CHEMISTRY 235 PROJECT

Students must write a project on the extraction of a commercially important metal from its ore ***or*** the manufacture of a commercially important compound. This might be about 5 pages in length. It should be submitted before the last week of teaching both in printed form and as a *.pdf or Word document. (The *.pdf or Word document need only contain text.) It should include diagrams and references. References should be given in the standard C.O.B. approved format and should include name of author(s), journal or book title, volume no. (if applicable), date of publication, page no., and publishers (if a book). Other details are given in the course outline, but in addition the uses of the material involved should be included, and particular attention should be paid to the physico-chemical principles involved. *Chemical equations should be included wherever possible.* The project contributes 5% of the final mark.

Any material copied from books or journals, or taken from the internet, must be *specifically* attributed. Otherwise the author of the project is guilty of plagiarism - a very serious offence. Each statement of fact, diagram, or table must be *specifically* attributed, unless, of course, it is the writer's own work. *Do not "cut and paste".* You must summarise ideas and express them in your own words. Diagrams and tables must be adapted to the context in which you present them – generally you should make up your own diagrams and tables based upon your specific needs.

Accuracy is extremely important. All types of errors – spelling, technical, grammar, punctuation etc. etc. – will cause you to lose marks. Make sure you use all the facilities at your disposal including grammar checkers and spellcheckers. Remember: if you copy a mistake, it becomes your mistake. Always double check your facts – never rely on just one source. Generally, textbooks and specialist journals are much more reliable than internet sources. You will be expected to show understanding of any technical terms that you include.

Style is very important. You are not writing a newspaper or magazine article, but rather a learned article for a well-informed audience. Consult some scientific papers in a journal such as "The Journal of Chemical Education" or "The Journal of Physical Chemistry" to get a good idea of the style required. The following excerpt from a Ph.D. thesis might also be helpful:

1.2 Solvolysis of the Phosphoglycerides

1.2.1 Solvolysis Involving the Phosphate Group

Many early workers in the field of phospholipids separated their crude extracts into two fractions on the basis of solubility differences. Hydrolysates of these' fractions appeared to differ in their content of glycerol 1-phosphate and glycerol 2-phosphate. On this basis, the fractions were thought to be two different types of phosphoglyceride, with the phosphate group esterified in either the 1- or the 2- position of the glycerol moiety. Thus Rae(18) proposed that egg lecithin was predominantly the 2-form (β-lecithin), for example.

However, at about this time, evidence was rapidly accumulating that the phosphate group could migrate during hydrolysis.
This was first noted, during the alkaline hydrolysis of methyl 1-glycerophosphate, by Bailly & Gaume(19) who discovered that the product was approximately one third glycerol 2-phosphate. They further showed that migration occurred both in acid and alkali, and that 2- to 1- migration also took place(20,21). Alkaline hydrolysis was found to favour the formation of the glycerol 2-phosphate and acid hydrolysis the l-isomer(22). In all cases only the methyl group was lost, no methyl phosphate being detected in the products(22,23)). By careful choice of conditions (boiling in 1% v/v sulphuric acid) it was found that glycerol 1-phosphate could be produced from glycerol 2-phosphate in 90 - 100% yield(24). Verkade et al.(25) confirmed the observation of Bailly(26) that the monoesters, glycerol 1- and 2-phosphates, isomerise in acid but not in basic conditions. They proposed that the reaction proceeds through a cyclic diester intermediate. Chargaff(27) showed that no interchange of phosphorus occurred between glycerol 2-phosphate and sodium ^{32}P-phosphate during its acid catalysed conversion to the 1-isomer. This confirmed Verkade's intramolecular mechanism.
Folch(28), meanwhile, pointed out that the question of whether the natural phosphoglycerides were the 1- or 2-phosphate esters remained open, since hydrolysis yielded mixtures of isomeric glycerophosphates whose proportions only depended on the conditions of hydrolysis. For example, three different preparations of phosphoglycerides, hydrolysed for 30 minutes with 6N HCl, all produced 73% 1-glycerophosphate and 27% 2-glycerophosphate. Similarly, either of these monoesters yielded the same mixture under the same conditions. Hydrolytic experiments, it seemed, could not reveal the position of the phosphate residue in naturally occurring phospholipids.

From the observations of these workers it was seen that the essential requirement for the migration of the phosphate group was the presence of a vicinal hydroxyl group. Kumler & Eiler(29) have shown that the polyol and sugar phosphates are abnormally strong acids because of hydrogen bonding between the ionised phosphate group and a neighbouring hydroxyl function. This has been quoted as evidence of a special interaction between a phosphate group and a *vicinal* hydroxyl, though in glycerol 1-phosphates interaction with the 3-hydroxyl seems to be equally, if not more, important since glyceraldehyde phosphoric acid is weaker than dihydroxyacetone phosphoric acid(29).

Burmaster(31) threw more doubt on the validity of hydrolytic methods of determining the structure of phosphoglycerides when he found that what had previously been thought of as being 1- and 2-isomers (vide supra) both gave 1:1 mixtures of glycerophosphates on hydrolysis. It was Baer & Kates(32 33), however, who finally resolved the matter in a series of detailed experiments on the acid and alkaline solvolysis of *sn*-glycerol 3-phosphorylcholine, 3-*sn*-phosphatidylcholine, 3-*sn*-phosphatidic acid and 3-*sn*-glycerophosphoric acid. 3-*sn*-PA and 3-*sn*-GPA were solvolysed with no phosphoryl migration in alkali, but in acid yielded considerably less 3-*sn*-GPA than would have been expected if no isomerisation hadtaken place. All the other compounds gave mixtures of 1-, 2- and 3-*sn*-GPA's, the ratio depending on whether the solvolytic agent was acidic or basic. The liberation of palmitic acid was about 15 times faster than that of choline from dipalmitoyl-3-sn-GPC at 370 in O.2N methanolic NaOH. In turn the release of choline from this compound was slightly slower than that from 3-*sn*-GPC. Thus it was clear that GPC was the main intermediate in the solvolysis of these lecithins. In addition the rate constants governing the isomerisation of 3-*sn*-GPA in an acid medium were estimated from optical activity measurements. These values were then used to predict the rate of loss of optical activity from 3-*sn*-GPC on the assumption that the first step in its hydrolysis was loss of choline, and that only after this did isomerisation occur. The predicted rate was in fact much smaller than that measured. This shows that, at least in acid, most migration takes place while the ester is still intact.

On the basis of their findings, and those of Chargaff(27) and Verkade et al.(25) (vide supra), they were able to propose a scheme for the alkaline reaction which is shown in figure 1. It was also clear from their work that there was no evidence for the existence of naturally occurring 2-phosphoglycerides, since the presence of 2-glycerophosphate in hydrolysates could adequately be explained by facile phosphate migration. On the other hand the occurrence of l-phosphoglycerides was firmly established by Karrer & Salomon's observation(34) that glycerol 1-phosphoric acid, obtained from natural lecithins by alkaline hydrolysis, exhibited optical activity. Only an optically active 1-phosphatidylcholine (l-sn- or 3-sn-) could yield optically active GPA. Hydrolysis of 2-phosphoglycerides could only yield an optically inactive mixture of isomers.

At about this time evidence was rapidly accumulating for the migration of the phosphate group during the hydrolysis of the…

(Figure 1 is on the next page.)

The project may be assessed according to the following scheme, or by "impression marking".

1.	TITLE	Choose your title carefully. It should clear define the subject of your project. Material not directly relevant to the title cannot be considered and will reduce your grade.
2.	INTRODUCTION	This should set the project in context. It will probably include the history of the topic – such as date of discovery and original method of isolation. It should also give a clear indication of what is to be covered in the body of the project and hint at the importance of the material dealt with. [5 marks]
3.	CONTENT	This should be clear, comprehensive and relevant to the topic. *Only material directly relevant to the title will be considered.* Environmental implications and hazards should be described. When technical terms are used a full explanation MUST be included. Nomenclature and terminology must be consistent throughout the work. If old sources are used it is important that nomenclature be brought up to date (eg. "ferric" is now referred to as "iron(III)") (unless the material is being quoted verbatim). Likewise, common names of compounds, and names used in other disciplines than chemistry,

must be replaced with accepted chemical names. Remember that this is a *chemistry* project and therefore you MUST emphasise the *chemistry* involved, bringing out principles such as kinetics and equilibria whenever possible. *Chemical equations are essential.* [15 marks]

4. ORGANISATION The project should be organised in a logical sequence. A table of contents, lists of figures and charts, and a bibliography or list of references, must be included. Pages must be numbered. Sections should be divided into headed subsections according to topic, and data should be presented in tabular format whenever appropriate. [6 marks]

5. ORIGINALITY The project should show input by the student in terms of presenting the information in an original and interesting manner, rather than simply quoting passages from reference sources. A good student re-works his material to produce an integrated whole. Information may also be obtained by interviewing persons in the community if appropriate. *There will be a severe penalty for material copied from sources but not clearly attributed.* The overwhelming majority of the material must be in your own words.[6 marks]

6. DIAGRAMS / CHARTS / ILLUSTRATIONS
Projects should contain data in forms other than written, *but credit may only be given to these if they are referenced in the main text* - ie. diagrams etc. must form an integral part of the text (even if they are placed in a separate section). Each diagram must have a suitable title and be attributed if it is copied. [5 marks]

7. CONCLUSION This should include general comments based on the content of the project. [3 marks]

The following is a list of suggested projects. Each student should do only one of these. Students may choose a project not on the list subject to the approval of the lecturer. Students may not choose a project selected by another student - so get your choice in early or you may find it taken. Submit your choice in writing to your lecturer. Note that the title of your project is very important. The content of the project must correspond exactly to the title. Minor changes to the title may be made up to the time the project is written, but any major change in topic must be approved by the lecturer.

1) The manufacture and uses of sulphuric acid.
2) The manufacture and uses of nitric acid.
3) The manufacture and uses of hydrochloric acid.
4) The manufacture and uses of ammonia.
5) The manufacture and uses of sodium carbonate and sodium hydrogencarbonate.
6) The manufacture and uses of sodium hypochlorite.
7) The manufacture and uses of sodium hydroxide.
8) The extraction and uses of aluminium.

9) The extraction and uses of iron.
10) The extraction and uses of copper.
11) The extraction and uses of lead.
12) The extraction and uses of nickel.
13) The extraction and uses of germanium.
14) The production and uses of silicon.
15) The production and uses of oxygen.
16) The manufacture and uses of heavy water.
17) The manufacture and uses of phosphoric acid.
18) The extraction and uses of lithium.
19) The extraction and uses of sodium.
20) The extraction and uses of magnesium.
21) The extraction and uses of zinc.
22) The extraction and uses of platinum.
23) The production and uses of uranium-235 (uranium enrichment).
24) The extraction and uses of uranium.
25) The manufacture and uses of zeolites.
26) The manufacture and uses of chlorodifluoromethane (R22, F22)
27) The extraction and uses of chromium.
28) The extraction and uses of gold.
29) The production and uses and purification of selenium.
30) The production and uses and purification of plutonium.
31) The production and uses and purification of sulphur.
32) The production and uses of sodium chlorate.
33) The production and uses of and purification of chlorine.
34) The production and uses of tetraphosphorus decasulfide (P_4S_{10}).
35) The production and uses of diborane (B_2H_6).
36) The production and uses of silicones.
37) The production and uses of buckminsterfullerene.
38) The production and uses of carbon nanotubes.

NB. The mention of a process in this list is no guarantee that sufficient information will be available for the completion of a good project. Check early to avoid problems later on. The above topics are in random order.