Year 12 Chemistry

Unit 3 Revision Lecture

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1 Course structure

- **Unit 3:** 2 SACs, 16% of study score
  1. Energy production
     - Obtaining energy from fuels
     - Fuel choices
     - Galvanic cells
     - Fuel cells
  2. Optimising yield
     - Rate of reactions
     - Extent of reactions
     - Production via electrolysis
     - Rechargable batteries
- **Unit 4:** 3 SACs, 24% of study score
- **Exam:** 60% of study score
  - 15 minutes reading time, 2.5 hours writing time
  - 30 multiple choice questions (spend 30—45 minutes, **do last**) - harder in new study design
  - 90 marks written questions (spend 1 hr 45 m—2 hr)
    Last year:
    * 23% calculations (21 marks)
    * 44% extended answer (40 marks)
    * 32% short answer (29 marks)
  - 5—10 marks on writing chemical equations
  - Same marking panel as last year
  - Indirect assessment of pracs
  - $\geq$ 1 mark for significant figures
  - Importance of written communication
  - First parts are important, no consequential marks
  - Use dot points (short form) - especially in rates & concentration

Key points

- Spend 30—45 minutes on multiple choice
- Focus on redox reactions
- Use data book
- Multiple choice questions are hard
- Memorise oxidation numbers

2 Energy production

- $C = n \div v$ or $C = m \div V$ (concentration in g L^{-1})
- Gases: $PV = nRT$ and $n = V \div V_m$
- Past exams before 2017 use different SLC
- Renewability - *reasonable* timeframe
- Fuel choices - consider:
  - External temperature
  - Viscosity (intermolecular forces)
  - Hygroscopic properties (attracts water $\implies$ forms H-bonds)
  - Cloud point
- Blended fuels - use energy per mass not energy per mol

3 Yield & rate

- Equilibrium constant K_C needs units
- $K_C \equiv K$
- Example question for rates: limiting factor for rate, given a set (equal) rate of both reactants consumption/production
- Collision theory:
  1. Particles must collide
  2. Particles must collide with sufficient energy to overcome E_A
- Increase of rate with temperature:
  1. $\uparrow$ temperature $\implies \uparrow$ energy $\implies$ more frequent collisions
  2. $\uparrow$ temperature $\implies \uparrow$ energy $\implies$ collisions occur with greater energy ($\implies$ greater *proportion* of particles that can react per unit time)
- $\uparrow c$(reactants) $\implies$ more collisions
- Definition of *rate*: more products per unit time $\longrightarrow$ faster rate
- Cause and effect: propose hypothesis and prove by induction
- Maxwell-Boltzmann distributions - x_{peak} is constant for different concentrations
- Memorise definition of *catalyst*: provides a reaction with an alternative energy pathway which has a lower activation energy

3.1 Equilibria

- all reactants and products are present at equilibrium
- K_C is fixed at a constant temperature and reaction
- K_C changes with concentrations (relative)
- If reaction equation is reversed, K_C value will be the reciprocal
- If temperature changes, K_C will change (but not necessarily proportionally)
- Le Chatelier's principle:
  If a change is made to a system at equilibrium,
  the system will partially oppose this change if it is possible

- Accuracy of graph drawing - use **clear** plastic ruler
  - Label vertical ratios
- Use concentration table format for calculating equilibrium constant K_C

Important

K_C is **not** related to the rate of reaction
$\implies$ we cannot say how fast a reaction os going to occur from the K_C value

3.2 Exothermic & endothermic reactions

- All combustion reactions are exothermic
- Data book: molar heat of combustion = $|\Delta H|$
- Endothermic reactions rarely occur naturally (creates instability/entropy)
- $E_A = |E_{\max} - E_{\text{initial}}|$
- If coefficients of a thermochemical equation are changed, ΔH also changes
- Possible data discrepencies in theoretical results:
  - State of H_2O
  - Incomplete combustion
  - Heat loss to environment
- Analogy with simultaneous equations
- Calorimetry - insulate *sides* of can not bottom. Be specific.

Multiple choice question examples (features of **exothermic** reactions):

a) Products are ________ as they have less chemical energy than reactants *(more stable)*

b) ________ required to break bonds in products compared to reactants *(more chemical energy)*

Multiple choice question examples (features of **endothermic** reactions):

a) Transformation of ________ energy from surroundings into ________ *(thermal, chemical)*

b) ∴ Surroundings and reaction becomes ________ *(colder)*

4 Oxidation numbers (memorise)

Species	**Rule**
Elements	Always 0
Ions	Same as common ion
Hydrogen	+1 (unless present as H_2O - O.N. = 0; or as hydride - O.N. = -1)
Oxygen	-2 (unless present as O_2 - O.N. = 0; or as peroxide - O.N. = -1)
Molecules	Sum of O.N. must equal zero
Molecular ions	Sum of O.N. must equal overall charge on ion

5 Redox reactions

- Verify equations: check charge of each side independently: charge(LHS) = charge(RHS)
- Electrochemical series always has oxidants on left
- Top left and bottom right always react spontaneously
- For electrochemical cell questions: first parts are important, no consequential marks
- Non-standard conditions can alter positions of half-equations on electrochemical series and change E^0 values
- Secondary cells - polarity is constant, but reaction at each electrode swaps

5.1 Galvanic cells

- Value of E^0 is *not* a reliable indicator for rate of reaction
- Half cells are physically separate
- Products must remain in contact with electrodes

5.2 Electrolytic cells

- Possible question: name observations
  - Bubbles
  - O_2 would *not* be visible
  - Cannot *see* $\uparrow [H^+]$
  - Can see Cu(s) deposit on electrode
  - Can see colour change (pH) - $Cu_2{}^+$ solution can be an indicator
- Less side reactions in e.g. lithium ion cells (efficiency)
- Lower reactions in electrochemical series do not occur forwards (L→R)
- Check state of H_2O - can it be liquid at that temperature?

5.3 Fuel cells

- Galvanic cells are primary cells, fuel cells are not primary are they secondary?
- Major disadvantage of fuel cells: expensive electrodes (they must also function as catalysts)
- Fuel cells - same overall reaction as combustion
- Reactangs must not come into contact
- Highly efficient

5.4 Electrochemical series

Strongest oxidant will always react preferentially with best reductant
Always identify *all* chemicals present in reaction on electrochemical series