Lesson 8: C8.8 – Tests for anions

Connection

Q1. What colour precipitate forms from Iron(III) metal?

Q2. why are further tests needed to distinguish between aluminium, calcium and magnesium precipitates?

Q3.
$CuSO_4 + NaOH \rightarrow Cu(OH)_2 + Na_2SO_4$
Balance this precipitate reaction equation

Activation

LI: identify anions and cations from the results of tests

1. https://www.youtube.com/watch?v=mWTgHjdea4Y
2. Make a note of the title and the LI
3. Read pages 278-279
4. Describe the test for carbonate anions
5. Write out the word equation for the reaction between sodium carbonate and nitric acid
6. Describe the test for halide anions
7. Write out the word equation for the reaction between metal halide and silver nitrate
8. Describe what colour precipitate forms from each halide ion
9. Describe the test for sulfate anions
10. Write out the word equation for the reaction between metals sulfate and barium chloride

Demonstration

Attempt questions 1-7
In 15 mins answer as many questions as you can.
Self mark the questions you have done making any necessary corrections in blue pen

Challenge yourself to answer as many as you can:
Green questions to GCSE Level 3
Blue questions to GCSE Level 6
Purple questions to GCSE Level 9

Consolidation

Complete and self assess the relevant past paper question for this topic - From the C8 DIP file

Extension

Make a note of one thing you think you understand well and one thing that you would like to ask your teacher

Answers: C8.8 – Tests for anions

Connection

1 Brown
2 all three produce a white precipitate
3 $CuSO_4 + 2NaOH \rightarrow Cu(OH)_2 + Na_2SO_4$

Demonstration

1 Pass the carbon dioxide into limewater. It will turn milky if carbon dioxide is present.
2 Add some acid (e.g. nitric acid) to the carbonate. If it bubbles, pass the gas into limewater. If the limewater turns milky, it is a carbonate.
3 A yellow precipitate.
4 It has dissolved salts in it e.g. sodium chloride, potassium chloride etc.
5 Barium chloride solution.
6 KI(aq) + AgNO3(aq) → AgI(s) + KNO3(aq)
7 CaCl2(aq) + 2AgNO3(aq) → 2AgCl(s) + Ca(NO3)2(aq)

Lesson 9: C8.9 – Use chemical tests to identify the ions in unknown single ionic compounds

Connection

Q1. What colour precipitate forms form: Chloride, Bromides and Iodides?

Q2. Potassium Carbonate + hydrochloric acid → ___________ + ____________ + ___________

Q3. Describe the test for sulfate ions

Activation

LI: identify unknown ions in chemical compounds.

1. https://www.youtube.com/watch?v=fCZztwJmAl0
2. Make a note of the title and the LI
3. Read pages 30-31
4. Make a poster describing the two ways to test for metals in a compound (flame tests and precipitate reactions) and how to test for each anion

Demonstration

Attempt questions 1-11
In 15 mins answer as many questions as you can.
Self mark the questions you have done making any necessary corrections in blue pen

Challenge yourself to answer as many as you can:
Green questions to GCSE Level 3
Blue questions to GCSE Level 6
Purple questions to GCSE Level 9

Consolidation

Complete and self assess the relevant past paper question for this topic - From the C8 DIP file

Extension

Make a note of one thing you think you understand well and one thing that you would like to ask your teacher

Answers: C8.9 – Use chemical tests to identify the ions in unknown single ionic compounds

Connection

1 Chloride: White
Bromide: Cream
Iodide: Yellow

2 Potassium Carbonate + hydrochloric acid → Potassium chloride + water + carbon dioxide

3 If sulfate ions in solution are tested with barium chloride solution in the presence of dilute hydrochloric acid they produce a white precipitate of barium sulfate

Demonstration

1 Bubble the gas through limewater. If it turns milky/cloudy it is carbon dioxide.
2 Dissolve each salt in water and add NaOH solution using a teat pipette. Wear safety spectacles, gloves and a lab coat. The following hydroxide precipitates will be seen: Copper: Blue precipitate. Iron(II): Light green precipitate. Iron(III): Brown precipitate.
3 Lithium: Crimson. Sodium: Yellow. Potassium: Lilac.
4 White hydroxide precipitates are formed in both cases.
5 Carry out a flame test. Calcium ions will give a red flame (no colour for magnesium ions).
6 A white hydroxide precipitate forms. However, this redissolves in excess NaOH, which distinguishes aluminium ions from calcium and magnesium.
7 CaCO3 / calcium carbonate.
8 FeCl3 / iron(III) chloride
9 NaBr / sodium bromide.
10 K2SO4 / potassium sulfate
11 CuI / copper(I) iodide

Connection

Q1. Flame Tests – Metals
Lithium →
Sodium →
Potassium →
Calcium →
Copper →
Q2. Precipitate reactions – Metals
Copper →
Iron (II) →
Iron (III) →
Calcium, Magnesium, Aluminium →

Lesson 10: C8.10 – Instrumental methods

Activation

LI: identify advantages of instrumental methods compared with the chemical tests

1. https://www.youtube.com/watch?v=Bd0A44Iv2OI
2. Make a note of the title and the LI
3. Read pages 282-283
4. Define "Spectroscopy" using the glossary
5. Give three advantages of using instrumental techniques
6. Draw and label figure 8.27

Consolidation

Complete and self assess the relevant past paper question for this topic - From the C8 DIP file

Extension

Make a note of one thing you think you understand well and one thing that you would like to ask your teacher

Demonstration

Attempt questions 1-6
In 15 mins answer as many questions as you can.
Self mark the questions you have done making any necessary corrections in blue pen

Challenge yourself to answer as many as you can:
Green questions to GCSE Level 3
Blue questions to GCSE Level 6
Purple questions to GCSE Level 9

Answers: C8.10 – Instrumental methods

Connection

Q1. Flame Tests – Metals
Lithium → Crimson
Sodium → yellow
Potassium → lilac
Calcium → orange-red
Copper →green
Q2. Precipitate reactions – Metals
Copper → blue
Iron (II) → light green
Iron (III) → brown
Calcium, Magnesium, Aluminium → white

Demonstration

1 Methane comes through in 12 minutes and carbon dioxide is the most abundant gas.
2 It is more rapid, more accurate and more sensitive.
3 Criminals sometimes leave traces of their DNA at crime scenes. The DNA can be chemically cut up and analysed. A DNA fingerprint is (almost) unique to an individual. So the DNA pattern can be compared to patterns in a criminal database or compared to a sample taken from a suspect.
4 10,000,000/400 = 25,000
5 DNA fragments separated and identified by electrophoresis.
6 Pentane has a molecular mass of 72. The peak at 72 is pentane itself (unfragmented).$CH_3CH_2CH_2^+$ is responsible for the peak at 43

Lesson 11: C8.11 – Flame emission spectroscopy

Connection

Q1. Name three types of instrumental methods

Q2. Give three advantages of instrumental techniques

Activation

LI: describe flame emission spectroscopy

1. https://www.youtube.com/watch?v=1BCc_RrrSSw
2. Make a note of the title and the LI
3. Read pages 34-35
4. Draw and label figure 8.31
5. Nam two advantages of flame emission spectroscopy
6. https://www.youtube.com/watch?v=FQJj2kBJ5A8

Consolidation

Complete and self assess the relevant past paper question for this topic - From the C8 DIP file

Demonstration

Attempt questions 1-7
In 15 mins answer as many questions as you can.
Self mark the questions you have done making any necessary corrections in blue pen

Challenge yourself to answer as many as you can:
Green questions to GCSE Level 3
Blue questions to GCSE Level 6
Purple questions to GCSE Level 9

Extension

Make a note of one thing you think you understand well and one thing that you would like to ask your teacher

Answers: C8.11 – Flame emission spectroscopy

Connection

1 Spectroscopy
Mass spectrometry
Electrochemical analysis
Thermal analysis
Separation techniques
Microscopy

2 more rapid
more accurate
more sensitive.

Demonstration

1 It is more sensitive / rapid / accurate. It can detect a wider range of metal ions. It can detect mixtures of metal ions.
2 Hydrogen only has 1 electron. Iron has 26. The spectrum for iron is therefore much more complicated.
3 Compare the flame emission spectrum of the solution to the spectrum of pure sodium ions and pure potassium ions. If the lines match the sodium spectrum, the solution only contained sodium ions. If there are potassium ion lines present then the solution was a mixture.
4 Use the intensity of the lines in the spectrum to measure the concentration of lithium and sodium. Then compare the emission spectrum of the mixture with the emission spectra of pure lithium and sodium. If there are lines present which are not in the pure spectra, contaminating metal ions are present.
5 Rubidium, Rb.
6 Lithium, Li. 411 and 494 may be contamination.
7 Electrons transition between energy levels. As they do so, they emit electromagnetic radiation of a characteristic wavelength. These energy levels are "fixed" for a particular metal (ion) so the lines do not change.

C8 - Revision

Connection

Q1. Name the instrument used to measure an emission spectrum to identify a particular substance?

Q2. Why is an emission spectrum better than a flame test?

Q3. How are the emission spectra produced?

Activation

LI: Create a topic summary sheet

1. Fold an A3 sheet so it is divided into 8 sections
2. Look back over you lesson and group them into 8 main headings
3. Summarise the key points into each section, use keywords and diagrams and symbols rather than sentences

Consolidation

Look though the relevant past paper questions for this topic - From the C8 DIP file – see if you can complete any additional questions

Extension

Make a list of anything that you would like to ask your teacher to go over again

Demonstration

Test yourself by working with the person sitting next to you by talking though each box on your summary sheet and seeing how many key facts you can remember

Answers: C8 - Revision

Connection

1 Spectroscope
2 You get to see all the colours separately in an emission spectrum whereas in a flame test the colours form a mixture that is dominated by a single colour.
3 The colours are produced by electrons in high energy states emitting light as they return to their original energy state

DART C8 Separating the guilty from the innocent

By Clare Sansom

If your interest in chemistry began in childhood, you may remember a simple experiment in which you put a spot of ink into water, added a vertical piece of blotting paper, and watched as the pigments in the ink moved up the blotting paper at varying rates. With luck, a dull-coloured ink would have separated into a beautiful rainbow of colours. This is a simple demonstration of a technique that has become one of the mainstays of analytical chemistry: chromatography. Its name is derived from the Greek words *chroma* (colour) and *graphein* (to write).

In this simple example, the blotting paper represents what is more generally known as the stationary phase and the water the mobile phase. Compounds in a mixture are separated through differences in the speed at which they move with the mobile phase through the stationary one – this difference is determined by their affinity for one phase over another. The chromatograph is linked to a detector in which the nature and often the quantities of the components will be determined.

Chromatography excels at separating and analysing complex mixtures of substances. It is therefore uniquely suited to applications in the broad area of forensic science. 'Criminal investigations often involve analysis of complex mixtures, perhaps involving soil, water, debris, body fluids or even bone,' explains Barron, an analytical chemist at King's College London. 'Forensic scientists have been using this technique for half a century, and it has now become the "gold standard" technique in forensic chemistry.' Its first applications in this area were in the 1960s, when gas chromatography was used to analyse the petroleum fuels used in arson cases. An extensive review in 1976 by chemists at the UK's Home Office Forensic Science Laboratory in Birmingham shows that by that time GC and mass spectrometry were being routinely applied to the investigation of arson, malicious damage and drug abuse.

Chromatography has played a large part in solving some of the most famous and infamous criminal cases of the last 50 years, including, in the UK, the London bombings on 7 July 2005 and the Harold Shipman case. Shipman, a family doctor in northern England and one of the most prolific of all known serial killers, administered lethal doses of diacetylmorphine to over 200 of his patients during the 1980s and 1990s: many of his victims were identified, long after death, by determining lethal amounts of the metabolite 6-monoacetyl morphine in their exhumed bodies. Analysis of traces of the explosives used in the 7/7 attacks led to the identification of a highly unstable explosive, triacetone triperoxide (TATP). This compound has since been described as the terrorists' 'weapon of choice' because it is non-nitrogenous and therefore difficult to trace. This type of analysis has now become so sensitive that forensic chemists are developing methods of tracking down terrorist plotters through the early detection of tiny traces of explosives, their precursors or transformation products in waste water.

All the drug tests at the 2012 London Olympics were carried out by the Drug Control Centre at King's College, London, in a satellite facility accredited by the World Anti-Doping Agency. Urine samples from thousands of athletes were screened for over 200 illicit substances using LC coupled to high resolution mass spectrometry, and for many other prohibited substances using GC coupled to tandem mass spectrometry. 'DNA profiling' has been used to identify individuals since the 1980s. It was first used successfully in a forensic case in 1986, to convict Colin Pitchfork of the rape and murder of two girls in Leicestershire and thence to exonerate an innocent suspect. During the last 30 years, technical advances, and particularly the use of the polymerase chain reaction (PCR) to 'amplify' DNA samples, have allowed individuals to be identified using smaller and smaller samples of DNA. This can enable an identification to be made from the tiniest samples of DNA, such as might be extracted from fingerprints at a crime scene.

Reference :

https://www.chemistryworld.com/features/separating-the-guilty-and-the-innocent/1017489.article

Questions

1a Where was the term chromatography derived from and what does it mean?

1b Briefly describe how you might have carried out chromatography in the lab

1c. Describe some examples of the use of chromatography in Forensic science

2a. Describe the mobile and stationary phases when chromatography is carried out in the laboratory to separate the component colours of ink.

2b. Describe how chemical analysis prevents fraud at athletic events.

2c. Explain how DNA profiling is used in forensic science.

3a. Explain what Barron, a chemical analyst at King's College, meant by the term 'gold standard' in forensic chemistry.

3b. Explain how forensic scientists were able to provide evidence to convict Dr Harold Shipman of killing his patients.

3c. Write a report for a scientific journal describing the technological advances in chromatography across the field of forensic science.

<u>Answers DART C8 - Forensics</u>

1a Derived from the Greek words *chroma* (colour) and *graphein* (to write).

1b. Example: Put a spot of ink into water, added a vertical piece of blotting paper, and observed the pigments in the ink move up the blotting paper at varying rates. The ink separated into its component colours.

1c. Chromatography was used to provide evidence in the Harold Shipman case by determining lethal amounts of the metabolite 6-monoacetyl morphine in the exhumed bodies of his patients. Mass spectrometry is routinely applied to the investigation of arson, malicious damage and drug abuse. (students can use any of the huge list of examples in the text)

2a. The blotting paper represents the stationary phase and the water the mobile phase. Compounds in a mixture of ink are separated through differences in the speed at which they move with the mobile phase through the stationary one – the difference is determined by their affinity for one phase over another.

2b Urine samples from thousands of athletes were screened for over 200 illicit substances using LC coupled to high resolution mass spectrometry, and for many other prohibited substances using GC coupled to tandem mass spectrometry.

2c. DNA profiling is used to identify individuals. The use of the polymerase chain reaction (PCR) to 'amplify' DNA samples, have allowed individuals to be identified using smaller and smaller samples of DNA. Only a tiny sample such as those lifted off fingerprints is required for analysis and crime solving.

3a. Criminal investigations often involve analysis of complex mixtures, involving soil, water, debris, body fluids or even bone. Chromatography successfully separates these mixtures and identifies different components using a range of techniques such as gas spectroscopy, mass spectroscopy and the recent advances in technology have allowed extensive DNA profiling. This type of forensic analysis is referred to as the 'gold standard'

3b. Shipman, a family doctor in northern England was a serial killer who administered lethal doses of diacetylmorphine to over 200 of his patients during the 1980s and 1990s: many of his victims were identified, long after death, by determining lethal amounts of the metabolite 6-monoacetyl morphine in their exhumed bodies.

3c. Students should briefly list/describe the different types of techniques in forensic chromatography from its early beginning to the present day. Can include examples of each use – how gas spectroscopy and mass spectroscopy are used to detect chemicals used by terrorists, DNA profiling and urine sample analysis used to detect fraud in major athletic events etc.

Attainment Band :	C8 Chemical analysis AQA)
	Knowledge and Understanding
Yellow Plus/ Yellow	Distinguish pure and impure substances using melting point and boiling point data. Interpret chromatograms and determine *R*f values. Describe the test for carbon dioxide.
Blue	Suggest separation and purification techniques for mixtures. Distinguish pure from impure substances. Describe the test for chlorine.
Green	Describe, explain and identify examples of processes of separation such as filtration, crystallisation and distillation. Describe how to set up paper chromatography. Describe the tests for oxygen and hydrogen.
White	Some elements of the above have been achieved