IE occur in gaseous state?
    - Particles are most active and have highest energy, so it is easier to remove the electrons. In solid state, much more energy is required because KPT thats why
6. Purpose of IE
    - Find out reactivity of metals

Homework
Graph plot:
1. First ionisation energy for elements across period 3
2. First ionisation energy for elements on Group 1
Numbers are on edmodo.

big jump in energy = change in electron shell
Sharp increase in IE due to removal of a 1s electron from inner electron shell for the 10th IE compared to the removal of a 2s electron from the 9th IE

Why successive IE increases
- inner electrons have greater force of attraction than those in valence shell
(ratio of proton attraction to number of electrons)
Greater amount of energy i sneede to remove electrons from a cation (positive charge) as compared to a neutral atom

**死背** this
"The largest difference is between the (insert number) and (insert number) ionisation energies. The (insert number from second blank) electron must have been removed from the inner electron shell. Therefore, there are (insert number from the first blank) electrons in the valence shell. Element X is in group (insert number from the first blank)

Factors affecting the value of IE

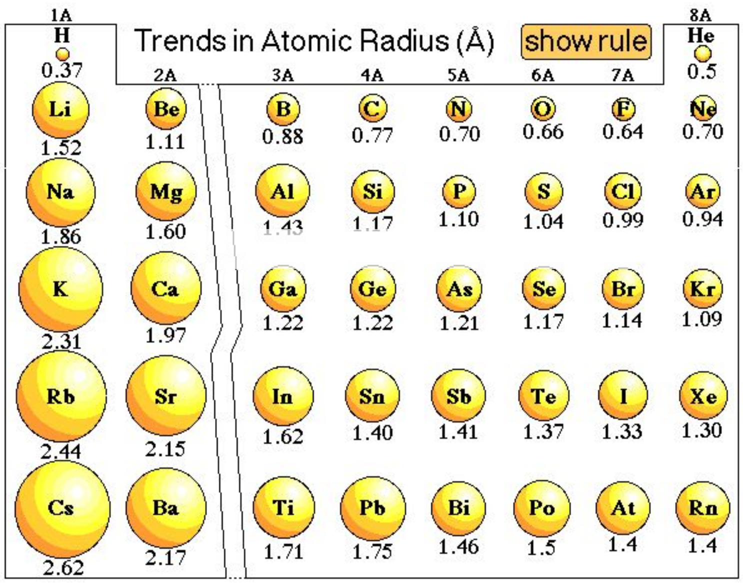
- Size of effective nuclear charge ($Z_{eff}$)
    - $Z_{eff}$ = Z - screening effect
    - Z is the number of protons (protons give <u>nuclear</u> charge)
    - Screening effect is the number of inner shell of electrons protecting/shielding the valence of electrons from the full force of electron of attraction from the nucleus
    - Electrons in the inner shells protect those in the outer shell away from the nucleus. The actual attraction between the nucleus and the valence electrons is lessened by the inner electrons.
        - The electrons on the valence shell (outer-most shell) gets "protected" from the force of attraction from the nucleus so the charge is less

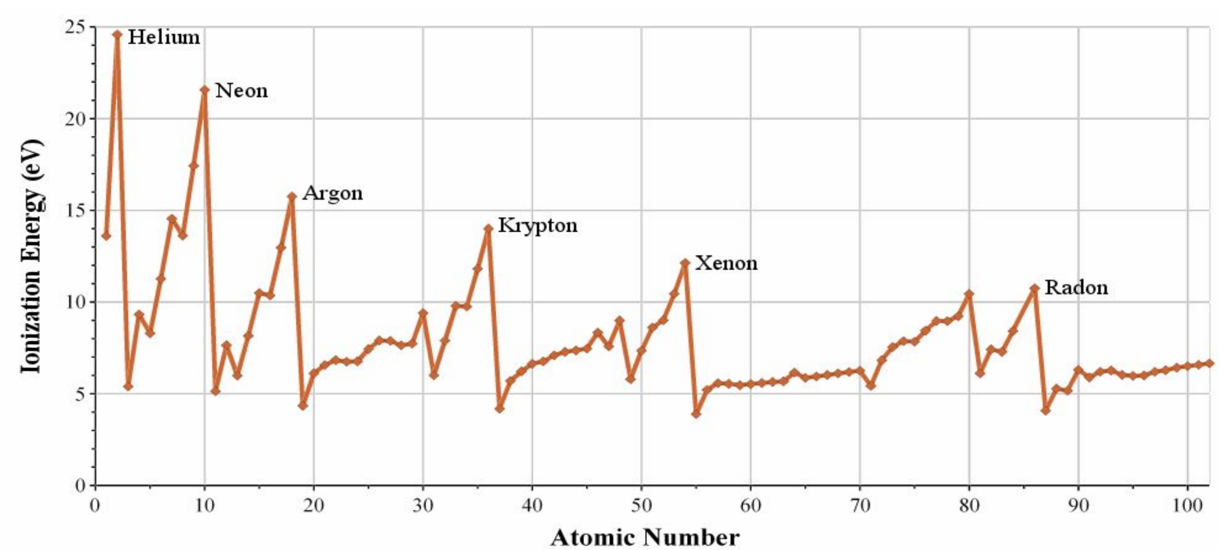
| Na | Mg | Al | Si | P | S | Cl |
|---|---|---|---|---|---|---|
| +1 | +2 | +3 | +4 | +5 | +6 | +7 |

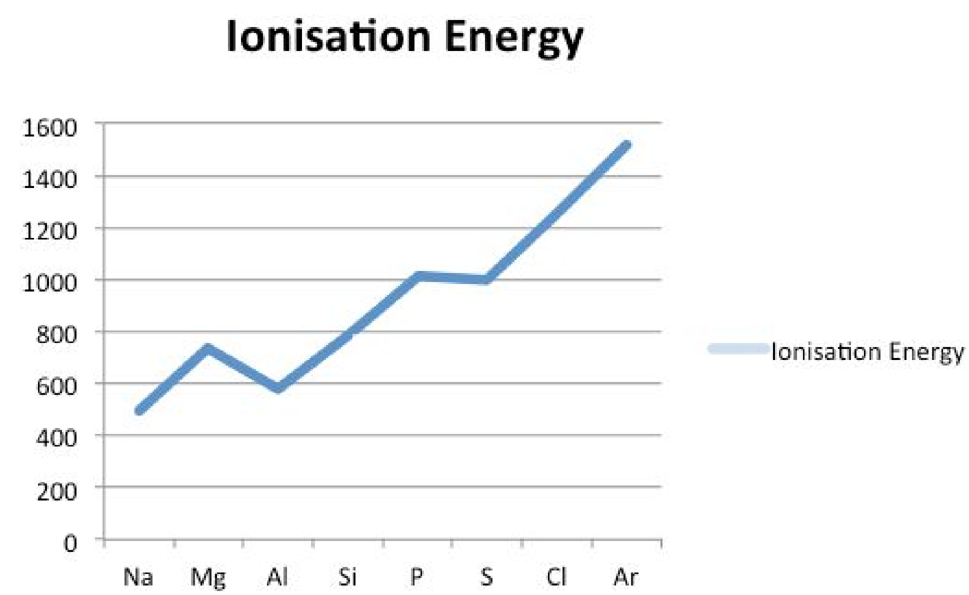
Noble gases have a very high IE and do not participate much in reaction.

- Atomic radius/size
    - This gives the distance between the nucleus and the outer-most electron.
    - As the distance increases,
        - The forces of attraction between the nucleus and valence electron decrease
        - The amount of energy required to remove the electron decreases

- The ionisation energy decreases.
  - All this stuff depends on the $Z_{eff}$ of the atom






It is ***generally*** increasing.

- Nuclear charge increases
- Screening effect remains ***almost*** constant
  - Mg: $1s^2$, $2s^2$, $2p^6$, $3s^2$ and Al: $1s^2$, $2s^2$, $2p^6$, $3s^2$, $3p^1$
    - That change in the orbital (3p has higher energy than 3s, so it is easier to remove the electron)
  - P: $1s^2$, $2s^2$, $2p^6$, $3s^2$, $3p^3$ and S: $1s^2$, $2s^2$, $2p^6$, $3s^2$, $3p^4$
    - The charge and inter-electronic repulsion. When 2 electrons repel each other, it is easier to be separated so there is a slight dip in the IE
    - Less energy is required to remove the paired 2p electron in S as it experiences inter-electron repulsion arising from 2 electrons occupying the same orbital
    - p subshell has 3 orbitals, so the 4th electron in S will repel and yadayadayada you get what i mean.
- $Z_{eff}$ increases
- Atomic radius decreases as the electrons are pulled closer to the nucleus
  Forces of attraction between nucleus and valence electron increases
- Larger amount of energy required to remove the electron

IE (periods and groups)
Go across, generally increases
Go down, decreases.

Ionisation Energy FA 2

2i) Group V. The largest difference in energy is between the 5th and 6th ionisation energy. The removal of the 7th electron comes from the inner shell. Thus, element X has 5 valence electrons and is in Group V.

2ii) $ns^2np^3$ The letter can only be n and not anything else (following quantum number)

3a) Lithium. It has the least number of protons and they are in the same shell

bi) copy from notes

bii) Boron. Copy from notes.

c) Decreases down. Copy from notes.

4a)$1s^2$ $2s^2$ $2p^6$ $3s^2$

b) Calcium has a larger atomic radius where the valence electron is further away from the nucleus. The force of attraction between the valence electron and nucleus is weaker. Smaller amount of energy is needed to remove the electron, lower 1st IE → more radioactive.

5a) A. The largest difference is recorded between the 1st and 2nd IE for A. Thus element A has 1 valence electron and forms an ion of +1.

b) Element B and D. Group II.

c) Group III. Largest difference between 3rd and 4th IE. Removal of 4th electron is from an inner electron shell. There are 3 valence electrons, thus Group III.

d) Add up the 2 IEs for each element and then you get it.

X (g) → $X^+$(g) + $e^-$ (A) 1st IE

$X^+$ (g) → $X^{2+}$ (g) + $e^-$ (B) 2nd IE

X (g) → $X^{2+}$ (g) + $2e^-$ (A+B) 1st + 2nd IE

Exam nonsense

Intermediate answer in 5sf, Final answer in 3sf.

Don't write mols. *eww what sort of unit is this*

So we can write

- no. of mols
- no. of moles
- amount of NaCl
- n(NaCl)

At the end of the (what we can write stuff), mention if it is formed or left or needed.

When writing mole ratio, don't put smth like 1 mol: 1 mol: 2 mol. *who even writes mol for mole ratio*

empirical formula, write as $C_2H_4O_2$ and not $(CH_2O)_2$

We need to know about valency...

Atomic structure
Isotopes
- Elements of the same element
- Same number of protons
- Different number of neutrons
- Different mass
  - Slightly different physical properties
  - Same chemical properties

Electron configuration
- Rules
  - Aufbau
    - $e^-$ will fill the lowest energy orbitals first
  - Hund's rule
    - Within a subshell, $e^-$ are placed singly before pairing up
  - Pauli's exclusion
    - $e^-$ in same orbitals have different spins (up spin and down spin)
- Notation
  - spdf xxxx
  - Shorthand [Ne]xxxx
  - Orbital diagram _ _ ___ _ ___

Ionization energy
- 1st IE: $X\ (g) \rightarrow X^+\ (g)\ e^-$
- 2nd IE: $X^+\ (g) \rightarrow X^{2+}\ (g)\ e^-$
- Factors
  - Effective nuclear charge
    - Shielding effect
      - No. of shells
    - Nuclear charge
      - No. of protons
  - Atomic radius
    - Affected by no. of shells
- Trend
  - Successive IE increases
    - More energy needed to remove electrons from cations than neutral
    - Electrons are removed from lower energy orbitals
  - Down a group
    - Increased $e^-$ shells → increased radius → increased shielding
    - Outweighs increase in nuclear charge

        - Increase in force of attraction between nucleus and valence electron → increase in energy needed to remove the electron
    - Across a period
        - Generally increases
            - Increased protons → increased nuclear charge
            - Same number of $e^-$ shells → Same screening
                - Increased $Z_{eff}$ → Increased force of attraction → increased force of attraction → increased IE
        - Anomaly
            - Mg > Al
                - $e^-$ from Al is from 3p. It is further away and has a higher energy so less energy is needed to remove the electron
            - P > S
                - $e^-$ removed from p orbital → interelectron repulsion → $e^-$ at higher energy level → lower energy needed