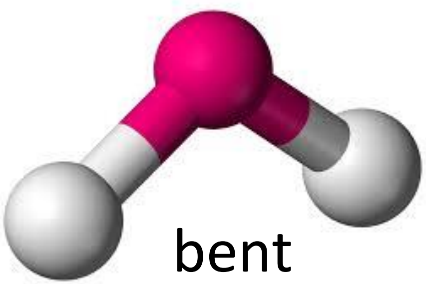
Do now:

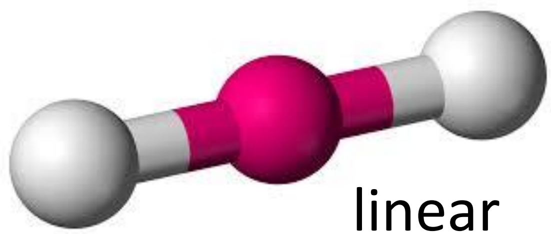
Brainstorm the key sections of CHEM2.4

Write down as many key words as your can for these sections

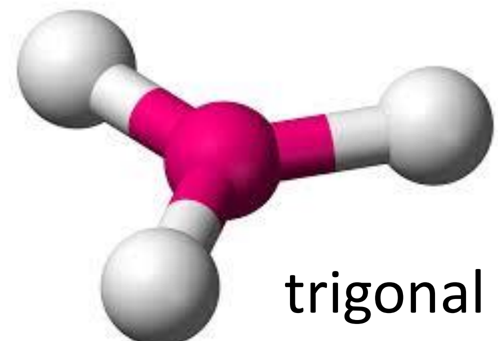
Name the shapes below



bent

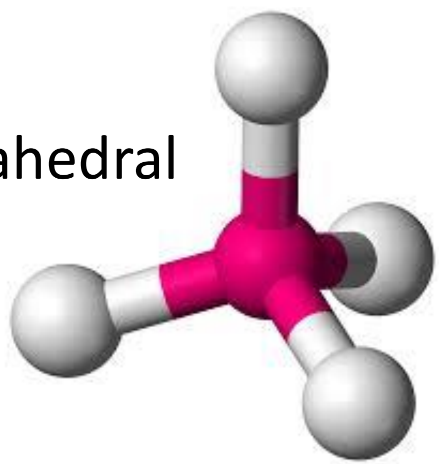


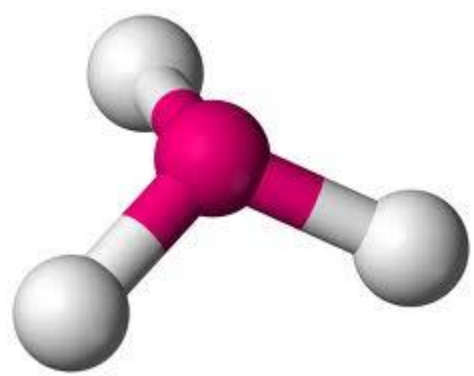
linear



trigonal planar

tetrahedral





trigonal pyramid

CHEM 2.4 Revision

There are three main sections to this standard.

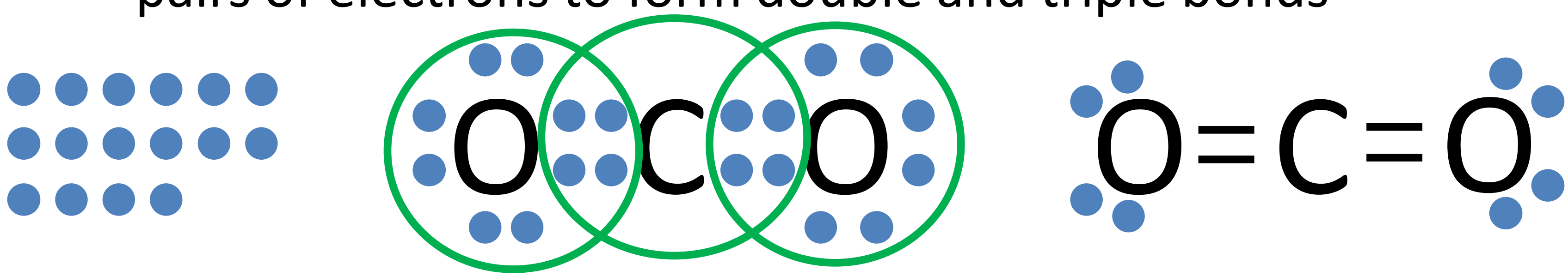
- Lewis diagrams, shapes and polarities
- structure, bonding and properties of metallic, ionic, molecular and network substances
- exo and endothermic reactions and calculations

Lewis diagrams, shapes and polarity

Drawing Lewis diagrams…

1. Place atoms around the central atom
2. Count the **total** number of valence electrons
3. Place 2 electrons between each pair of atoms
4. Place remaining electrons around outside atoms so they have a full valence shell
5. Place remaining electrons around central atom so it has a full valence shell
6. Check each atom has a full valence shell
7. If the central atom does not have a full valence shell move pairs of electrons to form double and triple bonds

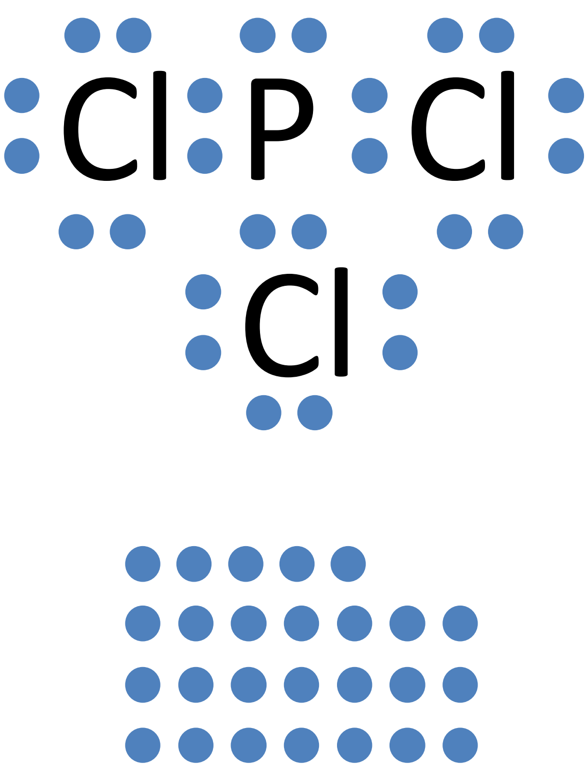
Try:
CH_2O
SO_2
PCl_3



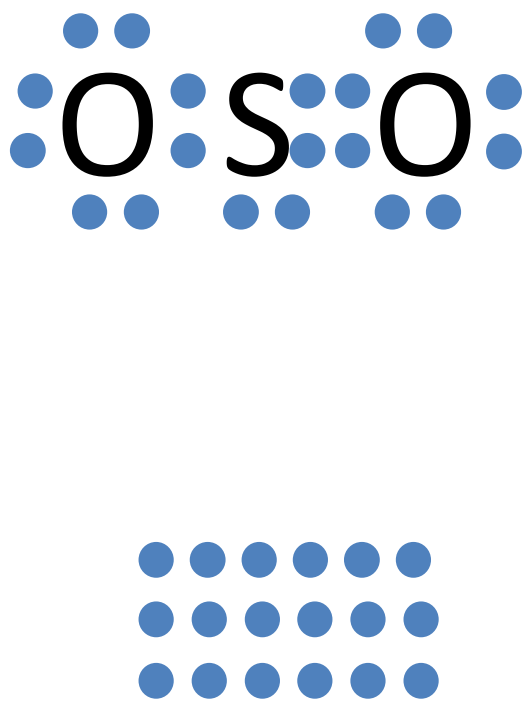
Lewis diagrams

Draw Lewis diagrams for the following compounds

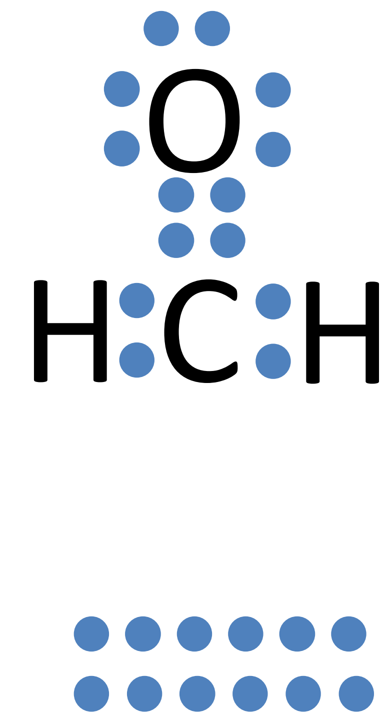
PCl_3



SO_2



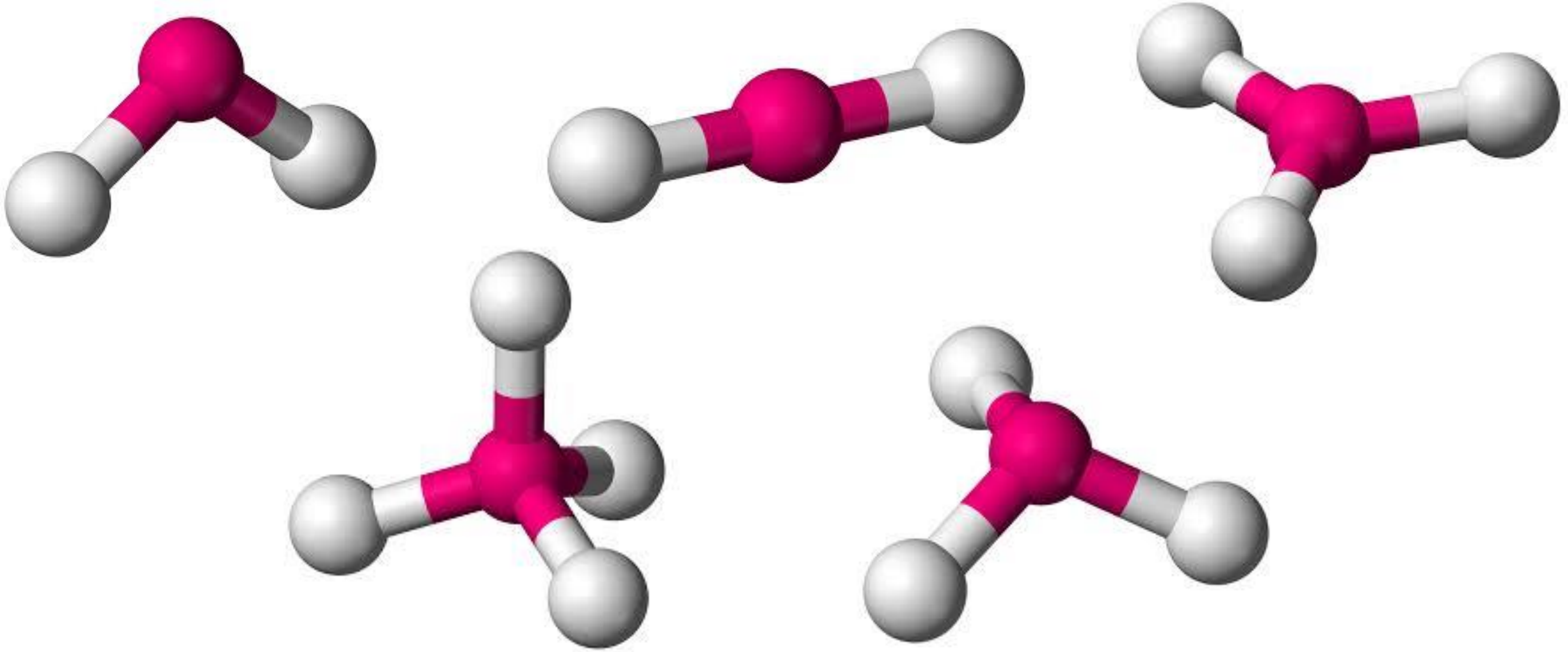
CH_2O



Shapes

Shapes of molecules are determined by the number of bonds and non-bonding regions around the central atom…

The regions of charge around the central atom repel each other to get as far away from each other as possible, this determines the shape and bond angle.



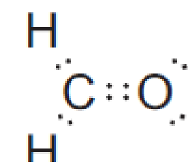
Shapes

Explaining shapes of molecules…

- State total regions around central atoms and if they are bonding or non bonding
- State that these regions want to repel each other to be as far away as possible from each other
- Link to observed shape because non-bonding regions are not seen in the shape

Shapes

The following table shows the Lewis structures and bond angles for the molecules SO_2 and H_2CO.

Molecule	SO_2	H_2CO
Lewis structure		
Approximate bond angle around the central atom	120°	120°

Explain why these molecules have different shapes, but have the same approximate bond angle.

In your answer you should include:

- the shapes of SO_2 and H_2CO
- factors which determine the shape of each molecule
- an explanation of why the approximate bond angle is the same by referring to the arrangement of electrons for each molecule.

Polarity

Polarity of molecules is determined by the shape of the molecule and the polarity of the bonds…

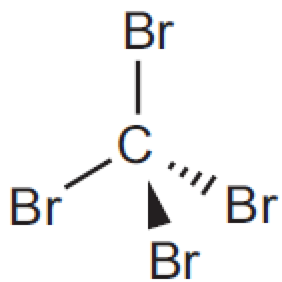
Molecules are polar if they have an overall dipole, eg a non-bonding region (lone pair of electrons) or bond dipoles are different

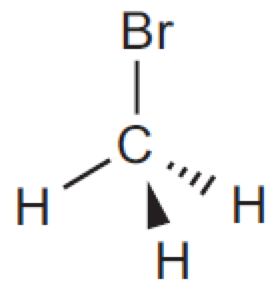
Explaining polarity of molecules…

- State if bonds are polar or non-polar
- Use electronegativity to assign δ^+ and δ^- to each atom in the bond
- State if the bond dipoles cancel/don't cancel or if there is a non-bonding region
- Link to overall dipole/no dipole for the molecule
- State polarity

Polarity

The 3-dimensional diagrams of two molecules are shown below.





Circle the word that describes the **polarity** of each of the molecules $\mathbf{CBr_4}$ and $\mathbf{CH_3Br}$.

CBr_4	**Polar**	**Non-polar**
CH_3Br	**Polar**	**Non-polar**

For each molecule, justify your choice.

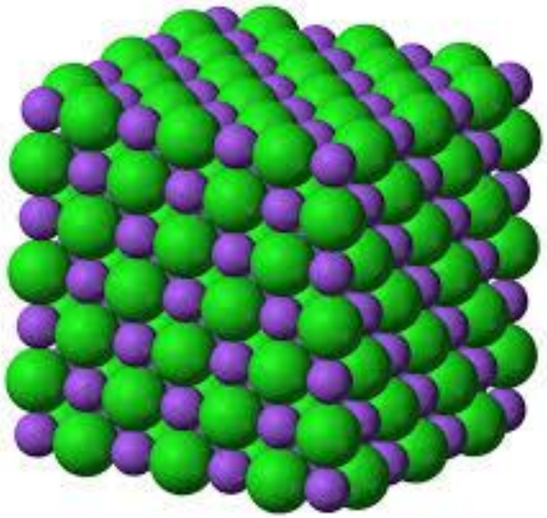
Structure, bonding and properties

What are the four types of compounds we need to able to explain structure and bonding for? Give an example of each one.

What determines the:

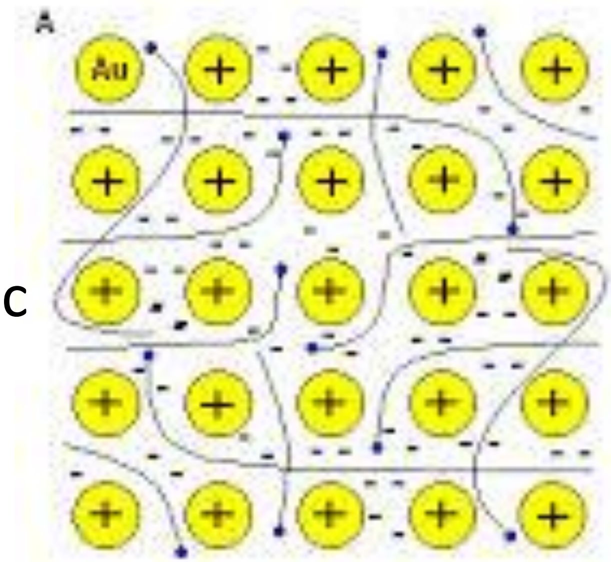
melting point of a compound	Bond strength
conductivity of a compound	Movement of ions or electrons
brittleness of a compound	Directionality of the bond
solubility of a compound	Type of forces between solvent and solute

Structure, bonding and properties

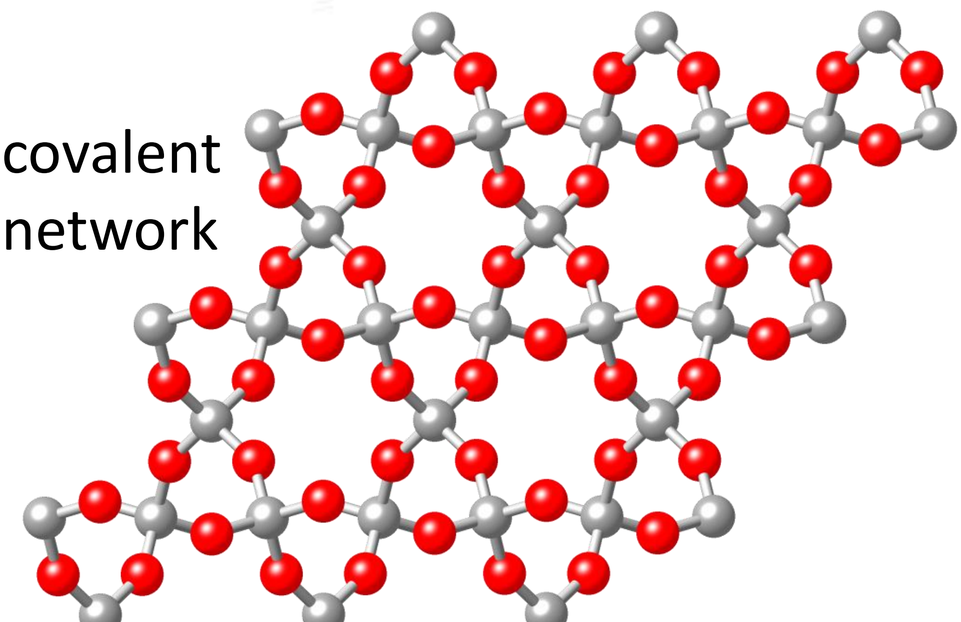


ionic

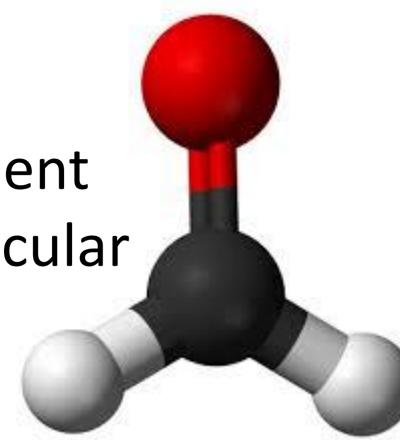
metallic



covalent
network



covalent
molecular



Structure, bonding and properties

Type of solid	Particles	Melting point	Conductivity	Solubility
Ionic	Ions	High	Only when liquid	In water
Metallic	Atoms	High	Yes	No
Covalent	Atoms	High	No	No
Molecular	Molecules	Low	No	Depending of polarity of compound and solvent

Structure, bonding and properties

Explaining properties through structure and bonding…

Main properties asked about are melting point, conductivity, brittleness and solubility

- State type of substance
- State the structure (type of particles, arrangement of particles)
- State the type and strength of bonding
- Link to the property (using because…)
- Refer back to the property

Structure, bonding and properties

Complete the table below by stating the type of particle and the bonding (attractive forces) between the particles for each of the substances.

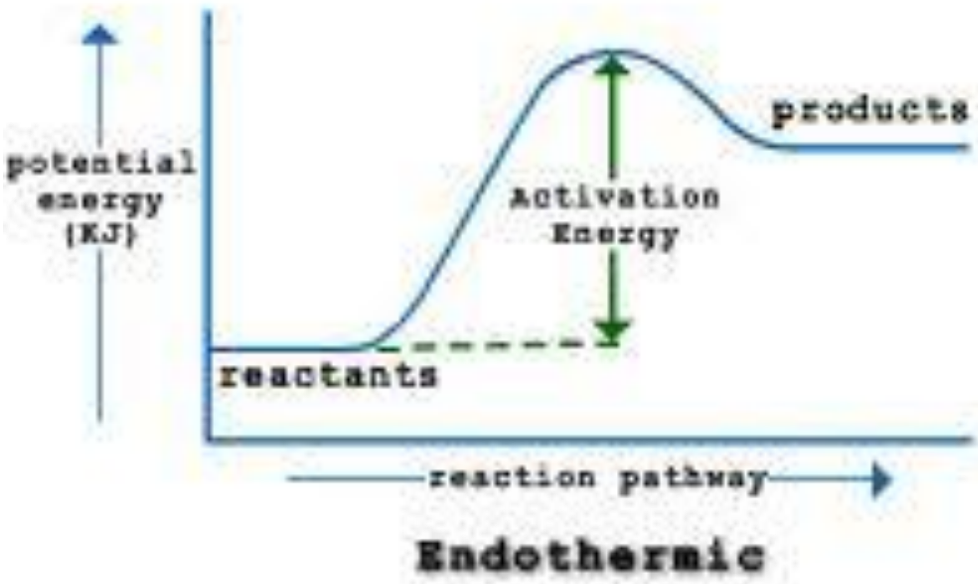
Substance	Type of particle	Attractive forces between particles
Ammonia, NH_3		
Zinc, Zn		
Silicon dioxide, SiO_2		

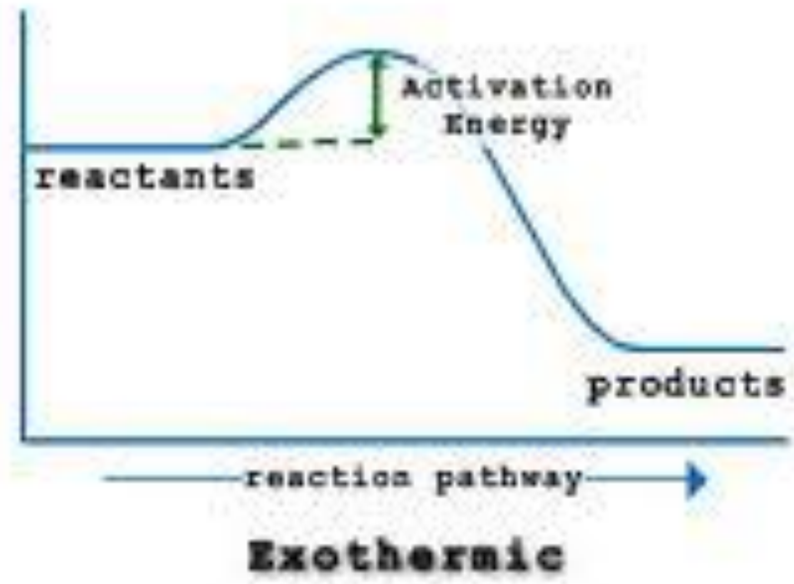
Silicon dioxide has a melting point of 1770°C.

Explain why silicon dioxide has a high melting point by referring to the particles and the forces between the particles in the solid.

Contrast both the electrical conductivity, and solubility in water, for both zinc, Zn, and zinc chloride, $ZnCl_2$, using your knowledge of structure and bonding.

Thermochemistry





- Requires energy
- Surroundings cool down
- Products have more energy than reactants
- Positive $\Delta_r H^\circ$

- Releases energy
- Surroundings warm up
- Reactants have more energy than products
- Negative $\Delta_r H^\circ$

Thermochemistry

The enthalpy of a reaction is the energy of the products – the energy of the reactants. Thermochemical equations express how much energy is released per reaction…

$2\ H_{2(g)} + O_{2(g)} \rightarrow 2\ H_2O_{(g)}$ $\Delta_r H = -570\ kJ.mol^{-1}$

We can use thermochemical equations to work out

- How much energy will be produced from an amount of compound
- How much compound is need to produce a certain amount of energy

Equation One: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ $\Delta_r H = -889\ kJ\ mol^{-1}$

Calculate the energy released when 128 g of methane is burnt.

$M(CH_4) = 16.0\ g\ mol^{-1}$.

Thermochemistry

For each of the following, circle the correct word to indicate whether it is an exothermic or endothermic change.

Give a reason for your choice.

(i) $NH_4NO_3(s) \rightarrow NH_4^+(aq) + NO_3^-(aq)$ $\Delta_r H = +25.7 \text{ kJ mol}^{-1}$

exothermic **endothermic**

Reason: ______________________________

(ii) Water vapour condensing, forming rain.

exothermic **endothermic**

Reason: ______________________________

Thermochemistry

The overall reaction occurring in many disposable hand warmers can be represented by:

$$4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s) \qquad \Delta_r H = -1652 \text{ kJ mol}^{-1}$$

(i) Calculate the energy released when 1.00 mol Fe_2O_3 is produced.

(ii) Calculate the mass of Fe that would be required to release 185 kJ of energy.

$M(\text{Fe}) = 55.9 \text{ g mol}^{-1}$.

Thermochemistry

The enthalpy of a reaction can be calculated by calculating the energy required to break the bonds – the energy released from the bonds being formed…

Some Bunsen burners use methane gas, CH_4, as a fuel. The reaction for the combustion of methane in a Bunsen burner is shown in **Equation One** below.

Equation One: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ $\Delta_r H = -889 \text{ kJ mol}^{-1}$

When this reaction occurs, bonds are broken and bonds are formed.

State which bonds are broken and which bonds are formed during the reaction.

Bonds broken: ______________________________

Bonds formed: ______________________________

Thermochemistry

Carbon monoxide can be reacted with steam to produce hydrogen gas:

$CO_{(g)} + H_2O_{(g)} \rightarrow H_{2(g)} + CO_{2(g)}$

Use the bond enthalpies given to calculate $\Delta_r H$ for this reaction

Bond	**Bond enthalpy ($kJ.mol^{-1}$)**
O – H	463
H – H	436
C = O	804
C ≡ O	1 072