Learn Chemistry

Problem Based Practical Activities

Introduction

Developed by Dr Catherine Smith, RSC School Teacher Fellow at the University of Leicester 2011-2012

This resource was produced as part of the National HE STEM Programme

National HE STEM Programme

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Registered Charity Number 207890

Problem Based Practical Activities

A collection of 10 practical activities for students aged 16-18 yrs designed to develop both the students' practical skills and their independent study skills in preparation for Higher Education.

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2011-2012

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Funded by the National HE STEM Programme

Contents

Foreword

Introduction

Health and safety guidance

Acknowledgements

List of problems

The problem based practical activities

Problem 1: Carbonate rocks!

Problem 2: A little gas

Problem 3: Cleaning solutions

Problem 4: Alcohol detective

Problem 5: Coursework conundrum

Problem 6: Acid erosion

Problem 7: Iodination inquiry

Problem 8: Compound confusion

Problem 9: Cool drinking

Problem 10: Patient prognosis

Foreword

The collection of problems presented here was created during my year as an RSC School Teacher Fellow funded through the HE STEM programme. During the 2011-2012 academic year, I was seconded from my post as an Advanced Skills Teacher at John Cleveland College in Hinckley, Leicestershire into the Department of Chemistry at the University of Leicester.

One of my aims for the year was to look at the practical aspect of the school to university transition. The key issue that emerged was that although the students entered the undergraduate teaching laboratories with a high level of perceived confidence in the practical skills expected of them by university teaching staff, their performance did not reflect this confidence. The students appeared to struggle to apply the tools and skills learnt in school outside the narrow environment in which they were taught. A review of the current A-level specifications and student questioning, revealed that the majority of practical work undertaken at A-level is of the expository[1] "recipe-style." As a result, the students' understanding of the practical techniques is only surface deep.

The problems presented here are designed to develop the students' understanding of the standard practical techniques they would be expected to be able to perform on entering an undergraduate teaching laboratory. They follow a problem based approach[1] to laboratory instruction, in which the students must work in groups to apply their understanding of a concept to devise a solution to a practical problem set in a real life context. In order to guide the students thinking and ensure that they have all the subject knowledge required to solve the problem, each problem is accompanied by a set of Pre-lab questions which the students must complete prior to the practical session. These include an element of research beyond the standard A-level specification, included to encourage the students to read beyond the set-text and develop their research skills. It is expected that the students will have been instructed in any practical techniques required in a separate session, prior to tackling the problem. Finally each problem asks for a written report in some format. Assessment of university laboratory work is commonly based upon the completion of a written report, yet scientific writing is something that is rarely touched on at school level. Inclusion of the requirement to complete a formal report, with formative feedback given by the teacher, will both increase the students' confidence in scientific report writing and will ensure the students pull the data collected together to reach a final conclusion and solve the problem.

The problems are designed to be incorporated into a Scheme of Work for post-16 Chemistry. By working through the complete collection during a two year programme, it is intended that the students will develop both the practical skills and the independent study skills required to succeed post-18. Initially the students may require substantial guidance, but as the students develop their problem solving and practical skills they will become more independent and it may be possible to remove the Pre-lab questions, the students instead deciding themselves what information they need to find out.

[1] Domin, D. S., (1999), A review of laboratory instruction styles, *J. Chem. Educ.*, **76**(4), 543-547.

Introduction

The problems are designed to fit into two separate one hour lessons or one single two hour lesson with the students working in groups of three. The Pre-lab questions and report writing can be completed in additional class time or set for homework.

1

Pre-lab questions

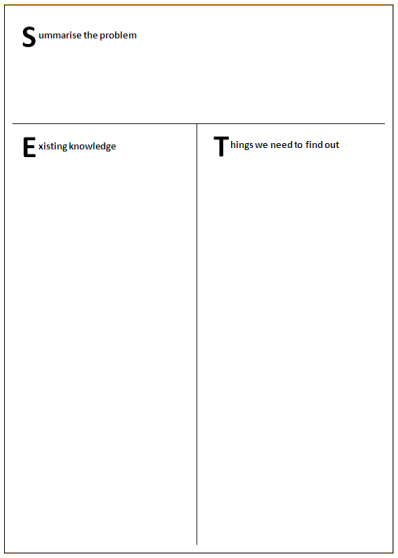
These should be given to the students prior to the laboratory session in which they are to complete the problem.

2

Hour 1 + Hour 2

Students are arranged in groups and presented with the full problem and any addition materials (spectra, samples etc).

The students discuss the problem using the SET sheet to scaffold the discussions. They should use their answers to the **Pre-lab questions** to provide the scientific knowledge they need.



During this time the teacher moves between the groups bringing out the best from each group by;

- asking leading and open ended questions
- helping students to reflect on the experiences they are having
- challenging the students thinking
- raising issues that need to be considered
- stimulating, encouraging and creating and maintaining a safe atmosphere in which individuals are willing to share experiences and ideas without fear of being ridiculed

Once the teacher is satisfied that the students have a clear understanding of the practical work to be undertaken and he/she has fully risk assessed the situation, the students work in a group to solve the problem posed**.**

NOTE It is the responsibility of the teacher to carry out a full risk assessment for any practical work to be undertaken by the individual groups. For further guidance see **Health and Safety Guidance**.

3

Final report

Students work together as a group to present a final report, making sure that all the points raised in the initial problem are answered. This can be read by the teacher and formative feedback given, in preparation for the next Problem Based Practical Activity.

Summarise the problem

Existing knowledge

Things we need to find out

Health and safety guidance

Before carrying out any practical activity, teachers should always check that the practical activity being proposed is compatible with their employer's risk assessments and does not need modification for their particular circumstances. Teachers should be aware that legislation and guidance regarding chemical hazard classification is subject to constant change and that any risk assessment should be based on up-to-date information.

As part of the reviewing process, the experiments on this webpage have been checked for health and safety. The RSC have made reasonable efforts to ensure that;

- all recognised hazards have been identified,
- suitable precautions are suggested,
- where possible, the procedures are in accordance with commonly adopted model (general) risk assessments,
- where (model) general risk assessments are not available, the RSC have done their best to judge the procedures to be satisfactory and of an equivalent standard.

One possible template for recording significant findings of a risk assessment procedure is provided on the next page. Since one of the aims of these activities is to provide students with the opportunity to develop higher level laboratory skills, this could be used by the students prior to them beginning any practical work. Note however that risk assessments developed by students must be checked by teachers **before** any hazards are met or practical work is permitted to start.

Teachers should provide students with instruction in new techniques and explain precautions as part of their health and safety education.

Key to health and safety symbols

The following symbols have been used throughout the Problem Based Practical Activities and are used to draw your attention to the health and safety precautions needed. Note that the text should be read to determine exactly the type of gloves, eye protection etc. that is needed for the proposed method for each different experiment.

Eye protection

Gloves

Fume cupboard

Record of significant findings from risk assessment procedure

Significant findings are best recorded on the 'point of use' text (e.g. by annotating the experiment instructions). However, the following template may be useful to help collate and record information and assist the decision-making process regarding the suitable control (or precautionary) measures to take.

Hazardous chemical used or made OR hazardous procedure undertaken (include state of chemical and concentration if in solution)	**Nature of the hazard and associated risk**	**Control or precautionary measures and/or warnings to be given (including any special waste disposal requirements)**	**Emergency procedures and/or immediate remedial measures required in case of spillage**	**Reference used /date**
e.g. sulfuric acid, 2M	*Corrosive – causes severe burns*	*Wear splash-proof goggles*	*If spilt on skin or in eyes – flood affected area with water. If in eyes – seek medical attention (continue irrigation if required).*	*CLEAPSS Hazcard 2007 Ed^{n} (2011 update)*

Acknowledgements

The collection of problems could not have been written without the help of the staff and students in the Department of Chemistry at the University of Leicester. Special thanks go to Aysha Bhatti and George Marshall who worked on the development of these problems as part of their final year BSc project. I am also extremely grateful to Dr Gero Frisch for our many excellent discussions and to Dr Dylan Williams for introducing me to problem based learning.

The College of past and present School Teacher Fellows have been a continuing source of support throughout the year for which I am very grateful.

The teachers listed below have been kind enough to trial the problems with their classes and have provided vital feedback. I am grateful to them and the many other teachers and students who have been involved in this work. It has been a pleasure and a privilege to meet and work with them;

Linda Cassidy, Chilwell Sixth Form College, Nottingham

Catherine Cross, Melton Vale Sixth Form Centre, Melton Mowbray, Leicestershire

David Godwin, Swanwick Hall School, Alfreton, Derbyshire

Karen Greenwood, John Cleveland College, Hinckley, Leicestershire

Gwyneth Heald, Heanor Gate Science College, Heanor, Derbyshire

Helen Meakin, Wreake Valley College, Syston, Leicestershire

Roger Onions, The American School in Japan, Tokyo

Wendie Summers and Michael Carrington, Hills Road Sixth Form College, Cambridge, Cambs

Members of the East Midlands Teaching Development Group

Practical work would not be possible without the help of many dedicated technical staff. I would like to thank Deborah Tedstone at John Cleveland College, Hinckley for repeated advice on the availability of chemicals and equipment at school level and Carla Jones, Dawn Kissoon and Richard Lane at the University of Leicester for responding kindly to my often random requests.

Thanks must also go to the Governors and Senior Leadership Team at John Cleveland College, Hinckley for granting me the permission to go on sabbatical. Thanks also to Prof. Paul Cullis for arranging my placement at the University of Leicester.

A final and special thanks go to Dr Richard Oakley for his support, enthusiasm and dedication during his time at the Royal Society of Chemistry.

The work was funded through the National HE STEM programme