SQA- SCOTTISH QUALIFICATIONS AUTHORITY

HIGHER NATIONAL UNIT SPECIFICATION

GENERAL INFORMATION

Unit Number	**D3R2 04**
Unit Title	MASS AND ENERGY BALANCES
Superclass Category	RC
Date of Publication (month and year)	
Originating Centre for Unit	Cleveland Open Learning Unit

DESCRIPTION

GENERAL COMPETENCE FOR UNIT:

Applying physical and chemical principles to mass and energy balances over chemical processes.

OUTCOMES:

1. analyse a chemical process in terms of simpler units;
2. apply thermodynamic principles to energy analyses of chemical processes;
3. produce and use pressure, volume and temperature data for ideal and non-ideal gases;
4. analyse the distillation and extraction of liquid mixtures by the construction and use of equilibrium diagrams;
5. perform a mass balance over a simplified chemical process;
6. perform an energy balance over a simplified chemical process.

CREDIT VALUE: 2 HN Credits

ACCESS STATEMENT:

Access to this unit is at the discretion of the centre. However, it would be beneficial if the student had competence in Chemistry, Mathematics and Chemical Plant Operations. Evidence of this competence could be the successful completion of modules in Chemical Plant Operations, Chemistry and Mathematics at National Certificate level or equivalent.

Additional copies of this unit can be obtained from: The Administrative Services Unit, SQA, Hanover House, 24 Douglas Street, Glasgow G2 7NQ (Tel: 0141-242 2166).

At the time of publication, the cost is £2.50 (minimum order £5.00)

Continuation

HIGHER NATIONAL UNIT SPECIFICATION

STATEMENT OF STANDARDS

Unit Number

Unit Title MASS AND ENERGY BALANCES

Acceptable performance in this Unit will be the satisfactory achievement of the standards set out in this part of the specification. All sections of the statement of the standards are mandatory and cannot be altered without reference to SQA.

OUTCOME

1. ANALYSE A CHEMICAL PROCESS IN TERMS OF SIMPLER UNITS

PERFORMANCE CRITERIA

(a) Identification of processing stages is correct within a process.
(b) Specification of the unit operations, transfer operations and unit process is correct for a given processing stage.
(c) Identification of mass, momentum and energy transfer is complete for a given operation.
(d) Selection of the appropriate processing method is correct for a given processing operation.

RANGE STATEMENT

Processing stage: feed preparation; reaction; separation; purification; recycle ; purge.
Processing method: pure inventory; separation; assembly; chemical change.

EVIDENCE REQUIREMENTS

PC (a) & (b) Written and graphical evidence showing ability to display one chosen and one given process in the form of block and flow diagrams, identifying the processing stages listed in the range statement.
PC (c) & (d) Written evidence showing ability to identify significant examples of mass, momentum and energy transfers for a given operation and ability to select appropriate processing methods for the given process.

OUTCOME

2. APPLY THERMODYNAMIC PRINCIPLES TO ENERGY ANALYSES OF CHEMICAL PROCESSES

PERFORMANCE CRITERIA

(a) Choice of thermodynamic function and laws are correct and meet the requirements of a given energy analysis.
(b) Predication of values based on thermodynamic functions and laws are sufficiently accurate for practical use.
(c) Solutions to problems include sufficient steps to indicate a logical progression.

RANGE STATEMENT

Function and laws: First and Second Laws of thermodynamics; standard heat of reaction; standard entropy; Gibbs free energy of formation; equilibrium constants; Hess's Law.

EVIDENCE REQUIREMENTS

Written evidence of correct, relevant application of thermodynamic function and laws to accurate solution of two problems that involve heats of reaction/formation and equilibrium.

OUTCOME

3. PRODUCE AND USE PRESSURE, VOLUME AND TEMPERATURE DATA FOR IDEAL AND NON-IDEAL GASES

PERFORMANCE CRITERIA

(a) Prediction of physical data for gases is accurate according to the ideal gas laws.
(b) Identification of the factors affecting the ideal and non-ideal nature of gases is complete according to scientific knowledge.
(c) Prediction of physical data for a non-ideal gas is accurate according to an appropriate equation for non-ideal gases.
(d) Extraction of data from reference sources is sufficient to enable problems to be solved.
(e) Solutions to problems involving the gas laws include sufficient steps to indicate a logical progression.
(f) Accuracy of gas law calculations is appropriate to the available data.

RANGE STATEMENT

The range for this outcome is fully expressed in the performance criteria.

EVIDENCE REQUIREMENTS

Written evidence to show correct interpretation of data obtained from standard reference books and application of gas laws to the accurate solution of two problems, one involving an industrially important ideal gas and one involving an industrially important non-ideal gas.

OUTCOME

4. ANALYSE THE DISTILLATION AND EXTRACTION OF LIQUID MIXTURES BY THE CONSTRUCTION AND USE OF EQUILIBRIUM DIAGRAMS

PERFORMANCE CRITERIA

(a) Calculations using given data are appropriate for the construction of diagrams for binary mixtures.
(b) The method of construction of diagrams is clear and accurate according to standard mathematical principles.
(c) Distinction between ideal and non-ideal mixtures is clear and accurate according to the type of diagram obtained.
(d) Extraction of information from constructed diagrams is sufficient for analysis of the given process.
(e) Solutions to problems include sufficient steps to indicate a logical progression.
(f) Accuracy of calculations is appropriate to the available data.

RANGE STATEMENT

Mixtures: liquid/vapour phase system: partially immiscible terniary system.

EVIDENCE REQUIREMENTS

Written and graphical evidence to show ability to accurately construct and interpret equilibrium diagrams – one for a liquid/vapour phase system and one for a partially immiscible terniary liquid system.

OUTCOME

5. PERFORM A MASS BALANCE OVER A SIMPLIFIED CHEMICAL PROCESS

PERFORMANCE CRITERIA

(a) Analysis of combustion and chemical processes (involving no more than three reactants) into simpler stages is sufficient for the balancing of materials entering and leaving.
(b) Mass balance calculations are sufficiently accurate for a balance to be achieved.
(c) Solutions to problems include sufficient steps to indicate a logical progression.
(d) Accuracy of numerical calculations is appropriate to the available data.
(e) Presentation of the results of a mass balance is clear according to an acceptable form.

RANGE STATEMENT

The range for this outcome is fully expressed in the performance criteria.

EVIDENCE REQUIREMENTS

Written and graphical evidence to show ability to present three mass balances of different chemical processes, in clear acceptable ways. These can be in the form of tables or flow diagrams and have accuracies appropriate to the available data.

OUTCOME

6. PERFORM AN ENERGY BALANCE OVER A SIMPLIFIED CHEMICAL PROCESS

PERFORMANCE CRITERIA

(a) Analysis of a given chemical process, involving temperature change, into simpler stages is sufficient for the balancing of energy inputs and outputs
(b) Application of the laws of thermodynamics and thermochemistry, together with the use of extracted physical data, is relevant to the given calculation.
(c) Solution of energy problems within a given industrial process includes sufficient steps to indicate a logical progression.
(d) Accuracy of numerical calculations is appropriate to the available data.
(e) Presentation of the results of an energy balance is clear according to an acceptable form.

RANGE STATEMENT

The range for this outcome is fully expressed in the performance criteria.

EVIDENCE REQUIREMENTS

Written and graphical evidence to show ability to present one industrial energy balance in a clear acceptable form, either as a table or in graphical form, having accuracies appropriate to the data available.

MERIT

To gain a pass in this unit, a candidate must meet the standards set out in the outcomes, performance criteria, range statements and evidence requirements.

To achieve a merit in this unit, a candidate must demonstrate a superior or more sophisticated level of performance. In this unit this might be shown by solving a problem of a more complex nature involving, for example, a combined mass and energy balance using information from an industrial process or actual plant equipment.

ASSESSMENT

In order to achieve this unit, candidates are required to present sufficient evidence that they have met all the performance criteria for each outcome within the range specified. Details of these requirements are given for each outcome. The assessment instruments used should follow the general guidance offered by the SQA assessment model and an integrative approach to assessment is encouraged. (See references at the end of support notes.)

Accurate records should be made of the assessment instruments used showing how evidence is generated for each outcome and giving marking schemes and/or checklists, etc. Records of candidates' achievements should be kept. These records will be available for external verification.

SPECIAL NEEDS

Proposals to modify outcomes, range statements or agreed assessment arrangements should be discussed in the first place with the external verifier.

Continuation

HIGHER NATIONAL UNIT SPECIFICATION

SUPPORT NOTES

Unit Number

Unit Title MASS AND ENERGY BALANCES

SUPPORT NOTES:

This part of the unit specification is offered as guidance. None of the sections of the support notes is mandatory.

NOTIONAL DESIGN LENGTH:

SQA allocates a notional design length to a unit on the basis of time estimated for achievement of the stated standards by a candidate whose starting point is as described in the access statement. The notional design length for this unit is 80 hours. The use of notional design length for programme design and timetabling is advisory only.

CONTEXT/CONTENT

Corresponding to the outcome:

3. Reference sources of data:
   - Perry , 'Chemical Engineering Handbook'
   - Kaye and Laby, 'Physical and Chemical Constants'
   - Prausnitz, Reid and Sherwood, 'The Properties of Gasses and Liquids'
   - Kemp, 'Engineers' Handbook'

REFERENCES

1. Guide to unit writing.
2. For a fuller discussion on assessment issues, please refer to SQA's Guide to Assessment.
3. Information for centres on SQA's operating procedures is contained in SQA's Guide to Procedures.
4. For details of other SQA publications, please consult SQA's publications list.