9. A scientific law is empirical, based on observation. A scientific theory is theoretical, based on unobservable concepts.
10. Scientific laws usually precede scientific theories.

Skills

(Page 75)

11. Material Safety Data Sheets (MSDS)
12. Wash the area with running water and inform your teacher. If the chemical comes into contact with your eyes, rinse under the tap for 15 min and inform your teacher.
13. Two items that may be worn in the lab for personal protection are a lab apron and safety glasses.
14. Three types of general safety equipment are a fire extinguisher, a first aid kit, fire blanket, shower, and an eyewash station.
15. The theory should be able to describe, explain, and predict evidence.

CHAPTER 3 Understanding Chemical Compounds

Starting Points

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(Students' answers will reflect their understanding at this point. There are no "correct" or "incorrect" answers. Students will revisit their answers at the end of the chapter.)

Exploration: Properties and Forces

(Page 77)

(a) No.
(b) No.
(c) Yes.
(d) Detergent seems to be a better adhesive.
(e) From the evidence, oil has greater cohesion but poorer adhesion. Detergent has greater adhesion but poorer cohesion.

3.1 BONDING THEORY AND LEWIS FORMULAS

Explore an Issue: Funding Research and Development

(Page 79)

Issue

What is the most effective use of government funding for research in science and technology?

Resolution

The provincial and federal governments should direct all their research funding to applied research.

Design

Within small groups, research the pros and cons of using public money to fund each of three categories of research: pure research, applied research, and the development of operational hardware. Gather information from a wide variety of perspectives.

Evidence

Funding pure research
Pros: specific areas can be studied in detail, elucidating structures and mechanisms and contributing to scientific knowledge.
Cons: much of the knowledge gained would be of interest to only a few individuals, and much of the information may have no practical use.

Funding applied research
Pros: the knowledge gained is applied, which may benefit large segments of society.
Cons: applied research is expensive; a lot of time, energy, and expense may yield little benefit.

Funding for development of operational hardware
Pros: the products developed are immediately useful.
Cons: no new knowledge is acquired.

Analysis
On the basis of the evidence, the resolution that government funding should be directed to applied research is supported.

Evaluation
The research provided sufficient evidence to support the resolution, but also provided some evidence to the contrary. Also, not all of the resources provided a balanced argument: some were quite biased. Research should be very thorough, to collect evidence from a variety of sources.

The position was argued quite well, but would have been better supported with actual examples.

Practice

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1. c, b, d, a, e
2.

Atom	Lewis formula	Energy-level diagram	Electronegativity value
(a) aluminium		3 e^- 8 e^- 2 e^- 13 p^+ Al aluminium atom	1.6
(b) chlorine		7 e^- 8 e^- 2 e^- 17 p^+ Cl chlorine atom	3.2
(c) calcium		2 e^- 8 e^- 8 e^- 2 e^- 20 p^+ Ca calcium atom	1.0
(d) argon		8 e^- 8 e^- 2 e^- 18 p^+ Ar argon atom	3.0

3. (a) Ca^{2+}
$\underline{8\ e^-}$
$\underline{8\ e^-}$
$\underline{2\ e^-}$
$20\ p^+$
calcium
$20p^+ + 18e^- = 2^+$ net
(b) The structure represents the calcium ion, Ca^{2+}.
4. In a Lewis symbol for potassium, the element symbol represents the nucleus and first three energy levels of electrons.
5. A new scientific concept must describe observations in terms of non-observable ideas, explain observations by means of ideas, predict the results of future experiments, and be simple and logical before it becomes accepted by the scientific community.

Section 3.1 Questions

(Page 84)

1. A bonding electron is a single, unpaired electron in a valence orbital of an atom. A lone pair is a pair of electrons in a filled valence orbital of an atom.
2. Electronegativity—a number that represents the relative ability of an atom to attract a pair of bonding electrons in its valence level
Covalent bond—the simultaneous attraction of two nuclei for a shared pair of bonding electrons
Ionic bond—the simultaneous attraction between positive and negative ions
3.

Element symbol	Electro-negativity	Group number	Number of valence electrons	Lewis symbol	Number of bonding electrons	Number of lone pairs of electrons
Na	0.9	1	1	Na·	1	0
Mg	1.3	2	2	·Mg·	2	0
Al	1.6	13	3	·Al·	3	0
Si	1.9	14	4	·Si·	4	0
P	2.2	15	5	:P·	3	1
S	2.6	16	6	:S·	2	2
Cl	3.2	17	7	:Cl:	1	3
Ar	3.0	18	8	:Ar:	0	4

4. The Lewis symbols for metal atoms have vacant valence orbitals and no lone pairs, whereas those for nonmetals have lone pairs and no vacant valence orbitals.
5. Electronegativities generally decrease from top to bottom within a group and increase from left to right within a period.
6. Hydrogen is an exception to almost every rule or generalization about elements. Hydrogen is unique in having only one valence orbital (in its ground state).
7. Diatomic and polyatomic elements, as well as metals that undergo metallic bonding, have perfectly equal sharing of valence electrons.
8. Metals have low electronegativity, so electrons can be easily displaced. This characteristic makes metals good conductors of electricity.
9. The calcium atom has one more proton in its nucleus, so the strength of attraction between the nucleus and the valence electrons is greater than in the potassium atom.