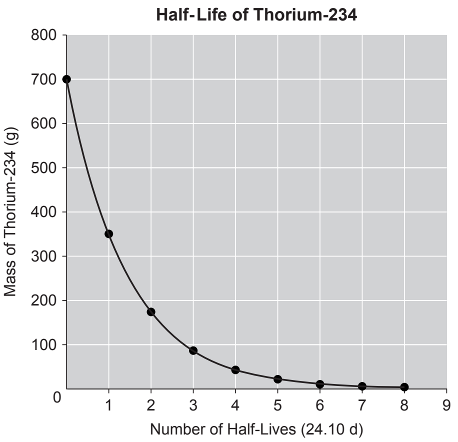
3. (a) These two atoms cannot be classified as isotopes of the same element because they do not have the same atomic number (*Z*).
   (b) This could be a "beta particle" radioisotope and its decay product, where there has been a conversion of two neutrons into two protons and two electrons. The result is that the mass number stays the same, but the number of protons — the atomic number — increases.
4. The usual classifying properties of nonradioactive elements are physical and chemical properties. The property of radioactivity — or radioactive decay — is a property that can be used to classify atoms of an element that can spontaneously change into atoms of another element. The classifying property of radioactivity is different in that it describes a nuclear change.

Applying Inquiry Skills

5. (a)



   (b) The above graph isolates the radioactive decay of thorium-234 through the lower mass values. For 24.0 g of thorium-234 to remain, approximately 4 half-lives and about 90% of a fifth half-life must pass — a total of 118.2 d.

Making Connections

6. (a) Radioisotopes are useful for diagnostic radiography, radiology, forensic anthropology, nuclear power, for killing bacteria in food and preventing spoilage, etc.
   (b) Safety precautions that may be used when handling radioisotopes include:
   - minimize the dose by reducing time of exposure
   - minimize the dose by maximizing the distance from the source
   - use shielding (common materials are lead, iron, concrete, and water) both for containment and for protective clothing
   - control access to the radioactive material
   - conduct frequent surveys of contact
   - conduct follow-up bioassays, looking for tissue damage
   - wear respiratory protection
   - practise good housekeeping; treat any waste from the lab as if it were radioactive

1.4 TOWARD A MODERN ATOMIC THEORY

PRACTICE

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Understanding Concepts

1. Bohr proposed the following explanation for the emission of light when a gas is heated: When energy (heat or electricity) is supplied to hydrogen atoms, electrons gain a certain quantity of energy and become excited (they jump from

a lower energy level to a higher energy level). When the electrons drop back to a lower energy level they release energy corresponding to a few precise wavelengths of light.

2. The different colours in a line spectrum correspond to different specific quantities of energy released, as electrons fall back to lower energy levels. With respect to the line spectrum for hydrogen gas, electrons falling from the sixth energy level to the second emit violet light; electrons falling from the fifth energy level to the second emit indigo light, etc.
3. Different substances show different spectra because each element has different electron transitions taking place, releasing energy that corresponds to that substance's own unique "signature" emission spectrum.
4. Since the sodium vapour emits a yellow light, we can deduce that sodium atoms have an electron transition taking place in which that frequency of light is emitted.

PRACTICE

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Understanding Concepts

5. The light given off by distant stars results from excited electrons moving from higher to lower energy levels in atoms. Since each element has a unique emission spectrum, astronomers can use spectroscopy techniques to analyze the starlight emission and identify the elemental composition of the atmosphere of the star.
6. According to the Bohr theory, when an electron absorbs energy it jumps from a lower energy level to a higher energy level, and when an electron drops back to lower energy levels it emits energy.
7. Since each element has a unique emission spectrum, the spectral lines act like a "fingerprint" in terms of identifying the element.

Making Connections

8. (a) Fireworks are composed of many different chemical elements, each element having its own unique electron energy level transitions, thus producing its own unique emission spectrum.
   (b) Students will probably cite the metals they used in their flame tests. Some of the chemicals they used in their tests are not readily available. Others are very stable and require intense heat to reach vapour state — not convenient for fireworks. Copper is available as an element, but in that form would be difficult to heat enough to vaporize.

Chemicall Compounds Used For Fireworks

Material	Special Effect
magnesium metal	white flame
sodium oxalate	yellow flame
barium chlorate	green flame
copper(II) sulfate	blue flame
strontium carbonate	red flame
iron filings and charcoal	gold sparks
potassium benzoate	whistle effect
potassium nitrate and sulfur	white smoke
potassium perchlorate, sulfur, and aluminum	flash and bang

Mixing the ingredients is dangerous and should only be attempted by well-trained professionals.
Maintaining the proper balance of ingredients, fuel, and source of oxygen is a difficult challenge.

9. The student is to use the Internet to research and report on the detection and generation of elements in stars and supernovas. The student is to comment on the following hypothesis: All elements are conglomerates of hydrogen.

   Students will discover that, using detectors sensitive only to a narrow range of wavelengths, astronomers can detect specific substances in the atmospheres of stars and in the debris generated by supernovas. Current cosmological theory is that only hydrogen, helium, and a relatively very small amount of lithium were present before the first star formed. All other elements were built (with hydrogen as a starting point) in the nuclear furnaces of stars.

GO TO www.science.nelson.com, Chemistry 11, Teacher Centre

PRACTICE

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Understanding Concepts

10. Valence electrons are those electrons that occupy the highest shell of an atom and form chemical bonds. Elements that have the same number of valence electrons have similar physical and chemical properties. Valence electrons are significant in that they are a powerful indicator of the relationship between electron arrangement and periodic trends.
11. Electrons within an atom can possess only discrete quantities of energy; electrons fill successive shells.
12.

	Number of Occupied Energy Levels	Number of Valence Electrons
beryllium	2	2
chlorine	3	7
krypton	4	8
iodine	5	7
lead	6	4
arsenic	4	5
cesium	6	1

SECTION 1.4 QUESTIONS

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Understanding Concepts

1. Hydrogen could be placed at the top of Group 17. In terms of atomic structure, hydrogen with its one electron would be followed by helium with two electrons - this fits with the rule of adding an electron as you move from left to right on the periodic table. In terms of periodicity, hydrogen, which does sometimes behave like a halogen, would be in periodic alignment with the other halogens. Like the halogens, hydrogen requires only 1 additional electron to complete its valence shell.
2. (a)

Table 2: Electron Structure of Selected Elements

Element	Number of Electrons	Number of Occupied Shells	Number of Valence Electrons
oxygen	8	2	6
sulfur	16	3	6
magnesium	12	3	2
sodium	11	3	1
beryllium	4	2	2
calcium	20	4	2
cesium	55	6	1
nitrogen	7	2	5
chlorine	17	3	7
lithium	3	2	1
helium	2	1	2
bromine	35	4	7
phosphorus	15	3	5
fluorine	9	2	7
potassium	19	4	1

2. (b)

Table 2: Groups According to Number of Valence Electrons

1 Valence Electron	2 Valence Electrons	5 Valence Electrons	6 Valence Electrons	7 Valence Electrons
sodium	magnesium	nitrogen	oxygen	chlorine
cesium	beryllium	phosphorus	sulfur	bromine
lithium	calcium			fluorine
potassium	helium			

(c) 1 valence electron: physical and chemical properties common to elements of the alkali metals (soft; metallic; react violently with water to form hydrogen and a basic solution; react strongly with oxygen; react with halogens to produce a crystalline solid)
2 valence electrons: physical and chemical properties common to elements of the alkaline earth metals (metallic; light; react with oxygen to form an oxide; react with water to release hydrogen; react with hydrogen to form a hydride)
5 valence electrons: chemical properties common to elements of Group 15 (nonmetals)
6 valence electrons: chemical properties common to elements of Group 16 (nonmetals)
7 valence electrons: physical and chemical properties common to elements of the halogens (nonmetals; extremely reactive with hydrogen and most metals)

1.5 TRENDS IN THE PERIODIC TABLE

ACTIVITY 1.5.1 GRAPHING FIRST IONIZATION ENERGY

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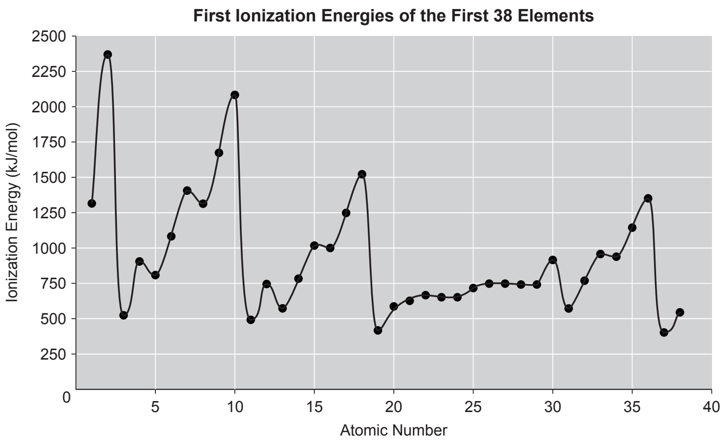
Procedure



Analysis

(a)
- Group 1 elements have the lowest first ionization energies.
- Group 8 elements have the highest first ionization energies.
- First ionization energies of metals are lower than those of nonmetals.
- First ionization energies generally decrease as you move down a group in the periodic table.
- First ionization energies generally increase as you move from left to right across a period.

Synthesis

(b) The general decrease in first ionization energies as you move down a group in the periodic table is related to the greater number of non-valence electrons between the nucleus and the valence electrons (a shielding effect). As a result, the attraction between the negatively charged electrons and the positive nucleus becomes weaker, so less energy is required to remove the first valence electron.

The general increase in first ionization energies across a period is related to the increasing size of the charge in the nucleus. As you move from left to right across a period, the nuclear charge increases while the shielding