Module guide

MATERIALS SCIENCE

UNIT EAC_4_132

BSc(Hons) Forensic Science

BSc(Hons) Combined Honours

LEVEL 1

2011_2012

UNIT LEADER: J.Orrin

become what you want to be

Department of Applied Science

Basic data

Level:	**1**	***Subject area:***	**SAS1**
Credit value	**30**		
Class contact hours	**78**	***Student managed study hours***	**222**
Pre-requisites	**None**		
Unit leader	**Dr J.Orrin**	***Room:M306***	**Tel:01718157950 E-mail:*orrinj@sbu.ac.uk***
Other teachers	**Mr S. Faulkner** **Dr C.Steele** **Dr V.Hilborne** **Professor P.Nolan**		

Assessment

Element	Description	Weighting
Course work	4 course work assignments in Materials(9%) Toxicology (7%) Fires and Explosions(7%) Energy Interactions/ Thermodynamics(7%)	30%
Examination	2 examinations Each exam is 1.5 hours duration (35% each)	70%

Short introduction to the unit

This module introduces students to the basic properties of forensically relevant materials. It includes their chemical nature and physical form which under certain 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 depressurisation. 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, 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. 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.

Aims

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.

4. To impart a fundamental understanding of the atomic and molecular basis for material properties and the main types of materials which are commonly found at crime scenes and accident scenes.

Learning outcomes

On successful completion of this unit the student will be able to:

Knowledge and Understanding

1. Understand basic properties of materials such as mass, density, colour, texture, refractive index, thermal conductivity, electrical conductivity, elasticity, tensile strength and calorific value.

2. Understand the principles of thermochemistry and chemical kinetics which define the stability of chemical compounds.

3. Classify materials according to origin.

Intellectual Skills

4. Identify hazardous materials from their structure and properties and apply techniques for identification of hazardous compounds.

5. Understand the nature of a range of forensically relevant materials such as metals, polymers (natural and synthetic fibres), wood, glass and concrete.

Practical Skills

6. Understand flammability characteristics and experimental procedures for their estimation.

7. Understand the value of scanning electron microscopy and infrared microscopy for material analysis.

Transferable Skills

8. Appreciate the application of techniques and methodology for the study of hazardous compounds.

Indicative content

Part A: Dangerous Properties of Materials

ENERGY INTERACTIONS. THERMODYNAMICS (Semester 1)

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.

2^{nd} 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 (Semester 1)

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 (Semester 2)

'Toxic Metabolites'

Biological transformation of drugs and poisons. Their distribution through the human body. Definition of allergens.

MATERIALS (Semester 1 and 2)

Areas covered include:

- **Periodic table. Elements and compounds**
- **Metals. Most common types, properties**
- **Metal alloys**
- **Crystalline and amorphous solids**
- **Glass**
- **Mass, density, elasticity, viscosity, tensile strength. Electrical conductivity. Thermal conductivity.**
- **Colour**
- **Rocks and Minerals: Basic classification and origin. Hardness scale.**
- **Wood and cellulose based material (including paper)**
- **Common polymers, thermosetting and thermoplastic, elastomers**

- **Natural and Synthetic Fibres (including cotton, silk, nylon, acrylic, human hair)**
- **Ceramics (other than glass)**
- **Concrete**
- **Composite materials including fibreglass and resin mixes**
- **Surface coatings. Structure of main types of coating systems, pigment and binder resins and water based products.**
- **Fuel and lubricants**

- **Brief introduction to instrumental methods**
- **Scanning electron microscope and energy dispersive x ray analysis.**
- **Infra red microscope.**

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 designed 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.

Assessment

Examinations:

There are 2 examinations. One examination is at the end of semester one (January). The second examination is in the summer and covers the material covered in the second semester only. Each examination is of duration 1.5 hour and both exams are unseen written examinations.

Coursework:

(1) Project on Materials Analysis set by Dr C. Steele (9%)

(2) Coursework on Energy Interactions/Thermodynamics by Dr J.Orrin (7%)

(3) Coursework on Fires and Explosions by Professor P. Nolan (7%)

(4) Coursework on Toxicology by V.Hilborne (7%)

Total 30%

	% of Unit Marks
Coursework	30%
Two 1.5-hour written examinations	70%
TOTAL	100%

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.

Core reading

Forensic Chemistry by Suzanne Bell. Pearson Prentice Hall. 2005. ISBN 0-13-147835

Introduction to Forensic Sciences. William G. Eckert (Editor).CRC Press. Hardcover - December 13, 1996

Course lecture handouts

Background Reading

Clarke's Analytical Forensic Toxicology; Editors: Sue Jickells and Adam Negrusz; 2008; Pharmaceutical Press.

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.

Students should be advised that the University retains the right to alter the indicative timetable shown at short notice in the event of exceptional circumstances or as deemed appropriate to enhance academic learning of this unit.