

Exam papers from 2013-2002

- 2013 Q.1 DO titration
- 2012 Q.7 ★
- 2011 Q.11(a) ★
- 2010 Q1 ★
- 2009 Q 7 ★
- 2008 Q10 (a)
- 2007 Q7 (c) and (d)
- 2006 Q.3 and Q 8 (b) done
- 2005 Q.1 and Q.8 (d) (e) DO titration
- 2004 Q. 1
- 2003 Q8 (c) ★
- 2002 Q.9 ★

Environmental chemistry and water

Temporary hard water

- Hard water is water that does not form a lather easily with soap
- caused by Ca^{2+} and Mg^{2+} ions
- How does temporary hardness happen?
- water + carbon dioxide = carbonic acid
- Can you write out the chemical equation?
- Limestone + carbonic acid = Calcium hydrogen carbonate
- Can you write out the chemical equation?
- When you boil water you remove the temporary hardness.
- Calcium hydrogen carbonate + heat = calcium carbonate and water.
- Can you write out the chemical equation?

Permanent hardness caused by calcium sulphate and magnesium sulphate

Advantages of hard water	Disadvantages of hard water
Provides calcium for teeth and bones	Blocks pipes
Nicer taste	Wastes water
Good for brewing and tanning	Produces scum

Removing both temporary and permanent hardness

1 Distillation

2 Washing soda = hydrated sodium carbonate

The sodium swaps with the calcium

3. Ion exchange resin

See page 265 fig 19.5

4. Cation exchange resin used for deionised water.

All positive ions replaced with H^+ . All negative ions replaced by OH^- ions and these combine to form water.

Distilled water versus deionised water

- Distilled water is the purest form of water as all dissolved and suspended solids are removed.
- Deionised water can contain dissolved gases and organic material.

To determine the total hardness of a water sample is expressed as ppm CaCO_3

1. Name the compound that is used to determine the concentration of Ca^{2+} ions in solution?
2. EDTA= ethylene diamine tetra acetic acid
3. This big molecule wraps itself around a Ca^{2+} ion
4. Burette = EDTA
5. Conical flask = Ballygowan+ buffer pH 10 + Eriochrome black T
6. Indicator =Eriochrome black T
7. Colour change = red to blue
8. Ratio of EDTA: Ca^{2+} = 1:1

Water treatment in Dublin

- **Dublin's Water Supply**
- 400 Million litres of treated water needed a day in Dublin.
- The main sources of water supply are from the man-made reservoirs at Roundwood (River Vartry), Bohernabreena (River Dodder),
- Poulaphouca (River Liffey) and Leixlip (River Liffey). Water quality can vary a lot depending on
- where it is obtained, as can its physical and chemical character. For example, water from
- Roundwood is soft, and that from Leixlip is hard.

Method	Description
Screening	water passes through wire mesh to remove floating objects
Flocculation	Aluminium sulphate $\text{Al}_2(\text{SO}_4)_3$ is used as a coagulant to join small particles into larger particles.
Sedimentation	These coagulated particles from stage 2 settle to the bottom of settlement tank.
Filtration	water then passed through bed of sand acting like filter Paper. Water is now clear but still contains bacteria.
Chlorination	Chlorine is added to sterilize the water to kill bacteria.
Flouridation	Fluorine compounds added for prevention of tooth decay
pH adjustment	optimum pH level 7-9

Determining the suspended and dissolved solids in ppm

Suspended solids

- Determination of total suspended solids is done by firstly filtering a known volume of the water sample through small-pore filter paper. The increase in mass of the dry filter paper is then determined.

Dissolved solids

- Determination of total dissolved solids is done by evaporating a known volume of the filtered water sample. The increase in mass of the container is then determined.

Method for Determining the suspended and dissolved solids in ppm

suspended

1. Find the mass of a dry filter paper.
2. Filter 1 litre of the water sample.
3. Dry the filter paper at about 105 °C overnight.
4. Find the mass of the dried filter paper.
5. Calculate the mass of total suspended solids in mg/l (p.p.m.).

dissolved

1. Find the mass of a clean dry 250cm³ beaker.
2. Add 100cm³ of a filtered water sample to the beaker.
3. Evaporate to dryness in a dust-free oven at 105 °C.
4. Find the mass of the cool dry beaker.
5. Calculate the total dissolved solids in the water sample in mg/l (p.p.m.).

Questions on Determining the suspended and dissolved solids in ppm

Suspended solids

Suggest some possible causes of high levels of total suspended solids. Algal growth. Sandpit washings. Sewage discharges.

What undesirable effects could result from high levels of total suspended solids? Eutrophication. Damage to aquatic plants and animals. Sludge deposits.

How are these particles removed in water treatment? In settling tanks, the action of gravity allows much of the suspended solids to settle as sediment. The remainder are removed by filtration through sand supported by gravel.

Dissolved solids

Why must filtered water be used in this experiment?

If the water has not been filtered, the result obtained will be the sum of the total suspended solids and total dissolved solids.

Suggest some possible reasons for high levels of total dissolved solids.

The sample contains a high level of inorganic and/or organic soluble salts. This could indicate that the sample is saline or that the water basin contains naturally occurring minerals such as limestone. Alternatively a high level of total dissolved solids could be an indication of domestic, agricultural or industrial pollution.

Calculations

A volume of 1200 cm³ of water was found to contain 0.09 g of dissolved solids. Express the concentration of the dissolved solids in p.p.m.

$$1,200 \text{ cm}^3 \text{ ----- } 0.09 \text{ g}$$

$$1,200 \text{ cm}^3 \text{ ----- } 90.0 \text{ mg}$$

$$1,000 \text{ cm}^3 \text{ ----- } 75.0 \text{ mg}$$

$$1,000 \text{ cm}^3 \text{ ----- } 75.0 \text{ p.p.m.}$$

A volume of 1200 cm^3 of water was found to contain 0.09 g of dissolved solids. Express the concentration of the dissolved solids in p.p.m.

Water pollution

- Oxygen is a non-polar molecule so its solubility in water is quite low and this solubility depends on temperature. DO is necessary for aquatic animal life to grow.
- Organic waste uses up DO.
- Domestic sewage
- animal slurry
- silage effluent
- effluent from food processing
- industrial waste

Water pollution

- When this organic waste is discharged into a river, the bacteria are delighted as they now have more food to live on in the form of nutrients. Bacteria are naturally found in water. Bacteria begin to multiply and they begin to break down the waste into CO_2 and water.
- Remember that bacteria respire e.g. they take in O_2 and give out CO_2 .
- When the O_2 levels drop to 0 the bacteria begin to respire anerobically.

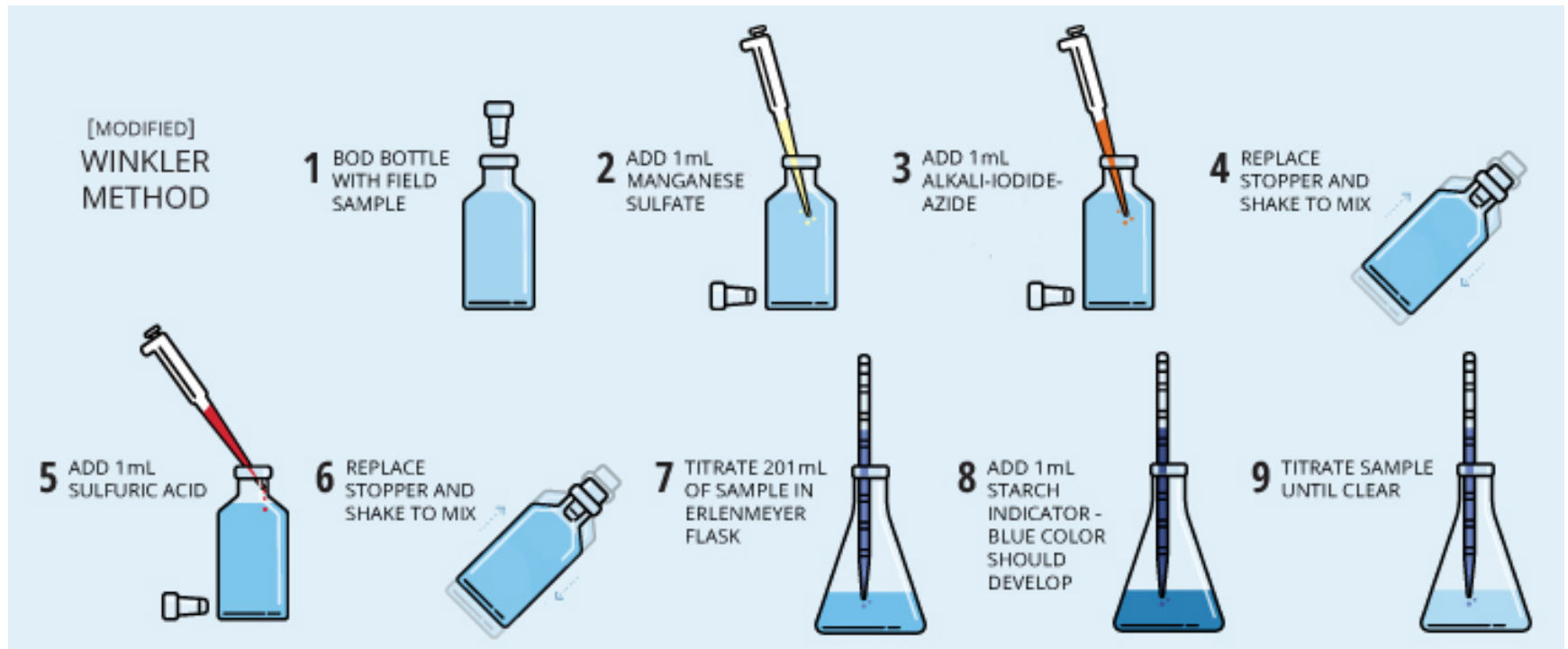
BOD

- A measure of the demand of water for Dissolved Oxygen (DO) is called BOD(Biological Oxygen Demand).17
- BOD is the amount of DO consumed by biological action when a sample of water is kept at 20°C in the dark for five days.
- A high BOD means that there is a high level of organic waste in the water. **Eutrophication**
- **Is the enrichment of water with nutrients which leads to excessive growth of algae.**

Toxic heavy metals

- Lead, mercury and cadmium are heavy metals
- Get into river water from industrial effluents and dumping of batteries, lead piping.
- Detected using AAS.
- Can you remember how AAS works. Worth revising.
- Removed from water by precipitation.
- Heavy metal + acid = salt ppt
- $\text{Pb}^{2+} + \text{HCl} = \text{PbCl}_2$

Measuring DO in a sample of water using a redox titration



Sewage treatment comes from waste water from homes, factories.

Primary	Screening and settling of sewage
Secondary	Activated sludge process where micro organisms break down the sewage. Air is continually pumped into the plant. Why? So DO levels are not decreased.
Tertiary	Removal of phosphorus and nitrogen compounds. These cause over enrichment of water(eutrophication).

Determination of free chlorine in swimming pool water using a comparator

- chlorine compound used to sterilise swimming-pool water = the HOCl.
- It kills micro-organisms by oxidation.
- Chloric (I) acid and its conjugate base, the chlorate(I) ion, ClO^- , together make up what is called “free chlorine”.
- Free chlorine oxidises DPD No.1 tablets to a soluble red product. The intensity of the red colour is a measure of the concentration of the oxidising chlorine in water.