Nevada Technical Associates, Inc.
Course Outline

Gamma Spectroscopy

A. Introduction

B. The atomic nucleus, notation and conventions

C. Radioactive decay, stability, equations of state, decay laws and gamma-ray production

D. Interaction of gamma-rays with matter, shielding and attenuation

E. Gamma-ray detection, scintillation and solid-state detectors

F. Geometries, energy and efficiency calibration, effects of shielding, quality assurance and problems

G. Statistics, reporting criteria, errors, qualitative and quantitative analysis and problems

H. Problem set

Practical Information

I. Counting System Components

1. Detector Assembly (Shield/Detector/Preamp/Liquid Nitrogen Dewar)
2. HV Bias Power Supply
3. Spectrometry Amplifier
4. ADC/MCA
5. Data Acquisition, Storage and Handling System (PC)
6. Applicable Software

J. Instrument Setup

K. Calibration of Counting System

1. Basis of Spectroscopy

2. Electronic Adjustment/Setup

3. Calibration Source Counting

4. Spectroscopy Software Parameter and File Setup

- Source standard file
- Nuclide library
- Efficiency file
- Background subtraction file
- Activity conversion factor
- Sample size conversion factor
- Peak search sensitivity
- Nuclide library resolution
- Standard tolerance
- Nuclide ID% fraction limit
- Nuclide decay limit

5. Energy Calibration

6. FWHM Calibration

7. Efficiency Calibration

8. Calibration Verification

L. Sample Counting and Data Entry

M. Sample Analysis Report (Review of Report)

N. Quality Control

(End of Course)

Nevada Technical Associates, Inc.
Radiation Safety Officer
Course Outline

Starting time: 8:30 each day. The course will end at about noon on Friday. Return flights should be scheduled for departure no earlier than 2:00 pm. The topics below will be more or less evenly distributed over the duration of the course.

1. Introduction

   a. Course objectives and schedule
   b. Origins of nuclear science
   c. Atomic structure, isotopes, nuclear stability
   d. Equations of radioactive decay

2. Radioactive Decay Processes

   a. Alpha emission
   b. Beta emission
   c. Gamma emission
   d. Other decay processes
   e. Statistics of radioactive decay

3. Radiation Detection and Measurement

   a. Gas-filled chambers
   b. Scintillation detectors
   c. Semi-conductors
   d. Photographic emulsions

4. Interaction of Radiation with Matter

   a. Modes of interaction
   b. Heavy charged particle interactions
   c. Beta particle interaction
   d. Gamma ray interaction
   e. Neutron interaction

5. Biological Effects of Radiation

   a. Radiation quantities and units
   b. Quality factors
   c. Biological effects
   d. Mechanisms of biological damage
   e. Acute, whole-body gamma radiation
   f. Risk of stochastic effects
   g. Fatality rates in various industries
   h. Radiation dose from natural and man-made sources

6. Shielding

   a. Charged particle shielding
   b. Photon shielding
   c. Neutron shielding
   d. Facility shielding

7. Personnel Radiation Dosimetry Devices and Methods

   a. External monitoring
   b. External dose evaluation
   c. Internal monitoring
   d. Internal dose assessment

8. Federal and State Regulations

   a. Chronology of standards
   b. Sources of standards, recommendations and requirements
   c. Basis of Standards
   d. Current regulations
   e. Licensing procedures

9. Radiological Safety Surveys, Records and Documentation

a. Surveys and inspections
b. Radiological Controls and ALARA
c. Records and documents
d. Operating and emergency procedures and document control

10. Radioactive Material Transportation and Disposal Regulations

a. Applicable regulations
b. Categories, packaging and limits
c. Manifests, records, markings, and labels
d. Radwaste disposal methods, sites, records and regulations

11. Radiological Emergencies

a. Definitions, classifications and phases
b. Notifications and assistance
c. Response: isolation, radiation and medical evaluations
d. Review of accident causes and recent accidents

12. Drafting a Radiological Safety Plan (student exercise)

a. Attendees prepare program
b. Exercise review

ENVIRONMENTAL RADIOCHEMISTRY

COURSE SCHEDULE

MONDAY MORNING

1. Historical Introduction
2. The Atomic Nucleus
3. Radioactive Decay and Ingrowth

MONDAY AFTERNOON

4. Problem Set on Radioactive Decay and Ingrowth
5. Radioactive Decay Processes
6. Nuclear Fission

TUESDAY MORNING

7. Interaction of Radiation with Matter
8. Radiation Detection and Measurement Techniques
9. Statistics in Radiochemistry

TUESDAY AFTERNOON

10. Biological Effects of Radiation
11. Principles of Sampling
12. Sample Preparation Methods

WEDNESDAY MORNING

13. Practical Laboratory Concepts
14. Acid-Base and Redox Chemistry
15. Gross Alpha and Gross Beta Analysis

WEDNESDAY AFTERNOON

16. Gamma Spectroscopy
17. Alpha Spectroscopy
18. Liquid Scintillation Counting

THURSDAY MORNING

19. Tritium Analysis
20. Radon Analysis

21. Radionuclides as Environmental Tracers (slides only)

THURSDAY AFTERNOON

22. Separation Methods for the Actinides
23. Regulatory Basis for Data Quality & Data Validation
24. Quality Control

FRIDAY MORNING

25. Quality Assurance Audits
26. Data Quality and Data Validation

This course starts at 8:30 each morning and will end on Friday at about 10:00 a.m.

Nevada Technical Associates, Inc.
Liquid Scintillation and Alpha Counting
Course Outline

1. Introduction (starting time: 8:30 each day)

   a. Course objectives and schedule
   b. Atomic structure, isotopes, nuclear stability
   c. Equations of radioactive decay

2. Radioactive Decay Processes

   a. Alpha emission
   b. Beta emission
   c. Gamma emission
   d. Other decay processes
   e. Statistics of radioactive decay

3. Radiation Detection and Measurement

   a. Gas-filled chambers
   b. Scintillation detectors
   c. Semi-conductors
   d. Photographic emulsions

4. Interaction of Radiation with Matter

   a. Modes of interaction
   b. Heavy charged particle interactions
   c. Beta particle interaction
   d. Gamma ray interaction
   e. Neutron interaction

5. Introduction to Alpha Spectroscopy

   a. Alpha counting equipment
   b. Interaction of alpha particles with matter
   c. Calibration of alpha counters
   d. Calculations in alpha counting
   e. Quality assurance in alpha counting
   d. Student exercise in alpha counting

6. Chemical separations prior to alpha counting

   a. Use of radioactive tracers
   b. Decontamination factors
   c. Final preparation of sample by electroplating or precipitation

7. Introduction to Liquid Scintillation Counting

   a. Liquid scintillation counting devices
   b. Organic scintillators
   c. Photomultiplier tubes
   d. Theory of liquid scintillation counting

8. Calibration and Quality Assurance of Liquid Scintillation Counters

   a. Quench corrections
   b. Instrument performance checks
   c. Blanks, spikes and duplicates

9. Tritium Analysis by liquid scintillation counting

   a. Establishing a quench curve
   b. Other methods of quench correction
   c. Typical calculations for tritium

10. Problems of liquid scintillation counting

   a. Chemiluminescence

b. Phosphorescence
c. Other sources of false counts
d. Choice of vials
e. Selection of vials

11. Student laboratory exercise with liquid scintillation counting (optional for instructor, if time permits)