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ABSTRACT

A prototype for the development of an auto-tutorial course in anatomy and physiology for adult learners in Associate Degree Nursing (ADN) was implemented in the fall semester, 1980, at Waukesha County Technical Institute in Pewaukee, Wisconsin. The format of the two-semester course consists of two hours of scheduled lecture time and three hours of scheduled anatomy-physiology laboratory time each week, plus an independent study session component, the auto-tutorial learning laboratory (ATL). The ATL contains audiovisual materials presenting new content that is to be learned and materials for the reinforcement of content presented in scheduled class sessions. The time devoted to the auto-tutorial learning laboratory varies with each student. Learnings in the courses are scheduled prior to the need for related content in nursing courses. The audiovisual materials in the ATL contain that part of the course content which could be presented effectively on filmstrips and cassettes and were selected from commercially produced materials rather than instructor-produced. Support materials have been written to guide and assist the student in achieving the course objectives. Instructional objectives are printed and handed to students for each unit. A combination of study guides, review sheets, and self-tests have been prepared for support of student learning in the auto-tutorial laboratory sessions. (A list of the audiovisual aids used, with their manufacturers, is included in the document.) (Author/KC)

Auto-Tutorial Anatomy And Physiology For Associate Degree Nursing Programs

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Abstract

This paper presents guidelines for the development of an auto-tutorial course in anatomy and physiology for adult learners in Associate Degree Nursing (ADN) programs. The prototype discussed was implemented in the Fall Semester, 1980, at Waukesha County Technical Institute in Pewaukee, Wisconsin, through the joint efforts of the science and ADN faculties. The present format of the two-semester anatomy and physiology course consists of two hours of scheduled lecture time and three hours of scheduled anatomy-physiology laboratory time each week plus an independent study session component, the auto-tutorial learning laboratory (ATL). The ATL contains audio-visual materials presenting new content that is to be learned and contains materials for the reinforcement of content presented in scheduled class sessions. The time devoted to the auto-tutorial learning laboratory varies with each student. Learnings in the courses are scheduled prior to the need for related content in nursing courses. The audio-visual materials in the ATL contain that part of the course content which could be presented effectively on filmstrips and cassettes. The audio-visual materials were selected from commercially produced materials rather than instructor produced. Some of the same audio-visual materials will be assigned to students in future nursing courses. The intent of this reassignment of materials is the reinforcement of student learning. Support materials have been written to guide and assist the student in achieving the course objectives. Instructional objectives are printed and handed to students for each unit. A combination of study guides, review sheets, and self-tests have been prepared for support of student learning in the auto-tutorial laboratory sessions.

Auto-Tutorial Anatomy and Physiology for Associate Degree Nursing Programs

Introduction to the Concept

The major teaching/learning innovation of the last twenty years was the development of the audio-tutorial (A-T) approach to learning developed by S. N. Postlethwait at Purdue University in 1961. (Postlethwait, Novak, & Murray, 1972). Dr. Postlethwait initially designed and implemented the A-T format in Botany and then expanded into other life science areas.

Originally the A-T format consisted of a Large Group Assembly Section (GAS) which was instructor oriented. In the GAS the instructor presented the introduction to the topic for the unit through lecture, demonstration or presented a film. The Small Group Assembly Section (SAS) which concluded the unit of study was student-centered small group discussion and questioning by students. In between the GAS and the SAS students spent their learning time in an Independent Study Session (ISS). The ISS was a learning laboratory with the students listening to instructor prepared tapes of lecture/discussion content with instructor guidance into science laboratory demonstrations and experimentations when appropriate to the discussion. The presentation on tape was discussed as a tutorial session between the instructor on tape and the student. Students would listen to the instructor prepared materials and would be directed to stop the tape and complete various science laboratory studies. Then students would proceed with the tape presentation. The present author has taught introductory biology at Forest Park Community College, St. Louis, Missouri using a format almost identical to the format described by Postlethwait, Novak and Murray (1972).

The audio-tutorial Learning Laboratory (ATL) was equipped with science laboratory materials specimens, and other materials used in learning. Students used the materials in individual study carrels. Each carrel was equipped with a tape player and other audio-visual equipment as necessary. The schematics of the ATL and the individual study carrels have been discussed by other authors (Postlethwait, et. al., 1972 and Waskoskie, 1978). In Postlethwait's original format the "audio" part of the title addressed the type of presentation in the Independent Study Session in which the content presented was on tape. The present anatomy-physiology course and other variations of the audio-tutorial format have also changed the name to "auto-tutorial" attesting to the self-instructional aspect of the ISS.

Audio visuals used in learning with the A-T format were originally instructor prepared and recorded on tape, film strips, or videotape. The advantages and disadvantages have been discussed in the literature (Fisher, 1976). One advantage of this method for the adult learner is that the student enters the auto-tutorial laboratory when he/she can conveniently schedule this learning experience. It is thought this feature facilitates learning because the student has scheduled the experience at his/her convenience when he/she may be more receptive to learning. Another advantage of this method is that the Independent Study Session is self-pacing. The structure permits the student to relisten to content and to stop the presentation of content when necessary for learning and note-taking. Indeed the self-pacing aspect of the format may be one of its greatest strengths. Another strength is the shift of emphasis from the instructor to the student's self-reliance (Waskoskie, 1978).

Auto-tutorial courses emphasize managing the student learning by providing learning resources and then challenging the student to take responsibility for his/her learning. The approach allows the instructor to be the manager of learning experiences rather than the disseminator of all knowledge. Many variations of the A-T format have been developed. The common component of each variation is the use of audio-visual materials for presentation of all or part of the course content that is planned for student learning.

The past research in science learning attempted to establish a difference in outcomes when contrasting a course based on an A-T format versus the traditional lecture-laboratory approach. The research has yielded conflicting results (Bish, Bowman, & Sarachek, 1978; Renner & Abraham, 1978; Herron, Jau, Neie, and Luce, 1976). In most cases of college-level research contrasting A-T formats and lecture-laboratory only course offerings Renner and Abraham (1978) and Simonson (1978) found no significant differences in student achievement. In a review of research Herron, et. al (1976) cited a number of studies in which self-pacing instruction contrasted with lecture-laboratory only formats supported the concept that the self-paced instruction enhanced student learning of content as measured by the final examination. Castaldi (1976) reported using the A-T format, self-pacing and mastery testing in which student achievement was described as being as good or better than it was in traditional lecture-laboratory-recitation format. Bish, et. al. (1978) contended that the divergence of findings reflected such variations as course content, purposes, student and faculty characteristics, and institutional resources. They concluded that the value of a particular instructional technique can only be determined for a specific course offering.

Several studies were found which specifically applied a variation of the A-T format to the teaching of anatomy and physiology in higher education. Langer (1972) reported a series of audio-tutorial courses developed at Milwaukee Area Technical College in Milwaukee, Wisconsin. The format used in biology, botany, business, nursing, machine shop, and speech courses was similar to the Postlethwait format but most independent study sessions had instructor prepared materials on videotape. Since the Langer report the MATC anatomy and physiology courses have been developed in this same A-T format. The present author visited MATC to observe the anatomy-physiology course and to discuss the format with the instructors, Wilma McNamara and Gary Neumann, in the summer of 1980. A modification of the A-T format has also been developed by Wendell Bell in the biomedical science course in the Associate Degree Nursing Program at North Central Technical Institute in Wausau, Wisconsin. This biomedical science course used instructor prepared tapes and is structured similar to the Postlethwait model. This course was visited by the present author in preparation for the development of the anatomy and physiology course discussed in this paper.

Cornelius reported (1974) when students in an introductory-level college anatomy-physiology course were in an individualized format in which students worked at their own pace 50 percent of the class finished the course before final examination week. Muzio and Pilchman (1979) reported developing a two-semester A-T Anatomy-Physiology Program at Kingsborough Community College (CUNY) which has been in operation since 1974. This course is taken by students in the nursing program. Muzio also states that the modules which were developed are used in a slightly different approach at Wenatchee Community College, Washington; Empire State College (SUNY), Bunker Hill Community College, Boston; and the University of Hawaii School of Nursing Center.

Some of the positive aspects reported are ease of updating content by altering only the individual modules and accompanying objectives, and the ease of student review later in the A-T laboratory when students are in nursing courses. The student review aspect releases the nursing faculty of teaching or reteaching anatomy and physiology. Students can review this content in the A-T laboratory.

Perry and Howe(1981) used the case-study method in research in an introductory-level college physiology course based on the A-T format. The course was taught during the 1976-77 academic year at the University of Illinois in Urbana. It was concluded that self-direction and maturation may seriously affect a student's ability to succeed in the A-T course as offered.

Format of the Present Anatomy and Physiology Course

In the course developed at Waukesha County Technical Institute (WCTI), the audio-visuals were not prepared by the instructor but were purchased commercially. Each audio visual deals with a single topic, such as "anatomy of the kidneys" or "digestive physiology of the lower GI tract." This paper discusses the WCTI prototype and offers guidelines for the development of an anatomy-physiology course with an auto-tutorial component for students in Associate Degree Nursing Programs.

Anatomy and physiology is a two-semester course for six-credit hours offered in day and evening programs for students in the Associate Degree Nursing Program. Presently the class uses the following format:

A. Assigned classroom lecture per week -- two hours

B. Assigned science laboratory per week -- three hours
   Two of these hours are used for laboratory and one hour is used for lecture/discussion.

C. Auto-tutorial session--non-assigned time.

It is recommended the students view A-V materials in auto-tutorial laboratory (ATL). Students may enter ATL day, evenings or Saturdays on a first-come, first-serve basis.

The course was initiated as an auto-tutorial course in September 1980 and operated throughout the 1980-81 school year.

Identification of Course Content

Course objectives were identified in a cooperative effort between the instructor and the faculty of the Associate Degree Nursing Department. The anatomy and physiology instructor met individually with ADN faculty members and attended ADN faculty meetings for course objective suggestions. All objectives are written meeting the specifications of the criteria established by Mager (1962). At the suggestion of ADN faculty, the course content was expanded to include the topics of stress, physiology of aging, and inherited malfunctions. Learnings are scheduled prior to the need for related content in nursing courses. The faculty has received positive feedback from students concerning this coordination of the anatomy-physiology and the nursing curricula. The agreed upon sequence of course content and the source of the A-V materials for each content area is given in Appendix A.

Selection of Audio-Visual (A-V) Materials

Commercial A-V materials were determined to have several advantages over instructor prepared materials. One advantage was that in some materials the visuals would be taken in actual health-care settings, and therefore, the examples of principles and concepts could be related more clearly to the nursing procedures.

A second advantage was that the learning format would be consistent with the format presently being used in the nursing courses that the students were taking. The third advantage was the assurance that a consistent presentation of content would be delivered to all students regardless of which instructor was teaching the course section. This common usage of A-V materials helped maintain consistency of the course content between instructors employed full-time in the day sections and instructors employed part-time teaching evening sections.

A search was begun in June, 1980 for A-V materials to present that portion of the course content which lends itself to presentation by audio-visuals. Approximately 400 filmstrips, 2 x 2 slides, 16mm films, programmed books, and other materials were previewed to determine the A-V materials which would be best in aiding students in achieveing the objectives.

The following criteria which were modified from Gerlack and Ely (1971) were decided upon for the evaluation of each piece of A-V material which was previewed.

1. Cognitive appropriateness (Will this material aid students in the attainment of the defined objectives? Is the depth and breadth of content coverage appropriate to the objectives?)
2. Level of sophistication (Is the material aimed at the level of the WCTI adult student?)
3. Technical quality (Is the quality of the production readable, visible, audible, contain appropriate sound effects, etc.
4. Content validity (Are the most current theories, principles, facts, and equipment used in the presentations?)

A form was developed to record the title, source, running time, etc. and a checklist of questions such as those above was devised to systematically record observations and impressions as each piece of A-V materials was previewed for consideration. The form has space for recording an outline of the content of each piece of audio-visual material and space for general comments. The worksheets and support materials were being written based on the preview; therefore, the preview was very thorough.

Filmstrips were given priority when possible. Some advantages of filmstrips were the planned sequences could not be gotten out of order, the small size provided for easy storing, the projection equipment was small, relatively inexpensive and easy to operate and the ATL did not need to be extremely dark in order to project the materials.

Filmstrip content was previewed briefly in class to permit the student to decide which optional materials he/she should select for reinforcement of learnings. The students make the above decision based on whether the material will be covered in lecture or in the textbook. Some A-V materials are assigned, not optional. The content topic of the A-V materials chosen from each company and the mailing address of each company is given in Appendix B.

Development of Support Materials

Instructional objectives are prepared for each unit stating concepts for which the student will be held responsible. Various materials have been written to guide and assist the student in achieving these course objectives. A combination of study guides, review sheets, and self-tests have been prepared for the A-V materials directing students to learnings expected from each filmstrip.

Some additional diagrams and charts, as needed, are prepared as handouts to supplement and illustrate interrelationships. Most of the materials were written as the A-V materials were being previewed. In some cases the companies that produced the materials provided worksheets which were easily modified to meet student needs. An example of one type of support sheet written for a review of atomic structure is given in Appendix C. All tests given are criterion referenced tests.

Procedures of Auto-Tutorial Laboratory

The audio-tutorial laboratory (ATL) facility is a cooperative effort of the Science, Associate Degree Nursing, Practical Nursing, and Allied Health Departments. Initially, only one nursing program planned to use the ATL. In 1980, all nursing programs and the Science Department adopted curricula and the one facility was shared. The Science Department provided a small room for expansion and purchased additional equipment and carrels for student viewing of materials. All audio-visual materials are viewed by students in the ATL. This learning center is staffed by laboratory assistants on days, evening, and Saturdays. Students are assigned a time during the week when they are given priority for A-V equipment. However, they may view audio-visual materials at any other time on a first-come, first-serve basis. Students individually or jointly check materials out for viewing in this room. When available, scripts are provided for use with the cassette tapes. Students have found the scripts facilitate their note-taking process.

Approximately 250 students use the ATL facility on each of the six days it is open. The following equipment is available for student use at all times:

1) Bell and Howell slide projectors-20
2) Sony video tape machines-2
3) Besselar filmstrip machines-43

There are 60 study carrels available.

Advantages and Disadvantages of This Auto-Tutorial Format

At the present state of development, the WCTI anatomy and physiology course in auto-tutorial format has several advantages over the traditional lecture-laboratory course. A few of the advantages and disadvantages taken from student responses on end-of-year evaluations, are as follows:

Students perceived auto-tutorial materials were advantageous in this course as:

1) Reinforcement of the learning,
2) Review of each unit at completion of the unit,
3) Review of content repetitively (increased learning through repetition)
4) Learning time was controlled by student and could occur at times best suited to his/her schedule,
5) Giving student the option of not viewing the materials,
6) A-V materials were the same as those used in the nursing courses,

However, students reported the following disadvantages:

1) Lack of teacher present to answer questions,
2) Difficulty student experienced in differentiating between pertinent and non-pertinent content,
3) Duplication of content occurred in some instances,
4) Frustration due to loss of time (see two and three above),

5) Content of all ADN courses and anatomy and physiology taught via ATL components resulted in excessive time spent in the learning laboratory.

Some of the student comments indicated a rating system is needed as a guide to the content of the A-V materials. This would permit students with different backgrounds to by-pass certain content when they had previously achieved the objective(s).

From the two instructors' perceptions the student achievement in this course was extremely satisfactory. Achievement based on end of second semester's cumulative test scores, approximately 29% of the students mastered 90%-100% of the objectives, 40% of the students mastered 80%-89% of the objectives and 31% of the students mastered 70%-79% of the objectives. The instructors thought the auto-tutorial component was a valuable component of this anatomy and physiology course.

Summary and Recommendations

The anatomy and physiology course at WCTI is presently offered as a modified auto-tutorial course. Like most courses it has its strengths and weaknesses. However, its overall strengths outweigh its weaknesses. As is true of traditional course offerings, the success of this method is dependent upon the expertise and enthusiasm and involvement of the teacher.

Several changes are planned for strengthening this course next semester. The changes are based primarily on student suggestions:

1) Develop a rating system or outline of each filmstrip which will relate the content to course objectives. (This will assist students to identify pertinent material and to sequence the materials in their learning, i.e. as preview or review);

2) Provide more complete instructor previews and orientation to the A-V materials prior to student viewing; and

3) Condense materials that are printed and handed to students--specifically decrease the number of instructional objectives and diagrams that illustrate interactions.

Appendix A

Appendix Of Course Content Sequence

APPENDIX OF COURSE CONTENT SEQUENCE

The following is a sequential listing of course topics, the source of the materials, and the number of A-V materials chosen to date in each area: (All A-V materials are filmstrips and cassettes unless otherwise noted).

SEMESTER I - TOPICS	SOURCE OF MATERIALS
1) Introduction to Homeostasis and Living Systems	National Geographic 16mm Film Man: The Incredible Machine
2) Chemistry Review and Organic Compounds	Bergwall - 9
3) Cells, Metabolism, Nucleic Acids, Cell Division, Mitosis	Bergwall and Trainex - 4
4) Tissues	Bergwall and Trainex - 1
5) Physiological Stress and the Organism	Concept Media - 3
6) Integumentary System	Robert J. Brady - 1
7) Skeletal System	Bassett Stereoscopic Atlas of Human Anatomy and Trainex and Robert J. Brady - 2 (Bassett is a series of viewmaster reels transformed into 2x2 slides)
8) Muscular System	Thorne Filmloops and Robert J. Brady - 4
9) Digestive System, Nutrition, Enzymes	Trainex and Robert J. Brady - 5
10) Renal System	Trainex - 4
11) Fluids, Electrolytes, Acid-Base Balance	Trainex - 8

SEMESTER II - TOPICS	SOURCE OF MATERIALS
1) Respiratory System	Robert J. Brady & Trainex - 4
2) Blood Transport System	Trainex - 3
3) Cardiovascular System	Trainex - 5
4) Blood Pressure	Trainex - 2
5) Lymphatic System and Immunity	Trainex - 1

6)	Nervous System (Pain and Sleep)	IBIS and Concept Media - 8 National Geographic 16mm film Marvels of the Mind
7)	Special Senses	Trainex - 1
8)	Endocrine System	Concept Media - 1
9)	Reproductive Systems	Trainex and Harper and Row - 6
10)	Genetics and Inherited Malfunctions	Trainex and Harper and Row - 2
11)	Review of Anatomy and Physiology of Aging	Trainex and N. Y. League of Nursing and Harper and Row - 3 (League of Nursing materials--cassette only)

Appendix B

Appendix Of Audio-Visual Producers

Selected For Auto-Tutorial Anatomy and Physiology Course

Appendix B

Appendix Of Audio-Visual Producers

Selected For Auto-Tutorial Anatomy and Physiology Course

The following is a list of audio-visual distribution companies, their addresses and the content area for A-V materials selected from each company.

COMPANY AND ADDRESS	A-V MATERIALS CONTENT TOPIC
Bergwall Productions 839 Steward Avenue Garden City, N. Y. 11530	Cells, (8f/c)*, Chemistry (9f/c)
Communications in Learning, Inc. (N. Y. League of Nursing) 2929 Main St. Buffalo, N. Y. 14214	Anatomy and Physiology of Aging (1c)
Concept Media P. O. Box 19542 Irving, CA 92714	Cardiovascular, Digestive, Endocrine, Pain, Sleep, Stress (6 f/c)
C. V. Mosby Co. 11830 Westline Industrial Drive St. Louis, MO	A Stereoscopic Atlas of Human Anatomy Distributed as a set of Stereoscopic Viewmaster Slide of Cadavers (transformed into s)
Harper & Row J. B. Lippencott Media 2350 Virginia Avenue Haggerstown, Maryland 21740	Biological Aspects of Sexuality (Modules on Genetic Defects, Embryology, Germ Cell Formation, Genetics.) (3 f/c)
IBIS Media Human Relations Media 175 Tompkins Avenue Pleasantville, N. Y. 10570	Nervous System (5 f/c)
National Geographic Films Distributed by: Educational Services Dept. 80 Washington, D. C. 14603	Man: The Incredible Machine (fi) Marvels of the Mind (fi)
Prentice-Hall Media Serv Code WG 150 White Plains Road Tarrytown, N. Y. 10591	Biotech Series, on Laboratory Techniques - How to Measure pH, etc. How to Use a Clinical Centrifuge (2 f)
Robert J. Brady Co. Bowie, Maryland 20715	Anatomy of Integumentary, Digestive, Muscular and Respiratory (5 f/c)

Appendix of Audio-Visual Producers - Continued

Thorne Films, Inc. 1229 University Avenue Boulder, Colorado Distributed by: Scott Education Division Holyoke, Mass 01040	Frog Skeletal Muscles and Cardiac Muscles (3 fl)
Trainex P. O. Box 116 Garden Grove, CA 92642	Cell Metabolism, Aging, Digestive, Reproductive, Renal, Fluids and Electrolytes, Cardiovascular, Blood, Immune System, Alkalosis-Acidosis. (32 f/c)

*f/c (filmstrip with cassette); f (fillstrip only); c (cassette only); s (2x2 slides); fi (16mm film); fl (film loops-silent)

Appendix C

Study Guide for Filmstrips and Cassettes by Bergwall

Chemistry: 103.1

Study Guide for Filmstrips and Cassettes by Bergwall
Chemistry: 103.1
(Worksheet modified from materials provided by Bergwall, Garden City, New York for student use with Bergwall A-V materials)

Before beginning this study preview the instructional objectives for the basic chemistry unit. These objectives identify the information that will be used for evaluation of your learning for this unit.

This guide summarizes the key points of each filmstrip and then gives you a set of problems or questions. After viewing each filmstrip read the summary and then try as many problems as it takes to verify your ability to work the type of problems provided in each section. Although it is best to do them without looking back, certainly review any parts of the filmstrip you need to see again. A set of completely worked-out answers follows each problem or question section. Needless to say, you will get the most benefit out of the subject matter by trying the problem before looking at the answer.

Cassette 103.1 - WHAT'S IN AN ATOM?

After viewing this filmstrip, you should understand the following:

(A) The three atomic particles: The proton, the neutron, and the electron. You should be aware of their weight and charge relationships as summarized in TABLE I.

TABLE I

Particle	Relative Weight	Electrical Charge
proton	1 atomic mass units (amu)	+1
neutron	1 amu	0
electron	$\frac{1}{1836}$ amu	-1

(B) The reason for the neutrality of atoms: Since it is the protons and electrons which contain the positive and negative charges, you can say that in order to be electrically neutral, atoms have equal numbers of protons and electrons.

Example: Using calcium as an example, the calcium atom has 20 protons and 20 electrons. The charge due to the 20 protons is +20. The charge due to the 20 electrons is -20. Adding them together shows you why calcium is electrically neutral. This is summarized below:

20 protons = +20
20 electrons = -20
Total Charge

(C) Atomic number is the number of protons in an atom.
Mass number is the sum of the protons and neutrons in an atom
Isotopes are atoms of the same element that differ only in the number of neutrons (and, therefore, in their mass numbers or masses).

(D) How to write an isotopic symbol:

Example: Using carbon as an example, for one of the isotopes, $_{6}C^{12}$,

6 represents the atomic number, while 12 is the mass number.
(This is often called carbon-12).

(E) Atomic weight of an element is the weighted average of the mass numbers of the isotopes of that element. This average takes into account the proportion in which these isotopes occur in nature.

BEFORE GOING ON TO PART 2, CHECK YOUR UNDERSTANDING OF THESE CONCEPTS BY DOING THE FOLLOWING PROBLEMS. THEN COMPARE YOUR ANSWERS TO THOSE WORKED OUT IN THE ANSWER SECTION.

PROBLEMS

1. A nitrogen atom has 7 protons and 7 neutrons.
Calculate:
(a) the atomic number
(b) the mass number

2. A phosphorus atom has 15 protons and 16 neutrons.
Calculate:
(a) the atomic number
(b) the mass number

3. If a sulfur atom is neutral in charge and contains 16 protons in the nucleus how many electrons are present outside the nucleus?

4. Write the isotopic symbol for lithium, with 3 protons and 4 neutrons.

5. Which of the following two are isotopes? Why?

(a) $_{16}S^{32}$

(b) $_{16}S^{36}$

(c) $_{18}Ar^{36}$

Cassette 103.1
What's in an Atom?
Page 3

WORKED-OUT ANSWERS TO PROBLEMS

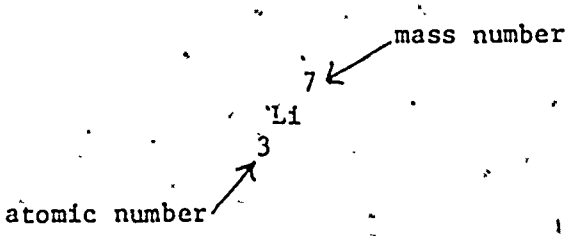
1. (a) The atomic number is the number of protons or 7.
   (b) The mass number is the sum of the protons plus neutrons, 7 + 7 or 14.

2. (a) The atomic number is the number of protons or 15.
   (b) The mass number is the sum of the protons plus neutrons, 15 + 16 or 31.

3. A neutral atom has an equal number of protons and electrons. Therefore, the number of electrons are 16. As you can see, this gives the atom a neutral charge, since 16 protons have a charge of +16, while 16 electrons have a charge of -16.

16 protons	= +16
16 electrons	= -16
Total Charge	= 0

4. In writing the isotopic symbol, the atomic number is written in the lower left-hand corner. Since there are 3 protons, the atomic number is 3. The mass number is written in the upper right-hand corner. The mass number is the sum of the protons and neutrons, 3 + 4 or 7. The isotopic symbol is:



5. (a) and (b) are isotopes because isotopes differ only in their mass numbers. In (a), sulfur has a mass number of 32; in (b), sulfur has a mass number of 36; in (c), the element is no longer sulfur, having a different atomic number. Don't be fooled by the fact that (b) and (c) have the same mass number. They are still different elements, since, if you recall, it is the number of protons (or atomic number), which identifies an element.

6. This is the end of tape 1. Review the objectives and identify the objectives which have been completed.

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