Problem Based Practical Activities
List of problems

Problem 1: Carbonate rocks!

Curriculum links; mole calculations, reacting masses, thermal decomposition of metal carbonates.
Practical skills; top pan balance, observation skills.

The chairman of a local geology society has contacted the students to ask them to help him identify four different rock samples (all essentially metal carbonates or hydrogen carbonates). The students need to heat the samples, measure the mass change and record visual observations. Using the visual observations, the students are asked to identify each sample and using the mass changes the students are asked to determine the purity of the samples.

Problem 2: A little gas

Curriculum links; ideal gases, Maxwell-Boltzmann distribution, y = mx + c
Practical skills; using computer simulations, graph plotting and interpretation.

The students are contacted to write a review on the use of computer simulations in sixth form chemistry for the student chemistry magazine “The Mole.” They are directed to a simulation on gas properties produced by PhET (University of Colorado at Boulder) and asked to use the simulation to determine the identity of the “light” and “heavy” gas used in the simulation.

Problem 3: Cleaning solutions

Curriculum links; oxidation numbers, redox, halogens, moles, reacting masses.
Practical skills; collecting gas, accuracy.

An ad agency is putting together an advertising campaign for a new bleach. They contact the students for help with determining the amount of NaOCl in various bleach samples (found by reacting a known quantity of each bleach with hydrogen peroxide and measuring the amount of oxygen produced). Using this information, the students are asked to determine if the new bleach is better value for money.

Problem 4: Alcohol detective

Curriculum links; alcohols – nomenclature and classification, oxidation, redox equations.
Practical skills; distillation, chemical tests.

The students use distillation to purify two samples of fake vodka seized by the local police and then identify the nature of the alcohol as either ethanol or *tert*-butanol from its boiling point. The identity of the alcohol is then confirmed using standard test tube reactions (potassium dichromate and the iodoform test).

Problem 5: Coursework conundrum

Curriculum links; oxidation of alcohols, carboxylic acids.
Practical skills; recrystallisation, thin layer chromatography.

A lazy student has contacted the students for help with purification of his sample of benzoic acid (contaminated with benzyl alcohol and Cr^{3+} residues). Recrystallisation of the sample is followed by TLC analysis to prove its purity.

Problem 6: Acid erosion

Curriculum links; titration, pH curves, strong and weak acids, pK_a
Practical skills; titration.

A dentist has contacted the students to determine which of three drinks is the least acidic, and hence which is the least likely to cause tooth enamel erosion.

Problem 7: Iodination inquiry

Curriculum links; rate equations, rate determining step.
Practical skills; clock reactions, accuracy.

A teacher asks the students to design a clock reaction to determine which is the rate-determining step in the iodination of propanone.

Problem 8: Compound confusion

Curriculum links; analytical methods, empirical formulae.
Practical skills; spectral analysis, melting point determination.

The students are contacted by the data collection manager for SpectraSchool. There has been a flood and the labels have come off a number of bottles. The students are to analyse various spectra (IR, mass spec, $_1$H and $_{13}$C NMR) and use these, together with melting point determination, to identify the six unknowns.

Problem 9: Cool drinking

Curriculum links; enthalpy changes, Born-Haber cycles.
Practical skills; experimental design, Health and Safety.

The students are set the problem of designing a new drinks container which will cool 100 cm^3 of a drink by 5 °C in 5 min. The students need to decide which of ammonium nitrate and ammonium chloride should be used based on the enthalpy of solution, the solubility's in water, the cost and the relevant health and safety information for each salt. They then need to trial their method and modify the quantity of salt required accordingly.

Problem 10: Patient prognosis

Curriculum links; transition metal complexes, colorimetry, alcohols, carboxylic acids, esters, analytical
Techniques.
Practical skills; dilution, colorimetry, observation skills, GC analysis.

A nineteen-year-old male has recently collapsed. His doctor would like the students to test;

I. the patient's urine for glucose
II. the concentration of salicyclic acid (the break down product from aspirin) in the patient's urine [by colorimetry of the iron (III) salicylate complex]
III. the patient's blood alcohol level (by interpretation of GC's provided)

Using this information the students are asked to make a recommendation as to the reason why the patient fainted.