Chemistry 111-112 Curriculum

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New Nouveau Brunswick
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Chemistry 111 – 112 Curriculum

Part 1

The Teaching Framework

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Introduction

Background

The curriculum described in *Foundation for the Atlantic Canada Science Curriculum* was planned and developed collaboratively by regional committees. The process for developing the common science curriculum for Atlantic Canada involved regional consultation with the stakeholders in the education system in each Atlantic province. The Atlantic Canada science curriculum is consistent with the science framework described in the pan-Canadian *Common Framework of Science Learning Outcomes K to 12.*

The development of these curricula involved further revision of the *Atlantic Canada Science Curriculum* for Chemistry 11 and Chemistry 12, in consultation with educators in New Brunswick over a 3-year period (as listed in the Acknowledgements).

Rationale

The aim of science education in the Atlantic provinces is to develop scientific literacy.

Scientific literacy is an evolving combination of the science-related attitudes, skills, and knowledge students need to develop inquiry, problem-solving, and decision-making abilities; to become life-long learners; and to maintain a sense of wonder about the world around them. To develop scientific literacy, students require diverse learning experiences which provide opportunity to explore, analyze, evaluate, synthesize, appreciate, and understand the interrelationships among science, technology, society, and the environment that will affect their personal lives, their careers, and their future.

Program Design & Components

Learning and Teaching Science

What students learn is fundamentally connected to how they learn it. The aim of scientific literacy for all has created a need for new forms of classroom organization, communication, and instructional strategies.

The teacher is a facilitator of learning whose major tasks include:

- creating a classroom environment to support the learning and teaching of science
- designing effective learning experiences that help students achieve designated outcomes
- stimulating and managing classroom discourse in support of student learning
- learning about and then using students" motivations, interests, abilities, and learning styles to improve learning and teaching
- analyzing student learning, the scientific tasks and activities involved, and the learning environment to make ongoing instructional decisions
- selecting teaching strategies from a wide repertoire

Effective science learning and teaching take place in a variety of situations. Instructional settings and strategies should create an environment which reflects a constructive, active view of the learning process. Learning occurs not by passive absorption, but rather as students actively construct their own meaning and assimilate new information to develop new understanding.

The development of scientific literacy in students is a function of the kinds of tasks they engage in, the discourse in which they participate, and the settings in which these activities occur. Students" disposition towards science is also shaped by these factors. Consequently, the aim of developing scientific literacy requires careful attention to all of these facets of curriculum.

Learning experiences in science education should vary and include opportunities for group and individual work, discussion among students as well as between teacher and students, and hands-on/minds-on activities that allow students to construct and evaluate explanations for the phenomena under investigation. Such investigations and the evaluation of the evidence accumulated, provide opportunities for students to develop their understanding of the nature of science and the nature and status of scientific knowledge.

The Three Processes of Scientific Literacy

An individual can be considered scientifically literate when he/she is familiar with, and able to engage in, three processes: inquiry, problem solving, and decision making.

Inquiry

Scientific inquiry involves posing questions and developing explanations for phenomena. While there is general agreement that there is no such thing as the scientific method, students require certain skills to participate in the activities of science. Skills such as questioning, observing, inferring, predicting, measuring, hypothesizing, classifying, designing experiments, collecting data, analyzing data, and interpreting data are fundamental to engaging in science. These activities provide students opportunity to understand and practice the process of theory development in science and the nature of science.

Problem Solving

The process of problem solving involves seeking solutions to human problems. It consists of the proposing, creating, and testing of prototypes, products and techniques in an attempt to reach an optimum solution to a given problem.

Decision Making

The process of decision making involves determining what we, as citizens, should do in a particular context or in response to a given situation. Decision-making situations are not only important in their own right. They also provide a relevant context for engaging in scientific inquiry and/or problem solving.

Meeting the Needs of All Learners

Foundation for the Atlantic Canada Science Curriculum stresses the need to design and implement a science curriculum that provides equal opportunities for all students according to their abilities, needs and interests. Teachers must be aware of and make adaptations to accommodate the diverse range of learners in their class. In order to adapt to the needs of all learners, teachers must create opportunities that would permit students to have their learning styles addressed.

As well, teachers must not only remain aware of and avoid gender and cultural biases in their teaching, they must strive to actively address cultural and gender stereotyping regarding interest and success in science and mathematics. Research supports the position that when science curriculum is made personally meaningful, and socially and culturally relevant, it is more engaging for groups traditionally under-represented in science, and indeed, for all students.

When making instructional decisions, teachers must consider individuals‟ learning needs, preferences and strengths, and the abilities, experiences, interests, and values that learners bring to the classroom. Ideally, every student should find his/her learning opportunities maximized in the science classroom.

While this curriculum guide presents specific outcomes for each unit, it must be acknowledged that students will progress at different rates. Teachers should provide materials and strategies that accommodate student diversity, and validate students when they achieve the outcomes to the maximum of their abilities.

It is important that teachers articulate high expectations for all students and ensure that all students have equitable opportunities to experience success as they work toward the achievement of designated outcomes. A teacher should adapt classroom organization, teaching strategies, assessment practices, time, and learning resources to address students‟ needs and build on their strengths. The variety of learning experiences described in this guide provides access for a wide range of learners. Similarly, the suggestions for a variety of assessment practices provide multiple ways for learners to demonstrate their achievements.

Assessment and Evaluation

The terms assessment and evaluation are often used interchangeably, but they refer to quite different processes. Science curriculum documents developed in the Atlantic region use these terms for the processes described below.

Assessment is the systematic process of gathering information on student learning.

Evaluation is the process of analyzing, reflecting upon, and summarizing assessment information, and making judgments or decisions based upon the information gathered.

The assessment process provides the data and the evaluation process brings meaning to the data. Together, these processes improve teaching and learning. If we are to encourage enjoyment in learning for students, now and throughout their lives, we must develop strategies to involve students in assessment and evaluation at all levels. When students are aware of the outcomes for which they are responsible, and the criteria by which their work will be assessed or evaluated, they can make informed decisions about the most effective ways to demonstrate their learning.

Regional curriculum in science suggests experiences that support learning within STSE, skills, knowledge and attitudes. It also reflects the three major processes of science learning: inquiry, problem solving and decision making. When assessing student progress it is helpful to know some activities/skills/actions that are associated with each process of science learning. Examples of these are illustrated in the following lists. Student learning may be described in terms of ability to perform these tasks.

Inquiry

- define questions related to a topic
- refine descriptors/factors that focus practical and theoretical research
- select an appropriate way to find information
- make direct observations
- perform experiments, record and interpret data, and draw conclusions
- design an experiment which tests relationships and variables
- write lab reports that meet a variety of needs (limit the production of “formal” reports) and place emphasis on recorded data
- recognize that both quality of both the process and the product are important

Problem Solving

- clearly define a problem
- produce a range of potential solutions for the problem
- appreciate that several solutions should be considered
- plan and design a product or device intended to solve a problem
- construct a variety of acceptable prototypes, pilot test, evaluate and refine to meet a need
- present the refined process/product/device and support why it is “preferred”
- recognize that both quality of both the process and the product are important

Decision Making

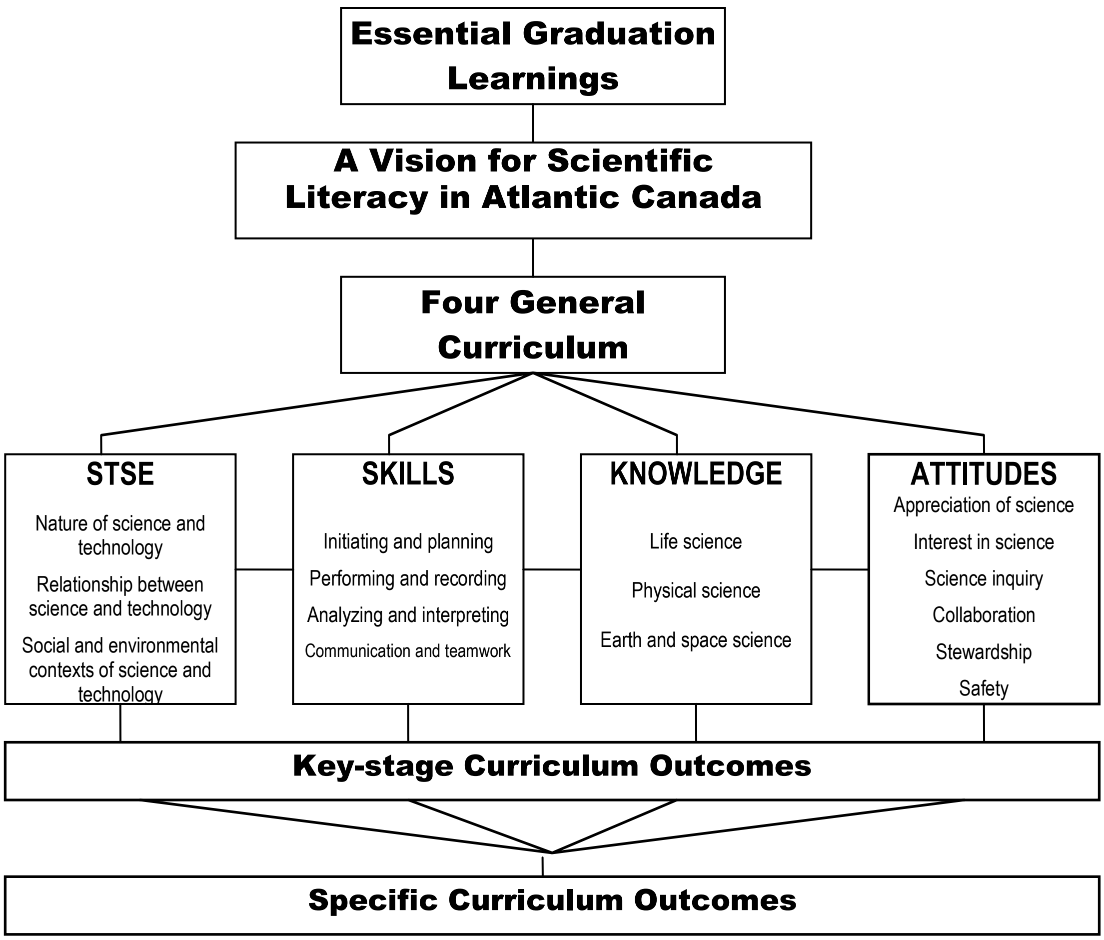
- gather information from a variety of sources
- evaluate the validity of the information source
- evaluate which information is relevant
- identify the different perspectives that influence a decision
- present information in a balanced manner
- use information to support a given perspective
- recommend a decision and provide supporting evidence
- communicate a decision and provide a “best” solution

Outcomes

Outcomes Framework

The science curriculum is based on an outcomes framework that includes statements of essential graduation learnings, general curriculum outcomes, key-stage curriculum outcomes, and specific curriculum outcomes. The general, key-stage, and specific curriculum outcomes reflect the pan-Canadian Common Framework of Science Learning Outcomes K to 12. The conceptual map shown in Figure 1 provides the blueprint of the outcomes framework.

FIGURE 1



This curriculum guide outlines grade level specific curriculum outcomes, and provides suggestions for learning, teaching, assessment and resources to support students‟ achievement of these outcomes. Teachers should consult the *Foundation for the Atlantic Canada Science Curriculum* for descriptions of the essential graduation learnings, vision for scientific literacy, general curriculum outcomes, and key-stage curriculum outcomes.

Curriculum Guide Organization

Specific curriculum outcome statements describe what students should know and be able to do at each grade level. They are intended to serve as the focus for the design of learning experiences and assessment tasks. Specific curriculum outcomes represent a reasonable framework for assisting students to achieve the key-stage, the general curriculum outcomes, and ultimately the essential graduation learnings.

Specific curriculum outcomes are organized in two to four units for each grade level. Each unit is organized by topic. Suggestions for learning, teaching, assessment, and resources are provided to support student achievement of the outcomes.

The order in which the units of a grade appear in the guide is meant to suggest a sequence. In some cases the rationale for the recommended sequence is related to the conceptual flow across the year. That is, one unit may introduce a concept which is then extended in a subsequent unit. Likewise, it is possible that one unit focuses on a skill or context which will then be built upon later in the year.

It is also possible that units or certain aspects of units can be combined or integrated. This is one way of assisting students as they attempt to make connections across topics in science or between science and the real world.

Extended time frames may be needed to collect data over time. These cases may warrant starting the activity prior to the unit in which it will be used. In all cases logical situations and contexts should be taken into consideration when these types of decisions are made.

The intent is to provide opportunities for students to deal with science concepts and scientific issues in personally meaningful, and socially and culturally, relevant contexts.

Unit Organization

All units comprise a two-page layout of four columns as illustrated in Figure 2. Each unit is comprised of outcomes grouped by a topic which is indicated at the top of the left page.

Column One: Essential Learning Outcomes

The first column lists a group of ***NB prescribed outcomes*** that relate to the pan-Canadian *Specific Curriculum Outcomes* listed at the beginning of each unit. These are based on the pan-Canadian *Common Framework of Science Learning Outcomes K to 12.* This column also includes appropriate extensions for those students enrolled in ***Chemistry 111*** or ***Chemistry 121***. The statements involve the Science-Technology-Society-Environment (STSE), skills, and knowledge outcomes indicated by the outcome number(s) that appears in brackets after the outcome statement.

Curriculum outcomes for each unit have been grouped by topic. Other groupings of outcomes are possible and in some cases may be necessary in order to take advantage of local situations. The grouping of outcomes provides a suggested teaching sequence. Teachers may prefer to plan their own teaching sequence to meet the learning needs of their students.

Column Two: Elaborations

The second column includes **Elaborations** of the outcomes, as well as background information These Elaborations explain further the depth of understanding that students should acquire. Also included in this column are **Teaching Suggestions**, and ***Optional*** extensions of the topic. The suggestions in this column are intended to provide a holistic approach to instruction. In some cases, the suggestions in this column address a single outcome; in other cases, they address a group of outcomes.

Column Three: Tasks for Instruction and/or Assessment

The third column provides suggestions for ways that students‟ achievement of the outcomes could be taught and assessed. These suggestions reflect a variety of assessment techniques which include, but are not limited to, informal/formal observation, performance, journals, interview, paper and pencil, presentations, and portfolio. Some assessment tasks may be used to assess student learning in relation to a single outcome, others to assess student learning in relation to several outcomes. The assessment item identifies the outcome(s) addressed by the outcome number in brackets after the item.

Column Four: Notes

This column will refer teachers to the supporting text and ancillary resources. For current useful websites, and shared teacher resources, teachers are directed to the NB government Teacher Portal at: https://portal.nbed.nb.ca/

FIGURE 2
Curriculum Outcomes Organization:
The Four-Column, Two-Page Spread

Topic			
NB Prescribed Outcomes	***Elaborations***	***Tasks for Instruction and/or Assessment***	***Notes***
• Outcomes based on Pan-Canadian Specific Learning Outcomes • Additional outcomes for Level 1 course • Optional outcomes to be completed after completion of above outcomes	Elaborations of outcomes listed in column one Teaching Suggestions	Informal/Formal Observation Performance Journal Interview Paper and Pencil Presentation Portfolio	References to prescribed text and supporting resources. References to Appendices.

Unit Overview

At the beginning of each unit, there is a two-page synopsis. On the first page, introductory paragraphs give a unit overview. These are followed by a section that specifies the focus (inquiry, problem solving, and/or decision making) and possible contexts for the unit. Finally, a curriculum links paragraph specifies how this unit relates to science concepts and skills that will be addressed at later grades so teachers will understand how the unit fits with the students‟ progress through the complete science program.

The second page of the two-page overview provides a table of the outcomes from the *Common Framework of Science Learning Outcomes K to 12* that will be addressed in the unit. The numbering system used is the one followed in the pan-Canadian document:

100s - Science-Technology-Society-Environment (STSE) outcomes

200s - Skills outcomes

300s - Knowledge outcomes

400s- Attitude outcomes (see pages 10-18)

These code numbers appear in brackets after each specific curriculum outcome (SCO).

FIGURE 3
Unit Overview

Unit Title: Unit Overview		**Unit Title: Pan Canadian Specific Curriculum Outcomes**		
Introduction	Synopsis of the unit	**STSE**	**Skills**	**Knowledge**
Focus and Contexts	Focus: Inquiry, Decision Making, or Problem Solving. Possible contexts suggested	### Science –Technology – Society -Environment outcomes from C*ommon Framework of Science Learning Outcomes K to 12*	### Skills outcomes from *Common Framework of Science Learning Outcomes K to 12*	###Knowledge outcomes from *Common Framework of Science Learning Outcomes K to 12*
Curriculum Links	Links to concepts studied within the K-12 science curriculum			

Attitude Outcomes

It is expected that certain attitudes will be fostered and developed throughout the entire science program, entry to grade 12. The STSE, skills and knowledge outcomes contribute to the development of attitudes, and opportunities for fostering these attitudes are highlighted in the *Suggestions for Learning and Teaching* section of each unit.

Attitudes refer to generalized aspects of behaviour that are modeled for students by example and reinforced by selective approval. Attitudes are not acquired in the same was as skills and knowledge. The development of positive attitudes plays an important role in students" growth by interacting with their intellectual development and by creating a readiness for responsible application of what they learn.

Since attitudes are not acquired in the same way as skills and knowledge, outcomes statements for attitudes are written for the end of grades 3, 6, 9 and 12. These outcomes statements are meant to guide teachers in creating a learning environment that fosters positive attitudes.

The following pages present the attitude outcomes from the pan-Canadian *Common Framework of Science Learning Outcomes K to 12.*

Common Framework of Science Learning Outcomes K-12
Attitude Outcome Statements

From entry through grade 3 it is expected that students will be encouraged to…

Appreciation of science	Interest in science	Scientific inquiry
400 recognize the role and contribution of science in their understanding of the world ***Evident when students, for example,*** – give examples of science in their own lives – give examples of how objects studied and investigations done in class relate to the outside world – recognize that scientific ideas help us to explain how or why events occur	401 show interest in and curiosity about objects and events within the immediate environment 402 willingly observe, question, and explore ***Evident when students, for example,*** – ask "why" and "how" questions about observable events – ask many questions related to what is being studied – participate in show-and-tell activities, bringing objects from home or sharing a story or an observation – ask questions about what scientists do – express enjoyment from being read to from science books – seek out additional information from library books and digital discs – express enjoyment in sharing science-related information gathered from a variety of sources, including discussions with family members and friends – ask to use additional science equipment to observe objects in more detail – express the desire to find answers by exploring and conducting simple experiments	403 consider their observations and their own ideas when drawing a conclusion 404 appreciate the importance of accuracy 405 be open-minded in their explorations ***Evident when students, for example,*** – raise questions about the world around them – willingly record observations in a given format – compare results of an experiment with other classmates – use observations to draw a conclusion or verify a prediction – take the time to measure with care – willingly explore a change and its effects – choose to follow directions when they complete a simple investigation – express the desire to find answers by conducting simple experiments

Common Framework of Science Learning Outcomes K-12
Attitude Outcome Statements

From entry through grade 3 It is expected that students will be encouraged to…

Collaboration	Stewardship	Safety
406 work with others in exploring and investigating ***Evident when students, for example***, – willingly share ideas and materials – respond positively to others' questions and ideas – take on and fulfil a variety of roles within the group – participate in science-related activities with others, regardless of their age or their physical or cultural characteristics – respond positively to other people's views of the world	407 be sensitive to the needs of other people, other living things, and the local environment ***Evident when students, for example,*** – ensure that living things are returned to an adequate environment after a study is completed – demonstrate awareness of the need for recycling and willingness to take action in this regard – show concern for other students' feelings or needs – care for living things that are kept in their classroom – clean reusable materials and store them in a safe place – willingly suggest how we can protect the environment	408 show concern for their safety and that of others in carrying out activities and using materials ***Evident when students, for example***, – are attentive to the safe use of materials – insist that classmates use materials safely – act with caution in touching or smelling unfamiliar materials, refrain from tasting them, and encourage others to be cautious – point out to others simple and familiar safety symbols – put materials back where they belong – follow given directions for set-up, use, and clean-up of materials – wash hands before and after using materials, as directed by teacher – seek assistance immediately for any first aid concerns like cuts, burns, and unusual reactions – keep the work station uncluttered, with only appropriate materials present

Common Framework of Science Learning Outcomes K-12
Attitude Outcome Statements

From grades 4-6 It is expected that students will be encouraged to…

Appreciation of science	Interest in science	Scientific inquiry
409 appreciate the role and contribution of science and technology in their understanding of the world 410 realize that the applications of science and technology can have both intended and unintended effects 411 recognize that women and men of any cultural background can contribute equally to science ***Evident when students, for example,*** – recognize that scientific ideas help explain how and why things happen – recognize that science cannot answer all questions – use science inquiry and problem-solving strategies when given a question to answer or a problem to solve – plan their actions to take into account or limit possible negative and unintended effects – are sensitive to the impact their behaviour has on others and the environment when taking part in activities – show respect for people working in science, regardless of their gender, their physical and cultural characteristics, or their views of the world – encourage their peers to pursue science-related activities and interests	412 show interest and curiosity about objects and events within different environments 413 willingly observe, question, explore, and investigate 414 show interest in the activities of individuals working in scientific and technological fields ***Evident when students, for example,*** – attempt to answer their own questions through trial and careful observation – express enjoyment in sharing and discussing with classmates science-related information – ask questions about what scientists in specific fields do – express enjoyment in reading science books and magazines – willingly express their personal way of viewing the world – demonstrate confidence in their ability to do science – pursue a science-related hobby – involve themselves as amateur scientists in exploration and scientific inquiry, arriving at their own conclusions rather than those of others	415 consider their own observations and ideas as well as those of others during investigations and before drawing conclusions 416 appreciate the importance of accuracy and honesty 417 demonstrate perseverance and a desire to understand ***Evident when students, for example***, – ask questions to clarify their understanding – respond constructively to the questions posed by other students – listen attentively to the ideas of other students and consider trying out suggestions other than their own – listen to, recognize, and consider differing opinions – open-mindedly consider non-traditional approaches to science – seek additional information before making a decision – base conclusions on evidence rather than preconceived ideas or hunches – report and record what is observed, not what they think ought to be or what they believe the teacher expects – willingly consider changing actions and opinions when presented with new information or evidence – record accurately what they have seen or measured when collecting evidence – take the time to repeat a measurement or observation for confirmation or greater precision – ask questions about what would happen in an experiment if one variable were changed – complete tasks undertaken or all steps of an investigation

Common Framework of Science Learning Outcomes K-12
Attitude Outcome Statements

From grades 4-6 It is expected that students will be encouraged to…

Collaboration	Stewardship	Safety
418 work collaboratively while exploring and investigating ***Evident when students, for example,*** – participate in and complete group activities or projects – willingly participate in cooperative problem solving – stay with members of the group during the entire work period – willingly contribute to the group activity or project – willingly work with others, regardless of their age, their gender or their physical or cultural characteristics – willingly consider other people's views of the world	419 be sensitive to and develop a sense of responsibility for the welfare of other people, other living things, and the environment ***Evident when students, for example,*** – choose to have a positive effect on other people and the world around them – frequently and thoughtfully review the effects and consequences of their actions – demonstrate willingness to change behaviour to protect the environment – respect alternative views of the world – consider cause and effect relationships that exist in environmental issues – recognize that responding to their wants and needs may negatively affect the environment – choose to contribute to the sustainability of their community through individual positive actions – look beyond the immediate effects of an activity and identify its effects on others and the environment	420 show concern for their safety and that of others in planning and carrying out activities and in choosing and using materials 421 become aware of potential dangers ***Evident when students, for example,*** – look for labels on materials and seek help in interpreting them – ensure that all steps of a procedure or all instructions given are followed – repeatedly use safe techniques when transporting materials – seek counsel of the teacher before disposing of any materials – willingly wear proper safety attire, when necessary – recognize their responsibility for problems caused by inadequate attention to safety procedures – stay within their own work area during an activity, to minimize distractions and accidents – immediately advise the teacher of spills, breaks, or unusual occurrences – share in cleaning duties after an activity – seek assistance immediately for any first aid concerns like cuts, burns, and unusual reactions – keep the work station uncluttered, with only appropriate materials present

Common Framework of Science Learning Outcomes K-12

Attitude Outcome Statements

For grades 7-9 It is expected that students will be encouraged to…

Appreciation of science	Interest in science	Scientific inquiry
422 appreciate the role and contribution of science and technology in our understanding of the world 423 appreciate that the applications of science and technology can have advantages and disadvantages 424 appreciate and respect that science has evolved from different views held by women and men from a variety of societies and cultural backgrounds ***Evident when students, for example,*** – recognize the potential conflicts of differing points of view on specific science-related issues – consider more than one factor or perspective when formulating conclusions, solving problems, or making decisions on STSE issues – recognize the usefulness of mathematical and problem-solving skills in the development of a new technology – recognize the importance of drawing a parallel between social progress and the contributions of science and technology – establish the relevance of the development of information technologies and science to human needs – recognize that science cannot answer all questions – consider scientific and technological perspectives on an issue – identify advantages and disadvantages of technology – seek information from a variety of disciplines in their study – avoid stereotyping scientists – show an interest in the contributions women and men from many cultural backgrounds have made to the development of science and technology	425 show a continuing curiosity and interest in a broad scope of science-related fields and issues 426 confidently pursue further investigations and readings 427 consider many career possibilities in science- and technology-related fields ***Evident when students, for example,*** – attempt at home to repeat or extend a science activity done at school – actively participate in co-curricular and extra-curricular activities such as science fairs, science clubs, or science and technology challenges – choose to study topics that draw on research from different science and technology fields – pursue a science-related hobby – discuss with others the information presented in a science show or on the Internet – attempt to obtain information from a variety of sources – express a degree of satisfaction at understanding science concepts or resources that are challenging – express interest in conducting science investigations of their own design – choose to investigate situations or topics that they find challenging – express interest in science- and technology-related careers – discuss the benefits of science and technology studies	428 consider observations and ideas from a variety of sources during investigations and before drawing conclusions 429 value accuracy, precision, and honesty 430 persist in seeking answers to difficult questions and solutions to difficult problems ***Evident when students, for example,*** – ask questions to clarify meaning or confirm their understanding – strive to assess a problem or situation accurately by careful analysis of evidence gathered – propose options and compare them before making decisions or taking action – honestly evaluate a complete set of data based on direct observation – critically evaluate inferences and conclusions, basing their arguments on fact rather than opinion – critically consider ideas and perceptions, recognizing that the obvious is not always right – honestly report and record all observations, even when the evidence is unexpected and will affect the interpretation of results – take the time to gather evidence accurately and use instruments carefully – willingly repeat measurements or observations to increase the precision of evidence – choose to consider a situation from different perspectives – identify biased or inaccurate interpretations – report the limitations of their designs – respond skeptically to a proposal until evidence is offered to support it – seek a second opinion before making a decision – continue working on a problem or research project until the best possible solutions or answers are identified

Common Framework of Science Learning Outcomes K-12
Attitude Outcome Statements

From grades 7-9 It is expected that students will be encouraged to…

Collaboration	Stewardship	Safety in science
431 work collaboratively in carrying out investigations as well as in generating and evaluating ideas ***Evident when students, for example,*** – assume responsibility for their share of the work to be done – willingly work with new individuals regardless of their age, their gender, or their physical or cultural characteristics – accept various roles within a group, including that of leadership – help motivate others – consider alternative ideas and interpretations suggested by members of the group – listen to the points of view of others – recognize that others have a right to their points of view – choose a variety of strategies, such as active listening, paraphrasing, and questioning, in order to understand others' points of view – seek consensus before making decisions – advocate the peaceful resolution of disagreements – can disagree with others and still work in a collaborative manner – are interested and involved in decision making that requires full-group participation – share the responsibility for carrying out decisions – share the responsibility for difficulties encountered during an activity	432 be sensitive and responsible in maintaining a balance between the needs of humans and a sustainable environment 433 project, beyond the personal, consequences of proposed actions ***Evident when students, for example,*** – show respect for all forms of life – consider both the immediate and long-term effects of their actions – assume personal responsibility for their impact on the environment – modify their behaviour in light of an issue related to conservation and protection of the environment – consider the cause-and-effect relationships of personal actions and decisions – objectively identify potential conflicts between responding to human wants and needs and protecting the environment – consider the points of view of others on a science-related environmental issue – consider the needs of other peoples and the precariousness of the environment when making decisions and taking action – insist that issues be discussed using a bias-balanced approach – participate in school or community projects that address STSE issues	434 show concern for safety in planning, carrying out, and reviewing activities 435 become aware of the consequences of their actions ***Evident when students, for example,*** – read the labels on materials before using them, and ask for help if safety symbols are not clear or understood – readily alter a procedure to ensure the safety of members of the group – select safe methods and tools for collecting evidence and solving problems – listen attentively to and follow safety procedures explained by the teacher or other leader – carefully manipulate materials, using skills learned in class or elsewhere – ensure the proper disposal of materials – immediately respond to reminders about the use of safety precautions – willingly wear proper safety attire without having to be reminded – assume responsibility for their involvement in a breach of safety or waste disposal procedures – stay within their own work area during an activity, respecting others' space, materials, and work – take the time to organize their work area so that accidents can be prevented – immediately advise the teacher of spills, breaks, and unusual occurrences, and use appropriate techniques, procedures, and materials to clean up – clean their work area during and after an activity – seek assistance immediately for any first aid concerns like burns, cuts, or unusual reactions – keep the work area uncluttered, with only appropriate materials present

Common Framework of Science Learning Outcomes K-12
Attitude Outcome Statements

From grades 10-12 It is expected that students will be encouraged to…

Appreciation of science	Interest in science	Scientific inquiry
436 value the role and contribution of science and technology in our understanding of phenomena that are directly observable and those that are not 437 appreciate that the applications of science and technology can raise ethical dilemmas 438 value the contributions to scientific and technological development made by women and men from many societies and cultural backgrounds	439 show a continuing and more informed curiosity and interest in science and science-related issues 440 acquire, with interest and confidence, additional science knowledge and skills, using a variety of resources and methods, including formal research 441 consider further studies and careers in science- and technology-related fields	442 confidently evaluate evidence and consider alternative perspectives, ideas, and explanations 443 use factual information and rational explanations when analysing and evaluating 444 value the processes for drawing conclusions
Evident when students, for example, – consider the social and cultural contexts in which a theory developed – use a multi-perspective approach, considering scientific, technological, economic, cultural, political, and environmental factors when formulating conclusions, solving problems, or making decisions on an STSE issue – recognize the usefulness of being skilled in mathematics and problem solving – recognize how scientific problem solving and the development of new technologies are related – recognize the contribution of science and technology to the progress of civilizations – carefully research and openly discuss ethical dilemmas associated with the applications of science and technology – show support for the development of information technologies and science as they relate to human needs – recognize that western approaches to science are not the only ways of viewing the universe – consider the research of both men and women	***Evident when students, for example,*** – conduct research to answer their own questions – recognize that part-time jobs require science- and technology-related knowledge and skills – maintain interest in or pursue further studies in science – recognize the importance of making connections between various science disciplines – explore and use a variety of methods and resources to increase their own knowledge and skills – are interested in science and technology topics not directly related to their formal studies – explore where further science- and technology-related studies can be pursued – are critical and constructive when considering new theories and techniques – use scientific vocabulary and principles in everyday discussions – readily investigate STSE issues	***Evident when students, for example,*** – insist on evidence before accepting a new idea or explanation – ask questions and conduct research to confirm and extend their understanding – criticize arguments based on the faulty, incomplete, or misleading use of numbers – recognize the importance of reviewing the basic assumptions from which a line of inquiry has arisen – expend the effort and time needed to make valid inferences – critically evaluate inferences and conclusions, cognizant of the many variables involved in experimentation – critically assess their opinion of the value of science and its applications – criticize arguments in which evidence, explanations, or positions do not reflect the diversity of perspectives that exist – insist that the critical assumptions behind any line of reasoning be made explicit so that the validity of the position taken can be judged – seek new models, explanations, and theories when confronted with discrepant events or evidence

Common Framework of Science Learning Outcomes K-12
Attitude Outcome Statements

For grades 10-12 It is expected that students will be encouraged to…

Collaboration	**Stewardship**	**Safety**
445 work collaboratively in planning and carrying out investigations, as well as in generating and evaluating ideas ***Evident when students, for example,*** – willingly work with any classmate or group of individuals regardless of their age, gender, or physical and cultural characteristics – assume a variety of roles within a group, as required – accept responsibility for any task that helps the group complete an activity – give the same attention and energy to the group's product as they would to a personal assignment – are attentive when others speak – are capable of suspending personal views when evaluating suggestions made by a group – seek the points of view of others and consider diverse perspectives – accept constructive criticism when sharing their ideas or points of view – criticize the ideas of their peers without criticizing the persons – evaluate the ideas of others objectively – encourage the use of procedures that enable everyone, regardless of gender or cultural background, to participate in decision making – contribute to peaceful conflict resolution – encourage the use of a variety of communication strategies during group work – share the responsibility for errors made or difficulties encountered by the group	446 have a sense of personal and shared responsibility for maintaining a sustainable environment 447 project the personal, social, and environmental consequences of proposed action 448 want to take action for maintaining a sustainable environment ***Evident when students, for example,*** – willingly evaluate the impact of their own choices or the choices scientists make when they carry out an investigation – assume part of the collective responsibility for the impact of humans on the environment – participate in civic activities related to the preservation and judicious use of the environment and its resources – encourage their peers or members of their community to participate in a project related to sustainability – consider all perspectives when addressing issues, weighing scientific, technological, and ecological factors – participate in social and political systems that influence environmental policy in their community – examine/recognize both the positive and negative effects on human beings and society of environmental changes caused by nature and by humans – willingly promote actions that are not injurious to the environment – make personal decisions based on a feeling of responsibility toward less privileged parts of the global community and toward future generations – are critical-minded regarding the short- and long-term consequences of sustainability	449 show concern for safety and accept the need for rules and regulations 450 be aware of the direct and indirect consequences of their actions ***Evident when students, for example***, – read the label on materials before using them, interpret the WHMIS symbols, and consult a reference document if safety symbols are not understood – criticize a procedure, a design, or materials that are not safe or that could have a negative impact on the environment – consider safety a positive limiting factor in scientific and technological endeavours – carefully manipulate materials, cognizant of the risks and potential consequences of their actions – write into a laboratory procedure safety and waste-disposal concerns – evaluate the long-term impact of safety and waste disposal on the environment and the quality of life of living organisms – use safety and waste disposal as criteria for evaluating an experiment – assume responsibility for the safety of all those who share a common working environment by cleaning up after an activity and disposing of materials in a safe place – seek assistance immediately for any first aid concerns like cuts, burns, or unusual reactions – keep the work station uncluttered, with only appropriate lab materials present

Chemistry 111 – 121 Curriculum

Part 2

Daily Teaching Guide

Table of Contents

CHEMISTRY 11 Quick Start Guide

Unit 1: From Structures to Properties *(38 hours)*

1. Classification of Matter *(6 hrs)* This section reviews the concept that the classification of matter is based upon its properties, the major categories of matter (e.g. pure substance, mixture, element, compound, solution), and differences between physical and chemical properties.

2. Underlying Structure of Matter *(8 hrs)* This section reviews the concept of matter consisting of atoms, ions, and molecules.

3. Elements and Compounds *(8 hrs)* This section reviews the concept that elements combine to form compounds having characteristic properties and assigned individual names.

4. Chemical Bonding *(9 hrs)* This section focuses on how the electronegativity of atoms can be used to predict the type of compounds formed (ionic or molecular) and the polarity of molecular compounds. Metallic bonds and covalent network solids are also investigated in this section.

5. Molecular Shape – VESPR Theory *(2 hrs)* Using previously introduced concepts of bond capacity, lone pairs and electronegativity, students will learn to predict three-dimensional molecular shapes and bond angles using VSEPR Theory (Valence Shell Electron Pair Repulsion Theory). Students will learn to identify isomers where more than one structure is possible for a given formula.

6. Intermolecular Forces *(2 hrs)* Using the idea of molecular shape and polarity, students will learn to predict the types of forces that act between molecules (i.e. dispersion forces, dipole-dipole forces and hydrogen bonding) and how these bonds influence the properties of materials.

7. Properties *(3 hrs)* Students will learn how different types of bonds account for the properties of ionic, molecular, metallic and covalent network substances.

Unit 2: Stoichiometry *(52 hours)*

1. The Mole *(12 hrs)* The concepts of the mole and molar mass of compounds are introduced, as well as how to write complete, balanced, chemical equations. Molar conversions are explored using known values of mass, volume, moles, molarity, and particles using Avogadro"s constant.

2. Chemical Changes *(8 hrs)* Chemical changes can be represented with chemical equations and energy is involved in each change that matter undergoes. The five types of reactions are investigated and predictions of products are demonstrated. Mole ratios are used to reinforce the law of conservation of mass.

3. Stoichiometry *(32 hrs)* Gravimetric, Solution, and Gases Applications of predicting both reactant and product quantities is demonstrated. Experimentation is used to reinforce this concept. Limiting reagents are identified using molar ratio. Percent yield is also calculated based on results both theoretically and experimentally. Gas stoichiometry explores the ideal gas law when calculating unknown variables with respect to chemical changes. When dealing with individual gases, the combined gas law is used when there is a change in conditions of pressure, volume and/or temperature.

Instructional Planning

Unit 1 – From Structures to Properties *(38 hours)*				
# hrs.	***Chemistry 11 Curriculum Topic***	***PH Chemistry SE Text Sections***	***PH Chemistry Text Pages***	***Core Activities*** ***PH Chemistry*** ***PH Chemistry Lab Manual*** ***PEI Labs on Portal/Appendix B***
6	*Classification of Matter*	Chapter 1.1, Chapter 2 Chapter 6.1, 6.2	6-11 38-52 154-169	**Inquiry** – p. 6, *"Solid or Liquid?"* **Inquiry** – p.38, *"Classifying Matter"* **Quick Lab** – p. 45, *"Separating Mixtures"*
8	*Underlying Structure of Matter*	Chapter 4 (all) Chapter 5.1, 5.2 Chapter 6.3 Chapter 7.1 *Chemistry 111 Chapter 5.3*	101-121 127-137 170 -178 186-193 *Chemistry 111 138-146*	**Small Scale Lab** – p. 120, *"The Atomic Mass of Candium"* **Inquiry** – p. 186, *"Shapes of Crystalline Materials"*
8	*Elements and Compounds*	Chapter 9 (all)	252-285	**Inquiry** – p. 252, *"Element Name Search"* **Small Scale Lab** – p.267, *"Names and Formulas for Ionic Compounds"* ***PEI Lab*** *"Identifying Elements using Flame Tests"(see Appendix B)*
9	*Chemical Bonding*	Chapter 7 (all) Chapter 8	186-211 212-251	**Small Scale Lab** – p.200, *"Analysis of Anions and Cations" (**Caution**: use a stirring rod instead of a pipette)*
2	*Molecular Shape – VESPR Theory*	Chapter 8 con't	212-233 237-251 *Chemistry 111 234-236*	***Lab Manual*** – Lab 11, p.73 "*Molecular Models"*
2	*Intermolecular Forces*	Chapter 8 con't	240-244, 445-449	
3	*Properties*	Chapter 8 con't	212-251	

Unit 2 – Stoichiometry (52 hours)				
# hrs.	***Chemistry 11 Curriculum Topic***	***PH Chemistry SE Text Sections***	***PH Chemistry SE Text Pages***	***Core Activities*** **PH Chemistry** ***PH Chemistry Lab Manual*** ***PEI Labs – on Portal***
The Mole				
5	*The Mole and Balancing Equations*	Chapter 10.1, 11.1, 12.1, 3.2	286-296, 320-329 353-356, 73-79	
5	*Molar Mass*	Chapter 10.2, 10.3	297-319	**Small Scale Lab** – p.304, *"Counting by Measuring Mass"* ***Lab Manual*** – Lab 13, p. 85 *"Empirical Formula Determination" (optional teacher demonstration)*
2	*Mole Ratio Calculations*	Chapter 12.2	352-367	
Chemical Changes				
8	*Chemical Changes*	Chapter 11.2, 11.3, 17.1, 18.1	330-352, 504-506, 540-548	**Small Scale Lab** – p. 345, *"Precipitation Reactions"* *Chemistry 111* ***Lab Manual*** – Lab 15, p.97 *"Reactivity of Metals"*
Stoichiometry				
6	*Solutions*	Chapter 11.3, 15.1, 15.2, 18.3	342-351, 450-458, 470-472, 560-562	
	Solubility curves (Chemistry 111)			
5	*Solution Concentration*	Chapter 16.1, 16.2, *Chemistry 111 - 16.3*	470-486 *Chemistry 111, 487-493*	**Small Scale Lab** – p.497, *"Making a Solution"*
2	*Solubility*	Chapter 16.1	472-477	
6	*Stoichiometric Calculations*	Chapter 12.2	359-367	**Small Scale Lab** – p.367, *"Analysis of Baking Soda"* *Chemistry 111* *use Probeware© if available*
4	*Limiting Reagents*	Chapter 12.3	368-378	**Small Scale Lab** – p.372, *"Limiting Reagents"* ***Lab Manual*** – Lab 20, p. 127, *"Balanced Chemical Equations"*
2	*Stoichiometric Experimentation*	Chapter 12	352-383	
2	*Applications of Stoichiometry*	Chapter 12	352-383	
5	*Gases*	Chapter 13.1, 14.1-14.3, *Chemistry 111 - 14.4*	384-389 384-431 *Chemistry 111, 432-436*	

Chemistry 111

In addition to defining requirements for *Chemistry 112*, this curriculum document defines additional requirements for *Chemistry 111*. Throughout the document you will find additional ***Chemistry 111*** required outcomes, elaborations and labs, highlighted in blue. Unless listed as ***Optional***, all *Chemistry 111* outcomes are required. ***Optional*** level 1 outcomes should only be undertaken after completing the other required level 1 outcomes.

In addition to these, each *Chemistry 111* student *must complete a chemistry research project* on a topic of their choice.

Chemistry 111 should move at an accelerated pace, and involve less repetition and practice than for *Chemistry 112*. This should free up time, which should then be used to enrich the course with more complex and challenging problems, and extensions of topics and activities. This enriched curriculum should focus on an increased depth of understanding, a greater development of lab skills and investigative techniques, and greater student responsibility for research.

Curriculum adjustments

The *Quick Start Guide* and *Instructional Planning* charts in this document, provide suggestions of how long to spend on each topic, and are based on a 90 hour course. However, recognizing that adjustments may be required due to various factors reducing instructional time, teachers are asked to follow the suggestions defined below to ensure common adjustments are implemented across NB schools.

Unit 2 :

"*Limiting Reagents*"

4 hrs → 2 hrs Focus on an introduction to this concept reducing time by spending less time on practice.

"*Applications of Stoichiometry*"

2 hrs → 0 hrs Reduce time by addressing this in the context of other topics in the unit.

"Gases"

5 hrs → 1 hrs This could be effectively addressed as a self-study unit if time is short.

The Four Column Spread

This curriculum document is intended as a guide to the required topics and skills to be covered in the New Brunswick Chemistry 11 course.

Column one identifies all learning outcomes for Chemistry 111 and 112. Following each outcome is a bracketed list of numbers which refers back to the "**Pan-Canadian Specific Curriculum Outcomes**" at the beginning of each unit.

In Column one, "***NB Prescribed Outcomes***" are required for all students. Those outcomes identified under "***Chemistry 111***" are required extensions of the course material for all those taking the level 1 course option. If chosen, those outcomes identified as "***Optional***" should only be undertaken after completing the other outcomes. Refer to notes on page 10 for further details if offering *Chemistry 111*.

In Column two, "**Elaborations**", are meant to clarify the level of detail and approach to take with reference to each of the prescribed outcomes. "***Teaching Suggestions***" are optional and intended to illustrate by example the approach one could take in teaching the outcomes.

In Column three, "**Tasks for Instruction and Assessment**", presents further suggestions for instruction and assessment to use and should be considered as optional.

Column four, titled "**Notes**", first refers to the relevant sections of in the prescribed text: the 2008 edition of "*Prentice Hall: Chemistry*" by Wilbraham et al. **(*PH Chemistry*)**.

Also listed in column four under "**Notes**", are "**Core Activities**". These are hands-on, and science inquiry activities that are considered a requirement for the effective teaching of this course. Those listed should be considered a minimum requirement, and a starting point. Teachers are strongly encouraged to include further science inquiry activities as they are able.

"**Core Activities**" listed can be found in the **Student text** (**PH Chemistry SE- Inquiry activity, Quick Lab, Small scale Lab**), on the **TeacherEXPRESS CD** teacher's resource (***PH Chemistry Lab Manual- Lab Manual, Small Scale Chemistry Lab Manual***), or as a ***PEI Lab*** (*Appendix B* of this document or on the NB Government Education Portal).

In addition to these resources teachers should refer often to the NB Government Education Portal at https://portal.nbed.nb.ca/ for current internet links and shared teacher resources.

Unit 1 - From Structures to Properties

(38 hours)

Introduction

All matter is held together by chemical bonds. Bonding is discussed in detail in this unit. The different forces of attraction involved in matter and how it influences their properties will be studied. This unit will address questions such as “Why does water have the formula H_2O?” and “Why does NaCl have such a high melting point?”.

Focus and Content

This unit could be framed around the use of chemicals in the home and in food as an inquiry-based approach. Students will begin by identifying and describing properties of ionic and molecular compounds as well as metallic substances. Using chemicals that would be found in their own homes, students will then differentiate among and classify these compounds and substances as being ionic, molecular, or metallic.

Students should use models to build chemical structures. Through the use of laboratory investigations and research, they can investigate and compare the strengths of intermolecular and intramolecular forces.

Science Curriculum Links

There are strong links between the “Atoms and Elements” unit in grade 9 science and the “Chemical Reactions” unit of science 10. The “Chemical Reactions” unit forms the foundation for all the chemistry 11 units. By the end of the “From Structures to Properties” unit, students will have studied the theoretical foundation of qualitative aspects in chemistry

Pan Canadian Specific Curriculum Outcomes

It is expected that students will:

STSE

114-2 explain the roles of evidence, theories, and paradigms in the development of scientific knowledge

114-8 describe the usefulness of scientific nomenclature systems

115-7 explain how scientific knowledge evolves as new evidence comes to light and as laws and theories are tested and subsequently restricted, revised, or replaced

Relationship between Science and Technology

116-4 analyse and describe examples where technologies were developed based on scientific understanding

Social and Environmental Contexts of Science and Technology

117-11 analyse examples of Canadian contributions to science and technology

118-2 analyse from a variety of perspectives the risks and benefits to society and the environment of applying scientific knowledge or introducing a particular technology

SKILLS

Initiating and Planning

212-8 evaluate and select appropriate instruments for collection evidence and appropriate processes for problem solving, inquiring, and decision making

212-5 identify the theoretical basis of an investigation and develop a prediction and a hypothesis that are consistent with the theoretical basis

212-8 evaluate and select appropriate instruments for collecting evidence and appropriate processes for problem solving, inquiring, and decision making

Performing and Recording

213-3 use instruments effectively and accurately for collecting data

213-6 use library and electronic research tools to collect information on a given topic

213-7 select and integrate information from various print and electronic sources or from several parts of the same source

Analyzing and Interpreting

214-2 identify limitations of a given classification system and identify alternative ways of classifying to accommodate anomalies

214-3 compile and display evidence and information, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, graphs, and scatter plots

KNOWLEDGE

319-1 (I) name and write formulas for molecular compounds using prefixes, include common compound names

319-1 (II) name and write formulas for ionic compounds (include binary, complex and hydrates), using the periodic table, a list of ions, and appropriate nomenclature for metal and non-metal ions

319-2 classify substances as acids, bases, or salts, based on their characteristics, and on the basis of their names and formulas

321-4 illustrate and explain the formation of ionic, covalent, and metallic bonds

321-5 illustrate and explain hydrogen bonds and van der Waals" forces

321-7 identify and describe the properties of ionic and molecular compounds and metallic substances

321-8 describe how intermolecular forces account for the properties of ionic and molecular compounds and metallic substances

321-9 classify ionic, molecular, and metallic substances according to their properties

321-11 explain the structural model of a substance in terms of the various bonds that define it

Classification of Matter

(6 hours)

NB Prescribed Outcomes

Students will be expected to:

- define and classify matter according to its composition (pure substances or mixtures).
- define and distinguish between, chemical and physical properties.
- define and classify matter as elements and compounds, and as heterogeneous mixtures and solutions.
- use the periodic law as illustrated by the periodic table to identify and distinguish metals and non-metals, periods and groups, representative and transition elements, and families.
- describe the factors which contribute to the unique position of hydrogen on the periodic table.
- identify the elements that are most prevalent in living systems.
- research ingredients and additives in consumer products. (213-7)
- identify consumer products and investigate the claims made by companies about the products. (212-5)

Elaborations

This section serves as a review of concepts in chemistry to which students were introduced in earlier grades.

At the beginning of the course it is imperative that all students can demonstrate an understanding that matter is classified based on differences between physical and chemical properties.

Students should have a clear understanding of different categories of matter, including pure substances, mixtures, elements, compounds, and solutions.

Students should also be well versed in the type of knowledge found in the periodic table and how to glean that knowledge from it.

Students should recognize that chemicals are a part of their everyday life and not only substances used in industrialized processes. They should select a food or other consumer product found in their home, and then research the ingredients or additives found in the product.

A distinction should be made between an "ingredient" such as oil, flour, sugar or salt required in the making of the product, or milk and cream in ice cream that make up part of the food, and an "additive" which is a chemical substance that is added to food to achieve a specific effect, such as texture, colour, or preservation. The Food and Drugs Act regulates the use of additives in Canada.

Students should also identify a familiar consumer product which makes claims about such things as a product"s safety, ingredients or effectiveness and then research the validity of these claims. Based on their research they should demonstrate support or refute of these claims.

As the unit progresses and the students become more knowledgeable of structures and properties of substances and the interrelationships between them they should return to their topic and add to it.

Teaching Suggestions

This would be a good opportunity to have students look into the history of the development of the periodic table.

Classification of Matter con't

Tasks for instruction and/or assessment

Notes

PH Chemistry
Chapter 1.1,
Chapter 2
Chapter 6.1, 6.2

Core Activities
Inquiry – p. 6,
"Solid or Liquid?"

Inquiry – p.38,
"Classifying Matter"

Quick Lab – p. 45,
"Separating Mixtures"

Check NB Government Portal for current links and shared resources *https://portal.nbed.nb.ca/tr/lr/HSS/Pages/default.aspx*

The Underlying Structure of Matter

(8 hours)

NB Prescribed Outcomes

Students will be expected to:

- use standard atomic notation to represent atoms, define isotope and use isotopic notation.
- predict ionic charges from position on the Periodic Table.
- define atomic mass, explain the relative nature of atomic mass.
- provide definitions and examples of atoms, ions, and molecules, including subatomic particles, atomic mass, atomic number, mass number, valence electrons, isotopes.
- identify the inadequacies in the Rutherford and Bohr models.
- identify the new proposal in the Bohr model of the atom.
- describe the energies and positions of electrons according to the quantum mechanical model.
- describe how the shapes of orbitals differ as it relates to different sublevels.
- write electron configuration diagrams using Hund‟s rule, Pauli exclusion principle and Aufbau principle (diagonal rule).

Chemistry 111

- demonstrate an introductory understanding of the Quantum Mechanical Model.
- demonstrate an understanding of periodicity of Ionization Energy, electronegativity and atomic radii.

Elaborations

Students should demonstrate an understanding of the type, location, mass and charge of subatomic particles and that matter has a well defined underlying structure, which consists of atoms, ions, and molecules. They should be able to draw energy level diagrams of atoms and ions.

Teaching Suggestions

Teachers might begin this unit by having students write individual lists of the things they know about how atoms are counted and how their masses are measured. A useful question is “If you know the mass of a dozen identical items, how could you find the mass of one of the items without measuring it directly?” After discussion, students might consider the question “How can chemists count atoms by using a balance?”

An activity to visualize the relationships between counting units, such as dozens, counting individual items within a unit, and finding the mass of both would help students consolidate their experiences with their new knowledge. Using rice or peas or any handful of identical items that could be counted and the mass of which could be found works well.

To answer the question “Why are relative atomic masses not exact whole numbers?”, teachers might use the particles of atoms and their relative masses and the mass of a mixture of isotopes to illustrate atomic mass units (amu) and their relationships to grams. Students could calculate the average atomic mass of an element from data for each of its isotopes. The atomic mass lab allows students to calculate the “atomic mass” of an “isotopic” mixture of noodles which are identified as the “element” soup mix. Teachers can provide a variety of methods for the effective and accurate massing of materials on a balance.

Chemistry 111

The study of modern atomic theory should include electronic configurations and how they relate to the position of the element in the periodic table.

Underlying structure of matter/ the structure of the atom con't

Tasks for Instruction and/or assessment

Informal Observation

- Compare your solutions to your partner‟s to see if the following are included: proper use of symbols, inclusion of all units in each step, logical sequence of steps, and completed answer. (ACC-1)

Paper and Pencil

- Prepare a KWL chart on atoms. Fill in the chart with your information about isotopes of atoms and their mass. (ACC-1)

KWL Chart

What I know:

____
____

What I want to know:

____
____

What I learned:

____
____

- List all the atoms and ions that are represented by the electron configuration $1s^2 2s^2 2p^6 3s^2 3p^6$.

Performance

- Perform an experiment to count rice particles and find the mass of one. Other particles that might be used are beans and peas (ACC-1, 213-3)
- Perform an experiment to find the "atomic mass" of a variety of isotopes of the element "soup mix". (ACC-1, 213-3)

Portfolio

- Include your laboratory report(s) in your chemistry portfolio. (ACC-1)

Chemistry 111

Paper and Pencil

- Calculate the average atomic mass of oxygen. Oxygen has three naturally occurring isotopes: oxygen-16, with a mass of 15.99 amu; oxygen-17 with a mass of 17.00 amu; and oxygen-18, with a mass of 18.00 amu. The relative abundances are 99.76%, 0.038%, and 0.20%, respectively. (ACC-1)

Notes

PH Chemistry SE
Chapter 4 (all)
Chapter 5.1, 5.2
Chapter 6.3
Chapter 7.1

Chemistry 111
Chapter 5.3

Core Activities

Lab – p. 120,
"The Atomic Mass of Candium"

Inquiry – p. 186,
"Shapes of Crystalline Materials"

Check NB Government Portal for current links and shared resources
https://portal.nbed.nb.ca/tr/lr/HSS/Pages/default.aspx

Elements and Compounds

(8 hours)

NB Prescribed Outcomes

Students will be expected to

- define and differentiate between ionic and molecular compounds, including acids and bases, using conductivity and indicators. (212-8, 319-2 (I))

- identify, name and write formulas for ionic (binary, multivalent, polyatomic, and hydrates) and molecular compounds, and acids using IUPAC and classical systems. (319-1(I), 319-1 (II), 319-2, 114-8-review)

Elaborations

Students should be able to demonstrate an understanding that elements combine to form a vast array of compounds, and that each compound has characteristic properties and a specific name.

They should become familiar with the different categories of compounds, and learn how to name them using IUPAC, classical and common names where appropriate. Students should be given a lot of practice.

This section should include a lab or demonstration on conductivity and litmus tests.

Teaching Suggestions

Play Chemical Bingo - Create ChEMGO cards that resemble BINGO cards with a “FREE” spot in the middle, all other squares will have chemical formulas in them. Create a special call sheet for the teacher. ChEMGO can be just elements, just binary compounds or a mixture of all types of compounds.

e.g.

Ch	E	M	G	O
Cu	Fe	C	B	Al
FeO	BH_3	HF	HCl	…
…		free		

Elements and Compounds con't

Tasks for Instruction and/or Assessment

Notes

PH Chemistry
Chapter 9 (all)

Core Activities
Inquiry – p. 252,
"Element Name Search"

Lab – p.267,
"Names and Formulas for Ionic Compounds"

PEI Lab
"Identifying Elements using Flame Tests"

Check NB Government Portal for current links and shared resources
https://portal.nbed.nb.ca/tr/lr/HSS/Pages/default.aspx

Chemical Bonding

(6 hours)

NB Prescribed Outcomes

Students will be expected to:

- illustrate and explain the formation of ionic, covalent, and metallic bonds (321-4b)
- define valence electrons, electronegativity, ionic, metallic bond, nonpolar covalent and polar covalent bond.
- identify lone pairs, bonding electrons, deduce bonding capacity, sketch Lewis Dot structures and structural diagrams.
- identify limitations of categorizing bond types based on differences in electronegativity between the elements and compounds (214-2)
- investigate covalent network solids with reference to the allotropes of carbon (diamond, graphite, fullerenes, Bucky ball, nanotubes).
- use library and electronic research tools to collect bonding information. (213-6)
- select and integrate information from various print and electronic sources. (213-7)

Elaborations

Students should use Lewis structures, structural diagrams, electronegativity difference and the octet rule (H_2 exception) and electron transfer to illustrate ionic and molecular compound formation and to define and explain structures of monatomic and polyatomic ions, ionic compounds, and molecular compounds.

Students should demonstrate ionic, covalent, and metallic bonding using the position of the elements in the periodic tale. They should predict the ionic charge for ions in the representative elements from their group number and using the octet rule. They should define and identify single, double, and triple covalent bonds.

Student should describe the bonding continuum from complete electron transfer, which is ionic, to unequal sharing of electrons (producing a dipole), which is polar covalent, to equal sharing of electron, which is non-polar covalent. They should identify the possible bond type - ionic, polar covalent or non-polar covalent - using the table of electronegativities.

The crystal structure for an ionic compound such as NaCl should be discussed with reference to bonding. Students should understand that the smallest representative unit of a molecular compound is a molecule and that the simplest whole number ratio of ions in a crystal lattice is a formula unit. It is important that students understand that the formula unit is a ratio and that a one-to-one ratio could mean that six cations continuously interact with six anions as is the case with NaCl.

Students should identify the limitations of using electronegativity values to determine the polar nature of a covalent bond. Categorizing bond types based on electronegativities is more accurate and analytical than using positions of the atoms involved in bonding on the periodic table. However, limitations do exist, particularly when the electronegativity differences are close to the values that are used to identify polar, nonpolar and ionic bonds.

Teaching Suggestions

Students could draw Lewis structures of simple food additives. Students might look at the salts in their food ingredient labels so that they could talk about the bonds that salts form as compared to other ingredients.

Chemical Bonding con't

NB Prescribed Outcomes

It is expected that students will:

Chemistry 111

- identify coordinate covalent bonds in ozone, carbon monoxide and various polyatomic ions.
- examine exceptions to the octet rule.
- examine resonance structures.
- analyse examples of Canadian contributions to bonding theory. (117-11)

Optional

- investigate current and possible uses of carbon nanotubes such as nanotechnology

Chemistry 111

Elaborations

Students should identify the possible bond type, ionic or covalent, from a chemical formula. They should illustrate the bonding structure of various polyatomic ions such as: NO_3^- NO_2^-, CO_3^{2-}, NH_4^+, SO_3^{2-}, OBr^{1-}.

Students should identify coordinate covalent bonds that result from the donation of the lone pair of electrons from a single atom involved in the bond formation.

Teaching Suggestions

Students could be introduced to the bonding structure of polyatomic ions with expanded octets, however, they should not be expected to illustrate these.

Students could read about John Polonya"s work on spectroscopy to see how a Canadian contributes to our world"s view of science. An alternate example might be Neils Bartlet at UBC in 1962 who got Xenon to react. He was responsible for the name change of Group 18 from inert to noble gases.

Chemical bonding con't

Tasks for Instruction and/or Assessment

Performance

- Play a game of joining elements to make a variety of compounds. Make a chart to keep track of the combinations and their bond types. With the element‟s symbol on a headband, try to find an element you can combine with to make a compound. Some elements, may have more than one combination. Keep track of the combination(s). From this, explain the bond type for your combination(s). (321-4b)

- Using ion chips, ion dice, or a game, write a balanced chemical formula for a variety of ionic compounds. (321-4b)

Paper and Pencil

- How are the lattice structure and chemical formula of NaCl related? (321-4)

- Draw Lewis structures for H_2O, N_2F_2, CO, CO_2, CH_3COOH, H_2, N_2 (321-4b)

- Show how ionic bonds are formed between: calcium and chlorine; sodium and oxygen; magnesium and nitrogen. (321-4)

Presentation

- Design a model to show the crystals of NaCl. (321-4)

- Use a concept map to show how energy changes occur in the formation of ionic compounds. (321-4)

- Students could research the structure of carbon nanotubes their potential applications (space elevator, bridges, super conductors, nanotechnology etc.) and current production problems and uses.

- In small groups, keep the ingredient labels from all the food products you eat in one day. Make a list of all the salts contained in each product. Research the properties and uses of the salts most frequently eaten. Create an information poster describing your research. (321-4)

Notes

PH Chemistry
Chapter 7 (all)
Chapter 8

Core Activities
Lab – p.200,
"Analysis of Anions and Cations"
*(**Caution**: use a stirring rod instead of a pipette)*

Check NB Government Portal for current links and shared resources
https://portal.nbed.nb.ca/tr/lr/HSS/Pages/default.aspx

Molecular Shape – VSEPR Theory

(2 hours)

NB Prescribed Outcomes

Students will be expected to:

- Explain the structural model of a substance in terms of the various bonds that define it (321-11)
- draw the structural diagram and name the shapes of various molecules. (321-11)
- identify the type of intermolecular bonding.(321-11)

Chemistry 111

- explain the hybridization of atomic orbitals of the central atom to produce molecular orbitals with the correct observed molecular geometry.

Optional

- describe the shapes of molecules based on five (trigonal bypyramidal) and six domains (octahedral) of electrons around the central atom e.g. SF_6 or PCl_5.

Elaborations

VESPR theory should be investigated, as molecular shape determines molecular polarity which in turn determines intermolecular forces, solubility, boiling points and melting points.

Students should explain the three-dimensional geometry of molecules using VSEPR theory. Students should determine the shapes about central atoms and corresponding bond angles in simple molecules by applying VSEPR theory to Lewis structures or structural formulas.

Students should learn the molecular shapes with the aim of determining polarity based on asymmetry. They should determine molecular polarity based on nonbonding electrons on the central atom, three-dimensional geometry, and bond polarity. This will enable students to determine the solubility of molecular compounds in water and understand intermolecular bonding. Generally small polar molecules are soluble in water.

Students should construct molecules with molecular models and draw the three-dimensional representation of the corresponding shapes, including molecular geometries represented by four bonding pairs of electrons surrounding the central atom and including linear, trigonal planar, trigonal pyramidal, bent, and tetrahedral. Students should identify isomers where more than one structure is possible for the same formula e.g. C_2H_6O.

Teaching Suggestions:

When a molecule is drawn, the polar bonds might be written using arrows (vectors). Using bond angles for direction, vector addition for each bond could be used qualitatively to determine if the molecule is polar or nonpolar. Looking at the shape and symmetry, the molecule is polar if it is asymmetric and non-polar if it is symmetric. By providing students with a variety of molecules to examine, data can be tabulated and patterns can be recognized.

Students might be introduced, through a research article or the Internet, to various lattice structure or network solids which will allow them to explore how our understanding of bonding has evolved.

Building models might help the students deduce the number of bonds an element is likely to form based on its position in the periodic table.

Students might look at H_2O, SiH_4, and C_2H_6O (isomer) and build a model to represent the resulting bonding.

Students could identify the elements involved in bonding in a food substance, and then draw the substance to help give information about its structure. They could use molecular model kits to construct the food substance and examine the three dimensional shape and polarity and then take a photo of the molecular model to add it to the their brochures or displays mentioned earlier in the unit.

Chemistry 111 Teaching suggestion

Construct a 3-dimensional model of a large molecule (glucose, sucrose etc.)

Molecular Shape - VESPR Theory con't

Tasks for Instruction and/or Assessment

Paper and Pencil

- Determine if the following molecules are polar or nonpolar based on bond polarity and molecular shape: CH_3Cl; Cl_2; NH_3; H_2O; CF_4 (321-11)
- Why is hexane nonpolar? What does bond type have to do with it? (321-11)
- Why is CCl_4 nonpolar? What does molecular shape have to do with it? (321-11)
- Explain VSEPR theory. Use diagrams. (321-11)
- Explain the geometry of the compounds ClF, OF_2, and NH_3. (321-11)
- Draw the structures and identify the geometries of NH_4 + and CO_3^{2-}. (321-11)
- Trace the development of bonding with reference to how technology helped us in our understanding of bonding. (115-7, 116-4)

Journal

- Is there a relationship between molecular shape and number of bonding/nonbonding electron pairs? (321-11)

Performance

- Draw the 3D representation, and create the molecular model of compounds that contain four bonding pairs of electrons surrounding the central atom with each of the following molecular geometries: linear; trigonal planar; trigonal pyramidal; bent; and tetrahedral. (321-11)

Presentation

- Draw a compound that is contained in a food and explain its bonding and structure. (321-11)
- Individually or in groups, present research on a Canadian chemistry prize winner and his/her contribution to science locally, nationally, and globally. This could be presented orally, in written form, or developed as a multimedia presentation.(115-7, 117-11, 116-4, 118-2)

Portfolio

- Keep a section of your chemistry portfolio available for issues that arise related to the relationship between science and technology. A bonding topic, such as chemical dentistry, is one that could be discussed. Follow up this discussion with a summary or piece of reflective writing for your portfolio. (115-7, 117-11, 116-4, 118-2)
- Include a piece of reflective writing in your portfolio. It might analyse a particular technology useful in bonding or it might talk about risks and benefits or the use of bonding knowledge. (118-2)

Notes

PH Chemistry SE
Chapter 8, p.212-233, 237-251

Chemistry 111
Chapter 8, p.237-251

Core Activities
Lab Manual
– Lab 11, p.73
"*Molecular Models"*

Check NB Government Portal for current links and shared resources
https://portal.nbed.nb.ca/tr/lr/HSS/Pages/default.aspx

Intermolecular Forces

(2 hours)

NB Prescribed Outcomes

Students will be expected to:

- identify types of intermolecular forces between molecules in a substance.
- illustrate and explain hydrogen bonds, van der Waals‟ forces (dispersion forces), and dipole-dipole. forces (321-5)
- compare the strength of van der Waals‟ forces, dipole-dipole forces, and hydrogen bonding.(321-5)
- analyse, from a variety of perspectives, the risks and benefits to society and the environment of applying bonding knowledge or introducing a particular technology. (118-2)
- explain how bonding theory evolved as new evidence and theories were tested and subsequently revised or replaced. (114-2, 115-7)
- analyse and describe examples where technologies were developed based on bonding. (116-4)

Elaborations

Students should identify types of intermolecular forces between molecules in a substance. Students should explain van der Waals‟ forces, dipole-dipole interactions and hydrogen bonding.

It is not the intent of this outcome to have students identify differences between two substances that both exhibit dipole-dipole interactions as a result of different halogen functional groups (varying degree of bond polarity), but rather to have them identify differences in physical properties between two substances of different molar mass where both exhibit the same intermolecular force OR between two substances of similar molar mass in which they exhibit different types of intermolecular forces.

Teaching Suggestions

Students could perform a boiling point lab activity using water (hydrogen bond) versus compounds such as TTE or cyclohexane (nonpolar bond), to discover the effect of hydrogen bonding. Melting points (water-ice, camphor or salicylic acid) could also be used for the lab.

A supplement to the lab might be for students to research boiling points of a variety of phase change compounds with similar molecular mass but varying bond types (electronegativities). They could compare other properties of these compounds to see the effect of bonding on the other physical and chemical properties. In doing this, the special nature of the three highly electronegative elements nitrogen, oxygen and fluorine could be noted.

Having knowledge of intermolecular forces, students could place substances in increasing order of melting (or boiling) point.

A class discussion about our understanding of chemical bonds could be initiated. Questions that might be asked include “Do more advanced technologies help us know more about atoms?” “How do geckos hang from the ceiling?” “What is surface tension?” “ Why does water expand on freezing?” “How does glue work?”

Students could investigate the structural model of bonding in materials such as titanium alloys and composites used in manufacturing. They could be prepared to defend the popularity of these materials based on properties which relate to their bonding structure and explain why they are so costly.

Chemistry 111

Elaborations

Students could research the importance of hydrogen bonding in biological systems (e.g. DNA)

Intermolecular Forces con't

Tasks for Instruction and/or Assessment

Performance

- perform a boiling point lab and report your findings. (321-5)
- In groups, select an intermolecular force and identify molecules that exhibit this force. Using the selected molecules, explain and illustrate the intermolecular force. (321-5)

Paper and Pencil

- Illustrate van der Waals" forces and hydrogen bonding using selected compounds. Provide an explanation for each. (321-5)
- Based on intermolecular forces, place the following compounds in a presumed order of increasing boiling point: $CH_3CH_2CH_3$; CH_3CH_3; CH_3CH_2Cl; CH_3CH_2OH. Explain your choices and confirm your order based on empirical evidence. (321-5)
- Explain how molecular size affects the cumulative strength of dispersion forces e.g. explain the states Cl_2 *(g)*, Br_2 *(l)*, I_2 *(s).* (321-5)
- Using intermolecular forces, explain various properties of H_2O e.g. Why does ice float?. (321-5)
- Trace the development of bonding with reference to how technology helped us in our understanding of bonding. (115-7, 116-4)

Presentation

- Quiz for Jigsaw - Properties of Liquids" MHR Website
- Using diagrams, illustrate how water exist in each of the three states. (321-5)
- Individually or in groups, present research on a Canadian chemistry prize winner and his/her contribution to science locally, nationally, and globally. This could be presented orally, in written form, or developed as a multimedia presentation. (115-7, 117-11, 116-4, 118-2)

Portfolio

- Keep a section of your chemistry portfolio available for issues that arise related to the relationship between science and technology. A bonding topic, such as chemical dentistry, is one that could be discussed. Follow up this discussion with a summary or piece of reflective writing for your portfolio. (115-7, 117-11, 116-4, 118-2)
- Include a piece of reflective writing in your portfolio. It might analyse a particular technology useful in bonding or it might talk about risks and benefits or the use of bonding knowledge. (118-2)

Notes

PH Chemistry SE
Chapter 8

Check NB Government Portal for current links and shared resources
https://portal.nbed.nb.ca/tr/lr/HSS/Pages/default.aspx

Properties

(2 hours)

NB Prescribed Outcomes

Students will be expected to:

- identify and describe the properties of ionic, molecular, metallic and covalent network substances. (321-7)
- classify ionic, molecular, metallic and covalent network substances according to their properties. (321-9)
- describe how the different types of bonds account for the properties of ionic, molecular, metallic and covalent network substances. (321-8)

Elaborations

Students should be given a variety of ionic, molecular, metallic and covalent network substances to observe and then classify according to their physical properties. They should be categorized by properties such as odour, hardness, conductivity, state, solubility, melting/boiling point. Students should classify representative substances as ionic, molecular, metallic and covalent network substances based on their properties.

Connection should be made between the exhibited physical properties from this initial investigation and the bonding types.

Using the theory of ionic and covalent bonding, students should explain the general properties of ionic and covalent compounds such as brittleness, melting and boiling points, and the ability to conduct electricity.

Using the theory of metallic bonding, students should explain why metals are malleable, ductile, and good conductors of heat and electricity, and why they have a wide range of melting and boiling points. Students also should compare the strengths of ionic and covalent bonds. Students should look at a wide variety of common compounds.

Teaching Suggestions

As compounds are categorized the information could be collected in a table like the one that follows. This activity will provide a concrete foundation for the concepts involved in the bonding theories to follow.

Compound	Properties	Samples
Molecular	solid, liquid or gas at STP; low melting point & boiling point; does not conduct electricity in aqueous solutions: simple molecular compounds are insoluble in water	SO_2, NH_3
Metallic	ductile; malleable; good conductors of heat and electricity; shiny when freshly cut or polished	Cu wire, Al foil (Include alloys)
Ionic	crystalline solid at STP; high melting point and boiling point; conducts electricity in aqueous solutions; good conductors in molten state; brittle; varying solubility in water	$NaCl$ $CuSO_4$
Covalent Network	Solid, very high melting point and boiling point; very hard; not soluble in water	C(s), SiC(s), $(SiO_2)_n$

Common household compounds that would allow students to view ionic, molecular, metallic and covalent network substances and the physical properties exhibited by each, could include sodium chloride, sugar, graphite, sand, acetic acid, vitamin C, an antacid, and cornstarch.

Properties con't

Teaching Suggestions con't

Students could rotate through lab stations to observe the properties of representative substances to compare melting points, conductivity, and solubilities in hot water, cold water, and methanol. From the physical property information collected, students can predict the substance type as being ionic, metallic, or covalent.

Students could compare acetic acid with hydrochloric acid or sodium acetate with ethyl acetate, sugar with salt, vinegar with sodium hydroxide. On the basis of properties like solubility, pH and conductivity, students could differentiate among ionic and molecular compounds, including acids and bases.

Chemistry 111 Teaching Suggestions

As a follow-up to previous work on ingredients or additives, the chemical formula of a food product previously selected could be examined and the physical properties identified.

Students could learn about, or review, the naming and writing of formula for ionic and covalent molecules and acids. This would give students the opportunity to recall information they might have seen before, to interpret the information, and to facilitate the learning of properties and bonding information in this unit. Working in groups could allow students to develop problem-solving and communication skills.

Students could build their own list of chemical substances that includes the name, formula, picture (if possible), bond type, properties, and useful information about the substance.

A sample of saturated sodium chloride solution (30g/100ml) allowed to evaporate in a Petri dish to form a sheet of sodium chloride. The difference between breaking this sheet and a piece of wax could be related to bond type.

From these activities, students will have collected evidence to identify bond types based on properties of substances.

Properties con't

Tasks for Instruction and/or Assessment

Performance

- Devise criteria to classify the following substances: C (graphite), H_2O, NaBr, Cu, $CaCO_3$. When your criteria are approved, obtain the substances and test them. (321-7)
- Predict which substance will have the highest melting point and explain: NH_3 or H_2O? HCl or HBr? NaCl or HCl? H_2 or Br_2?
- Given an unknown substance, predict the type of substance and devise a test to verify your hypothesis. (321-9)
- Classify the bond types of given substances based on their properties. (321-9)
- Identify an unknown sample(s) by comparing its properties to a set of known properties. Use the following criteria:
  - follow the recommended outline
  - use chemical and physical properties to classify or identify the unknown sample
  - observe and measure accurately
  - explain conclusions clearly (321-9)
- Perform an experiment to identify various properties of different types of substances. (321-8)

Journal

- Why does salt melt ice? (321-7)
- What holds a salt together? (321-7)
- Sodium chloride and sugar have different bond types, yet these both dissolve in water. Explain. (321-9)
- How does chemistry affect your life? Identify chemicals and discuss their bond type in terms of electronegativity. (214-2)

Paper and Pencil

- How do ionic compounds differ from molecular compounds? (321-7)
- Devise your own classification in a flow chart for bonding in all compounds. Use a list of supplied compounds. (214-2, 321-8)
- Describe the relationship between electronegativity and hydrogen bonding. (321-8)
- Draw and label the forces that affect atoms in a covalent bond. (321-8)
- Using bonding, describe how compounds may be: malleable vs ductile; hard versus brittle; able to conduct electricity efficiently; able to conduct heat efficiently; high vs low boilers. (321-8)

Presentation

- Display the bonding information you collected on the bulletin board. (321-7)
- Draw diagrams to show sodium and chloride ions being surrounded by water molecules.
- Draw diagrams to show sucrose molecules surrounded by water molecules. (321-9)

Chemistry 111

Presentation

- Silicon, a covalently bonded solid, is harder than pure metals. Research theories that explain the hardness of covalently bonded solids and their usefulness. Present your findings as a newspaper article or memo. (321-8, 213-6, 213-7, 214-3)

Notes

PH Chemistry SE
Chapter 8

Check NB Government Portal for current links and shared resources https://portal.nbed.nb.ca/tr/lr/HSS/Pages/default.aspx

Unit 2 – Stoichiometry

(56 hours)

Introduction

Chemistry is a qualitative and quantitative science. Students have generally been studying chemistry in a qualitative sense. In this introduction to the quantitative aspect of chemistry, students will examine stoichiometry. Stoichiometry is the mole to mole relationship in a balanced chemical equation.

This unit provides the opportunity to apply chemical principles to everyday life and industry. When studying reactions, students need the opportunities to investigate the usefulness of the reactions. The corresponding calculations provide the tools to investigate and support the students‟ responses.

Focus and Context

This unit focuses on problem solving and decision making. One way to introduce this unit is to begin with a contextualized problem requiring students to learn the chemistry to solve the problem and make decisions. The unit begins with an introduction to the concept of moles, Avogadro‟s number, and molar mass.

Stoichiometry introduces the problem-solving aspect of this course, providing students with the opportunity to develop skills in single problem solving (finding molar mass) and multi-level problem solving (percent yield).

This unit should focus on both the laboratory exercises and mathematical calculations as well as research on commercial production of compounds used by society. Chemicals in commercial or industrial environments are a context used through stoichiometry.

Science Curriculum Links

In Science 10, students began naming and writing formulas for ionic and molecular compounds and balancing equations. In Chemistry 12, stoichiometry is used in thermochemistry, from solutions to kinetics to equilibrium and acids and bases. The stoichiometry unit provides the quantitative foundations for the remainder of high school chemistry.

Pan-Canadian Specific Curriculum Outcomes

Students will be expected to:

STSE

Nature of Science and Technology

114-2 explain the roles of evidence, theories, and paradigms in the development of scientific knowledge

114-4 identify various constraints that result in trade-offs during the development and improvement of technologies

114-7 compare processes used in science with those used in technology

115-3 explain how a major scientific milestone revolutionized thinking in the scientific communities

Social and Environmental Contexts of Science and Technology

117-2 analyse society"s influence on scientific and technological endeavours

Skills

Initiating and Planning

212-3 design an experiment identifying and controlling major variables

212-4 state a prediction and a hypothesis based on available evidence and background information

Performing and Recording

213-3 use instruments effectively and accurately for collecting data

213-4 estimate quantities

213-5 compile and organize data, using appropriate formats and data treatments to facilitate interpretation of the data

213-8 select and use apparatus and materials safely

Analysing and Interpreting

214-10 identify and explain sources of error and uncertainty in measurement and express results in a form that acknowledges the degree of uncertainty

214-12 explain how data support or refute the hypothesis or prediction

214-13 identify and correct practical problems in the way a technological device or system functions

Communication and Teamwork

215-1 communicate questions, ideas and intentions, and receive, interpret, understand, support, and respond to the ideas of others

Knowledge

321-1 represent chemical reactions and the conservation of mass, using molecular models and balanced symbolic equations

321-2 describe how neutralization involves tempering the effects of an acid with a base or vice versa

323-1 define molar mass and perform mole-mass inter-conversions for pure substances

323-4 explain solubility, using the concept of equilibrium

323-7 explain the variations in the solubility of various pure substances, given the same solvent

323-8 use the solubility generalizations to predict the formation of precipitates

323-10 identify mole ratios of reactants and products from balanced chemical equations

323-11 perform stoichiometric calculations related to chemical equations

323-12 identify various stoichiometric applications

323-13 predict how the yield of a particular chemical process can be maximized

The Mole and Balancing Equations

(3 hours)

NB Prescribed Outcomes

Students will be expected to:

- define the Mole in terms of the number of atoms in exactly 12 g of carbon-12 (Avogadro"s number of particles). (323-1)
- define the law of conservation of mass. (321-1)
- demonstrate the proper use of SI units and significant digits in all computations.

Chemistry 111

- Convert number of particles to mass and moles
- explain how a major scientific milestone, the mole, changed chemistry. (115-3)

Elaborations

Chemists work with macroscopic samples of substances that contain extremely large numbers of particles. Students should engage in discussions regarding the convenience of grouping particles of substances into a quantity defined as the mole. Engage students in discussion regarding other units which represent large quantities could assist in developing the importance of the concept of the mole.

From the table below, students should see that 6.02×10^{23} is common in each case and is the quantity to represent the number of particles in a sample of a given substance. The new unit created is called the mole (mol) which is defined as the number of atoms in exactly 12 g of carbon- 12.

Students should discuss the mole and its influence on chemistry with reference to commercial or industrial production.

Avogadro's number, 6.02×10^{23}

	Element	Ionic Compound	Molecular Compound
name	carbon, C	sodium chloride, NaCl	water, H_2O
mass	12.01 g	58.44 g	18.02 g
number	6.02×10^{23} atoms	6.02×10^{23} formula units of NaCl 6.02×10^{23} Na^+ ions 6.02×10^{23} Cl^- ions	6.02×10^{23} molecules of H_2O 6.02×10^{23} O atoms $2(6.02 \times 10^{23})$ H atoms

Students should demonstrate an understanding of how the law of conservation of mass applies to chemical equations.

Teaching Suggestions

One mole of sample elements and compounds that are visible in sealed bottles could be displayed so students see the volume associated with molar mass of elements and compounds. Or one mole of aluminum foil could be molded into a mole (!).

The impact of the mole, based on a standard, carbon-12, might be an interesting discussion for students because of its effect on production of chemicals for society. Chemistry has changed from hit and miss calculations for a product to exact amounts being calculated for an industrial product.

Avogadro"s number, 6.02×10^{23}, might be celebrated on the 10th month, 23rd day from 6:02 a.m. to 6:02 p.m. This is Mole Day! For students" interest, the number is named after Avogadro but it was Perrin"s work on Brownian movement that connects the number and the mole.

The Mole and balancing equations con't

Teaching Suggestions con't

Students can be invited to look at various types of chemical equations, balance them, and compare masses and mole ratios. This might be done through worksheets, chemical models, or balancing games. This will allow students to practice the mole ratio while they refresh their memories about equations. To assist in teaching the concept of mole ratio, an analogy can be made which links the ratio of ingredients to the creation of a hamburger to mole ratios of balanced chemical equation.

Students could read chemical equations to identify the conditions of the chemical reaction, the information about the reactants and products, and the number of molecules and/or moles involved. Students might use a chart to organize the information and to check the total mass of reactants and of products.

When an air bag inflates the chemical reaction that occurs is:

Balanced Chemical Equation Information: Air Bag Inflation Reaction

equation	$2NaN_3(s)$ →	$2Na(s)$ +	$3N_2(g)$
molar mass (g/mol)			
mass (g)			
moles	2	2	3
total mass (g)			
words	2 moles of solid sodium azide decompose to 2 moles of solid sodium plus 3 moles of nitrogen gas		

Students can identify that atoms are always conserved in a balanced chemical equation by counting the number of individual atoms on each side of the yields symbol. Student could increase of decrease the number of moles of substances in an equation and check to see that the ratio stays the same, obeying the Law of Conservation of Mass.

$2\ NaN_3(s)$ →	$2Na(s)$ +	$3\ N_2(g)$
2	2	3
10	10	15
4	4	6
16	16	x
x	x	$1.5x$

Demonstrate the Law of Conservation of mass by adding baking soda to vinegar in a sealed baggie. Pre-weigh ingredients.

Chemistry 111

- Research some methods chemists initially used to arrive at Avogadro"s number, and then compare these methods with modern methods. How have methods used in science changed or improved? (115-3)

The Mole and balancing equations con't

Tasks for instruction and/or assessment

Paper and Pencil

- How is the mole defined? (115-3)
- State the Law of Conservation of Mass. (323-10)
- What information does the following balanced chemical equation provide about the cellular respiration equation?
  $C_6H_{12}O_6(aq) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l)$ + heat (323-10)
- To illustrate the size of Avogadro"s number (6.02×10^{23} or 602 sextillion), ask students to calculate the number of years it would take to spend 602 sextillion dollars at a rate of a billion dollars per second.

Presentation

- Celebrate Mole Day. Develop a mole day activity. Present your activity to the class in a variety of formats, such as a scavenger hunt, games, puzzles, songs artwork, or poems. (115-3)
- Research an element noting its industrial uses and present a time line of the information. Silicon and semiconductors might be a good example to show how scientific thinking has helped society. (115-3)
  - Write a newspaper article about a famous chemist and the times in which they lived. (115-3)
- In groups, create an analogy that relates a common event (making a sandwich) to mole ratios of balanced chemical equations. Share the analogy with your class (323-10)
- Ask students to find a mole fact on the internet. Collect mole facts for your class e.g. "a mole of pennies will make seven stacks to the moon."

Journal

- What do all of the following have in common: dozen, gross, pair, grand, and mole? What amount does each of these represent? (115-3)
- Identify quantities that are always conserved in a chemical reaction. Provide examples. (323-10)

Portfolio

- Include a copy of your presentation activity (newspaper article, poem, song etc.) in your chemistry portfolio (115-3)

Performance

- Assign coloured Smarties™ to each type of atom involved in a chemical equation. Group the Smarties™ (atoms) to represent compounds. Represent a chemical equation using the Smarties™ compounds you created. Using your Smarties™ representation of the chemical equation, prove that law of conservation of mass is upheld. (323-10)

Notes

PH Chemistry
Chapter 10.1, 11.1, 12.1, 3.2

Check NB Government Portal for current links and shared resources
https://portal.nbed.nb.ca/tr/lr/HSS/Pages/default.aspx

Molar Mass

(4 hours)

NB Prescribed Outcomes

Students will be expected to:

- define molar mass and determine the molar mass of an element and compound. (323-1)
- define molar volume @STP for gases.
- perform mole-mass inter-conversions and mole-mass-volume inter-conversions for gases. (323-1)
- calculate the percent composition from a compound‟s formula. (323-1)
- calculate molecular formula from percent composition and molar mass. (323-1)

Elaborations

Students should solve a variety of problems by performing calculations relating the number of moles to the mass, volume (at STP), and representative particles of various substances.

Students should perform an experiment involving mole-mass calculations and measurements.

Teaching Suggestions

Teachers might use learning centre activities for students to learn/review information on naming and writing chemical formulas. Students could associate the formula with its molar mass. Students could use various problem-solving techniques that involve mole-mass conversions. The conversion factor or the factor-label methods are examples of techniques that might be used.

$$\begin{array}{ccccc} & \textit{Molar Mass} & & 6.02\times10^{23} & \\ \text{Mass(g)} & \longleftrightarrow & \text{Mole(mol)} & \longleftrightarrow & \text{Particles} \\ & & \Big\updownarrow \; \textit{22.4L/mol@STP} & & \\ & & \text{Volume(L)} & & \end{array}$$

Students could convert a substance from moles to mass (# of particles or volume @ STP) and then trade their answer with that of another student who will convert the quantity back to moles. This co-operative learning will help students communicate the process of conversions using moles, masses, particles, and volumes of elements and compounds. Teachers might use interesting compounds for conversions, such as: glucose, vinegar, ascorbic acid, propane and ammonia.

Teachers might look at students‟ work involving calculations for the correct use of units and organization/planning of responses. Although time should be spent on understanding problem solving, attention to details such as units and significant figure rules should be continually addressed.

For percent composition, students could use everyday substances whose formulas they have looked up in the Handbook of Chemistry and Physics or the Merck Index. Examples could include household chemicals, vitamins, drugs, nitrogen in fertilizers, and steroids.

One student could choose a formula and find the percent composition. This could be given to another student to find the empirical formula and thus arrive back at the original formula. Students should understand that a compound cannot be identified by its empirical formula only. To determine the molecular formula, molar mass information is needed and questions could be solved involving this. Teachers might check students‟ work for appropriate choice of compounds, clear layout of the question, and correct molar masses and units.

Students might develop problems or activities based on the mole, molar mass, and mole-mass inter-conversions for pure substances.

Molar Mass con't

Tasks for Instruction and/or Assessment

Paper and Pencil

- Define: molar mass, molar volume (323-1)
- Calculate the mass of two moles of hydrogen gas. (Hint: Diatomic molecules can be remembered by various mnemonics such as: 7Up, HOBrFINCl, HOFBrINCl, HON Hal) (323-1)
- Calculate how many moles are in 80.0 g of ammonium nitrate. (323-1)
- Calculate how many molecules are in 5.0 mol of water. (323-1)
- Calculate how many grams are in 1.2×10^{24} molecules of CH_3COOH. (323-1)
- Calculate the mass of 44.8L of $H_2(g)$ at STP. (323-1)
- Calculate the molar mass of NaCl, MgBr, and Na_2O. (323-1)
- A student has one mole of NaCl, one mole of $K_2Cr_2O_7$, and 6.02×10^{23} molecules of $C_6H_{12}O_6$. What aspect(s) of each sample is not equal? (323-1)

Performance/Presentation

- Perform an experiment to do a comparative analysis of mass-mole-volume which requires mole-mass conversions for various substances (323-1, 213-3, 213-8)
- Perform a simple lab where students weigh some common compounds (e.g. sugar cube, baking soda, pennies) and calculate the number of moles. A *level 1 extension*, or a bonus could be to calculate number of molecules and/or number of atoms and/or number of protons.
- Design a flashcard game that converts between moles, mass, molar volume, and representative particles for various substances. (323-1)
- Your teacher will give you a card with one of the following formula of a Hydrate on it: $NaCH_3COO \cdot 3H_2O$; $MgSO_4 \cdot 7H_2O$; $MgCl_2 \cdot 6H_2O$; $LiC_2H_3O_2 \cdot 2H_2O$. What percentage by mass of water is contained in your compound?
- Design an experiment to determine the percentage of water by mass in the hydrated salt described by the formula. Explain the steps you would take to dry the salt completely. If your design is approved, obtain the salt and do the experiment. (323-1b)
- Describe (role-playing, poster presentation, video, etc.) proper procedures for the use of apparatus and materials safely and effectively. (213-3, 213-8, 214-13)
- Conduct a lab to determine the empirical formula of an oxide or hydrate (323-1, 213-3, 213-4, 213-9, 214-10, 214-12, 214-13)

Journal

- Describe conversions between moles, mass, molar volume, and representative particles for a particular substance (323-1)
- What is the difficulty with using a calculator for conversions? (323-1)

Portfolio

- Include your laboratory report(s) in your chemistry portfolio (323-1b)
- Place your material involving proper laboratory procedures in your chemistry portfolio (213-3, 213-8, 214-13, 323-1)

Notes

PH Chemistry
Chapter 10.2, 10.3

Core Activities
Lab – p.304,
"Counting by Measuring Mass"

Lab Manual – Lab 13, p. 85
"Empirical Formula Determination" (optional teacher demonstration)

Check NB Government Portal for current links and shared resources
https://portal.nbed.nb.ca/tr/lr/HSS/Pages/default.aspx

Mole Ratio Calculations

(2 hours)

NB Prescribed Outcomes

Students will be expected to:

- identify mole ratios of reactants and products from balanced chemical equations. (323-10)
- perform calculations using mole-to-mole stoichiometric problems.
- perform stoichiometric calculations related to chemical equations. (323-11)
- use instruments effectively and accurately for collecting data. (213-3)
- select and use apparatus and materials safely. (213-8)
- state a prediction and a hypothesis based on available evidence and background information. (212-4)
- identify practical problems that involve technology where equations were used. (214-13)

Elaborations

Proper lab safety procedures and proper use of instruments should always be followed. Students might need demonstrations and information on safety for these labs.

Students should look at an industrial experiment that has solved a practical problem. Students should discuss a prediction and a hypothesis based on collected information about the process.

Teaching Suggestions

Students could calculate mole-to-mole gravimetric stoichiometric problems by performing an experiment to show the ratio of reactants to products. The equation using limestone, $CaCO_3$*(s)*, yielding quicklime, CaO*(s),* and carbon dioxide, CO_2(*g*), or the equation using anhydrous Na_2CO_3 plus HCl*(aq)* could be used. The reaction between antacid tablets and stomach acid might be used in the lab as a relevant example for students:

$CaCO_3(s)$	+	$2HCl(aq)$	→	$CaCl_2(s)$	+	$H_2O(l)$	+	$CO_2(g)$
antacid	+	*stomach acid*	→	*salt*	+	*water*	+	*carbon dioxide*

Students might look at different equations that produce the same product for an industrial application. Students might predict which equation would be the best to use to produce a certain product(s). Students, in groups, might collect information about the reactants and products for the various equations and decide which equation would be the most cost efficient to use. Students" evidence might include the availability of materials, the cost of production, and the demand for the products. The equation, with evidence, that makes the most money might be the hypotheses that some students favour. Others might look at health or safety as a goal. Students" information about a chemical process in an industrial/technological application connects chemistry to their lives. It describes how industries use stoichiometric principles in their day-to-day functions.

Examples might include:

1) heating camping meals using the equation
$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(s) + \text{heat}$

2) removing CO_2 in a spacecraft using the equation
$CO_2(g) + 2LiOH(s) \rightarrow Li_2CO_3(s) + H_2O(l)$

Mole Ratio Calculations con't

Tasks for Instruction and/or Assessment

Journal

- What is the reasoning used that does not allow you to just convert grams to grams when doing stoichiometric problems? (323-10)

Performance

- Perform a lab involving the relationships between reactants and products in a chemical reaction. (323-10, 323-11, 212-4, 213-3, 213-8, 214-13)

Portfolio

- Include your laboratory report in your chemistry portfolio. (323-10)

Notes

PH Chemistry
Chapter 12.2

Core Activities

Chemistry 111
Lab Manual – Lab 15, p.97
"Reactivity of Metals"
(Chemistry 111)

Check NB Government Portal
for current links and shared resources
https://portal.nbed.nb.ca/tr/lr/HSS/Pages/default.aspx

Chemical Changes

(8 hours)

NB Prescribed Outcomes

Students will be expected to:

- compare and contrast physical, chemical, and nuclear changes (in terms of the bonds broken and magnitude of energy changes involved).
- investigate Kinetic Molecular Theory (KMT).
- investigate Collision Reaction Theory.
- identify empirical evidence that may indicate that a chemical change has occurred.
- differentiate between endothermic and exothermic changes.
- predict products of chemical reactions. (321-1)
- identify the five types of chemical reactions: formation, decomposition, combustion, single, and double replacement including precipitation, neutralization. (321-1, 321-2)
- write balanced chemical equations for the five different types of chemical reactions: formation, decomposition, combustion, single, and double replacement. (321-1)
- predict the states of the products to identify gases produced, solids as in precipitates etc.

Elaborations

Students should be able to demonstrate an understanding that energy is involved in each change that matter undergoes.

Students should do a lab on chemical changes, or identifying chemical reactions.

Students should identify the mole ratios of reactants and products in a chemical reaction as the coefficients in a balanced equation. They should understand that mass and atoms are always conserved in a balanced equation.

Teaching Suggestions

Use Diagnostic tests to prove the presence of the products that have been predicted.

Design a lab that will use diagnostic tests to prove the presence of the products e.g. Calcium in water produces a base (litmus), a solid and hydrogen gas (“pop” test).

Demonstrate the KMT by placing $KMnO_4$(s) in hot water and in cold water.

Chemistry 111

Teaching suggestions

Other reactions such as nuclear reactions could be included here.

A further extension for level 1 students could be the introduction of redox reactions and the identification of oxidation and reduction reactions.

Chemical Changes con't

Tasks for Instruction and/or Assessment

Paper and Pencil

- Describe the energy changes involved when two atoms come together and form a covalent bond. (114-2)
- Do atoms actually remain at the distance stated as the bond length? (114-2)

Journal

- Explain the energy involved in exothermic and endothermic reactions in terms of bond breaking and bond forming. (114-2)

Notes

PH Chemistry
Chapter 11.2, 11.3, 17.1, 18.1

Core Activities
Lab – p. 345,
"Precipitation Reactions"

Chemistry 111
Lab Manual – Lab 15, p.97
"Reactivity of Metals" (Chemistry 111)

Check NB Government Portal for current links and shared resources
https://portal.nbed.nb.ca/tr/lr/HSS/Pages/default.aspx

Solutions

(6 hours)

NB Prescribed Outcomes

Students will be expected to:

- compile and organize solution data, using appropriate formats and data treatments to facilitate interpretation of solubility. (213-5)
- explain solubility, using the concept of equilibrium. (323-4)
- identify different types of solutions (acids, bases, neutral, ionic and molecular) and their properties (conductivity, pH, solubility).
- identify dissociation and ionization equations.
- use the solubility generalizations to predict the formation of precipitates. (323-8)
- conduct a precipitate lab and include recording, observing and collecting data, writing ionic and net ionic equations, and analyzing results.

Elaborations

Students should explain and give examples of solutes, solvents, and solutions. Students should explain and give examples of the following terms: diluted, concentrated, saturated, unsaturated, supersaturated, electrolytes and non-electrolytes.

Students should explain and give examples of intermolecular forces of attraction between solute and solvent particles.

Students should understand that particles of solute will continue to dissolve until the solution becomes saturated. They should relate saturated solutions to the concept of equilibrium in that the rate of dissolving equals the rate of crystallization at the saturation point.

The concept of "dynamic equilibrium" should be addressed. Although the dynamic equilibrium cannot be seen by the naked eye, students can relate to the shape of the crystals of excess solute as they change over time since crystallization and dissolving occur simultaneously at the same rate.

Students should conduct a precipitate lab (Aqueous Solution Reaction) that includes recording, observing and collecting data, writing ionic and net ionic equations, and analyzing results.

Teaching Suggestions

Students might begin these tasks by listing what they know about solutions in their lives and they might also identify similarities and differences between solutions and terms they have heard before.

Examples of familiar compounds bring solutions into the students" framework. Kool-aid, air, and brass are examples that the students can relate to. Suspensions such as milk might be discussed. Other compounds might include some of the following chemicals: $Na_2S_2O_3$, used for photograph development; $NaClO$, sodium hypochlorite used as household bleach; $Ca_3(PO_4)_2$, calcium phosphate, used in fertilizers; $C_4H_4Au_2CaO_4S_2$, used in rheumatoid arthritis treatment.

Students could organize their examples of solutions in a chart to show that solutions can be created from various combinations of solids, liquids, and gases.

From a simple demonstration during class, the general properties of a solution could be identified and discussed. Students could make another chart containing solution properties and the evidence to support the properties. Conductivity could be used here to determine if a solution is an electrolyte or non-electrolyte. Providing diagrams showing the interaction between solute and solvent particles during the solution creation process could be helpful.

Students could grow a crystal over an extended period of time ($CuSO_4$ works very well). The use of solubility curves, solubility calculations, saturated solutions, managing temperatures and the rate of evaporation will teach this concept. This could be a class competition for the largest crystal.

Students could write ionic and net ionic equations for all reactions to provide evidence for which substances produce precipitates. Through deductive reasoning, students might see patterns, from their data and identify develop explanations of how solubility and precipitation are related.

Solutions con't

Tasks for Instruction and/or Assessment

Paper and Pencil

- Draw a concept map to show the links among solutions, solvents, solutes, electrolytes, and non-electrolyte. Add other terms if needed. Explain the links between the terms. (213-5)
- You have a solution of table salt in water. What happens to the salt concentration as the solution boils. Draw pictures to show the particles before, during, and after boiling. (213-5)
- List ten (10) solutions you encounter in everyday life. (213-5)
- Write an ionic and net ionic equation for the following: Aqueous potassium hydroxide is mixed with aqueous iron(II) nitrate. A precipitate of iron (II) hydroxide is formed. (323-8)
- Research why large doses of vitamin A are potentially more toxic than large doses of vitamin C. (323-8)

Presentation

- Draw the positions of the particles to represent each of the following: sugar in water, an alloy such as a dental filling, a suspension such as a beam of light through fog. Present your interpretation of the diagrams to the class. (213-5)

Performance

- Perform an experiment involving the creation and testing of unsaturated, saturated, and supersaturated solutions. (213-5)
- Crystal growing competition teaches these concepts very well.
- Develop a simple test that can be used to determine if a solution is unsaturated, saturated, or supersaturated.
- Design and conduct an experiment on precipitates. Calculate % difference from predicted and experimental. Report your qualitative operations and write ionic and net ionic equations. (323-8)
- Perform a lab to separate combinations of two or three ions. Include a flow chart to illustrate your reasoning. Produce a table of solubility for your lab report that includes organized data, accurate observations, and logical reasoning used to determine the identity of the ions. (323-8, 214-10)

Portfolio

- Include your laboratory report(s) in your chemistry portfolio. (213-5, 323-7, 214-10)

Notes

PH Chemistry
Chapter 11.3, 15.1, 15.2, 18.3

Check NB Government Portal for current links and shared resources
https://portal.nbed.nb.ca/tr/lr/HSS/Pages/default.aspx

Solubility Curves *Chemistry 111*

NB Prescribed Outcomes

Students will be expected to:

- perform a lab involving solubility curves.
  - plot the solubility and average temperature data.
  - calculate solubility and perform calculations involving solubility.
- identify and explain sources of error and uncertainty. (214-10)

Elaborations

Students should become familiar with the common method of expressing the solubility of a substance (#g solute/100mL solvent) and understand that solubility value must be accompanied by a temperature value. They should be able to read solubility values from a chart or solubility curve, and perform calculations based on these values.

Students should perform an experiment involving solubility curves. A collaborative approach could be employed such that the entire class data is used to construct the solubility curve. Students could discuss error, source of error, and ways to minimize or eliminate the sources of error.

Teaching Suggestions

One possible lab that students could perform involves dissolving known masses of solute in various amounts of warm solvent and allowing the solutions to cool until a solid begins to form. The temperature, solute mass, and solvent volume information would be recorded. Each group would repeat the mass they used.

Students could use the class data to plot a solubility curve, perhaps of NH_4Cl or KCl. Once the curve is constructed, students could then use it (interpolate and extrapolate) to determine the solubility of their substance at various temperatures in which they have not collected data.

Solubility Curves ***Chemistry 111*** *con't*

Tasks for Instruction and/or Assessment

Paper and Pencil

- The solubility of a substance in aqueous solution is 22g/ 100mL at 50^{o}C. Calculate the quantity of solute in 200 mL of water at 50^{o}C.
- A saturated solution of KNO_3, in 1 00g of water, is cooled from 50^{o}C to 20^{o}C. Calculate the quantity of solute that remained in the solution. Calculate the quantity of solute that is crystallized.

Performance

- Plot the solubility curve of NH_4Cl. Compare the solubility at a given temperature with the accepted value. (214-10)

Portfolio

- Include your laboratory report(s) in your chemistry portfolio. (213-5, 323-7, 214-10)

Presentation

- Research the use of solubility principles to remove a pollutant, such as Pb^{2+}, Cl^{-}, PO_4^{3-}, or SO_4^{2-}, from waste water. Present your research
- Choose a career related to working with solutions. Present to the class the part of the career that involves understanding solubility. Your presentation could be actual, audiovisual, multimedia, or you could act the part of your career by dressing appropriately. (323-8)

Notes

Not covered in text

Check NB Government Portal for current links and shared resources *https://portal.nbed.nb.ca/tr/lr/HSS/Pages/default.aspx*

Solution Concentration

(6 hours)

NB Prescribed Outcomes

Students will be expected to

- determine the molar solubility of a pure substance in water. (322-6)
  - calculate the concentration in mol/L or molarity, M, of solutions based on mass and/or moles of the solute (or solute ions) and volume of the solution.
  - calculate concentration as %weight/volume (%w/v), % volume and parts per million (ppm).
  - practice preparation of a standard from a solid, and performing a dilution to produce a standard solution.
  - know that [ ] always implies concentration in mol/L.
  - perform experiments involving the creation of stock solutions and relevant calculations.
  - perform experiments involving dilutions and relevant dilution calculations.
- identify and describe science- and technology-based careers related to solutions and equilibrium. (117-7)

Chemistry 111

- differentiate between molarity and molality.
- demonstrate an understanding of colligative properties.

Elaborations

Students should be able to calculate the molar concentration (molarity) in mol/L, or M, of solutions based on mass and/or moles of the solute and volume of the solution. Students should make stock solutions in the lab of a specified concentration and volume.

Students should identify a career related to solutions and concentration. A description of the career, the importance of solubility and concentration, and the technology involved could be presented in creative formats.

Teaching Suggestions

The solution types and concentrations could be based on solutions that may be required in further experiments for qualitative analysis (precipitation experiments, electrochemical cells, etc). Solutions should contain appropriately labeled WHMIS labels.

Students could perform an experiment involving dilutions. A standard curve could be constructed from dilutions of a stock solution. The curve could be used to determine the concentration of an unknown. Various methods could be employed to detect solution concentration such as specific gravity (specific gravity vs conc.[ ]) and light absorption (absorption vs conc.[ ]). This is an ideal opportunity for students to use graphing technology such as the TI-83 graphing calculator. Student could enter the data and have the calculator plot the corresponding graph. Using the linear regression feature, a linear equation can be obtained and used to calculate the concentration of a solution given the measured value (specific gravity or absorbance). Alternatively, students could also use the trace feature on the calculator to identify the concentration of the unknown.

Students could perform a lab to investigate “Why does salt melt ice?”. Have them quickly, put the ingredients for ice cream in a zip lock bag. Then place in a 2L container, add ice and road salt. Take temperature readings of the salt/ice mixture every 2 minutes and make a graph. Be sure to take the temperature of the air. Bonus points to the best tasting ice cream. Do not give students the recipe. No nuts, not eggs no cooking. They will need to pre-measure the ingredients. Since most recipes are designed for multiple liters, some nice ratio math is required to parse it down.

Careers to investigate could include a laboratory technologist, hospital technologist, and a chemical engineer. Examples of related work could include preventing lead poisoning by removing lead from paint, destroying a fish shipment containing a higher than legal limit of mercury, mixing gasoline and oil for boat motors, identifying the concentration of contaminants in drinking water, identifying concentration of various substances (iron, cholesterol, etc) in blood, or any other relevant context.

Tasks for Instruction and/or Assessment

Performance

- Prepare 1.0 L of a 0.50 M stock solution of NaOH. (323-6)
- Perform an experiment involving dilutions of a stock solution. (323-6)
- Perform an experiment to determine the approximate concentration of a solution given only a sample of the solution and access to lab equipment. Write a theory and procedure for the experiment. If the procedure is approved by your teacher, perform the experiment. (Assume the density of pure water is 1.00g/ml)

Journal

- What do you need to know in order to calculate the molarity of a solution? Explain. (323-6)
- Outline the steps required to prepare or dilute a solution to a specific concentration. (323-6)
- When performing a dilution, describe why the moles of solute is common to the aliquot of concentrated solution obtained and the dilute solution. (323-6)

Paper and Pencil

- Which solution would contain the largest mass of solute? The solute is Na_2SO_4 and the solvent is H_2O. (323-6)
  a) 0.12 M in 500 mL c) 0.67 M in 199 mL
  b) 0.23 M in 200 mL d) 0.080 M in 1000 mL
- Which solution would contain the largest mass of solute? The solvent is H_2O. (323-6)
  a) 0.13 M of Na_2SO_4 in 100 mL c) 0.62 M of $AlCl_3$ in 500 mL
  b) 0.42 M of NaCl in 100 mL d) 0.87 M of AlF_3 in 1200 mL
- Calculate the molarity, M, of a sodium chloride solution that has a volume of 300.0 mL and contains 25.0 g of NaCl . (323-6)

Presentation

- With a partner, make a solution of $CuSO_4 \cdot 5H_2O$ of a known molarity. Pour various volumes (10.0 mL, 15.0 mL, 25.0 mL) of the blue liquid into 3 test tubes. Answer the following questions:
  - Which contains the most solute?
  - Calculate the mass of solute in each test tube.
  - Which has the highest concentration? Explain.
  - Do these solutions have the same or different number of ions per unit volume?
  - Present your answers to the class. (323-6)

- In a pictorial or photo-essay, demonstrate the use of solutions and precipitates as related to a career of your choice. (117-7)

Portfolio

- Include your laboratory report(s) in your chemistry portfolio. (323-6)

Notes

PH Chemistry
Chapter 16.1, 16.2,

Chemistry 111
Chapter 16.3

Core Activities
Lab – p.497,
"Making a Solution"

Check NB Government Portal for current links and shared resources
https://portal.nbed.nb.ca/tr/lr/HSS/Pages/default.aspx

Solubility

(2 hours)

NB Prescribed Outcomes

Students will be expected to:

- explain the variations in the solubility of various pure substances, given the same solvent. (323-7)
  - explain the factors that affect dissolving and the rate of dissolving (temperature, pressure etc.).
  - explain how ionic and molecular compounds form solutions by relating the dissolution to intermolecular forces and forces of attraction.
  - describe the solubility of ionic and molecular compounds in polar and nonpolar solvents.
  - develop an understanding that solutions are mixtures formed by the physical mixing at the particle level and do not involve a chemical change.

Elaborations

Students should be able to explain how ionic and molecular compounds form solutions by relating solutions to intermolecular forces. Students should explore solubility and how it relates to temperature and pressure. Situations such as salt water heated on a stove or soda pop cooled in the refrigerator might be used as examples.

Students should make generalizations about the solubility of solutes in solvents such as “like-dissolves-like”. They should understand that solutions are mixtures formed by the physical mixing at the particle level and do not involve a chemical change.

Students should recognize that the solubility generalizations are not comprehensive. Students should offer plausible explanations as to why there may be exceptions to the generalization. For example: ethanol dissolves in water but hexanol does not (or very little); most ionic compounds dissolve in water, but some do not ($BaCO_3$).

Students should investigate when a substance will dissolve in another substance.

Teaching Suggestions

Predictions might include whether a given solute will dissolve in a given solvent.

Students could examine solubility data of sugar or salt at various temperatures. Interpretation of data tables or graphs could be used to help make generalizations about pure substances and their solubility.
Students could describe the bonding forces related to “Where is the best place to go trout fishing?” This would depend on the solubility of O_2 in the H_2O.

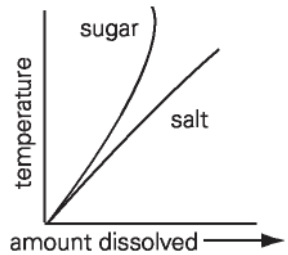
Teachers might wish to have a discussion about one of the following, relating it to how a solution forms: solubility of vitamins in water or oil; cleaning clothes with water and with tetrachloroethane, ($C_2H_2Cl_4$); cleaning up oil spills.

Solubility con't

Tasks for Instruction and/or Assessment

Paper and Pencil

- Compare the solubility of salt and sugar with reference to the graph. (323-7)



Journal

- List the factors that affect the rate at which a solute dissolves in a solvent. Explain how each factor can increase the rate. (323-7)

- Which, if any, of the factors that affect the rate of dissolving will also affect the solubility? Explain. (323-7)

- The solubility of gases in liquids is opposite of most solids in liquids. Gases become less soluble as the temperature of the solution increases. Explain this phenomenon with reference to your understanding of solubility. (323-7)

- If like dissolves like, why does sodium chloride dissolve in water? (323-7)

- If like dissolves like, why do some ionic compounds dissolve in water while others do not? (323-7)

Performance

- Perform an experiment to test the factors that affect the rate at which a substance dissolves. (323-7)

Portfolio

- Include your laboratory report(s) in your chemistry portfolio. (213-5, 323-7, 214-10)

Notes

PH Chemistry
Chapter 16.1

Check NB Government Portal for current links and shared resources
https://portal.nbed.nb.ca/tr/lr/HSS/Pages/default.aspx

Stoichiometric Calculations

(6 hours)

NB Prescribed Outcomes

Students will be expected to:

- Define molar mass and perform mole-mass interconversions for pure substances (323-1)

– perform stoichiometric calculations related to chemical equations – both gravimetric and volumetric.

Elaborations

Students should perform mole to mass, mass to mole, and mass to mass stoichiometric calculations. Students could use the factor-label method or dimensional analysis.

Teaching Suggestions

Students could write the complete balanced chemical equations for the complete combustion of natural gas (CH_4), ethanol (C_2H_5OH*(l)*),gasoline (C_8H_{18}*(l)*) and oil ($C_{15}H_{32}$*(l)*). Discuss the product CO_2 (g) and global warming. Ask the students how they might determine the mass of CO_2 (g) produced by burning a kilogram of each of the fuels. Discuss what other factors need to be considered when choosing a fuel.

Students could set up several problems without doing the calculations to practise with numbers and units. Students could work in groups to practise their problems and calculations. One member of the group could calculate the theoretical mass of a product from a given mass of reactant; another member of the group could then work backwards and confirm the originally given mass of reactant. This would help students develop their problem-solving strategies and communication skills. Students should predict stoichiometric results before doing the calculations.

Stoichiometric Calculations con't

Tasks for Instruction and/or Assessment

Informal Observation

- In the problem solutions, look for evidence of: variables identified, answers in correct units, logical sequence of steps, information needed to be collected elsewhere, and completed solutions to word problems. (323-1)

Paper and Pencil

- Propane, C_3H_8(g), burns in oxygen, $O_{2,}$ to produce CO_2(g) and H_2O(g). What mass of propane is needed to burn 25.0 mol of oxygen? (323-11)
- Calculate the mass of CaO(s) produced when 40.0 g of $CaCO_3$ is heated. (323-11)
- How many moles of NH_3(g) are formed when 42.0 g of nitrogen gas reacts with enough hydrogen gas? (323-11)
- Explain, in words, how you would intend to solve the problem: How many grams of NaOH are needed to react with 50.0 g of HCl? (323-11)

Presentation

- In a small group, perform a mass-mass stoichiometric calculation. Present your solution (method and calculations) to the class. (323-11)

Journal

- Without the use of data describe the steps (conversion factors, mathematical operations, etc.) involved to perform a mass-mass stoichiometric calculation. (323-11)

Notes

PH Chemistry
Chapter 12.2

Core Activities
Lab – p.367,
"Analysis of Baking Soda"

Chemistry 111
use Probeware© if available

Check NB Government Portal for current links and shared resources
https://portal.nbed.nb.ca/tr/lr/HSS/Pages/default.aspx

Limiting Reagents

(4 hours)

NB Prescribed Outcomes

Students will be expected to :

- explain the concept of limiting reagent
- perform stoichiometric calculations related to chemical equations. (323-11)

Elaborations

Calculations should involve theoretical, actual, and percent yield, and should involve limiting reagent in chemical reactions

Teaching Suggestions

As a quick introduction to the concept of limiting reagent theoretical, actual, and percent yield, an analogy can be made which links chemical equations to the creation of a hamburger. Another analogy that could be used is the use of a vending machine. The vending machine only accepts exact change. You wish to purchase an item that costs 45 cents, you have ten dimes and ten quarters. How many items can you purchase? What is the limiting amount? What is present in excess?

Students might design their own industrial experiment to identify the limiting reagent in a chemical reaction. This planning might show students the connections between chemistry and industry. By changing the amount of one reactant while the other is constant, students could calculate the effect on the product(s) yield.

Students could perform stoichiometric calculations to show the limiting reactant, the amount of excess reactant, and the conservation of mass in a chemical change. For example, tin (II) fluoride is added to some dental products to help prevent cavities. "What mass of tin (II) fluoride can be made from 100.0 g of hydrofluoric acid, HF, if there is excess tin?" might be a question in an experimental design.

Chemistry 111

Teaching Suggestions

Students might define theoretical, actual, and percent yield based on a lab they have done. Students might use a 2.0 g sample of magnesium reacting with excess hydrochloric acid. During the reaction the mass of magnesium chloride produced can be found. Students could calculate the percent yield for this reaction.

Limiting Reagents con't

Tasks for Instruction and/or Assessment

Paper and Pencil

- In the equation to make aspirin, acetic anhydride reacts with salicylic acid to yield aspirin and acetic acid.

  $C_4H_6O_3 + C_7H_6O_3 \rightarrow C_9H_8O_4 + CH_3COOH$

  Using this information, write the steps to solve the following problem: What mass of salicylic acid is needed to make two aspirin tablets, each 0.35 g? You have 50.0 g of salicylic acid. Assuming a 100% yield, is it enough? Justify. (323-11)
- Calculate the theoretical and percent yield if you have 300.0 g of salicylic acid and 240.0 g of aspirin are produced. (323-11)
- Distinguish between the limiting reagent and the excess reagent in a chemical equation. (323-11)

Presentation

- In groups, create an analogy that relates a common event (making a sandwich, bicycle assembly) to the concept of limiting/excess species, and actual/theoretical/percent yield. Present your analogy to the class. (323-11)

Journal

- Identify and describe three methods of mathematically determining the limiting reagent of a chemical reaction. (323-11)

Notes

PH Chemistry
Chapter 12.3

Core Activities
Lab – p.372,
"Limiting Reagents"

Lab Manual – Lab 20, p. 127,
"Balanced Chemical Equations"

Check NB Government Portal for current links and shared resources
https://portal.nbed.nb.ca/tr/lr/HSS/Pages/default.aspx

Stoichiometric Experimentation

(2 hours)

NB Prescribed Outcomes

Students will be expected to::

- design stoichiometric experiments identifying and controlling major variables. (212-3)
- predict how the yield of a particular chemical process can be maximized. (323-13)
- use instruments effectively and accurately for collecting data. (213-3)
- select and use apparatus and materials safely. (213-8)
- identify and explain sources of error and uncertainty in measurement using precision and accuracy. (214-10)
- communicate questions, ideas, and intentions, and receive, interpret, understand, support, and respond to the ideas of others. (215-1)

Elaborations

Students should do a minimum of two stoichiometric labs (including a titration) involving the number of moles, the masses of some reactants and/or products, and the theoretical and percent yield for a reaction. Possible reactions might include the following:

$Zn\ (s) + 2HCl\ (aq) \rightarrow ZnCl_2\ (aq) + H_2\ (g)$
$CaCl_2\ (aq) + Na_2CO_3\ (aq) \rightarrow CaCO_3\ (s) + 2NaCl\ (aq)$

Teaching Suggestions

Students could predict how to maximize the yield of a chemical process in consideration of proper collection techniques and use of equipment.

Students could defend an hypotheses or a prediction by explaining supporting data.

Students could design a stoichiometric experiment that is safe to do in the laboratory.

Students could identify the variables to be manipulated and controlled, the instruments to be used to collect data, and the possible sources of error that might result.

Teachers could give a reaction that students might use, such as the decomposition of $NaHCO_3$, baking soda. Students should only do the procedure if the teacher approves. Students should follow safety procedures that have been discussed in class, such as wearing goggles and a lab apron/coat. Students should practice the proper techniques for using lab equipment. Disposal of materials could be discussed with reference to WHMIS.

Students could record possible decomposition reactions for $NaHCO_3$ to see which reaction might result.

After doing the approved lab, students should record their data in a table, list their procedure, and analyse their results. Students could evaluate the method used to collect data and what sources of error could be identified. Students should know and give examples of precision and accuracy.

Discussion could focus on the minimum loss of product(s), or on techniques used to collect information. Students do not need to do uncertainty of mass in terms of “±” at this level. Teachers might want to discuss this with reference to the uncertainty of a student‟s mass on a balance. If given an accepted value and a table of collected data, students could comment on the precision and accuracy of laboratory results. The lab could be reported in a variety of formats, such as a lab report, discussion among peers, a memo, or an abstract.

Stoichiometric Experimentation con't

Tasks for Instruction and/or Assessment

Performance

- Perform a lab on theoretical and percent yield. (212-3, 213-3, 213-8, 214-10, 215-1, 323-13)

Paper and Pencil

- Given the objective, materials, and equipment, write the theory and experimental procedure for a stoichiometry experiment. (212-3, 213-3, 214-10, 215-1, 323-13, 213-8)

- Write a summary report of a plan for the production of a chemical. Include the list of equipment needed, the cost, the chemical equation with masses and moles, and the theoretical and percent yields of the product. Possible sources of error should be included. (212-3, 214-10, 114-4, 323-13)

Presentation

- Deliver an oral report of two to five minutes detailing your stoichiometric experiment. (212-3, 215-1, 114-4)

- Work in small groups to design two or more experiments to demonstrate stoichiometric relationships. As each group presents its experimental design to the class, classmates should assess the design using criteria developed collaboratively before the activity. A checklist (self and peer) could be used for this assessment. Criteria might include correct use of chemistry principles and of lab equipment, identification of variables, creativity, proper vocabulary, safety, and possible error sources. (212-3, 213-3, 213-8, 214-10, 215-1, 323-13)

Portfolio

- Place a copy of your laboratory report(s) in your chemistry portfolio. (212-3, 214-10, 215-1, 323-13)

Notes

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Applications of Stoichiometry

(2 hours)

NB Prescribed Outcomes

Students will be expected to:

- identify various stoichiometric applications. (323-12)
- communicate questions, ideas, and intentions, and receive, interpret, understand, support, and respond to the ideas of others. (215-1)
- compare processes used in science with those used in technology. (114-7)
- analyse society"s influence on science and technology. (117-2)
- identify various constraints that result in trade-offs during the development and improvement of technologies. (114-4)

Elaborations

Students should identify various applications of stoichiometry and be able to discuss the maximum yield with reference to supporting data. Students should compare lab work and technology use and decide, with reasons, how society influences chemical production.

Teaching Suggestions

Students will be more engaged and motivated if they are exposed to examples of stoichiometry in their everyday lives. Examples that could be considered are commercial production of H_2O_2, the production of Kevlar, cis-$Pt(NH_3)_2Cl_2$, which is used in cancer therapy, $CaCO_3$ or $Mg(OH)_2$ antacid production, pollution clean-up, photography using $I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$, heating camping meals using $CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(s)$ + heat.

Students might compare stoichiometry used in both science and technology by using chemical reaction examples. For example, in a coal generating plant, SO_3 emissions should be prevented from being released into the atmosphere. The SO_3 is treated with calcium hydroxide to produce gypsum according to the reaction: $SO_3(g) + Ca(OH)_2(s) + H_2O(l) \rightarrow CaSO_4 \cdot 2H_2O(s)$

Without this or a similar reaction, SO_3 would be released and would contribute to the problem of acid rain. Knowing how much sulfur trioxide is released from the coal can help the industry provide adequate calcium hydroxide for the reaction.

Students could report on how society influences science and technology.

A report on aspirin could include aspects such as how to maximize purity, commercial potential, costs, and amounts. The conflict between maximizing purity and maximizing yield might lead students to look at other factors that might influence a chemical reaction. Students might include chemical equations for evidence in their report.

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Teaching Suggestions

Students might conduct research on a variety of industrial processes such as extraction of gold, production of aspirin, neutralization of acidic lakes, and electroplating.

Students might investigate safe commercial examples of chemical processes and discuss these reactions in terms of the usefulness to society, technology trade-offs, and the intentions of the producer of the products. The commercial preparation of urea or water softeners or aspirin or replacement of CFCs might be examples of interest to students.

Applications of Stoichiometry con't

Tasks for Instruction and/or Assessment

Paper and Pencil

- Identify and explain two stoichiometric applications. How does/ did society influence the science and technology of the applications? (117-2, 114-4)

Presentation

- Using multimedia, present an industrial process. Include data, yield of the product, technology information, societal issues, and the chemistry involved. (323-12, 215-1, 114-7, 114-4)

Journal

- How does the stoichiometry you have studied help your understanding of chemical processes? (117-2, 323-12)
- Identify industrial constraints where an increased yield is technologically feasible but not cost-effective. (114-4)
- Write about a safe commercial chemical process. (114-4)
- Is the technology involved in chemical production always helpful to society? (114-4)

Notes

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Gas Laws and Stoichiometry

(5 hours)

NB Prescribed Outcomes

Students will be expected to:

- describe the behavior of ideal and real gases in terms of the kinetic molecular theory.
- convert between the Celsius and Kelvin temperature scales and express atmospheric pressure in a variety of ways, including mm of Hg, torr, atm, kPa .
- perform calculations, using Boyle"s, Gay-Lussac"s and Charles" laws, and illustrating how they are related to the combined gas law.
- define an ideal gas, and relate Boyle"s, Charles", and Avogadro"s laws to the ideal gas law.
- explain Avogadro"s law and molar volume.
- determine molar volume under constant conditions, using molar ratio in balanced chemical equation.
- define STP and SATP and the molar volume of an ideal gas at STP and SATP
- perform stoichiometric calculations based on the ideal gas equation, PV = nRT, under a variety of conditions, e.g., standard temperature and pressure (STP), standard ambient temperature and pressure (SATP).

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- explain Graham"s Law of Diffusion.
- explain Dalton"s Law of Partial Pressures.

Elaborations

A model of the gaseous state of matter provides insight into molecular behaviour. Students should be able to demonstrate an understanding that the behavior of gases has been extensively described and relationships quantified by the kinetic molecular theory.

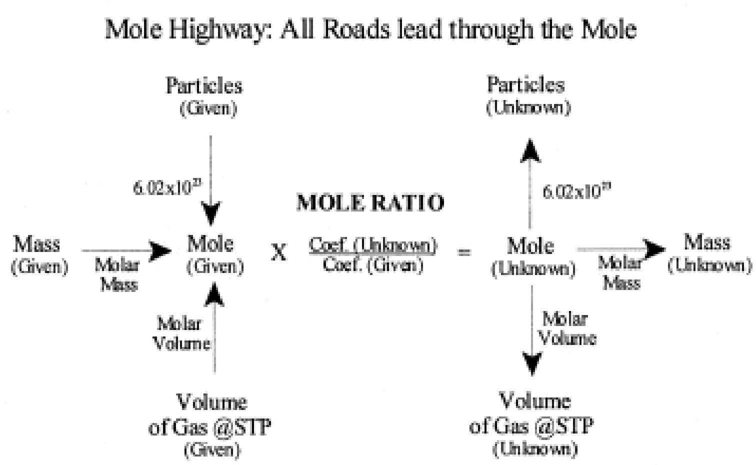
Demonstrations should be done to illustrate Boyles Law (e.g. Cartesian Diver) and Charles Law.

Teaching Suggestions

A possible demonstration would be to heat a pop can with a little liquid and then flip it upside down in cold water, thereby crushing it
OR observe as a balloon is submerged in liquid nitrogen.

A lab or demonstration can be done to determine the molar mass of a gas using PV = nRT.

Teachers might use strategies to help students to organize their calculations such as the mole highway or the mole heart.



Gas Laws and Stoichiometry con't

Tasks for Instruction and/or Assessment

Notes

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Chapter 14.4

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Appendix A MATERIALS LIST FOR PRESCRIBED ACTIVITIES

Chemistry 11

Unit 1 – From Structures to Properties		
Topic	**Activity**	**Materials**
Classification of Matter	**Inquiry** – p. 6, *"Solid or Liquid?"*	teaspoon, cornstarch, bowl, water
	Inquiry – p.38, *"Classifying Matter"*	cups, scotch tape, pen, half cup measure, water, half teaspoon measure sugar, baking powder, flour, baking soda, stirring rod, stop watch
	Quick Lab – p. 45, *"Separating Mixtures"*	marking pen, filter paper, metric ruler, clear tape, pencil, rubbing alcohol, clear cups, clear plastic wrap
Underlying Structure of Matter	**Small Scale Lab** – p. 120, *"The Atomic Mass of Candium"*	coated candy (various colours), balance, pencil, paper
	Inquiry – p. 186, *"Shapes of Crystalline Materials"*	clear cups, distilled water, ruler, spoon, sodium chloride, sucrose, sodium hydrogen carbonate, magnesium sulfate, magnifying glass
Elements and Compounds	**Inquiry** – p. 252, *"Element Name Search"*	labels from food and household items
	Small Scale Lab – p.267, *"Names and Formulas for Ionic Compounds"*	pencil, paper, ruler, reaction surface (glass?), $AgNO_3$, $Pb(NO_3)_2$, $CaCl_2$, Na_2CO_3, Na_3PO_4, NaOH, Na_2SO_4
	PEI Lab *"Identifying Elements using Flame Tests"(Appendix B)*	Splints, burner flame (Bunsen burner), lithium chloride, calcium chloride, copper (II) nitrate, strontium chloride, potassium chloride, copper (II) chloride, strontium nitrate, sodium sulphate, potassium nitrate
Chemical Bonding	**Lab** – p.200, *"Analysis of Anions and Cations" (**Caution**: use a stirring rod instead of a pipette)*	pencil, ruler, medicine droppers, paper, reaction surface, sodium sulfate, hydrogen nitrate, sodium phosphate, silver nitrate, hydrochloric acid, lead (II) nitrate, potassium iodide, potassium chloride, iron (III) chloride, sodium hydroxide, potassium thiocyanate (KSCN)
Molecular Shape – VESPR Theory	***Lab Manual*** – Lab 11, p.73 *"Molecular Models"*	ball-and-stick models

Unit 2 – Stoichiometry		
Topic	**Activity**	**Materials**
Molar Mass	**Small Scale Lab** – p.304, *"Counting by Measuring Mass"*	water, sodium chloride, calcium carbonate, plastic spoon, weigh paper, watch glass or beaker, balance, pen, paper, ruler
	Lab Manual – Lab 13, p. 85 *"Empirical Formula Determination" (optional teacher demonstration)*	goggles, crucible with lid, clay triangle, ring stand, ring support, crucible tongs, gas burner, balance, magnesium ribbon, exposed film
Chemical Changes	***Lab Manual*** – Lab 15, p.97 *"Reactivity of Metals" (Chemistry 111)*	goggles, apron, rubber gloves, glass marking pencil, 8 test tubes, metal strips (copper, zinc, magnesium), 5%W/V in dropper bottles (lead (II) nitrate, silver nitrate, copper (II) sulfate, magnesium chloride, zinc chloride, sodium chloride, potassium chloride, steel wool, test tube rack, 3 dropper pipettes, tweezers
	Small Scale Lab – p. 345, *"Precipitation Reactions"*	pencil, paper, ruler, reaction surface, silver nitrate, lead (II) nitrate, calcium chloride, sodium carbonate, sodium phosphate, sodium hydroxide, sodium sulfate, sodium chloride
Solution Concentration	**Small Scale Lab** – p.497, *"Making a Solution"*	sodium chloride, water, 50 mL volumetric flask, balance
Stoichiometric Calculations	**Small Scale Lab** – p.367, *"Analysis of Baking Soda" (Chemistry 111 use Probeware© if available)*	baking soda, plastic cups, soda straw, balance, pipettes (hydrochloric acid, sodium hydroxide, bromothymol blue), pH sensors (Chemistry 111 only)
Limiting Reagents	**Small Scale Lab** – p.372, *"Limiting Reagents"*	200 mL graduated cylinder, balance, 250 mL Erlenmeyer flask, balloons of same size, magnesium ribbon, hydrochloric acid (1M)
	Lab Manual – Lab 20, p.27, *"Balanced Chemical Equations"*	Goggles, 6 large test tubes, test tube rack, 50 mL burettes (2), twin burette clamp, ring stand, glass marking pencil, 250 mL beaker (2), 6 rubber stoppers, ruler, dropper pipette, spot plate, plastic wash bottle, 0.5M lead (II) nitrate, 0.5M sodium iodide

Appendix B IDENTIFYING ELEMENTS USING FLAME TESTS

Name ______________________

Purpose

To observe the flame colours of known chemical samples
To determine the elements present in unknown samples using their flame colours

Introduction

When atoms are heated an electron in the ground state may absorb energy and jump to an outer level. The electron is now in the excited state. When the electron moves back top the ground state, the energy is emitted. Some of this energy can often be seen as visible light of very specific wavelengths (colours).

Each element emits its own particular wavelengths of light , different from every other element. Thus the light emitted can be used to identify the element.

You will test individually a set of splints each of which has been soaked overnight in concentrated solution of a chemical. You will note the colour of the flame produced and use these observations to determine which element is present in three „unknowns".

Important :
Number each splint before soaking
Do NOT allow the splints to dry out. Dry splints will catch fire and create smoke !! The wet ones will not do this !!

Procedure

1. Obtain a set of the numbered *wet* splints (do NOT allow the splints to touch and thus contaminate each other).

2. Place each of the first ten splints in turn in a burner flame. Record the colour of the flame produced.

Note : You will probably see several shades of red that will need further distinguishing. You can do this by using the splints a second time to check the colour.

Results

Compound Name	Compound Formula	Flame Colour
1. lithium chloride		
2. calcium chloride		
3. copper (11) nitrate		
4. strontium chloride		
5. sodium chloride		
6. potassium chloride		
7. copper (11) chloride		
8. strontium nitrate		
9. sodium sulphate		
10. potassium nitrate		
11. unknown #1		
12. unknown #2		
13. unknown #3		

Conclusions

1. Which part of the compound (metal/ non-metal) is responsible for the colour of the flame? Explain.

2. Identify the elements present in the three unknowns.