BTEC Level 3 Applied Science
Unit 2: Practical Scientific Procedures and Techniques

Learning Aim A: Undertake titration and colorimetry to determine the concentration of solutions

During this taster session you will be introduced to BTEC Applied Science and will undertake a titration in order to determine an unknown concentration of Hydrochloric acid (HCl) using a known concentration and volume of a solution of Sodium Carbonate (Na_2CO_3).

The tasks in this booklet and in the summer work booklet will help prepare you for your Unit 2 coursework in September.

Taster Session

You will be undertaking a titration to find the concentration of Hydrochloric acid (HCl) using a 0.1Mol/dm solution of Sodium Carbonate (Na_2CO_3).

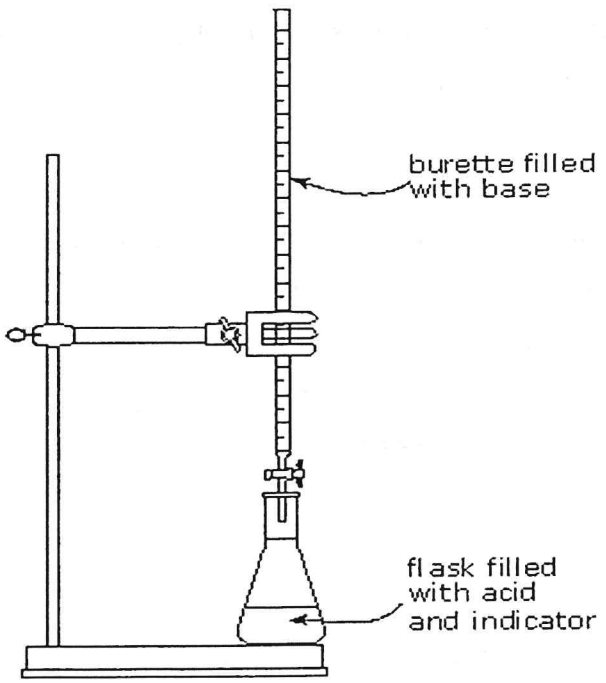
Hydrochloric acid + Sodium Carbonate ----> Sodium Chloride + Carbon Dioxide + Water

$2HCl + Na_2CO_3 \text{ -----> } 2NaCl + CO_2 + H_2O$

You will be using a pH meter to measure the change in pH throughout the reaction.

From this, you will be able to plot a pH graph and find the neutralization point of the reaction.

This will then enable you to calculate the concentration of the acid.



BTEC Level 3 Applied Science
Unit 2: Practical Scientific Procedures and Techniques

pH Meter Titration

Aim: Carry out a pH meter titration to accurately and skillfully to determine the concentration of a sample of hydrochloric acid

Equipment

- pH meter with standard buffer of pH 10.0
- 50cm^3 burette
- burette clamp and stand
- 250cm^3 beaker
- Bulb pipette and pipette filler
- Small funnel
- HCl Solution of unknown concentration
- Distilled water
- 0.1mol/dm^3 Na_2CO_3 (Sodium Carbonate) Solution

Method pH meter calibration

1. Take off the cap of pH meter to expose the electrode
2. Rinse the electrode with deionized water and blot dry using a piece of tissue
3. Press and hold the ON/OFF button until "CAL" is displayed.
4. When "7.01" blinks on the display, place the tip of the probe into a pH10.01 buffer solution
5. The pH value of the buffer will be recognised and will display
6. When the reading is stable **"Sto"** will be displayed when the calibration is saved.
7. Meter will exit to measurement mode

Method pH Titration

1. Rinse out your burette, pipette and beaker with distilled water.
2. Place your burette in the burette clamp on your clamp stand. **CLOSE THE TAP.**
3. Use the pipette to transfer 25cm^3 of Na_2CO_3 into your beaker.
4. Place the pH meter in the beaker and record the starting pH in your results table.
5. Using the funnel, add HCl to your burette. *Overfill your burette slightly and tap off the excess into the bottle.*
6. Add 2cm^3 of HCl to the beaker. Swirl. Record the pH.
7. Repeat step 6 until you have added 50cm^3 HCl.
8. Aim for 2 full titrations so that a mean can be calculated.

BTEC Level 3 Applied Science
Unit 2: Practical Scientific Procedures and Techniques

Titration results

Record your pH results in the table below.

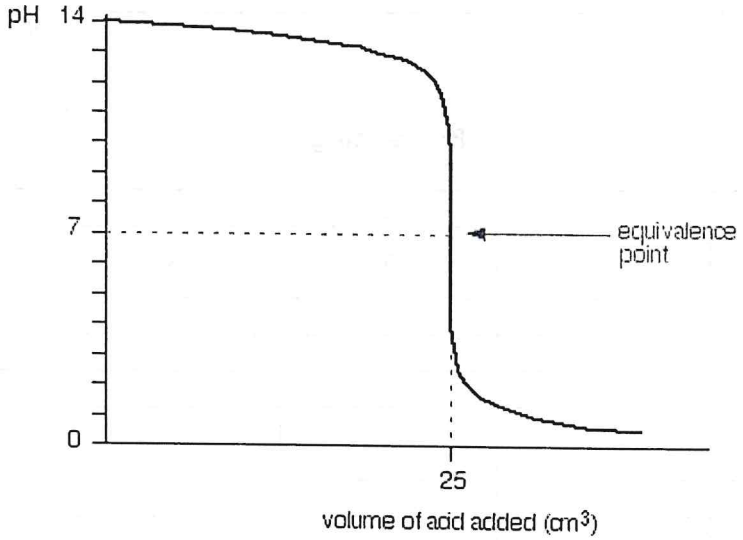
Aim to collect two full titres to calculate a mean pH (we can share data if needed).

Reagents: Alkali: Na_2CO_3 *Sodium Carbonate* Acid: HCl *Hydrochloric acid*	**PH Reading**			**Run 1 + Run 2 + Run 3 = Ans** **Ans/3 = mean pH**
	Titre			**Mean pH**
Volume (cm^3)	**1**	**2**	**3**	
0				
2				
4				
6				
8				
10				
12				
14				
16				
18				
20				
22				
24				
26				
28				
30				
32				
34				
36				
38				
40				
42				
44				
46				
48				
50				

BTEC Level 3 Applied Science
Unit 2: Practical Scientific Procedures and Techniques

Titration curve

Once you have collected your results from the pH titration you need to calculate a mean pH level, which can then be plotted on a graph to give a pH curve.



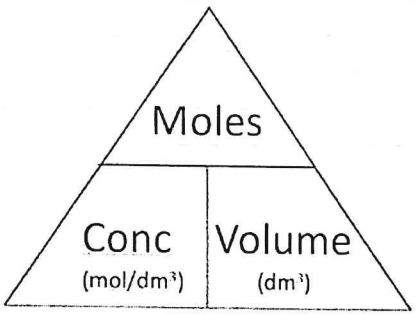
Use the graph paper provided to produce a pH graph of volume of acid added against mean pH.

Equivalence point

Once you have completed the graph you need to find the equivalence point. This is where neutralization has taken place and will ultimately give you the volume that was required to neutralize the solution.

1. Draw a line directly from pH 7 to the graph line.
2. Where these intersect, draw a line down to intercept the x-axis.
3. This will give you the exact volume of acid required to neutralize your alkali.

Once you have this volume you can calculate the concentration of the Hydrochloric acid using the calculation on the next page.



BTEC Level 3 Applied Science
Unit 2: Practical Scientific Procedures and Techniques

Calculation of Concentration

The reaction we have just carried out is as follows:

Hydrochloric acid + Sodium Carbonate ----> Sodium chloride + Carbon Dioxide + Water

$2HCl + Na_2CO_3 \longrightarrow 2NaCl + CO_2 + H_2O$

1. Use this table to help you determine the concentration of Hydrochloric acid (HCl)

	2HCl	Na_2CO_3
Volume (dm^3)		
Concentration (mol/dm^3)		
Moles (mol)		

2. Fill in the table with the information you have (this is an example don't copy it)

	2HCl	Na_2CO_3
Volume (dm^3)	17.5 / 1000 = **0.0175**	25.0/1000 = **0.025**
Concentration (mol/dm^3)		**0.2**
Moles (mol)		

3. Work out the moles of Na_2CO_3 (moles = conc x vol)

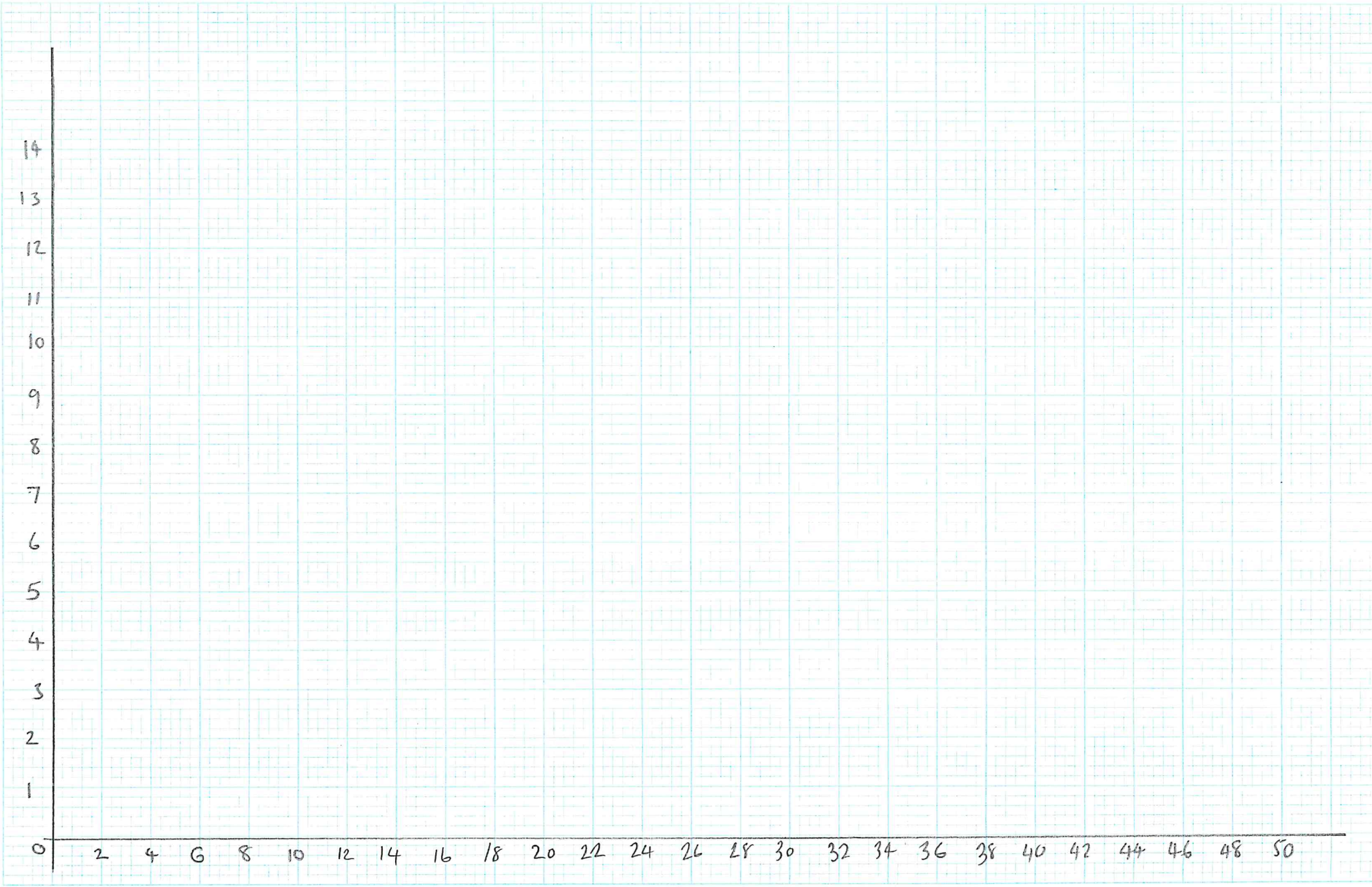
	2HCl	Na_2CO_3
Volume (dm^3)	**0.0175**	**0.025**
Concentration (mol/dm^3)		**0.2**
Moles (mol)		0.2 x 0.025 = **0.004**

4. Look at the stoichiometry (ratio) of reactants. For 1 mole of Na_2CO_3 you react 2 moles of HCl

	2HCl	Na_2CO_3
Volume (dm^3)	**0.0175**	**0.025**
Concentration (mol/dm^3)		**0.2**
Moles (mol)	0.004 x 2 = **0.008**	**0.004**

5. Finally, calculate the concentration of HCl (conc = moles / vol)

	2HCl	Na_2CO_3
Volume (dm^3)	**0.0175**	**0.025**
Concentration (mol/dm^3)	0.008 / 0.0175 = **0.46**	**0.2**
Moles (mol)	**0.008**	**0.004**


14
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BTEC Applied Science

Summer Work

To help prepare you for your first unit of coursework next year, there are a short series of tasks here to cover your 3 practical learning aims.

If you have any problems or questions, please feel free to contact me (SSandever@rossettschool.co.uk).

I look forward to seeing you all again in September.

Take care,

Miss Sandever

Learning Aim A – Keeping up the Standards: Undertake titration and colorimetry to determine the concentration of solutions

Following the completion of your practical taster session tasks, please complete the following;

Methods

Research and write methods, including labelled diagrams and equipment lists, for;

- Preparing a standard solution of sodium carbonate
- pH titration between sodium carbonate and hydrochloric acid

Calibration

Explain what is meant by the 'calibration of equipment' and explain why it is important to check your measuring equipment is calibrated, prior to commencing an investigation.

Describe how to calibrate the following pieces of equipment, including diagrams/pictures.

- pH meter
- Glass pipette and volumetric flask
- Balance

Titration

Explain what a titration is and why they are used.

You may find the following links useful to complete the tasks above.

https://www.youtube.com/watch?v=g5azAxTywgc

https://www.chemguide.co.uk/physical/acidbaseeqia/phcurves.html

https://www.bbc.co.uk/bitesize/guides/zx98pbk/revision/1

https://www.youtube.com/watch?v=3o2hRQ91gzE

https://www.birmingham.ac.uk/teachers/study-resources/stem/Chemistry/acid-base-titration.aspx

Learning Aim B – Keeping your Cool: Undertake calorimetry to study cooling curves

In learning aim B, you will investigate the cooling rate of paraffin wax and stearic acid. This will require you to check the calibration of your equipment in order to collect accurate data, plot a graph of your data and use tangents to identify the cooling rate at different points.

Thermometers and Thermometer Calibration

1. Watch this video https://www.youtube.com/watch?v=eiPWPyU-KgI to learn how thermometers work.

2. Read the information from this commercial calibration laboratory to find out what services they offer. https://www.calibrationlab.ie/temperature-calibration/

3. Next watch these two videos to see alternative methods that can be used to check, set or adjust the calibration of liquid-in-glass thermometers.

   https://www.youtube.com/watch?v=EPoYt1t_3xQ – calibration method 1

   https://www.youtube.com/watch?v=iFiSaJ4qGZ0 – calibration method 2

4. Now write your explanation of why **checking the calibration of thermometers** is performed in schools whereas **checking AND adjusting calibration of thermometers** is only carried out by commercial calibration laboratories.

5. Finally, describe how to **check the calibration** of a 'liquid in glass' thermometer, including diagrams/pictures. Use this video for guidance - https://www.youtube.com/watch?v=He-L6v03NSY - checking calibration (similar to what you will do in school).

Cooling Curves

After checking its calibration, you will use your thermometer to measure the temperature changes that occur as liquid stearic acid cools down and solidifies.

Below is a set of data obtained by a student from this year's course.

Using the A4 piece of graph paper, plot a graph of the data below.

Time – x-axis, Temperature – y-axis

Time (mins)	Stearic Acid Temperature (°C)
0	95
1	78
2	74
3	69
4	67
5	66
6	66
7	65
8	65
9	64
10	63
11	63
12	64
13	64
14	64
15	63
16	63
17	62
18	62
19	61
20	59
21	59
22	58
23	57
24	55
25	53
26	51
27	49
28	47
29	45
30	43

Tangents can be used to determine the cooling rate (rate in change of temperature) of a substance. A tangent is a straight line that touches a particular point on a data curve. The gradient of the tangent can then be calculated. This gives a cooling rate in °C/min.

Gradient = change in y axis ÷ change in x axis

Draw a tangent and determine the cooling rate at the following times;

- 1 minute into cooling
- 5 minutes into cooling
- During the change in state

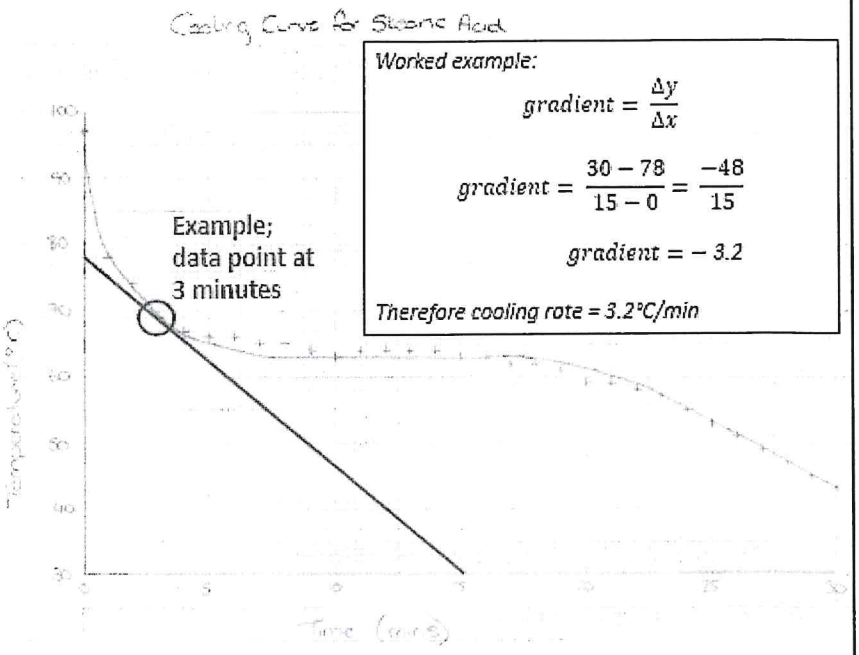
Here is some extra guidance on drawing tangents –

What is a tangent?

A tangent is a straight line that touches a particular point (your data point) on a curved section of a graph.

The steepness of your tangent line should represent the direction the data is going <u>at that point</u>.

Tangent lines will vary in steepness varying from one data point to the next. The gradient (steepness) can be calculated to estimate the rate of change at that point.



Worked example:

$$gradient = \frac{\Delta y}{\Delta x}$$

$$gradient = \frac{30 - 78}{15 - 0} = \frac{-48}{15}$$

$$gradient = -3.2$$

Therefore cooling rate = 3.2°C/min

It is important that you tangent line does not cross through the curve.

Learning Aim C – Separate to Identify: Undertake chromatographic techniques to identify components in mixtures

In learning aim C, you will produce paper and thin layer chromatographs in order to separate and identify plant pigments and amino acids.

Here are some weblinks that you may find useful to help you complete the tasks.

https://www.bbc.co.uk/bitesize/guides/zpbkh39/revision/4

https://www.chemguide.co.uk/analysis/chromatography/paper.html#top

https://www.chemguide.co.uk/analysis/chromatography/thinlayer.html#top

https://www.youtube.com/watch?v=-XCPPB-sBFU

https://www.youtube.com/watch?v=P8i4QYncQxI

https://www.youtube.com/watch?v=J8r8hN05xXk

Task 1 – Chromatography keyword definitions

Define the following keywords:

- Mixture
- Chromatography
- Soluble
- Solvent
- Mobile Phase
- Stationary Phase

Task 2 – Method for paper chromatography

Write a step-by-step method describing how to carry out paper chromatography. You should include a simple explanation of why the mixture is separated.

Task 3 – Calculating Rf values

What is the equation to calculate an Rf value?

Which substance is more soluble in a solvent – a high Rf value (closer to 1) or a low Rf value (closer to 0)?

Calculate the Rf values for the 8 colours below. Show your calculations.

Task 4 – Researching the uses/ applications of paper and thin layer chromatography

Type of chromatography	What is it used to do it? Give an example	Advantages	Disadvantages
Paper chromatography			
Thin layer chromatography			