LONDON SOUTH BANK UNIVERSITY

Unit guide

BSc(Hons) Single honours

BSc(Hons) Combined honours

SFO-1-151

DANGEROUS PROPERTIES OF MATERIALS

Faculty of Engineering, Science and the Built Environment

become what you want to be

Unit Leader Dr J.Orrin

Session 2007/2008

UNIT SFO-1-151, DANGEROUS PROPERTIES OF MATERIALS

Basic data

Level:	1	***Subject area:***	SAS1
Credit value	1	***Semester***	2
Class contact hours	36	***Student managed study hours***	114
Pre-requisites	None		
Unit leader	Dr.J.Orrin	*Room: M306*	0207 815 7950
			Email: orrinj@lsbu.ac.uk
Other teachers	Prof. P.F Nolan	*Room: E236*	*Tel:020718157901*
	Ms H.Willson		

Assessment

Element	*Description*	*Weighting*
Coursework	reports/calculations	30%
Examination	2 hour unseen examination	70%

Short introduction to the unit

This unit introduces you to the properties of materials, their chemical nature or physical form which under the right circumstances may endanger life or be potentially lethal.

Physical properties of materials may pose a danger due to their physical energy content, for example liquid water held at high temperature and pressure. Catastrophic failure of the containment vessel would lead to an explosive depressurization. Load bearing materials used to construct buildings or in transportation may pose a danger if the design loads are exceeded.

Chemical properties of materials may pose a danger due to their chemical energy content or their chemical reactivity or their inherent toxicity. Explosives are a good example of a compound which can undergo an oxidation reaction liberating a large amount of energy in the form of gas generation. For example, concentrated nitric acid may cause a danger because of its corrosive nature, a form of chemical reactivity. Ethylene oxide is dangerous because of both its explosive nature and its toxicity.

Toxicity as a dangerous property of material is looked at in some depth from a forensic view point. The toxicity of a material may be of concern in an accident investigation when the leak of a toxic gas has effected the local population of a town as in Bhopal. Toxicity is also an important issue when looking at the effects of substances at a crime seen, this may be from deliberate poisoning, suicide or from the effects of drugs of abuse. A special area of toxicity relates to the effects of combustion products and inhaled smoke.

How to Study

As you can see a consideration of dangerous properties of materials must be broad based and requires understanding of both chemical and physical processes. Just to complicate matters further we will also be considering electrical hazards and the special problem of radioactivity.

You will need to find a first year undergraduate book in chemical principles (there are some listed in the reading list). You will need it to read further into the material covered in lectures. The lectures will start off by looking at the physical basis for understanding the dynamics of energy interactions. It is essential that you understand this.

Lectures will move on to consider flammable liquids and their vapours. We will need to define flammability limits and learn about chemical thermodynamics.

Another main theme of the course is the physiological effects of hazardous materials especially toxins. Some emphasis is placed on drug abuse by way of introduction to important units which come later in the course.

As the course progresses make sure you follow up comments by the lecturer concerning case studies covered by the internet. Don't undervalue this resource.

All of you will have various strengths and weaknesses. Don't try to solve problems all by yourself but don't copy straight from someone else either. Try to pool your resources to work out the problem exercises set. A good place to do this is the refectory between 9-9.30 am over coffee just before the first lecture starts on Tuesday.

If you were thinking of investing in a book I would advise you to think carefully. You may be better off buying a book on Chemical Analysis, particularly one which covers drug analysis. This book will cover the chemistry basics but also be very useful later on in the course. The newest books even have interactive CD ROMs. Talk to your unit tutors about these latest books. They may let you take a good look at the most recent publication.

During the course you will be asked to submit course work which will be in the form of a number of problems to solve, which should give you some familiarization with topics covered in this unit. Make sure you don't get behind with solving them. Your tutors will, from time to time require you to attend a personal academic tutorial aimed specifically at finding out and discussing the progress you have made with your work.

This unit is the sister unit to Forensic Materials and both are closely related to Introduction to Forensic Chemistry. Each unit reinforces the other and it is vital that you attend all three!

Aims

Aims of this unit are:

1. To introduce the students to the physical and chemical properties of materials.

2. To give an appreciation of correlations between atomic and molecular structure of materials, their physical states and their hazardous properties.

3. To familiarize the students with the characteristics of hazardous materials and techniques of identifying and quantifying them.

Learning outcomes

On successful completion of this unit the student:

1. Will understand the principles of thermo chemistry and chemical kinetics which define the stability of chemical compounds.

2. Will be able to identify hazardous materials from their structure and their properties.

3. Will be able to apply techniques for identification of hazardous compounds.

4. Will appreciate the application of techniques and methodologies for the study of hazardous compounds.

5. Will understand flammability characteristics and the experimental procedures for their estimation.

Indicative content

ENERGY INTERACTIONS. THERMODYNAMICS

Definitions. Forms of energy. Ist law of thermodynamics. Work and heat as energy transfer processes. State variables and state properties. States of matter. The gas laws. Specific and latent heat. Chemical equations and Hess's law. Exothermic reactions and reaction enthalpies. Heats of formation and the bomb calorimeter. Bond energies. Arhennius rate equation.

2nd law of thermodynamics. Reversible and irreversible processes. Driving forces for change in chemical reactions.

Introduction to industrial chemical hazards

Thermodynamics of guns.

FIRES AND EXPLOSIONS.. AN INTRODUCTION

Flammability limits. Flash point. Auto ignition temperature. Minimum oxygen concentration. Minimum ignition energy and temperature. Maximum safe gap, self heating. Ignition testing (spark, flame, hot surface). Detonators and other explosive devices.

Combustion Product Toxicology

Smoke. Death in Fire.

Fire Investigation, Arson

Types of fire. Standard Fire curve. Fire Investigation. Types of fire setter. Common arson techniques.

TOXICITY

Classification and measurement. Sites of contamination and absorption: respiratory tract, skin, ingestion, injection, eye.

Fate of and excretion of toxins. Factors influencing toxic effects. Individual susceptibility. Levels of toxins in the blood. Acute and chronic effects. Examples of chemical and biological toxins. Diagnosis. Toxic effects of solvent and drug abuse.

Toxic Effects of Radiation

Electromagnetic and ionising radiations. The electromagnetic spectrum. UV radiation. Infrared radiation. Xrays and Gamma rays. Lasers. Nuclear radiation.

Electrical Hazards

Current and voltage. Industrial and domestic voltages. Fibrillation current and skin resistance. Relationship to applied voltage. Earth leakage paths. Electrical safety devices. Electrical fires.

Teaching Method

The unit will be delivered by mixture of lectures and seminars with tutorials. Additional reference may be given to external lectures as and when appropriate.

Details of times and locations are given in the published class timetables.

Meetings with tutors, tutorial assistance and answers to other questions relating to the work may be obtained through e-mail

The course is design to allow students to understand concepts and apply calculation techniques.

Whist students will be marked individually it is expected that students should co-operate when trying to solve calculation questions. It is recognised that peer learning is a valuable resource in this unit.

Weekly teaching and learning programme

The programme of classes below is intended only as a guide and is subject to modification according to rate of progress and unforeseen factors.

Week No	Prof Nolan 1 hour	Ms H.Wilson 1 hour	Dr J Orrin 1 hour
1	Introduction to Fire and Explosion	Introduction to toxicity	Introduction to energy interactions. Work and heat as energy transfer processes.
2	Flammability	Introduction to Toxicity	Dangerous effects of energy interactions
3	Intro to Explosives	Basic Principals and absorption of toxicants	Examples of energy transfer
4	Explosive calculations	Distribution and metabolism 1	Matter and Energy. States of matter
5	Detonators and Primers	Distribution and metabolism 2	Ideal gas laws
6	Explosive devices	Elimination	Hess's law and exothermic reactions
7	Fire and Materials	Toxic effects of nuclear radiation	Standard heats of formation and bomb calorimetry
8	Smoke and Other Combustion Products 1	Nuclear case study	Bond energies
9	Smoke and other Combustion Products 2	Toxic effect of solvent and drug abuse 1	What makes a chemical reaction occur?
10	Case study 1	Toxic effect of solvent and drug abuse 1	Electrical Hazards
11	Case study 2	Classification	Thermodynamics of guns
12	Revision	Revision	Revision

Assessment

Examinations: The examination will be of 1.5 hours duration. Students will attempt 3 questions out of a total of six. All questions will carry equal marks. The examination paper will contain three sections consistent with the lecture series given by each academic tutor. Students will be required to answer one question from each section.

Coursework:

Students will be set a series of problems concerning calculations or specific aspects of various hazards. Each member of the teaching staff will set their own series of problems and each will contribute 1/3 of the total coursework mark. All work should be word processed. Students may at any time seek counsel from the teaching team with respect to the problems set. However students should be advised that it is not the intention of the staff to solve the problems for the students. In this respect students may only seek clarification of the correctness of the calculation or problem solving method they are using not on the outcome of the final answer.

Students should be reminded that the University has a policy on late submission of coursework and on claiming for mitigating circumstances. REMEMBER you must fill in the appropriate forms relevant to your circumstances. Failure to do so will invalidate any claim to mitigating circumstances at a later date.

	% of Unit Marks
Coursework	30%
1.5 Hour Exam	70%
TOTAL	100%

Recommended reading

Core reading
Course lecture handouts

Background Reading

Bodurtha. F.T: Industrial Explosion Prevention and Protection. Mc Graw-Hill

Lees F.P. Loss Prevention in the Process Industries. 2nd edition. 1996. Butterworth.Optional reading

Chemistry and Chemical Reactivity: Kotz and Treichel. Fourth edition. Harcourt Brace.

On-line materials

To be advised by individual unit lecturers.