How self-directed learning impacts academic success

by

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ABSTRACT

Self-Directed Learning (SDL) and academic success are defined through a literature review while the positive and negative attributes of SDL are described and analyzed in order to contrive a model that will allow students to be academically successful in the context of Alberta's education system. This project aims to assist teachers in expanding their knowledge of the many facets of SDL and the best possible way to integrate SDL into their classroom and schools as per the Government of Alberta's mandate in order to ultimately assist their students on their educational journey. A quasi-experimental approach is taken to conclude whether or not SDL and academic success are correlated to one another by evaluating students' academic success in a traditional classroom in comparison to students in an SDL learning environment.

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Chapter One

"The world as we have created it is a process of our thinking. It cannot be changed without changing our thinking." – Albert Einstein

Self-directed learning (SDL) is not a new topic or idea to education. In fact, my mother told me that when she first started teaching, thirty some odd years ago in Alberta, that SDL was considered to be the newest and best teaching method. She said that having kids in the driver seat of their own learning was quickly replaced by the next educational methodology which in turn was also replaced by something bigger and better. The Government of Alberta is now promoting SDL through their Framework for Student Learning which focuses on competencies for engaged thinkers and ethical citizens with an entrepreneurial spirit (Alberta Education, 2011, p.1). I was intrigued to hear that this proposed redesign of our current education system was not new and I am interested to see what it will look like in today's educational context. It seems as though we have come full circle but will this just be another educational fad or will it actually be implemented in a way to assist the students in our classrooms?

I was attracted to SDL initially because of my Progressivist ideals which Eisner (1995) explains as an educational ideology based on a dynamic view of the human population. Progressivists do not simply see students as passive participants who are to be filled with knowledge but instead as individuals whose feelings, life experiences and environment all affect and contribute to their ability to learn. Eisner also stresses that Progressivists do not see curriculum as a static body that is handed down by government agencies or administration but instead curriculum should be situational and problem-centered. SDL mirrors Progressivism as it allows for adaptations to be made on behalf of the learner based on a flexible construct of knowledge that can be transformed.

The Government of Alberta and the Edmonton Catholic School District are continuously introducing different initiatives to improve education that are for the most part imposed upon the different stakeholders within the educational community such as the Alberta Initiative for School Improvement or the Student Ministerial Order for Inclusive Education. A noted above, the Government of Alberta is employing their Inspiring Education Initiative (2010a) which intends to transform the current education system through a set of principles which includes a learner-centered, flexible approach such as SDL.

My school is currently implementing SDL which dictates the role of the teacher, the way in which a classroom is run and how students learn. The implementation of this initiative directly affects current teaching methodologies and will have implications for students and all stakeholders therefore I feel it is imperative that educators be aware of not only the information being provided through our government and school board's initiative but also what the literature reveals about the topic of SDL. SDL proposes changes that will directly affect every teacher in the province and will upset the traditional teacher-student role. This is when controversy and back lash from teachers can occur as they feel these initiatives are being forced upon them and supplied with only the essential and basic information about these imposed changes. Most teachers will strongly advocate for their students and if teachers are educated about SDL there is a greater chance they will buy into the process as they will see how it can positively impact the learning in their classrooms.

I had many misconceptions about SDL as I was not adequately educated about the topic however, upon reflection I realized that I had actually been a student in an SDL program. In grade two I was selected to be part of an Academic Challenge (AC) group where students from different grades all collaborated to learn about various topics that we selected in addition to our regular classroom studies. I loved this class! It was the main reason why I enjoyed going to school. We got to research, discover and experiment with new ideas and materials that personally intrigued us. We got to be independent, creative and responsible for our own learning. The teacher was there to support us and answer our questions but never assigned deadlines and encouraged us to collaborate with our peers and experts in various fields. When we felt we had completed our task, we submitted it. Assuming the teacher felt we had sufficiently met the goal of the project, we were then permitted to select a new topic.

Some of my favourite academic memories and experiences from elementary school are from this AC class. I never applied the term SDL to these memories until I started this project however that is exactly what these experiences were: a self-paced environment where students were in charge of their own mastery learning through collaboration with the support of a guide. Due to these positive outcomes in my own personal learning history, I'm optimistic that SDL can be beneficial for my students as well.

The goal of this project is to define self-directed learning and academic success in the context of my school while discovering the positive and negative attributes of SDL as described in the literature to contrive a model that will allow students to be academically successful. Through studying the literature, I hope to discover gaps in the research and discover in what situations SDL can be advantageous. I hope my project will contribute to the successful implementation of SDL in my school so that students will benefit from the best plausible out comes of this initiative.

Chapter Two

Educators are continuously subject to curriculum trends and topics that impact their practices and challenge their roles in the classroom. Mary Ann Wolf (2010) highlights how our current “education system is inadequate to meet the needs of tomorrow” (p.6) and is therefore failing our students. She stresses that “our education system must be fundamentally reengineered from a mass production, teaching model to a student-centered, customized learning model to address both the diversity of students’ backgrounds and needs as well as our higher expectations for all students” (p.6). Teachers “represent a growing chorus of educators across the country who are increasingly focusing on redesign for personalized learning as critical to meeting the needs of all students” (p.9). SDL is an example of personalized learning and it has “gained importance with changing philosophies concerning the roles of schooling and education” (Long and Agyekum, 1983, p.78). This literature review will explore the definitions of self-directed learning, characteristics of self-directed learning, what is being mandated by the Government of Alberta in terms of self-directed learning, the role of the teacher within a self-directed environment, the key components of self-directed learning models and how self-directed learning effects the academic success of students.

Definition of Self-Directed Learning

Self-directed learning, or SDL, does not have one specific definition common to all literature however SDL encompasses “the opportunity to choose ‘what’ is to be learned, ‘how’ it is to be learned, ‘when’ it is to be learned, and ‘how to evaluate’ one’s own progress in learning” (Krabbe, 1983, p.372). Skager (1979) identifies SDL as the intentional learning of some definite knowledge and skill that will be retained over time revealing mastery of the information and techniques. Wolf (2010) proposed SDL includes flexible, anytime, anywhere learning that is student driven through authentic learning opportunities that are competency based and focused on mastery of skills. Della-Dora and Wells (1980) see SDL as opportunities for students to make their own decisions about their education in order to learn how to become democratic citizens. Thomas, Strage and Curley (1988) view SDL as “activities that are wholly or partly under the control of the learner that are initiated and regulated autonomously” (p. 314).

Despite there not being one, cohesive definition of SDL, the literature shows the commonalities of the term SDL amongst various authors. SDL puts students at the forefront of their own learning by allowing them the choice of what, when and how they learn and are evaluated.

Muddling the Definition of Self-Directed Learning. Della-Dora (1979), Krabbe (1983), Loyens, Magda and Riker (2008), Silen and Uhlin (2008) and Skager (1979) take the time to distinguish between SDL, personalized learning, project based learning, individualized learning and self-regulated learning as these terms are at times used synonymously in the literature, however the interchanging of these terms is inaccurate. “The major difference is the student’s ability to learn to make decisions and to learn to take responsibility for one’s own learning. In individualized instruction, the teacher diagnoses the student’s needs, prescribes the remedies, and monitors the progress” (Skager, p. 372) which is contrary to the principals of SDL. “Self-directed learning, is considered to be a core concept in problem-based learning” (Silen and Uhlin, p. 461) and personalized learning which is characterized by “students hav(ing) access to a greater variety of learning experiences that include and extend beyond traditional education settings and benefit from increased community involvement in their learning” (Alberta Education, 2010a, p. 14). Loyens, Magda and Rikers observe that “SDL is often bracketed together with lifelong learning…(and) although both concepts start with the student’s intrinsic motivation to learn, they are not the same." (p. 416). They also observed that "very few literature sources describe SDL and SRL (self-regulated learning) as distinct concepts" (p.417). The authors caution that despite the relationship amongst these terms and the obvious overlap, it is important that self-directed learning not be used as an umbrella term for these various processes.

Although there is not one cohesive definition of SDL, it is imperative that other terminology is not transposed on SDL even though there are similarities between SDL and other forms of learning such as personalized learning, project based learning, individualized learning, lifelong learning and self-regulated learning.

Characteristics of Students in an SDL Environment

The literature reveals that there are many clear benefits to SDL which include the acquisition of a variety of skills, knowledge, attitudes and behaviours. Karabe (1983) states that SDL will "lead to students having an increased responsibility for their own learning, be willing and capable of learning from and with others, participating in diagnosing, prescribing and evaluating their progress and exercising self-discipline" (p. 372). Henney (1978) stresses many benefits including emphasis on higher level thinking such as analysis, synthesis and evaluation which employ critical thinking through designing, creating, problem solving and evaluating. SDL is not just about the content being covered but how the learner improves oneself through discovering their own and others' strengths and weaknesses, biases and learning styles. SDL forces students to support their work, to argue constructively, to be open-minded and to acknowledge that mistakes are not failures but steps to learning. Long and Agyekum (1983) described SDL learners as responsible, curious, and self-disciplined individuals who are confident and goal orientated with a strong desire to learn. "Children will have some skill at monitoring their thinking behaviour to determine whether they are proceeding along a productive path and they should be able to judge between answers that are current and relevant and those that are off-target, incomplete, or inaccurate." (Hudgins and Edelmand, 1988, p.264). Long and Agyekum (1983) include "intelligence, independence, confidence, persistence, initiative, creativity, (the) ability to critically evaluate one's self, patience, desire to learn and take orientation" (p.78) as some of the advantages of SDL.

Other behavioural characteristics identified by Long and Agyyekum (1983) included tolerance of ambiguity, adaptability, the ability to discover and use multiple resources, to plan and to be able to carry out that plan. Della-Dora (1979) explains that through SDL students "will also learn to prize human differences including those related to race, sex, ethnicity, religious affiliation, and social class. Students will use these differences to clarify and develop their own ideas about and their own understandings of self and others" (p.11). Della-Dora and Wells (1980) state that SDL "enhance the abilities of students to develop individual responsibility for learning to provide adequately for individual differences and enable students to examine subjects in depth" (p. 136). Thomas, Strange and Curley (1988) found that "self-directed learning activities such as goal-setting, self-control and self-monitoring improves both the on task behaviour and academic achievement" (p.316) and "it enhanced feelings of personal efficacy, increased motivation to learn, and increased effort expended on learning tasks" (p.317).

It is difficult to assess if all of these claims are true as most of these authors do not state how these positive attributes are achieved but simply that they were gained through the use of SDL. Further studies would be required to deduce whether the acquisition of these attributes are directly correlated to the use of SDL or perhaps due to other factors. These factors could include, but would not be limited to the model of SDL being run, the teacher's ability to facilitate SDL, the amount of resources available for the SDL program and the students' academic or cultural background. Based on the literature reviewed, there were no negative aspects of self-directed learning and if there were, it was due to SDL models not being carried out appropriately.

The literature states that there are multiple benefits to the learners within a SDL context both academically, metacognitively and skill wise that will enhance the learners' overall abilities to learn however more research would need to be done to discover how these attributes are acquired and if they are a direct result of SDL.

Alberta Education Mandate

Personalized learning environments are being mandated by the Government of Alberta as one of the many key areas of change found in the framework for new education legislation. The figure below (Alberta Education, 2010a) captures the competencies expected of a 21st century learner in today's classroom:

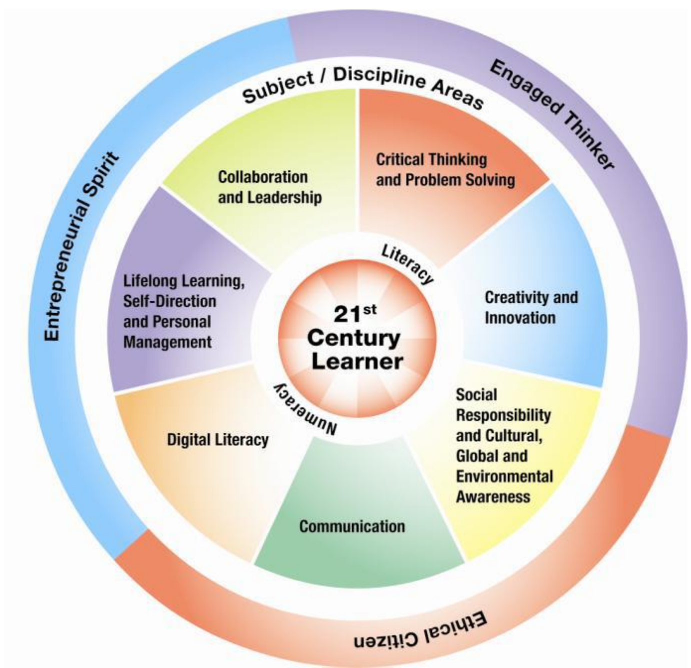


Figure 1. Alberta Education's identified 21st Century Competencies

Competencies transcend subject areas and are developed through learning approaches that include subject/discipline-specific learning outcomes. A

> competencies-based, student-focused curriculum requires the attainment of attitudes, skills and knowledge as well as values for living, learning and working. Students are engaged thinkers, demonstrate ethical citizenship, and develop their entrepreneurial spirit. (Alberta Education, 2010a, p.9)

One of the competencies is life-long learning, self-direction and personal management which is defined as the following by Alberta Education (2010a):

> Alberta students develop competencies that help them to contribute actively and positively in their communities. Throughout life, students balance various roles and life-work priorities while understanding their personal strengths, history and identity. They participate in career exploration and planning as they adapt to change and seek opportunities for personal and professional growth throughout their lives. They act autonomously, make responsible choices and demonstrate personal financial literacy, taking ownership for emotional, intellectual, physical, spiritual and social well-being (p.11).

One way to possibly achieve these competencies is through SDL as it requires students to make choices about what, how, when and where to learn as highlighted by Alberta Education "through flexible timing and pacing, in a range of learning environments" (2010a, p.14). SDL would also allow for the growth in other competencies such as collaboration, leadership, problem solving and critical thinking which are a few of the many benefits of SDL.

These many advantages of SDL are reflected in Alberta Education's competencies therefore with a flexible model of learning such as SDL, many competencies can be reached and achieved simultaneously. Just as there is no one definition for SDL, there is no one model. Alberta Education (2010a) highlights key aspects of any SDL model which include students working at their own pace with flexible hours of instruction and schedules in a way that is consistent with their individual learning style with increased community involvement to support and optimize student success through the development and sharing of knowledge.

SDL is only one component of achieving the Government's goal of having our school system produce 21st century learners. The document defines and explains the multiple components listed as well as their benefits to learners however no instruction is given on how to specifically achieve these items. The document also fails to establish where the funding will come from to support these initiatives, how stakeholders will be supported throughout these changes or how these initiatives will be successfully implemented into the current education system.

The Role of the Teacher in a Self-Directed Classroom

Krabbe (1983) states the "undoubtedly, the strongest way of enhancing self-directed learning in the student is to surround the student with self-directed teachers. The leadership role of the teacher is that of a helping professional, a self-actualized and self-directed individual who supports and facilitates these characteristics in others." (p373). The teacher in a SDL learning environment should be seen as someone who "helps the students achieve the delicate balance between societal rules in a democratic society and the individual's rights and responsibilities" (p.372).

Blumberg (2000) found teachers to be controlling in the classroom which undermined SDL as it did not allow students to take responsibility or ownership of their own learning. Henney (1978) stated that "only an adult who has successfully experienced this process of learning will be likely to feel secure enough to provide children with opportunities to try it…(as) it is expected that they will then be better able to guide children in such an experience, encouraging and giving structure where needed." (p.128). The guidance and support from the classroom teacher is instrumental in allowing students to develop self-directive skills as well as their attitude which "is a crucial factor in the success of such a program" (p.129). The literature fails to evaluate how many teachers have experienced a self-directed learning environment or how many future teachers are trained at the post-secondary level to establish a successful SDL environment.

Della-Dora and Wells (1980) summarized four key guidelines for teachers to successfully carry out SDL. Firstly, the teacher needs to set realistic limits which include the level of participation a student will have in the decision making process. "Some of the most notable failures by teachers in fostering self-directed learning have arisen because teachers have not clearly explained to students what the limits of their participation can be" (p.137). Secondly, the teacher is expected to provide a variety of experiences and choices for the students. Thirdly, teachers need to have a strong grasp on the dynamics of individual and group decision making so that clear goals can be established, clarifying values, learning how to sequence events, recognizing the function of various group members so they can work effectively, establishing criteria in which to base decisions on and demonstrating a willingness to evaluate oneself and to receive feedback from others. Lastly, teachers need to be responsible for selecting what is to be learned, how the topic is to be learned, reporting what is being learned and evaluating the students' progress.

Many educators find it challenging to simply sit by and allow their students to struggle. Most students have been in a traditional school system where their education has been teacher-centered and they expect the teacher to have and provide all of the correct answers and solutions. Drexler (2010) states that teachers "are challenged to provide the appropriate balance between structure and learner autonomy in order to facilitate self-directed, personalized learning" (p.370). The role of the teacher in an SDL class must be revised in order for students to experience all of the positive attributes that SDL has to offer. The literature reveals that more control needs to be shifted from the teacher to the learner so there is increased responsibility on the student to make decisions about their own education.

The literature explored above reports that the role of the teacher in a self-directed classroom is distinct from that of a teacher in a traditional learning environment. The role of the teacher is instrumental in allowing students to learn successfully in a SDL setting. These accomplishments are impossible to achieve without extensive professional development for teachers and support from all stakeholders. The next section will discuss ways in which the traditional role of the teacher can be modified so that educators can be successfully integrated into a SDL classroom.

How to Modify the Traditional Role of the Teacher. Hudgins and Edelman (1988) reported on studies where teachers modeled behaviours that would encourage students to engage in self-directed acts. In-service training was shown to be instrumental for training and preparing teachers to do so. The literature fails to mention how this training can be successfully structured or implemented.

Drexler (2010) insists on pre-service teachers having the opportunity to experiment with SDL so they may apply these techniques successfully in their future classrooms. Sizer (1999) strongly feels that the role of the teacher cannot shift unless there is less dependence on the administration and government to make and approve the appropriate changes in order for SDL to be implemented successfully. Owen (1992) states that "we need to radically re-conceptualize our roles, and develop insight into and strategies to overcome a variety of institutional and faculty-related constraints” (p.478). Teachers need to be given proper training and need to be empowered to make decisions and to act upon their conclusions to create a SDL environment.

The teacher’s role in a SDL classroom is complex and needs to be precociously balanced between being a “sage on the stage and a guide on the side” (King, 1999, p. 30). The literature fails to acknowledge some of the short comings in regards to obtaining this role. With limited time, funds and resources for future teacher training and professional development, it is difficult to foresee how teachers would be adequately prepared to thrive in a SDL environment. Until all stakeholders see the value of SDL, it will be difficult to transform and actualize the role of the teacher in accordance with the literature.

Models of SDL

Just as with the definition for SDL, there is not one specific model for SDL. Most of the models share similar components. For example, Wolf (2010) shares five essential elements of a SDL model which include flexible learning, student-driven learning path, redefining the teacher’s role, project-based and authentic learning opportunities, and mastery or competency-based progression. Other models discuss more specifically how SDL classes or grouping of students should be managed or what techniques should be implemented to deduce the best results. It is important to note that the literature does not substantiate the improvement of academic success through any of these models however students have been reported to gain a variety of skills including creativity, decision making, higher level thinking, time management, negotiating and metacognition. Many of these skills are important to the Alberta Government’s initiative for 21st century learning as previously discussed.

Flexible Learning as a Model of SDL. Flexible learning allows for learning to take place anywhere at any time. Students may learn at home, school or out in their community individually, collaboratively or with the help of technology. Students can choose when in their day they would like to work on a task and can select how they would like to complete the task. Students can pace their own learning at a speed that is comfortable for them (Alberta Learning, 2010a). Flexible learning would allow an increase in community-based education projects that can help all stakeholders to work together in a way in which all parties benefit (Della Dora and Wells, 1980). Flexible learning is limited under the Carnegie model which is currently used in Alberta's schools. The Carnegie model designates how many hours of in-class learning is required of each student. This restricts the implementation of models such as SDL which offer flexible learning time and place. Until the current structure of our school systems is altered, educators will not be able to successfully implement SDL.

Collaboration as an Important Component of SDL Models. Della-Dora and Wells (1980) report that "most schools spend almost all their instructional time on tasks created by teachers and other educators for students…(and that) students are spending less time than ever (perhaps no time at all) in learning how to share the responsibility for directing their own learning" (p.135). Karabe (1983) suggests that teachers and students should collaboratively and cooperatively establish learning goals, subject matter and criteria.

Krabbe (1983) found that SDL encourages collaboration however that "homogeneous small groupings within a class is a deterrent to self-directed learning" (p.373) and Drexler (2010) pointed out that construction of a student-driven learning path "does not necessarily facilitate comprehension or deep understanding" as a student's "learning potential exists in what the student does with the compilation of content and how it is synthesized" (p.374).Other models suggest multiage and multi-ability groupings have been found to create an atmosphere that encourages learners to be "accepting of others' strengths and weaknesses, interests, dislikes, biases, hopes, insecurities, values, personalities etc., meanwhile gaining insight into his own" (Henney, 1978, p.129). In summary of the literature highlighted above, collaboration has been shown to reduce competition amongst students as they learn to value each other's opinions and points of views and also to successfully and respectfully communicate their own.

SDL allows for a more collaborative model of learning amongst teachers and students which puts students in charge of their own learning which is an important aspect of SDL and the competencies stressed by the Government of Alberta above.

The Chaos and Cosmos Created by SDL Models. According to Silen and Uhlin (2008), SDL reveals a juxtaposition between chaos and cosmos which is created when students are challenged to take responsibility for their own learning (p.463). Chaos refers to the learners' frustration and disorientation when first exposed to SDL and cosmos refers to the structures they construct to manage their SDL environment. The teachers' role within these models is crucial. "If the students get the impression that they can influence their learning situation and gain the competence to do so, they take responsibility and make their own decisions. If they feel abandoned and left alone, unable to manage, their behaviour will instead be characterised by dependence, looking for strategies to survive, 'right answers' and cue seeking" (p. 464). Henney (1978) states that "frustration from the ambiguity of the situation is expected and accepted as an important part in the development of a self-directed learns…The first experience for many of the students with such an unstructured approach to learning, much frustration occurs prior to the final realization of enjoyment and pride which result from self-direction" (p.128). Analyzing this dialectic can allow educators and researchers to see why certain models allow for learners to become self-directed and others do not.

The literature shows that frustration is a natural part of the SDL process however Drexler (2010) challenges educators to “imagine the potential frustration that self-regulated learning holds for students who are quite comfortably accustomed to specific teacher directions with finite expectations” (p. 370). Skager (1979) cautions educators that learning declines as situations become more anxiety provoking. If students are not properly prepared for a SDL educational system then they will not reap the benefits that it has to offer. Most of Alberta’s students are not prepared for this shift to a student-centered classroom as these competencies have not before been stressed in the explicit curriculum.

The importance of the teacher and the crucial role they play is once again highlighted in this section. Frustration seems to be a normal emotion displayed by students who have not been exposed to SDL before however there is little mention as to how to reduce this anxiety. Common sense would state that a proper model and appropriate teacher training would allow students to surpass this stage and continue on to experience achievement in the desired area.

The Role of Technology in SDL Models

Technology is an important aspect and resource for various SDL models. Drexler highlights that technology is an important aspect of a SDL model as “computers and mobile devices continue to broaden access to all types of information and learning sources” (p.373) when “often the traditional classroom setting provides a form for a limited point of view” (p.373) such as that of the teacher’s or a textbook’s. “The teacher may not be the only expert in the process. The ability to locate expertise beyond the classroom walls is a powerful benefit of a well-structured personal learning environment” (p.375) which enriches learning experiences and allows learning to apply itself in a real-life context. Technology allows collaboration with stakeholders, community members and with peers. It also permits the teacher to more easily transition out of their role as the ultimate leader in the classroom as discussed in the previous section.

Most SDL models use some sort of technology to facilitate learning. Technology allows learning to take place anywhere at any time and it also allows students find information on their own as opposed to always relying on the teacher therefore further facilitating the shift from teacher to student-centered. Despite technology's multiple benefits to SDL, many schools do not have the infrastructure in place to support the effective use of technology in and out of the classroom. Devices need to be portable and accessible. There is often a shortage of monies and funds to purchase, install, up-grade, maintain and train individuals to use the technology effectively.

Portfolios and Projects as a Demonstration of Learning through SDL

"A development portfolio may contain formative self-assessment of performance, reflections on task performance, artifacts like pictures, documents, photographs and video fragments, which indicate the failures and successes the student experienced during his or her skill development, and may also contain a plan to work on skill improvement based on performance assessments and reflections." (Kickens et al., 2009, p.454-455). These types of learning opportunities "can help increase the relevance of learning and improve students' ability to apply knowledge and use critical thinking skills" as this instructional shift can be a " better way to incorporate meaningful content and 21st century skills and to meet the interests and learning styles of many students" (Wolf, 2010, p.15).

Learning environments that foster SDL (such as portfolios or project-based learning) are believed to promote higher level thinking and processing skills primarily due to the fact that learners have the freedom to choose what and how they learn. This highlights the importance of performance outcomes through the use of effective learning strategies (Candy, 1991). Once again, there is no evidence that these models increase academic standing for students.

SDL vs. Required Learning

These various models stress mastery or competency based progressions that “provide opportunities for students to work at their own pace and to reinforce a particular skill or standard until they have mastered the content” (Wolf, 2010, p.16). Students have the flexibility to accelerate or slow down their pace of learning based on their interests, abilities and needs so that students master the information. The emphasis placed on governmental exams (such as Diploma Exams) restricts the flexibility of SDL as these assessment pieces are neither performance-based nor time-flexible. These high-stakes tests are a one-size fits all assessment pieces that do not take into account students’ varying interests, learning styles or abilities. These exams rarely test competencies such as collaboration, leadership or creativity. Our current funding model of a dollar amount for every credit earned or for the number of students in a seat is a “disincentive for a school or teacher to help advance a student faster than proficiency within a traditional or blended setting or to provide, alternative, off-campus learning opportunities” (Wolf, 2010, p. 23).

All of the models reviewed pose a challenge in balancing SDL and required learning. Price (1976) poses the central question of “how we calibrate the balance between structure and process and between self-assertion and standards of performance” (p.105). Eisner (1995) describes curriculum as “the ideologies that give direction to one of the school’s major means for addressing the aims it values” and “what school’s should teach for what ends and for what reasons” (p.47). Curriculum is the content that is mandated by the Alberta government in a document called the Program of Studies which contains a prescribed set of outcomes for a subject area at a particular grade level.

These outcomes focus on what is considered important and essential for students to learn based on our society's beliefs and values, contradictory to a personalized SDL environment which stresses an individual's interests and abilities. Our current curriculum is not competency based nor does it encourage mastery as students must complete the curriculum in a fixed amount of time. According to Schwab (1973), curriculum is something that should be created collaboratively, not something simply mandated to teachers in a top-down fashion from the government or other governing bodies. Curriculum should be co-created with all stakeholders including students, teachers and parents so all voices within the community are present and heard. According to Della-Dora (1979):

> Teachers and students cooperatively establish and use criteria for selecting subject matter. These criteria typically take into account goals, current student interests and needs, possible value for college preparation, potential value for career choice and preparation, necessary general citizenship knowledge and skill, and contributions to understanding self and others (p.5).

That means that curriculum needs to evolve to allow for "appropriate opportunities (for students) to take ownership of and responsibility for their progress, their learning and the assessment of learning" (Alberta Education, 2010b, p.1).

Until Alberta Education reduces the amount of content and specificities found in the Program of Studies for all subject areas and grade levels and in turn places a greater emphasis on assessment for learning, SDL will not be successful as students do not have the flexibility to explore their own interests or learn at their own pace.

Academic Achievement and SDL

Lavin (1965) defines academic performance as “some method of expressing a student’s scholastic standing” (p.18) which is usually represented by a grade commonly expressed as an average in a course or a group of courses in the form of a number, letter or percentage.

There have been many studies done on academic performance however very few are longitudinal therefore it is impossible to infer if there is consistency in academic performance due to a certain set of criteria. Intellectual ability measures are commonly the predictor of academic performance however multiple other factors that affect academic performance should be considered such as the student’s sex, socio-economic background, family dynamic, study habits, attitudes, interest in a topic, motivation, impulsivity, anxiety, sociability, learning style, student-teacher relationship etc.

Upon reviewing multiple different studies, Lavin (1965, p. 57) observes that the “best predictor of performance on the college level is the high school academic record”. With this in mind, the Government of Alberta suggested seven shifts under their proposal for the curriculum redesign, many of which that promote SDL such as the first and third shift (Alberta Education, 2010b):

- First Shift: less centered on the system, more centered on the student. Educators must make students the centre for all decisions and students will have more opportunities to take ownership of and responsibility for their progress, learning and assessment which will enable flexible choices that lead to personalized learning opportunities.

- Third Shift: from prescriptive curriculum with limited flexibility to more opportunities for local decision making and greater depth of study. More student choice, opportunities for broad exploration and project-based learning

Despite giving learners more control over what, how and when they learn, there was little to no variance in students' academic or leadership abilities compared to those who were not in control of these variables. Wolf (2010) notes that "each student's path may vary not only in terms of when and where learning takes place, but also in terms of the modalities and instructional strategies used, the pace and place of learning and the types of courses and topics studied" (p.15). With so many factors, it is difficult to associate achievement with one sole attribute.

Thomas, Strage and Curley (1988) caution that SDL is not for everyone and educators must be cognisant that "young children might be incapable of carrying out certain activities or disinclined to engage in these activities" (p.318) as they do not have the pre-requisite skills to be successful. It is important to consider that all students will have developmental limitations. Henney (1978) argues this point by stating that in any successful SDL model that the "the process of learning how to learn (needs to be) stressed more than the final product" (p. 129) as the "intrinsic motivation (to learn) is more effective than extrinsic, that the process of learning is more important for future development of the individual than accumulation of factual knowledge and skills" (p.129-130). Unfortunately, for most students, this is not the case as they are not exposed to SDL until high school or post-secondary making the process challenging as they have not developed the appropriate skills to be prosperous in an SDL model.

Wood (1975) completed a study which examined the "relationship between achievement (grade point average) and the degree of perceived self-direction indicated by students" (p.162).

Wood concluded that SDL (which included mastery learning) did not relate to grade point average.

Academic performance cannot be traced to a single trait or variable however academic performance at the high school level is a strong predictor of how students will do in a post-secondary situation. Most of these institutions and learning environments require students to have self-directed skills therefore it seems as though it would be beneficial for students to gain the skills attributed to SDL in order to be more academically successful. The shifts the government is proposing would allow for a more student centered, flexible approach to learning.

Conclusion

SDL offers learners many exceptional benefits which is why Alberta Education has encouraged the use of personalized learning however, it will never be as successful as possible until our current models and paradigms shift from that of a teacher-centered model to that of a student-centered classroom. Fixed learning times, numerous specific outcomes and skills assessed for learning with inadequate technology and poor teacher and student training must transform and evolve into flexible learning, competency based assessment of learning with appropriate supports for teachers, students and technology. These items will have implications on the success of SDL in Alberta and ultimately it will be how we approach and integrate these changes into our learning environments that will dictate our students' academic and non-academic success.

This project aims to assist teachers in expanding their knowledge of the many facets of SDL and the best possible way to integrate SDL into their classroom and schools as per the Government of Alberta's mandate in order to ultimately assist their students on their educational journey. The next chapter continues to explore SDL and its academic impact on students.

Chapter Three

This chapter will expand on the theoretical knowledge explored in the previous chapter in regards to the academic success experienced by students in a SDL model which Wolf (2010) defines as flexible, anytime, anywhere learning that is student driven through authentic learning opportunities that are competency based and focused on mastery of skills. The use of a quasi-experiment which is “a type of evaluation which aims to determine whether a program or intervention has the intended effect on a study’s participants” (The National Center for Technology Innovation, 2011) will be utilized to address the problem below.

Statement of the Problem

To what extent does SDL affect academic success?

Justification and Use of the Results

Throughout this chapter SDL will be dealt with from a Progressivist stand point where students are not viewed simply as “empty receptacles waiting to be filled with knowledge but that they come with personal experiences that will affect their learning… (and therefore) learning should be tailored to the individual so they may show growth” (Simon, 2000). Since no two students have had the exact same life experiences, reality will be different for each person and therefore their learning styles will differ as well (Simon). SDL mirrors Progressivism as it allows for adaptations to be made on behalf of the learner based on a flexible construct of knowledge that can be transformed.

SDL is being implemented across Alberta to adhere to the mandate presented by Alberta Education which states that competencies including lifelong learning, self-direction, personal management, collaboration, leadership, critical thinking and problem solving are to be included in classrooms in order for students to be engaged thinkers and ethical citizens while upholding an entrepreneurial spirit (Alberta Education, 2010a). These competencies however will not be altering the emphasis on academics or formal summative assessment pieces therefore it is important to analyze if SDL will able to achieve success both in the attainment of competencies and the academic success of the students.

This quasi-experiment hopes to capture quantitative evidence to support or deny the claim that SDL improves academic success through summative assessment pieces and self-reflection. If students show a strong correlation between their overall summative averages on their tests in comparison to their average on their self-reflective piece, then one could assume that SDL effectively dictates academic success. It is difficult to define what a strong correlation may be as all students are treated as individuals as per the progressivist approach. Despite our school system attaching a specific number to determine success (sixty percent and over is a pass and eighty percent and over is honours), it is impossible in this quasi-experiment to do so.

The results of this study would aid a school community to evaluate if their current implementation of these competencies in the classroom were favourable for students' academic success on various outcomes. This school would then expectantly re-evaluate their current system and assess how to improve their SDL model. The obtainment of this knowledge would hopefully result in dissemination and collaboration with other schools across the district and province to improve education for all students through professional dialogues, networking, informal mentorships and professional development.

Theoretical Framework

As explored in the literature review in chapter two, there are many obvious benefits of SDL which include the acquisition of a variety of skills, knowledge, attitudes and behaviours. The literature states that there are multiple benefits to the learners within a SDL context both academically, metacognitively and skill wise that will enhance the learners' overall abilities to learn; however, there was no direct link found between SDL and academic performance. For example, Wood (1975) looked at the relationship between academic achievement at a post-secondary level and the degree of perceived self-direction as indicated by the students and concluded that SDL had no impact on their grade point average. The literature allows the reader to assume that through the acquisition of SDL that students should perform better academically as they are improving multiple skills such as problem solving, researching, evaluating, analyzing etc. that should allow them to perform better in an academic environment. The hypothesis would be that an SDL learner would perform better academically than a non-SDL leaner due to the skills they have achieved through SDL however there is no evidence of this relationship in the literature.

To test this relationship, a quasi-experiment will be carried out. A quasi-experiment is similar to a true experiment as it "attempts to establish cause-effect relationships among the variables" however the "independent variable is identified but not manipulated by the experimenter, and effects of the independent variable on the dependent variable are measured" (Baltimore County Schools, 2010). The objective of this quasi-experiment are highlighted below.

Research Objective

General Objective. The objective of this research is to evaluate if SDL positively affects the academic success of students.

Specific Objective. The specific objective of this quasi-experiment is to determine the existence of statistically significant differences in test scores between self-directed and non-self-directed learners on specific outcomes from the curriculum.

Methodology

Operational Definition of Variables. Within this quasi-experiment, two groups of students will be exposed to SDL at different points throughout a unit to quantitatively measure if SDL improved their marks on summative assessment pieces that highlight specific outcomes from the Science 10 Program of Study in Alberta. Students will also complete a self-reflection piece at the end of the unit in the form of a self-evaluation survey.

Type of Study & General Design. Two groups of students will be exposed to SDL at different points throughout the Science 10 course. These students will both complete the same outcomes for the chemistry portion of the course as well as write the same examinations and self-reflection pieces.

Sample Selection & Size. Both classes are randomly assigned during the school's registration process however they both contain thirty two students with varying genders, ages (between fourteen to eighteen years of age) and ability levels.

Data Collection Procedure. Class A and Class B both contain thirty-two students that have randomly been assigned to the same teacher during the same semester (five months in length). Both classes will complete the appropriate outcomes as per the Program of Study for Science 10 chemistry as found in the appendix. There are three sections in this unit. As shown in the unit plan found in the appendix, Class A will receive traditional instruction for seven classes where the teacher is in control of the learning environment, delivery of content, materials and pacing for sections one and two and then they will have seven classes of SDL instruction for section three. Class B will receive SDL instruction for seven classes on sections one and two and traditional instruction for seven classes on section three. Both classes will write the same quiz at the completion of section two which includes outcomes for sections one and two and the same unit exam at the conclusion of section four which includes outcomes from sections one through three. All students will complete a self-reflection piece at the culmination of the unit.

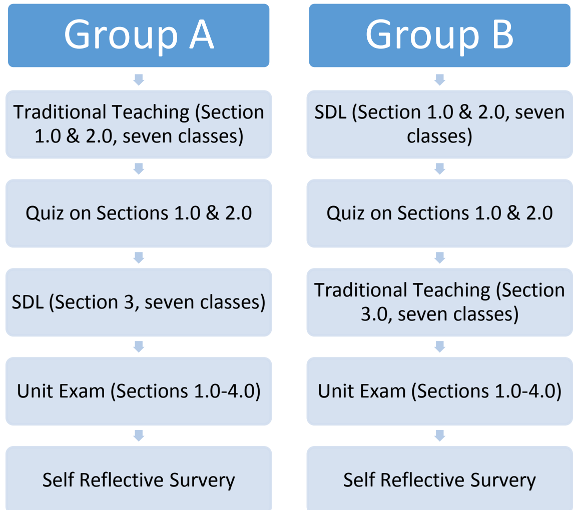


Figure 2. Timeline for the different control groups

Traditional. The word traditional in this context gives the connotation that students will have seven days to complete the assigned outcomes through teaching methods that include teacher explanations at the front of the class with the help of visual displays such as PowerPoints and videos and assigned practice opportunities (primarily worksheets/practice questions and readings from text book). Students will also have access to all of the course materials on an online classroom which include study guides for the quiz and unit exam (as found in the appendix). A sample traditional lesson plan has also been attached to the appendix for review.

SDL. The SDL portion of the course pertains to students accomplishing outcomes at their own pace however they must complete the outcomes within seven classes and must write the assessment pieces at assigned times. They can choose to accomplish outcomes as they see fit (individually or collaboratively) using a multitude of resources (textbook, teacher, peers, other experts, online etc.). The teacher will offer support and guidance when necessary. Students will have access to all of the materials that the traditional class receives including the online classroom which includes all of the PowerPoints, videos, worksheets and study guides. A sample SDL lesson plan has also been included in the appendix.

Analysis of Results

The quiz and unit exam scores will be collected and analyzed quantitatively. The scores will be compared between the two classes as well as the averages of the two classes. Analysis of individual students will also occur to see if they improved or regressed while transitioning between SDL and traditional instruction. Students will also complete a self-reflective survey that will allow them to score themselves on a scale of one to five in the following eight areas: pace of learning, adapting curriculum, using self-teaching curriculum materials and packages, using study skills, planning a work schedule, using class time, seeking answers independently and the amount of teacher direction they require with one implying a strong traditional teaching environment and five implying strong self-directed learning environment.

The students' responses to the eight reflective questions will be averaged and then compared to the scores they received on their assessment pieces. We would expect to see students with a high average (three and higher) on the self-reflection piece to also have a higher average on the outcomes that were completed in the SDL environment. If a student had a lower average (lower than three) on the self-reflective piece, we would expect to see that they scored lower on the outcomes completed in an SDL setting as they have not yet mastered the skills to be successful in this type of learning environment.

The answer to the research question would be answered by analyzing the evidence found during this process to state if self-directed learners benefitted more academically than students exposed to a more traditional learning environment. One would expect to see that students in Class B would have scored higher on both their quiz, unit exam and self-reflection as they commenced this study in an SDL environment and would be able to continue to apply these techniques during the second half of the unit when placed in a more traditional classroom allowing them to feel more confident in their abilities and skills and ultimately rating themselves higher on their self-reflective piece. Class A on the other hand should score lower than Class B on the quiz as they have only been exposed to the traditional environment but would improve on the unit exam after being exposed to the SDL environment. They would most likely score the similarly to Class A on the reflective piece as they will have improved academically overall therefore improving their self-reflection.

Limitations. Despite attempting to control as many variables as possible during this quasi-experiment it would be impossible to ultimately conclude whether or not SDL in fact dramatically affects academic standings as we are dealing with human beings in a dynamic environment. There are so many factors to consider, of which, most are out of the researcher's control such as the many examples below:

- How many students in the class are coded for physical, behavioural or cognitive disabilities?
- How many students are English language learners?
- How many students have already completed the Science 10 course and are perhaps repeating the course?
- Has the teacher had adequate development in order to facilitate a SDL environment and are the resources (monetary and materials) available to do so?
- How many students have been exposed to an SDL environment before and are better equipped to function in this type of setting as opposed to students who have strictly received a traditional delivery approach?

- How many students are passionate about science and have had positive experiences in regards to their previous science classes versus those students who have a negative outlook on the subject?
- How many students have an emotional, socio-economic or cultural background that may or may not allow them to be successful at this time?
- Are the classes evenly divided in ability or is one group stronger in regards to academics and skills?
- How many students have already completed the lower streaming of science (Science 14 & 24) in order to achieve their graduation credits and are just trying this course to see if they can be successful or the reverse, how many of these students were recommended to take the lower level stream of science but decided to attempt Science 10 regardless?
- How does a student's attendance and timeliness for class affect their comprehension of these outcomes?
- How does a student's opportunity to access various resources such as tutors affect their academic standing?
- How does a student's time table (all core classes, a balance of cores and options or all options) affect their success in comprehending the outcomes?

It is impossible to control all of these variables. In fact, according to Wolf (2010), this isn't even a true example of a SDL environment as students do not have the ability to learn when and where they want as she defines SDL as flexible, anytime, anywhere learning that is student driven through authentic learning opportunities that are competency based and focused on mastery of skills. These students would still be required to attend school during the regularly scheduled hours and would have to complete the course work during their regularly scheduled block. These students would also be forced to follow a strict time line to ensure they are completing all of the proper outcomes before the examination as the teacher is ultimately responsible to ensure that all of the outcomes are covered prior to the end of the semester when students write their common district final exam. Strict time lines do not allow for mastery learning and it is extremely difficult to test competencies on a pen and paper examination (Bloom, 1974).

A school would never allow a teacher to hand pick their classes based on ability or other factors in order carry out an experiment such as this, plus it would be an impossible task at the high school level when timetabling multiple courses.

A longitudinal study would benefit this field of research where a group of students is studied starting at the beginning of their elementary education and continuing into post-secondary to see if there are any true academic benefits for students who receive primarily a SDL education. There would still be numerous uncontrolled variables throughout this process however this would allow researchers to observe students in multiple subject areas at numerous points in a child's education so a more accurate conclusion could be drawn.

With so many uncontrolled variables, it is impossible to have conclusive evidence that SDL either does or does not support a student's academic standing however, we can create a confident hypothesis built on the literature. Overall, the findings would most likely show that SDL does not directly impact academic scoring in a class but that it does provide students with a multiple of competencies and skills that could be used to allow a student to be a stronger learner in a multitude of environments.

Conclusion

SDL is anything but simple, especially since we are applying its principals to individuals who are all unique and all come with their own history which advertently or inadvertently affects the way they learn. Strong educators will be on board with implementing any techniques in their classrooms that will help their students to learn and achieve. SDL allows for so many positive attributes and competencies to be gained by the learner however it is not practical in our current school model which restricts how, where and when students learn. SDL needs to be implemented in classrooms when it is possible and appropriate to do so. Ultimately, it is the teacher who needs to decide how their particular group of learners is going to learn best based on each of their own students' individual backgrounds and the context of the school environment. They need to create a balance where SDL is used in the classroom while still managing traditional constraints all while adhering to their program of study.

Chapter Four

The last two years of completing my Masters in Education program through the University of Victoria have been tumultuous with many highs and lows. This last chapter will be a reflective piece that will draw upon my courses and Capstone Project research experiences to discuss what aspects of my professional thinking have evolved and which aspects have been reinforced throughout this process and how I plan on applying what I have gained from my graduate experiences to my professional career in education. Finally, I will make three recommendations to other educators who would be interested in engaging in SDL.

Summer 2013

This first summer of my journey reinforced and enlightened me to my ontological and epistemological views and ideologies in regards to teaching. I knew why I became a teacher and what I valued as an educator but I lacked the language, academic experience and clarity to verbalize my beliefs and to know where they fit within educational paradigms. Educators must explore their values and ideologies since this introspective element is “at the heart of teachers’ development” (Lincoln & Guba, 2000, p. 183). Teachers cannot study their own practices or compare them to others without knowing what it is they value and believe therefore teachers must be prepared to look closely at what they say, do and think. This course required me to take a self-critical stance and it fortified my belief that teaching is not simply applying a methodology or utilizing a strategy and that the field of education is not black and white but extremely grey.

For example, I knew that as an educator I valued the whole child including their emotional and spiritual wellbeing and their background and experiences that shaped and determined who they are on a daily basis in my classroom. This reinforced my beliefs and brought clarity to my role as a teacher because I now had the ability to describe my beliefs under an all-encompassing label: Progressivism. Is this the best educational paradigm on the scale? Is it better than someone who is a Rational Humanist? Absolutely not. Educators use and adopt beliefs from multiple criterion to best fit their students at a particle point in time. This is a hard lesson for me as I like to have items in absolutes and education is anything but. Having a clearer picture of my belief system has made me a better educator as I can clearly state my beliefs, why I believe them and justify why I do what I do which is important when dealing with various stakeholders.

Fall 2013 & Winter 2014

Taking the course on instructional leadership and change forced me to be more appreciative of those in an administrative position however it allowed me to see that all educators are in a leadership position and that all educators have the ability to take on leadership roles in their classrooms, schools and districts. Leadership does not only have to apply to administration but should be taken on and upheld by all stakeholders. Neuman and Simmons (2000) state that "every member of the education community has the responsibility and the authority to take appropriate leadership roles... (as instructional leadership has been) reconceptualised to include all facets of the school community" (p. 9). Overall, I foresee myself attempting to take on more leadership roles in the future such as department head as I feel more prepared, cognisant and empathetic for those balancing the many demands and expectations placed on them from various stakeholders.

I was actually being resistant to change in regards to some of our school initiatives, primarily because they were being mandated by the school district with no thought or concern to our school's individual needs. Leaders need to be able to effectively help people to get through this implementation dip which Fullan (2011) refers to as the bumpy road leaders have in front of them from the time a change is introduced to the time the change is realized. This can only be achieved if leaders are committed to the change, display empathy for those affected by the change and find alternatives when any of their approaches get stuck.

I came to the realization that behaviours will change before beliefs therefore it is crucial to give people new experiences in non-threatening circumstances to inspire attitudinal change. In the future, if I wish to be a leader in my school, I have to allow for positive interactions to take place between peers so everyone feels supported in achieving new skill sets. Simply stating we are implementing change because the district says so will not allow you to have the support to effectively achieve any of these changes. External change needs to be embraced internally.

Summer 2014

Teachers are constantly working the dialectic between educator and researcher. We are constantly evaluating our lesson plans, classroom activities and our actions to determine whether or not they were effective and finding ways to improve them. I never viewed myself as a researcher therefore I never considered my work to be qualitative or quantitative in nature. It was fascinating to see how many different selections of research design were available and how as teachers we steal a little from every part of the spectrum. This is another section where education cannot be seen as black and white is exemplified.

Knowing the delineation between qualitative and quantitative research allowed for me to be successful for my capstone project but it also allowed me to cognisant of the fact that some do not view qualitative methods as legitimate research methods. It is important for educators to be mindful with so many paradigms and methodologies available that academics will try to force us into one research design method but why can't we pick and choose what we need from various paradigms? Ultimately, our obligation is to our students and we are going to select methods that advocate for our students, not what fits nicely into a paradigm.

As our educational system evolves from being teacher to learner-centered, educators must strive to increase collaboration and engagement in the classroom to allow for the development of inquiry, creativity, critical thinking and innovative skills. "Technology has the potential to fundamentally change learning and teaching…(as) textbooks are not meeting the needs of students (which) emphasizes the need for new generation devices and software that are easy to use and are effective" (Alyahya & Gall, 2012, p. 1266). Technology is sometimes used unnecessarily or inappropriately and this course fortified the point that it depends on the individual teacher to ensure the technology is being used to enhance the programing and not just being used for the sake of using it.

This course helped with my professional career as it made me comfortable using technology I had never interacted with and gave me assurance that it is okay to admit when you are not an expert in something. The reality is that most students are going to have more confidence and skills in technology than most teachers due to the level of integration of technology in their everyday life. Educators can learn a lot from their students and it is wonderful when they can take the lead in certain areas. Educators should allow students to help them and their peers with technological pieces as it is such a multi-faceted and dynamic area that it is impossible to be aware of all of its functions and opportunities. Being able to say “I don’t know” and asking for help is an invaluable skill we try to ingrain in our students so educators should be able to model the same behaviour.

Fall 2014 & Winter 2015

Despite having done multiple literature reviews and countless hours of research throughout this program, this was the first time I was challenged to critically evaluate a journal and its publisher. As an educator, I continuously tell my students that they need to be deductive when selecting sources for assignments and projects however I cannot say I did the same when looking up journals for my assignments. I simply trusted that because the journal was found on the University of Victoria’s library page that it was safe to use. I now feel much more equipped to evaluate literature in the future including items presented on behalf of the district or the Government of Alberta such as research findings and text books.

Completing my capstone project really reminded me what it was like to be a student and the ups and downs of completing assignments, receiving critical feedback and meeting deadlines.

It has made me a better teacher as it has allowed me to be more appreciative of my students' experiences and the struggles they go through while attempting to complete their course work and balance all of the other aspects in their lives. I quickly forgot after completing university what it was like to sit in a classroom. Having the opportunity to work the dialectic between being a teacher and a student simultaneously for two years has made me a better teacher who is more appreciative of my students' feedback and empathetic towards their individual concerns.

All of my courses have forced me to be reflective; reflective of my beliefs, reflective of my practices, reflective of this entire process. This was an invaluable experience considering the multitude of changes that are currently occurring in regards to the Alberta curriculum and the implementation of various mandates by the government such as the implementation of competencies. This program has allowed me to be at the forefront of these changes and has made me knowledgeable so I can actively participate in conversations about these transformations that will affect my school. I can effectively collaborate with my peers and I am confident in assisting my school's administration in implementing SDL in our school. It has allowed me to take on a leadership position within the school.

The intricacies of being an educator are even more apparent to me now. The complexities of our roles is endless and my drive for personal and professional improvement has only been extended through this graduate studies process. There is so much to learn and such a multitude of knowledge to be obtained. I will never be done learning or discovering something new in the field of education.

Despite the daunting task of undertaking all of these transitions and transformations, I feel that this process has affirmed that as an educator I am doing so many things right. I have discovered it is important to be reflective not only to discover how you can improve but to recognize all of the wonderful things you are doing. I find that educators are hypercritical of themselves and we fail to disclose to ourselves and others all of the amazing contributions we make to our students' lives. This process has reinforced so many of my beliefs and practices and has also allowed me to grow professionally and improve in an abundance of areas so that I continue to be successful in my role as an educator in the future.

SDL Recommendations

With the completion of this project being at hand, I would give three recommendations to those wishing to pursue the implementation and use of SDL in their classrooms or schools. This includes the ideas that SDL does not need to be implemented in an all or nothing fashion, that collaboration is key and that there is no perfect time or place for the implementation SDL.

New trends in education are often presented in a fashion that implies they are the best way to deliver all of the content in your classroom. This is not true and SDL needs to be used subjectively. I would not recommend that all content is delivered in an SDL environment despite its advantages. Attempting to implement SDL throughout the curriculum would be extremely overwhelming for both the teacher and the students as certain criteria must be met by specific deadlines and certain examinations must be written. I would recommend taking small steps by introducing SDL at specific times where the classroom dynamic and course work naturally lend themselves toward this type of teaching and learning style. Teachers should not be overhauling all of their lesson plans. They should be aiming to improve on what you are already doing.

Collaboration throughout the SDL process should not be underestimated by both the teacher and the students. I would encourage all educators to collaborate with other teachers in their school in order to build a supportive network where they have a safe place to admit mistakes, be reflective, share ideas and plan. If students have the opportunity to collaborate with one another it will allow them to build their communication, teamwork and leadership skills while improving their ability to analyze, evaluate and be independent. This will force students to struggle a little which is part of the SDL learning process. It will push students to be resourceful and to collaborate with other stakeholders and to reach out to other experts in their communities. This will allow for the teacher to effectively remove themselves from the all-knowing power position in front of the classroom to a guide who helps students navigate through issues. Collaborative skills will allow the teacher and students to gain confidence in their new found SDL roles.

Educators are currently bound to a government mandated curriculum that they are legally responsible for covering within a certain number of hours known as the Carnegie Model. This model states that students must have a minimum of one hundred and twenty hours of class time with an instructor in order for the institution to consider giving credit to the student for the specific course. This bounds schools to a model that does not necessarily allow for an abundance of flexibility however teachers need to be creative and advocate for flexible learning times and spaces for their students while still abiding to their professional obligations. It is important that the students have choice and we are advocating for them to have a voice and a say in their own education. Students having the ability to choose where and when they learn is a key aspect of SDL. We may not be able to offer them infinite possibilities, however we need to collaborate with administration to devise a successful SDL environment.

The purpose of this thesis is to disseminate the information discovered about SDL. Sharing this knowledge with other educators and stakeholders in order to improve one’s understanding of SDL and its effects on a student’s academic success was the ultimate intention through a literature review, quasi-experiment and reflection of the process.

References

Alberta Education. (2010a). *Inspiring Action on Education: A Discussion Paper.* Retrieved from https://ideas.education.alberta.ca/media/2905/inspiringeducation%20eng.pdf on July 17, 2014.

Alberta Education. (2010b). *Understanding the Shifts.* Retrieved from: http://education.alberta.ca/media/6855101/understanding%20thr%20shifts.pdf on July 17, 2014.

Alberta Education (2011). *Framework for Student Learning.* Retrieved from http://education.alberta.ca/media/6581166/framework.pdf on January 2, 2015.

Alberta Education (2014). *Program of Studies Science 10.* Retrieved from https://education.alberta.ca/media/654833/science10.pdf on March 2, 2015.

Alyahya, S. & Gall, J.E. (2012). iPads in Education: A Qualitative Study of Students' Attitudes and Experiences. *In T. Amiel & B. Wilson (Eds.),* Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications, 1266-1271. Retrieved from http://www.editlib.org/p/40913.

Baltimore County Schools (2010). *Key Components of a Research Proposal: Quantitative Proposal.* Retrieved from: https://www.bcps.org/offices/lis/researchcourse/develop_quantitative.html

Bloom, B. (1974). Time and Learning. *American Psychological Association*,(29)9, 682-688.

Candy, P.C. (1991). *Self-Direction for Lifelong Learning.* Jossey-Bass: San Francisco.

Della-Dora, D. & Wells, J. (1980). Teaching Methods: Learning Applications. *Theory into Practice*, 19(2), p.134-140.

Della-Dora, D. (1979). *Moving Toward Self-Directed Learning*: *Highlights of Relevant Research and of Promising Practices.* Association for Supervision and Curriculum Development: Virginia.

Drexler, W. (2010). The Networked Student Model for Construction of Personal Learning Environments: Balancing Teacher Control and Student Autonomy. *Australasian Journal of Educational Technology*, 26(3), 369-385.

Eisner, E.W. (1995). Curriculum Ideologies. *The Educational Imagination: on the Design and Evaluation of School Programs* (3rd Ed.), 47-86. New York, NY: Oxford Publishing Co.

Fullan, M. (2011). *Change Leadership*. San Francisco, CA: Jossey-Bass.

Goldberg, M. et al. (1966). *The Effects of Ability Grouping.* Teachers College Press: New York.

Hammond, M. & Collins, R. (1992). Self-Directed Learning: Critical Practice. *Canadian Journal of Education,* 17(4), 476-478.

Henney, M. (1978). Facilitating Self-Directed Learning. *Improving College and University Teaching*, 26(2), 128-130.

Hudgins, B. & Edelman, S. (1988). Children's Self-Directed Critical Thinking. *The Journal of Educational Research,* 81(5), 262-273.

Kickens, W., Brand-Gruwel, S., van Merrienboer, J. & Slot, W. (2009). Design and Evaluation of a Development Portfolio: How to Improve Students' Self-Directed Learning Skills. *Instructional Science,* 37(5), 453-473.

King, A. (1993). Sage on the Stage to Guide on the Side. *College Teaching,* 41(1), 30-35.

Krabbe, M.A. (1983). Self-Directed Learning of the Basic Skills. *The Clearing House*, 56(8), 372-373.

Lavin, D.E. (1965). *The Prediction of Academic Performance*. Russell Sage Foundation: New York.

Lincoln, Y.S. & Guba, E.G. 2000. Paradigmatic controversies, contradictions and emerging confluences in *Handbook of Qualitative Research.* Thousand Oaks: Sage, 163-188.

Long, H.B. & Agyekum, S. (1983). Guglielmino's Self-Directed and Learning Readiness Scale: A Validation Study. *Higher Education*, 12(1), 77-87.

Loyens, S.M., Magda, J. & Rikers, R. (2008). Self-Directed Learning in Problem-Based and its Relationship with Self-Regulated Learning. *Educational Psychology Review*, 20(4), 411-427.

Neuman, M and Simmons, W. (2000) Leadership for student learning. *Phi Delta Kappan*, 82(1), 9-12.

Price, H. (1976). Achieving a Balance Between Self-Directed and Required Learning. *Journal of Education for Social Work*, 12(1), 105-112.

Quasi-Experiment (2011) In *National Center for Technology Innovation online.* Retrieved from http://www.nationaltechcenter.org/index.php/products/at-research-matters/quasi-experimental-study/

Schwab, J.J. (1973). The Practical 3: Translation into Curriculum. *The School Review*, 81(4), 501-522.

Silen, C. & Uhlin, L. (2008). Self-Directed Learning – a Learning Issue for Students and Faculty. *Teaching in Higher Education*, 13(4), 461-475.

Simon, L. (2000) *Foundations of Education.* Retrieved from http://facstaff.elon.edu/simonl/

Sizer, T.R. (1999). No Two Are Quite Alike. *Educational Leadership*, 57(1), 6-11.

Skager, R. (1979). Self-Directed Learning and Schooling: Identifying Pertinent Theories and Illustrative Research. *International Review of Education*, 25(4), 517-543.

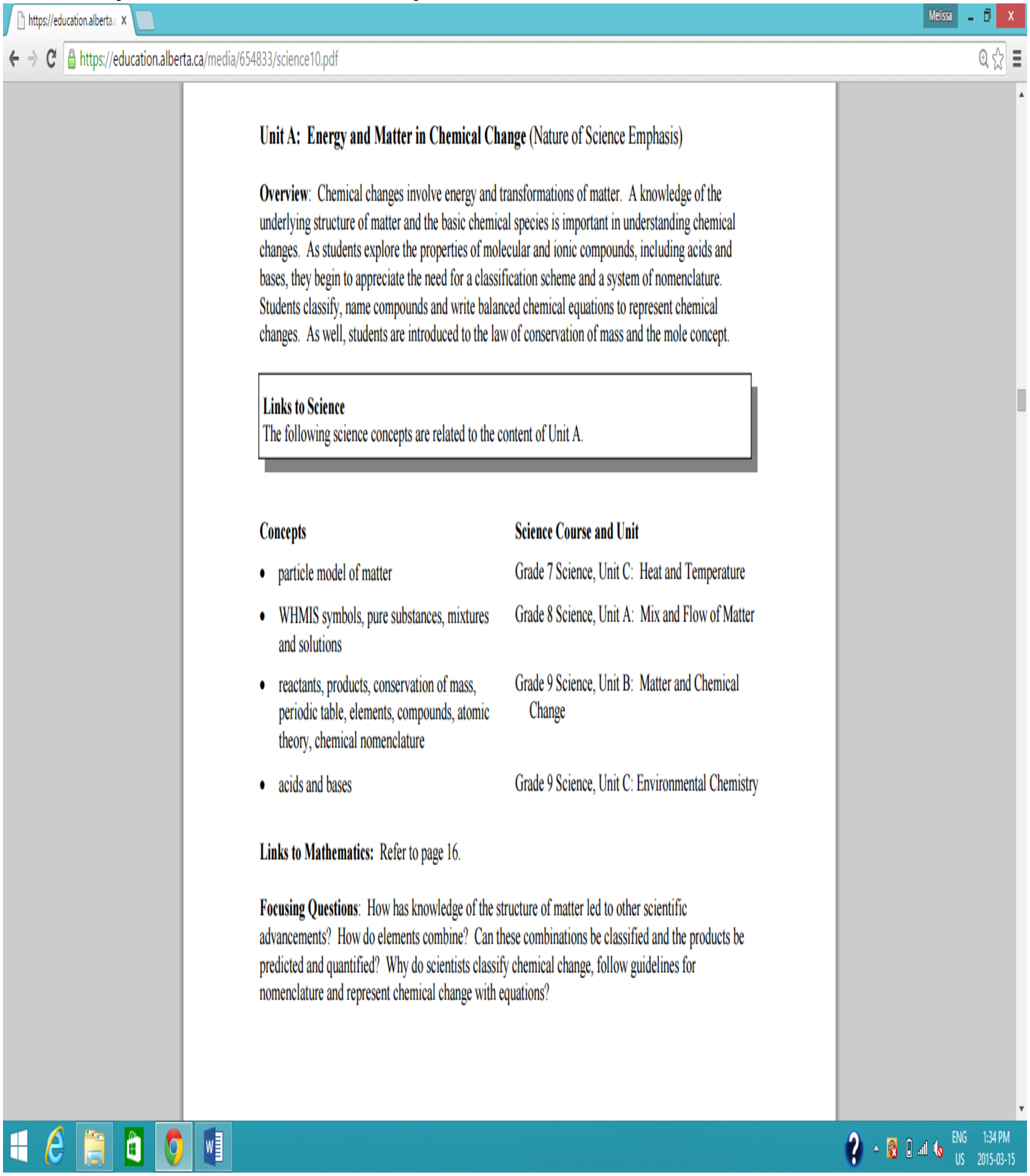
Thomas, J. W., Strange, A. & Curley, R. (1988). Improving Students' Self-Directed Learning: Issues and Guidelines. *The Elementary School Journal*, 88(3), 313-326.

Wolf, M.A. 2010. *Innovate to Educate: System (Re)Design for Personalized Learning*. Retrieved from: http://www.siia.net/pli on July 17, 2014.

Wood, F. (1975). Self-Directed and Achievement: Are They Related?. *The High School Journal*, 58(4), 161-169.

Appendix A

Program of Study for Science 10 Chemistry



Unit A: Energy and Matter in Chemical Change (Nature of Science Emphasis)

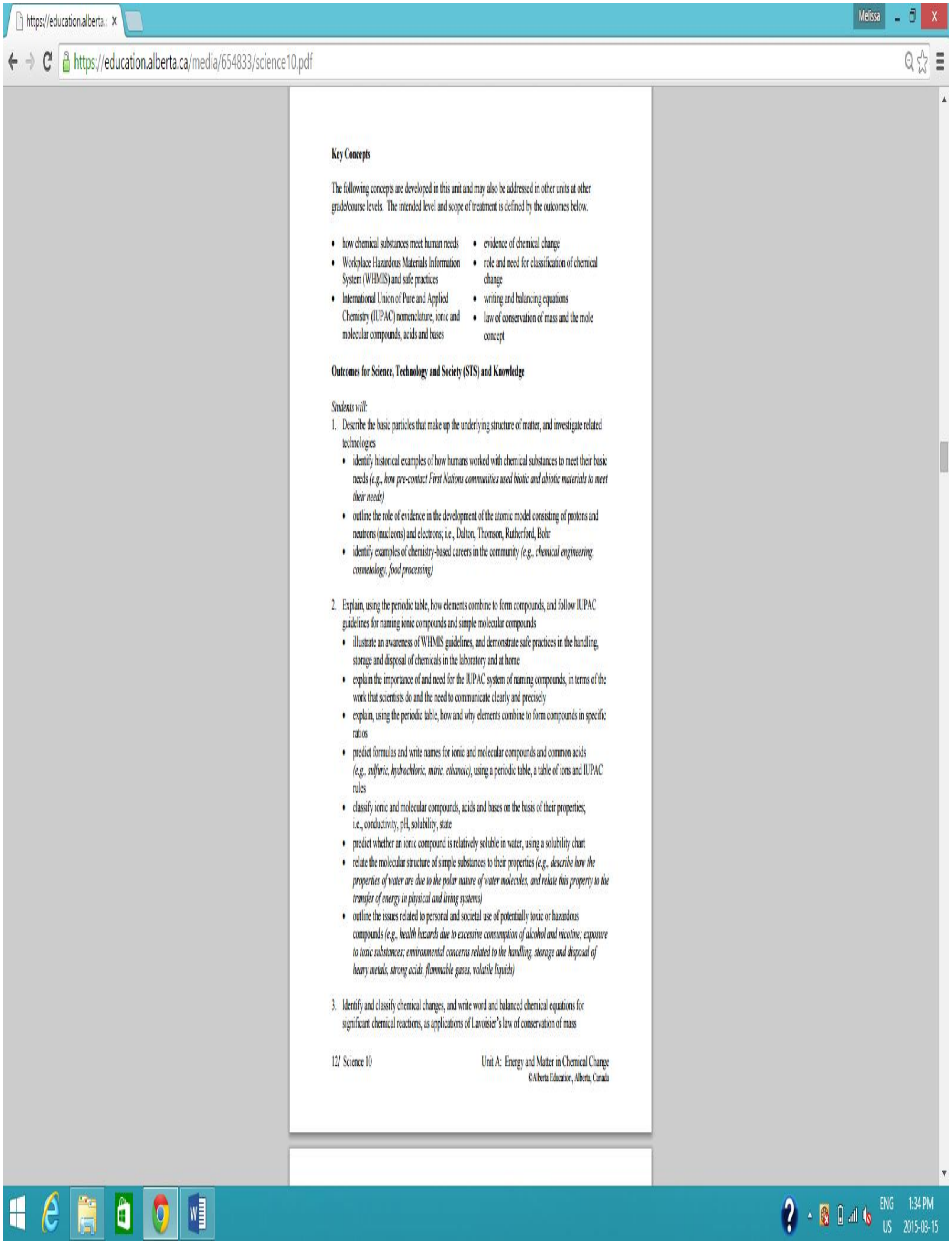
Overview: Chemical changes involve energy and transformations of matter. A knowledge of the underlying structure of matter and the basic chemical species is important in understanding chemical changes. As students explore the properties of molecular and ionic compounds, including acids and bases, they begin to appreciate the need for a classification scheme and a system of nomenclature. Students classify, name compounds and write balanced chemical equations to represent chemical changes. As well, students are introduced to the law of conservation of mass and the mole concept.

Links to Science
The following science concepts are related to the content of Unit A.

Concepts	Science Course and Unit
• particle model of matter	Grade 7 Science, Unit C: Heat and Temperature
• WHMIS symbols, pure substances, mixtures and solutions	Grade 8 Science, Unit A: Mix and Flow of Matter
• reactants, products, conservation of mass, periodic table, elements, compounds, atomic theory, chemical nomenclature	Grade 9 Science, Unit B: Matter and Chemical Change
• acids and bases	Grade 9 Science, Unit C: Environmental Chemistry

Links to Mathematics: Refer to page 16.

Focusing Questions: How has knowledge of the structure of matter led to other scientific advancements? How do elements combine? Can these combinations be classified and the products be predicted and quantified? Why do scientists classify chemical change, follow guidelines for nomenclature and represent chemical change with equations?



Key Concepts

The following concepts are developed in this unit and may also be addressed in other units at other grade/course levels. The intended level and scope of treatment is defined by the outcomes below.

- how chemical substances meet human needs
- Workplace Hazardous Materials Information System (WHMIS) and safe practices
- International Union of Pure and Applied Chemistry (IUPAC) nomenclature, ionic and molecular compounds, acids and bases
- evidence of chemical change
- role and need for classification of chemical change
- writing and balancing equations
- law of conservation of mass and the mole concept

Outcomes for Science, Technology and Society (STS) and Knowledge

Students will:

1. Describe the basic particles that make up the underlying structure of matter, and investigate related technologies
   - identify historical examples of how humans worked with chemical substances to meet their basic needs *(e.g., how pre-contact First Nations communities used biotic and abiotic materials to meet their needs)*
   - outline the role of evidence in the development of the atomic model consisting of protons and neutrons (nucleons) and electrons; i.e., Dalton, Thomson, Rutherford, Bohr
   - identify examples of chemistry-based careers in the community *(e.g., chemical engineering, cosmetology, food processing)*

2. Explain, using the periodic table, how elements combine to form compounds, and follow IUPAC guidelines for naming ionic compounds and simple molecular compounds
   - illustrate an awareness of WHMIS guidelines, and demonstrate safe practices in the handling, storage and disposal of chemicals in the laboratory and at home
   - explain the importance of and need for the IUPAC system of naming compounds, in terms of the work that scientists do and the need to communicate clearly and precisely
   - explain, using the periodic table, how and why elements combine to form compounds in specific ratios
   - predict formulas and write names for ionic and molecular compounds and common acids *(e.g., sulfuric, hydrochloric, nitric, ethanoic)*, using a periodic table, a table of ions and IUPAC rules
   - classify ionic and molecular compounds, acids and bases on the basis of their properties; i.e., conductivity, pH, solubility, state
   - predict whether an ionic compound is relatively soluble in water, using a solubility chart
   - relate the molecular structure of simple substances to their properties *(e.g., describe how the properties of water are due to the polar nature of water molecules, and relate this property to the transfer of energy in physical and living systems)*
   - outline the issues related to personal and societal use of potentially toxic or hazardous compounds *(e.g., health hazards due to excessive consumption of alcohol and nicotine; exposure to toxic substances; environmental concerns related to the handling, storage and disposal of heavy metals, strong acids, flammable gases, volatile liquids)*

3. Identify and classify chemical changes, and write word and balanced chemical equations for significant chemical reactions, as applications of Lavoisier's law of conservation of mass

12/ Science 10 Unit A: Energy and Matter in Chemical Change
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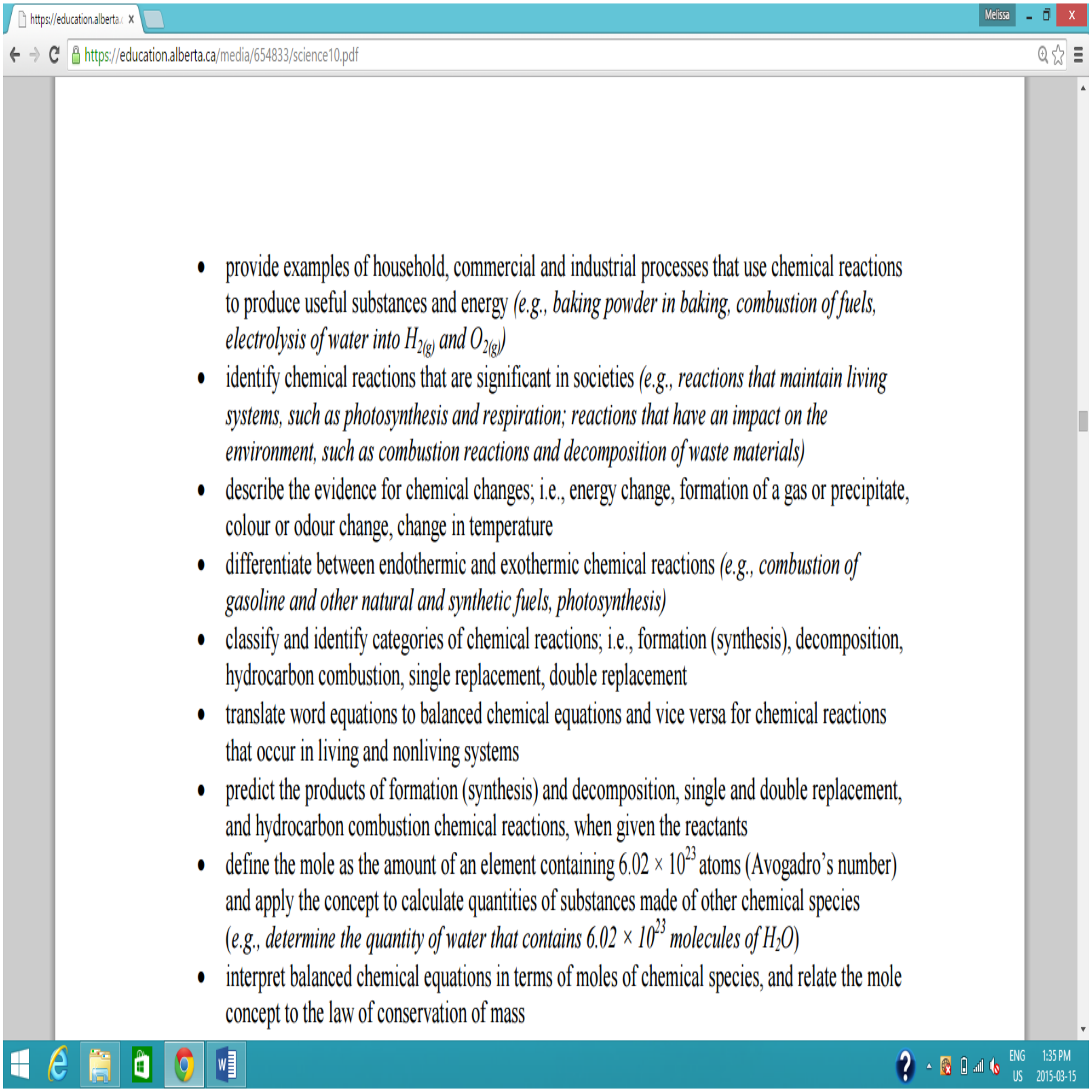


- provide examples of household, commercial and industrial processes that use chemical reactions to produce useful substances and energy *(e.g., baking powder in baking, combustion of fuels, electrolysis of water into* $H_{2(g)}$ *and* $O_{2(g)}$*)*
- identify chemical reactions that are significant in societies *(e.g., reactions that maintain living systems, such as photosynthesis and respiration; reactions that have an impact on the environment, such as combustion reactions and decomposition of waste materials)*
- describe the evidence for chemical changes; i.e., energy change, formation of a gas or precipitate, colour or odour change, change in temperature
- differentiate between endothermic and exothermic chemical reactions *(e.g., combustion of gasoline and other natural and synthetic fuels, photosynthesis)*
- classify and identify categories of chemical reactions; i.e., formation (synthesis), decomposition, hydrocarbon combustion, single replacement, double replacement
- translate word equations to balanced chemical equations and vice versa for chemical reactions that occur in living and nonliving systems
- predict the products of formation (synthesis) and decomposition, single and double replacement, and hydrocarbon combustion chemical reactions, when given the reactants
- define the mole as the amount of an element containing 6.02×10^{23} atoms (Avogadro's number) and apply the concept to calculate quantities of substances made of other chemical species (*e.g., determine the quantity of water that contains* 6.02×10^{23} *molecules of* H_2O)
- interpret balanced chemical equations in terms of moles of chemical species, and relate the mole concept to the law of conservation of mass

Appendix B

Unit Plan

	Group A	Group B	Topic (Per class for Traditional Instruction)	In Class Activities & Resources (Traditional Instruction)	Text Book Readings and Assigned Questions (Traditional Instruction)
2	Traditional Instruction	SDL	1.1 Safety in the Lab & 1.2 Properities & Classification of Matter	Powerpoint	Read p. 12-26 Q 1-10
3	Traditional Instruction	SDL	1.3 Developing Ideas about Matter	Powerpoint	Read p. 12-26 Q 1-11
4	Traditional Instruction	SDL	2.1 Periodic Table & Atomic Theory	Powerpoint	Read p. 28-34
5	Traditional Instruction	SDL	2.1 Atomic Theory	Powerpint, Colouring & Labelling Periodic Table Activity	Read p.28-39
6	Traditional Instruction	SDL	2.2 Ionic Compounds	Powerpoint, Worksheet	Read p.40-47
7	Traditional Instruction	SDL	2.3 Molecular Compounds	Powerpoint, Worksheet	Read p.48-50
8	Traditional Instruction	SDL	2.4 Acids and Bases	Powerpoint, Worksheet	Read p. 62 – 68, Q 1 – 8
9	Quiz	Quiz	A2 Quiz	Quiz	N/A
10	SDL	Traditional Instruction	A3.1 Important Examples of Chemical Change	Powerpoint, Worksheet	Read p. 78 – 85, Q 1 – 7, 9 – 12
11	SDL	Traditional Instruction	A3.2 Writing Chemical Equations	Powerpoint, Worksheet	Read p. 86 – 90, Q 1 – 9
12	SDL	Traditional Instruction	A3.2 Writing Chemical Equations	Powerpoint, Worksheet	Read p. 86 – 90, Q 1 – 9
13	SDL	Traditional Instruction	A3.3 Five Common Types of Chemical Reactions	Powerpoint, Worksheet	Read p. 91 – 97, p. 93 Q 1 – 3, p. 97 Q 1 - 4
14	SDL	Traditional Instruction	A3.3 Five Common Types of Chemical Reactions	Powerpoint, Worksheet	Read p. 97 – 105, Q 1 – 10
15	SDL	Traditional Instruction	A3.4 The Mole	Powerpoint, Video	Read p. 107 - 111, Q 1 – 7, 9 – 13
16	SDL	Traditional Instruction	A3.5 Our Chemical Society	Powerpoint	Read p. 112-114 Q 2-4, 6-7
17	Unit Exam, Self Reflection	Unit Exam, Self Reflection	Unit A Exam	Exam & Self-Reflection	N/A

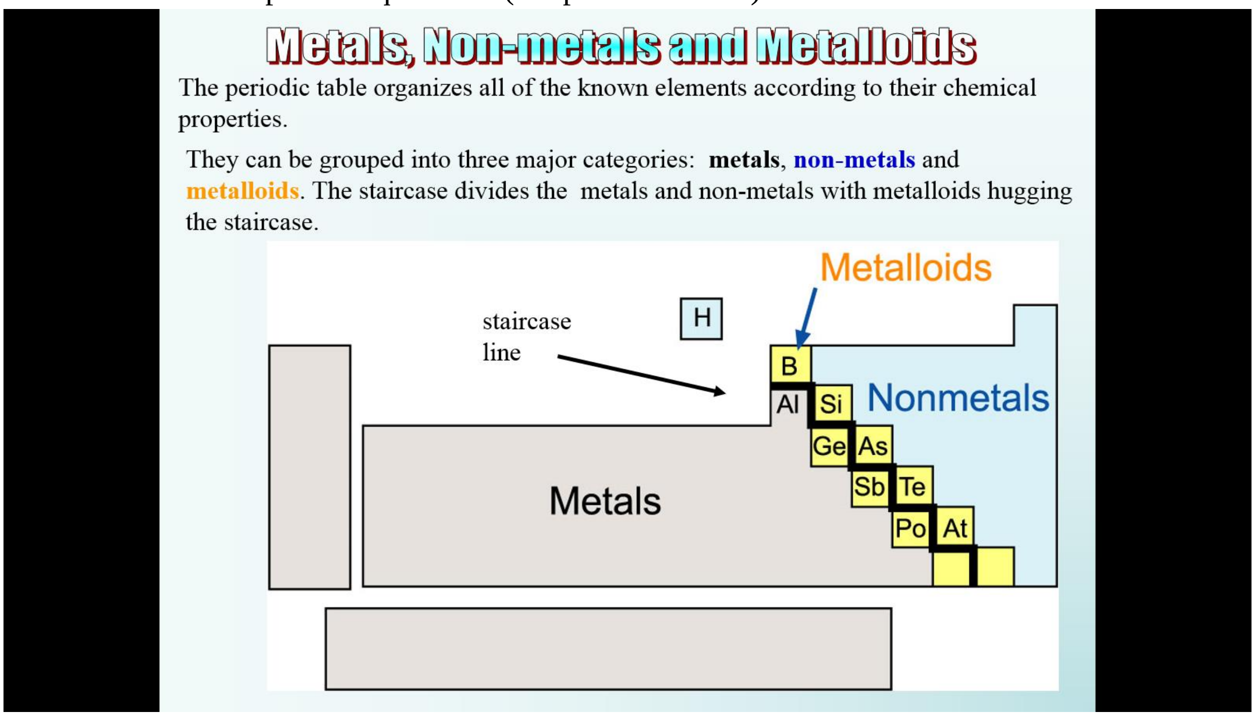
Appendix C

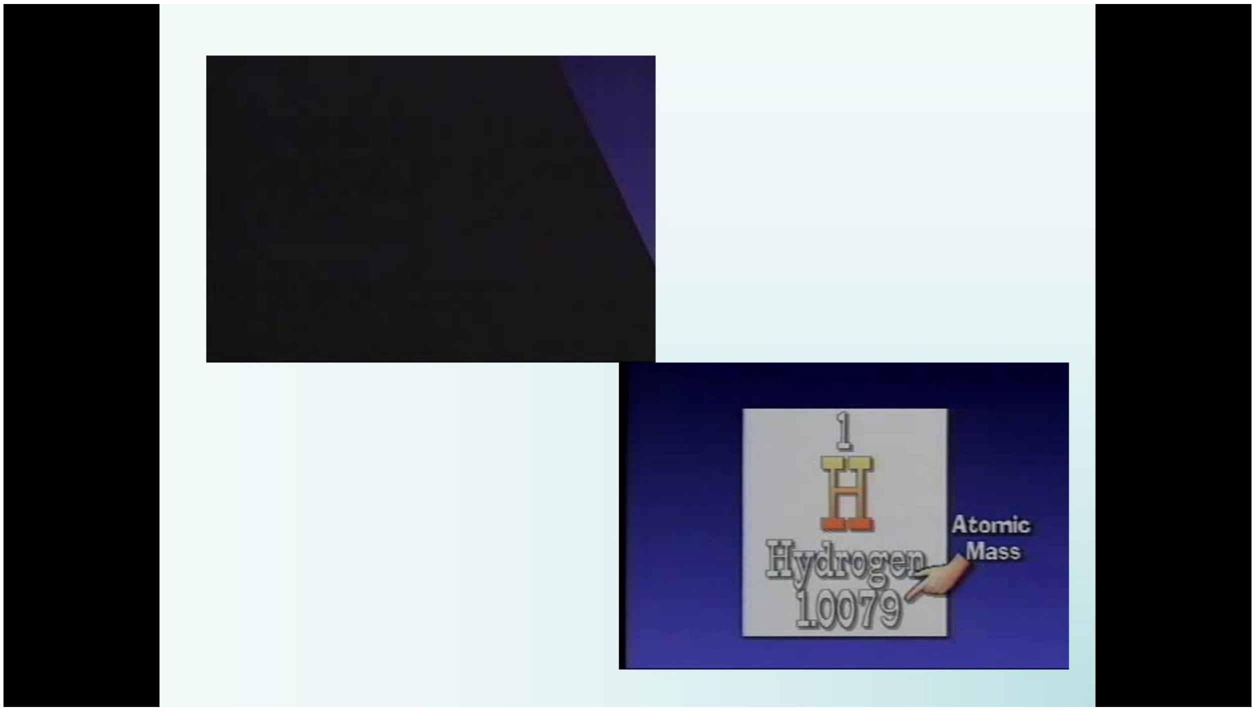
Traditional Lesson Plan

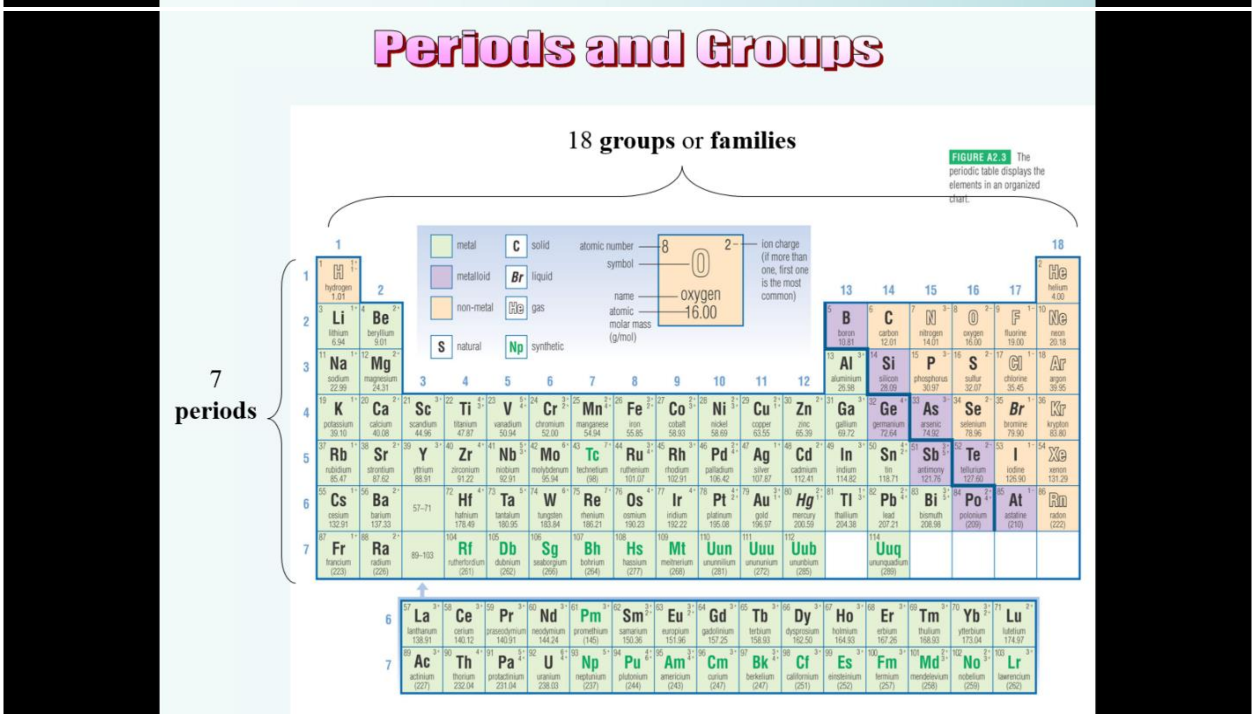
2.1 Atomic Theory (Lesson 4) – 80 minute class

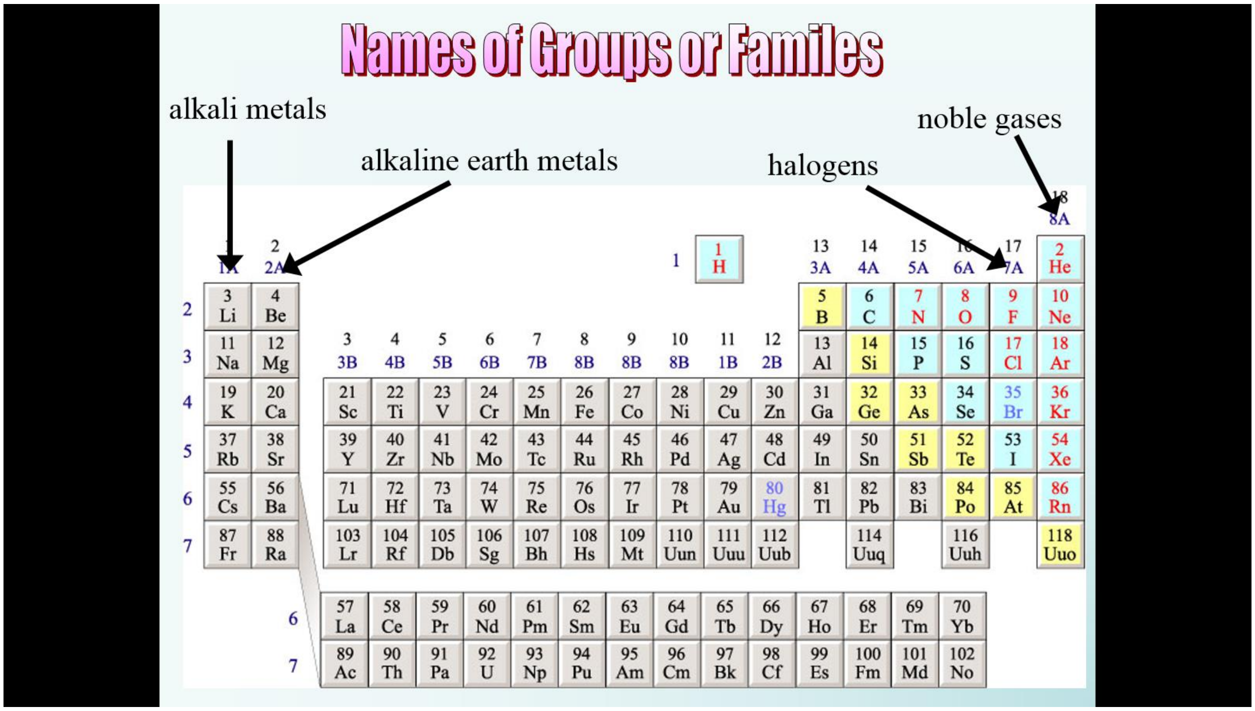
PowerPoint presentation – 45 minutes

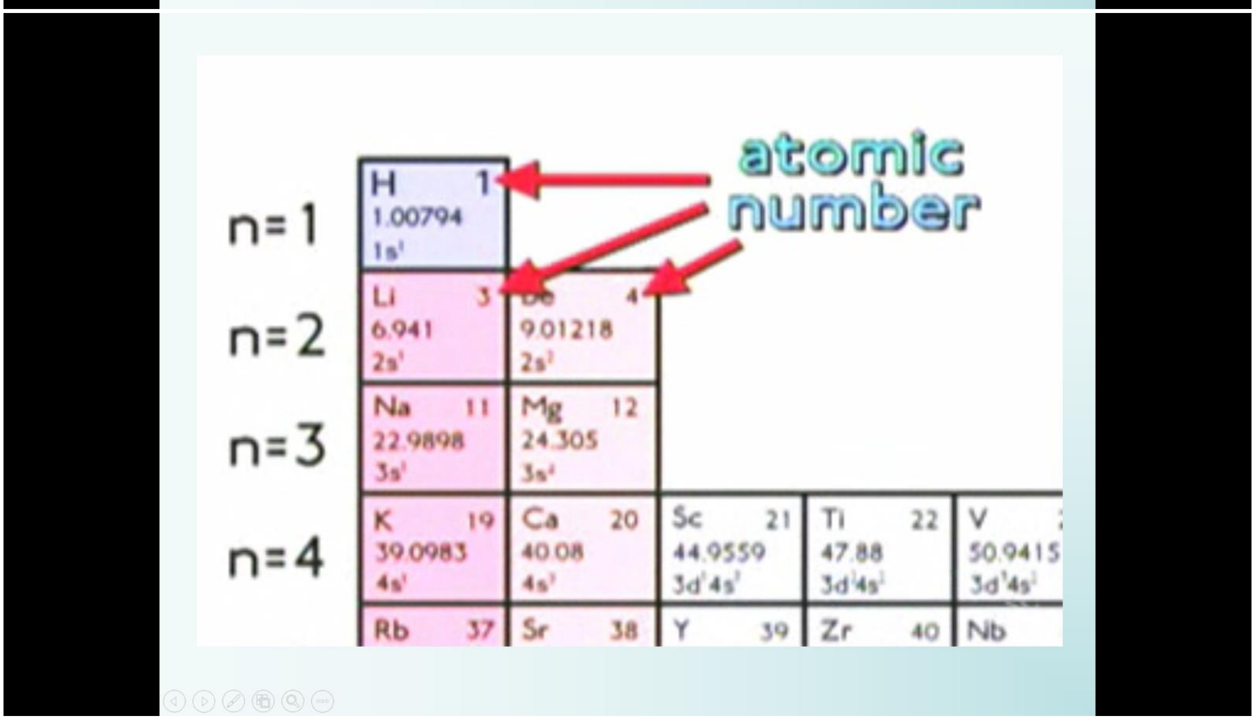
- Highlights key information from section and program of study including metals, non-metals, metalloids, periods and families, subatomic particles, energy levels, atomic number, mass number, atomic molar mass, formation of ions, valence electrons and the octet rule.
- Includes videos and practice questions (see pictures below)



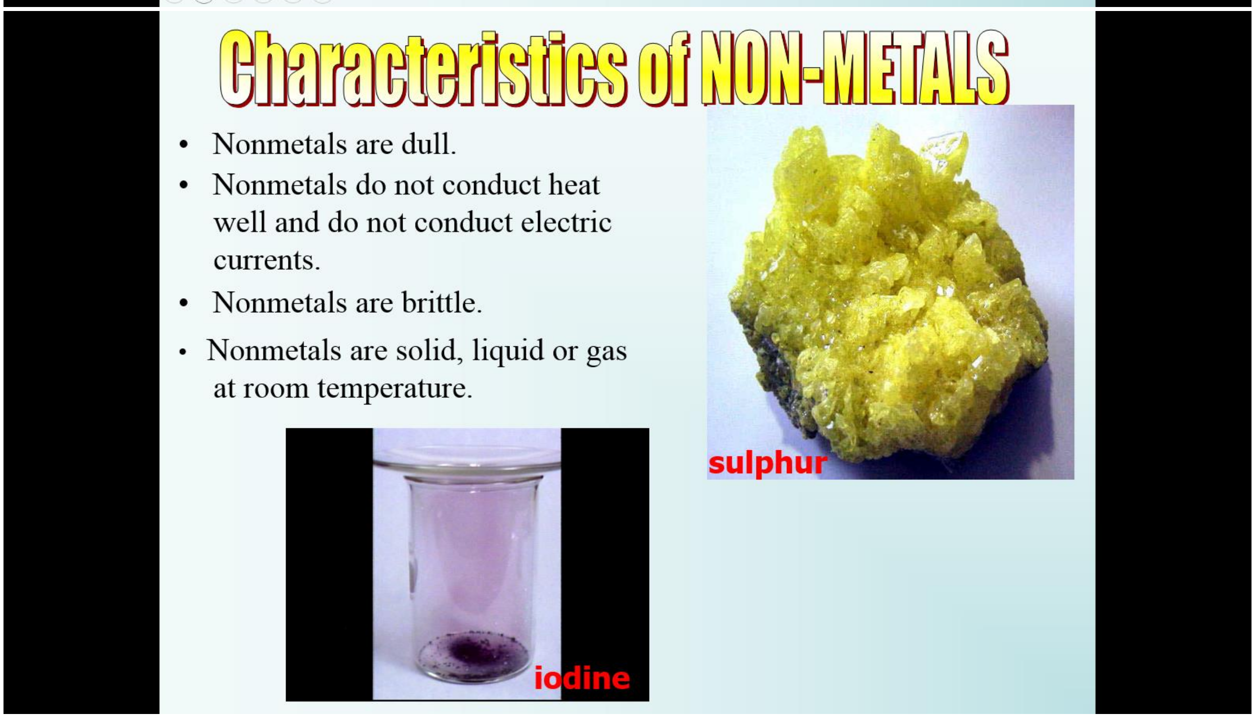

1
H
Hydrogen
Atomic
Mass

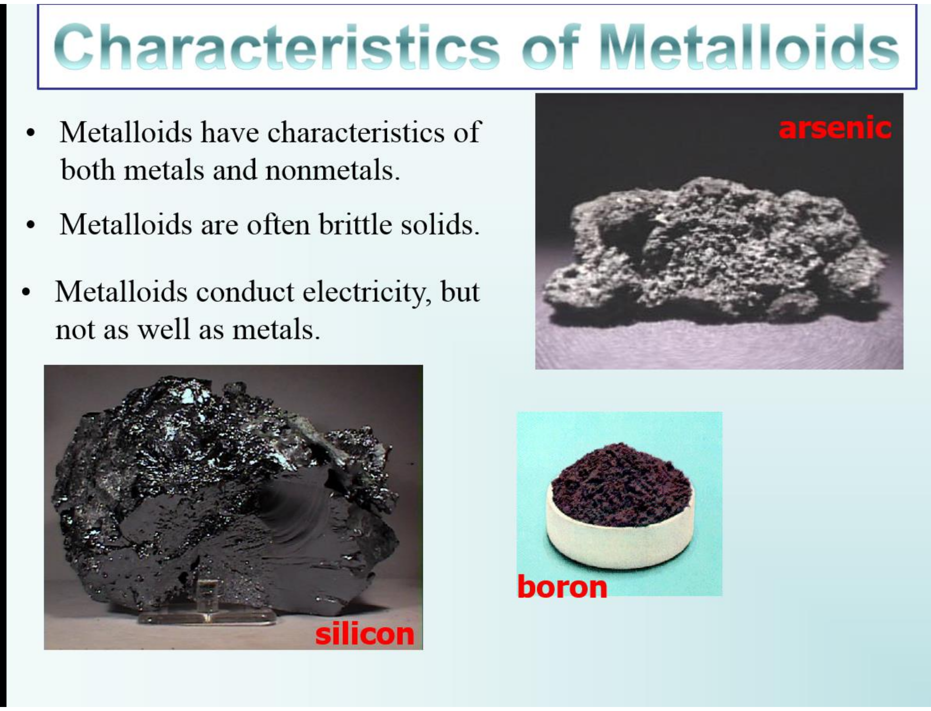

Periods and Groups
18 groups or families
FIGURE A2.3 The periodic table displays the elements in an organized chart.
7
periods
metal
metalloid
non-metal
solid
liquid
gas
natural
synthetic
atomic number
symbol
name
atomic molar mass (g/mol)
ion charge (if more than one, first one is the most common)
oxygen
16.00


Names of Groups or Familes
alkali metals
alkaline earth metals
halogens
noble gases


atomic number
n=1
n=2
n=3
n=4

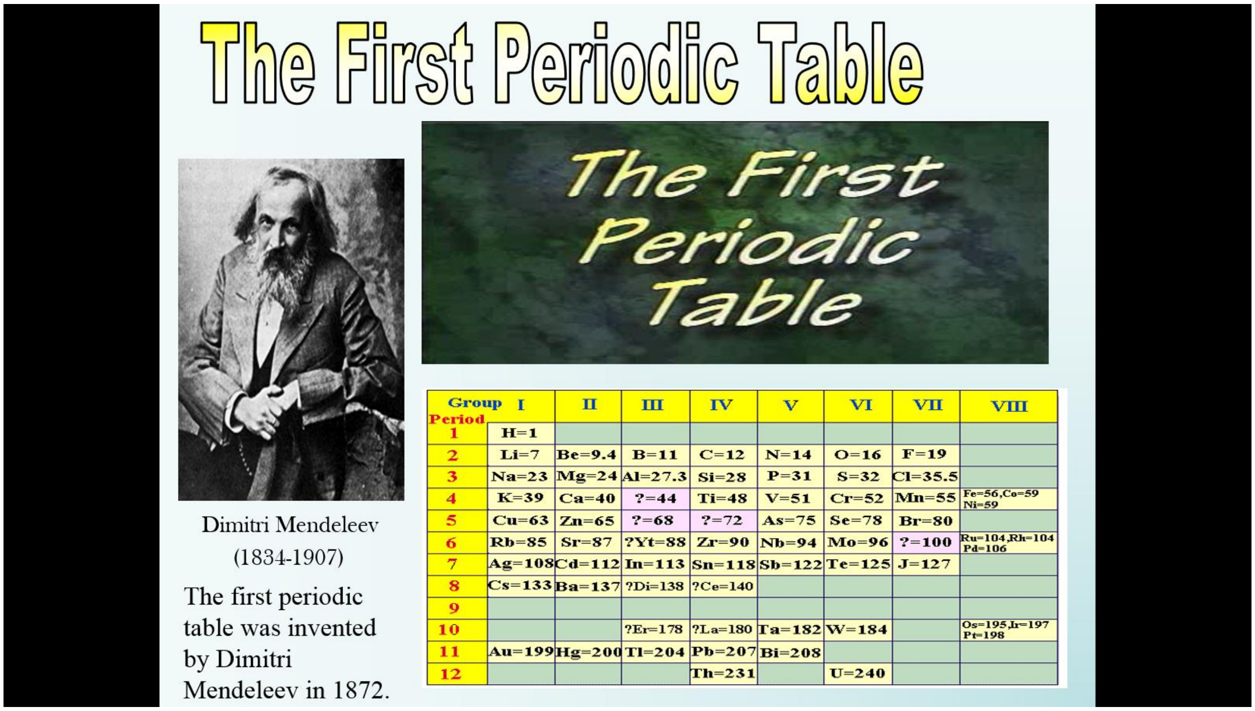

Characteristics of METALS
• Metals have a shiny, metallic lustre.
• Metals are good conductors of heat and electricity.
• Metals are malleable. (can be beaten or rolled into sheets without crumbling)
tin
• Metals are ductile. (can be drawn and stretch into a long wire.
• All metals are solids at room temperature, except for mercury (Hg), which is a liquid.
silver


Characteristics of NON-METALS
• Nonmetals are dull.
• Nonmetals do not conduct heat well and do not conduct electric currents.
• Nonmetals are brittle.
• Nonmetals are solid, liquid or gas at room temperature.
sulphur
iodine

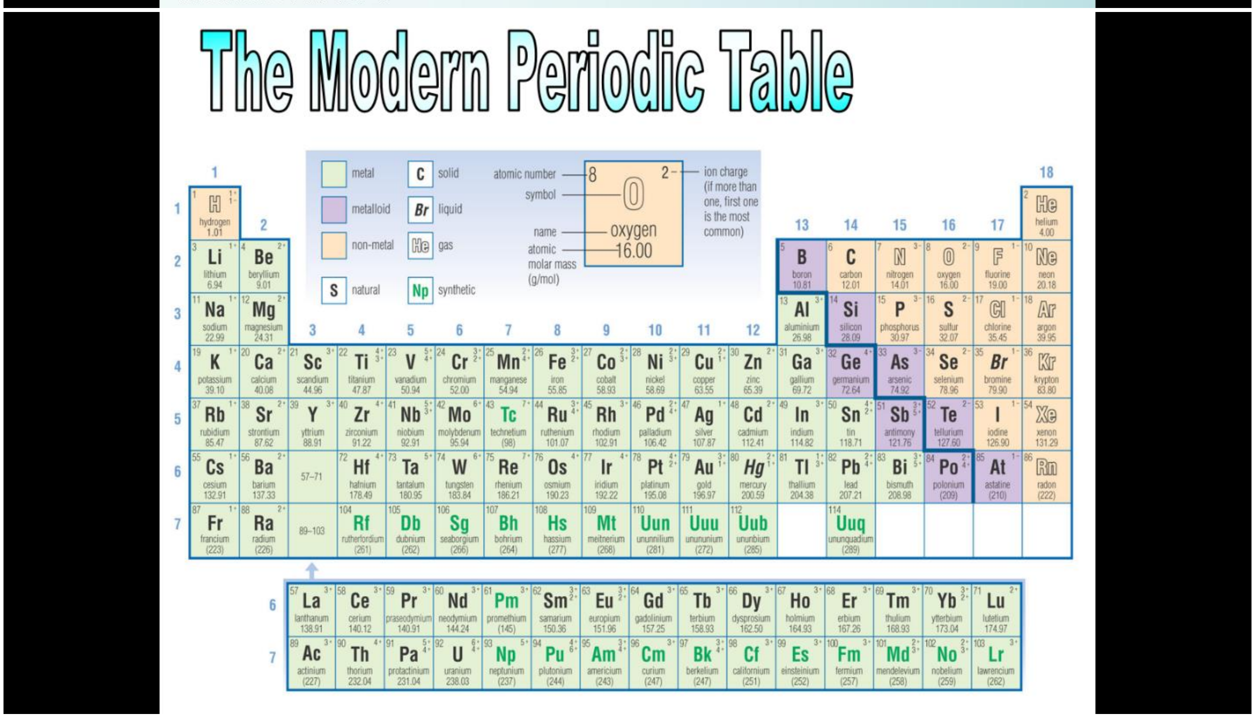

Characteristics of Metalloids
• Metalloids have characteristics of both metals and nonmetals.
• Metalloids are often brittle solids.
• Metalloids conduct electricity, but not as well as metals.
arsenic
silicon
boron


Nonmetals

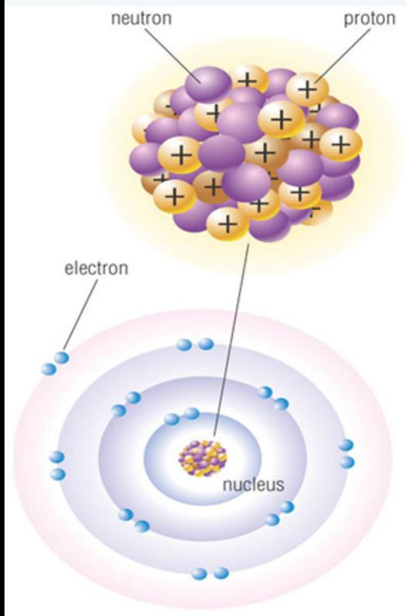

Metalloids



Group / Period	I	II	III	IV	V	VI	VII	VIII
1	H=1							
2	Li=7	Be=9.4	B=11	C=12	N=14	O=16	F=19	
3	Na=23	Mg=24	Al=27.3	Si=28	P=31	S=32	Cl=35.5	
4	K=39	Ca=40	?=44	Ti=48	V=51	Cr=52	Mn=55	Fe=56,Co=59 Ni=59
5	Cu=63	Zn=65	?=68	?=72	As=75	Se=78	Br=80	
6	Rb=85	Sr=87	?Yt=88	Zr=90	Nb=94	Mo=96	?=100	Ru=104,Rh=104 Pd=106
7	Ag=108	Cd=112	In=113	Sn=118	Sb=122	Te=125	J=127	
8	Cs=133	Ba=137	?Di=138	?Ce=140				
9								
10			?Er=178	?La=180	Ta=182	W=184		Os=195,Ir=197 Pt=198
11	Au=199	Hg=200	Tl=204	Pb=207	Bi=208			
12				Th=231		U=240		



Subatomic Particles



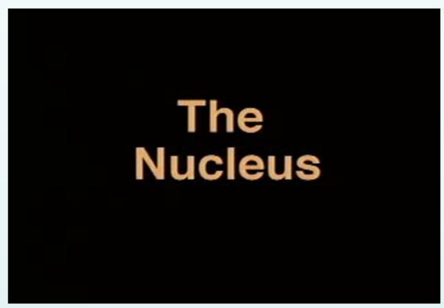
All atoms are made up of three subatomic particles:

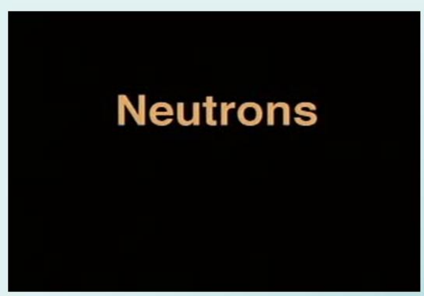
1) proton symbol: p^+
2) neutron symbol: n^0
3) electron symbol: e^-

Protons and neutrons are located in the nucleus.

The mass of a proton or neutron is about 1800 times the mass of an electron.

Electrons are found in energy levels around the nucleus.





The **atomic number** of an element indicates the number of **protons** its atoms have.

An atom of any element is electrically neutral, so the number of positive charges (protons) is equal to the number of negative charges (electrons).

Look at the following elements. Find their atomic number. This is the number of protons and electrons this atom has.

Element	Atomic #	Protons	Electrons
Na	11	11	11
Ga	31	31	31
S	16	16	16

Therefore, the charge of the atom is 0 since the protons and electrons equal each other.

Symbol	Number of Protons	Number of Electrons	Electric Charge
Li	3	3	0
C	6	6	0
F	9	9	0
Mg	12	12	0
K	19	19	0
P	15	15	0
S	16	16	0
Ne	10	10	0
Ar	18	18	0
O	8	8	0
Cl	17	17	0
Na	11	11	0
Ca	20	20	0
Fe	26	26	0
Ni	28	28	0
Au	79	79	0
Hg	80	80	0
Pb	82	82	0
Zn	30	30	0

Isotopes

Atoms of the same element have the same number of protons, but can have different numbers of neutrons.

Isotopes are atoms of the same element that contain different numbers of neutrons.

To differentiate between isotopes of a given element, we use a number called the mass number.

The **mass number** is a number equal to the total number of **protons and neutrons** in the nucleus of an atom. (mass number = protons + neutrons)

Remember that the nucleus where the protons and neutrons are found make up 99.9% of the mass of an atom!

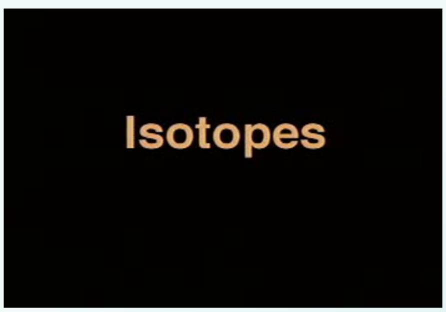
Isotope notation:

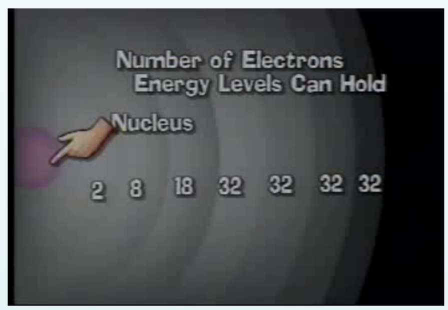
mass number

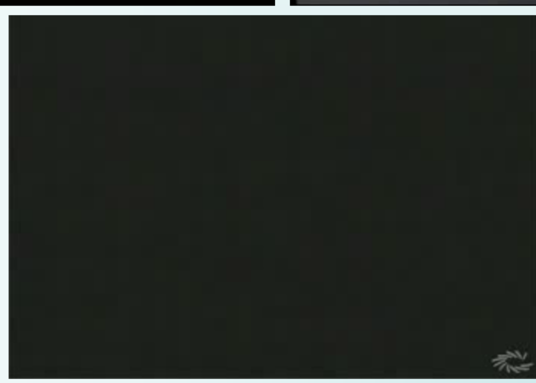
$$^{A}_{Z}X$$

element symbol

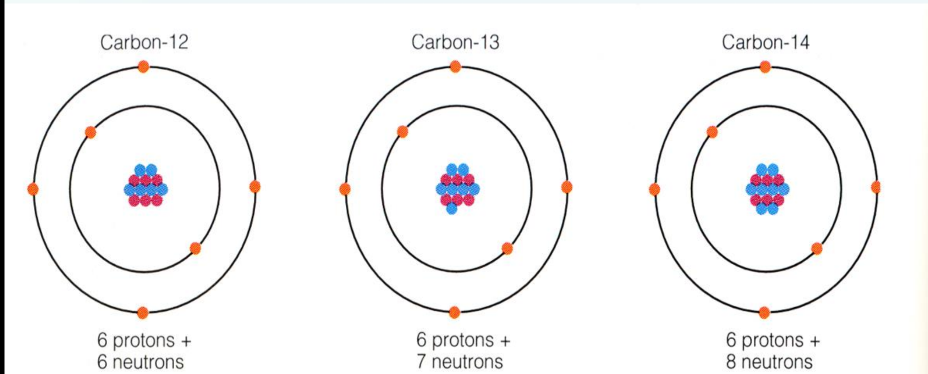
atomic number







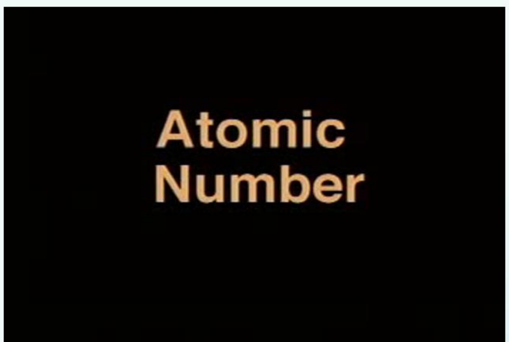
Three naturally occurring isotopes of carbon:

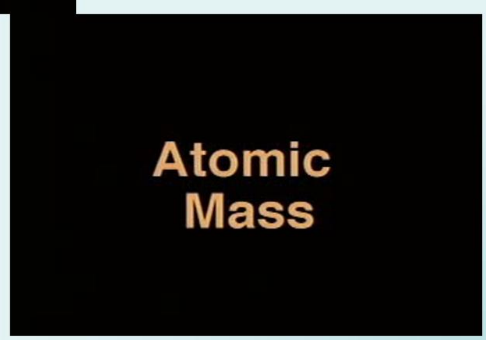


$^{12}_{6}C$ ← mass number → $^{13}_{6}C$ mass number → $^{14}_{6}C$

← atomic number → atomic number →

The bottom number is sometimes not written because you can determine the atomic number from the symbol.





The atomic mass of an element that is listed on the periodic table is called the **atomic molar mass**.

This value is calculated as the average mass of all of the isotopes of an element, taking the percent abundance into account.

The Atomic Mass Unit

Since the mass of individual atoms is so small, it is not convenient to use a unit like grams (g). Instead, we use the **atomic mass unit** (**amu**).

An atom of carbon-12 was assigned an exact mass of 12.00 amu.

Therefore, to calculate the number of neutrons, we subtract the atomic number (number of protons) from the atomic mass (number of protons and neutrons). 12 (atomic mass) – 6 (atomic number) = 6 (neutrons)

Remember, the protons and neutrons make up majority of the mass of the atom!

Scandium = Sc
Atomic Number = 21 (on periodic table)
Protons = 21 (always the same as the atomic number)
Electrons = 21(equal to the protons to keep the charge at zero)

Let's say that scandium has 22 neutrons: scandium – 22
Atomic Mass = 21 + 22 = 43 (protons + neutrons or atomic number + mass number)

Let's say there is an isotope of scandium and it's atomic mass is 45. How many protons and neutrons are we looking at?
Protons = 21 (never changes! Always the same as the atomic number)
Neutrons = 45 (atomic mass) – 21 (atomic number) = 24 neutrons

Name	Mass number	Atomic number	Number of protons	Number of neutrons
carbon-14	14	6	6	8
hydrogen-1	1	1	1	0
hydrogen-2	2	1	1	1
carbon-12	12	6	6	6
oxygen-18	18	8	8	10
helium-4	4	2	2	2
neon-20	20	10	10	10
copper-64	64	29	29	35
bromine-80	80	35	35	45
nitrogen-14	14	7	7	7
sulfur-32	32	16	16	16
calcium-41	41	20	20	21
fluorine-19	19	9	9	10
iron-56	56	26	26	30
iodine-127	127	53	53	74
calcium-40	40	20	20	20
tin-119	119	50	50	69
iron-59	59	26	26	33
lead-208	208	82	82	126
silver-108	108	47	47	61
mercury-201	201	80	80	121

Learning Check

An atom has 14 protons and 20 neutrons.

1) Its atomic number is :

A) 14 B) 16 C) 34

2) Its mass number is :

A) 14 B) 16 C) 34

3) The element is:

A) Si B) Ca C) Se

4) Another isotope of this element is :

A) $^{34}_{16}X$ B) $^{34}_{14}X$ C) $^{36}_{14}X$

Learning Check

An atom has 14 protons and 20 neutrons.

1) Its atomic number is :

A) 14 B) 16 C) 34

2) Its mass number is :

A) 14 B) 16 C) 34

3) The element is:

A) Si B) Ca C) Se

4) Another isotope of this element is :

A) $^{34}_{16}X$ B) $^{34}_{14}X$ C) $^{36}_{14}X$

Learning Check

Write the atomic symbols for atoms with the following:

A. 8 p^+ , 8 n^0 , 8 e^-

B. 17 p^+ , 20 n^0 , 17 e^-

C. 47 p^+ , 60 n^0 , 47 e^-

Learning Check

Write the atomic symbols for atoms with the following:

A. 8 p^+ , 8 n^0 , 8 e^- $\quad {}^{16}_{8}O$

B. 17 p^+ , 20 n^0 , 17 e^- $\quad {}^{37}_{17}Cl$

C. 47 p^+ , 60 n^0 , 47 e^- $\quad {}^{107}_{47}Ag$

Learning Check

An atom of zinc has a mass number of 65.

1) The number of protons in the zinc atom:

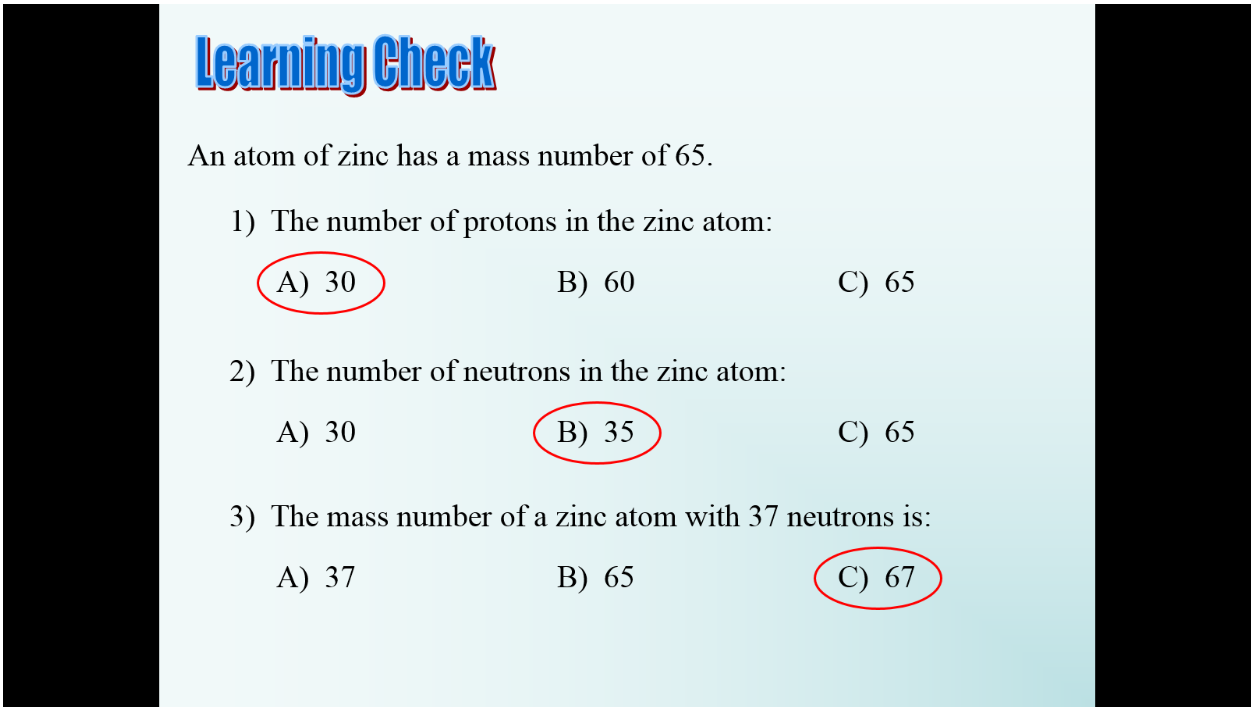
A) 30 B) 60 C) 65

2) The number of neutrons in the zinc atom:

A) 30 B) 35 C) 65

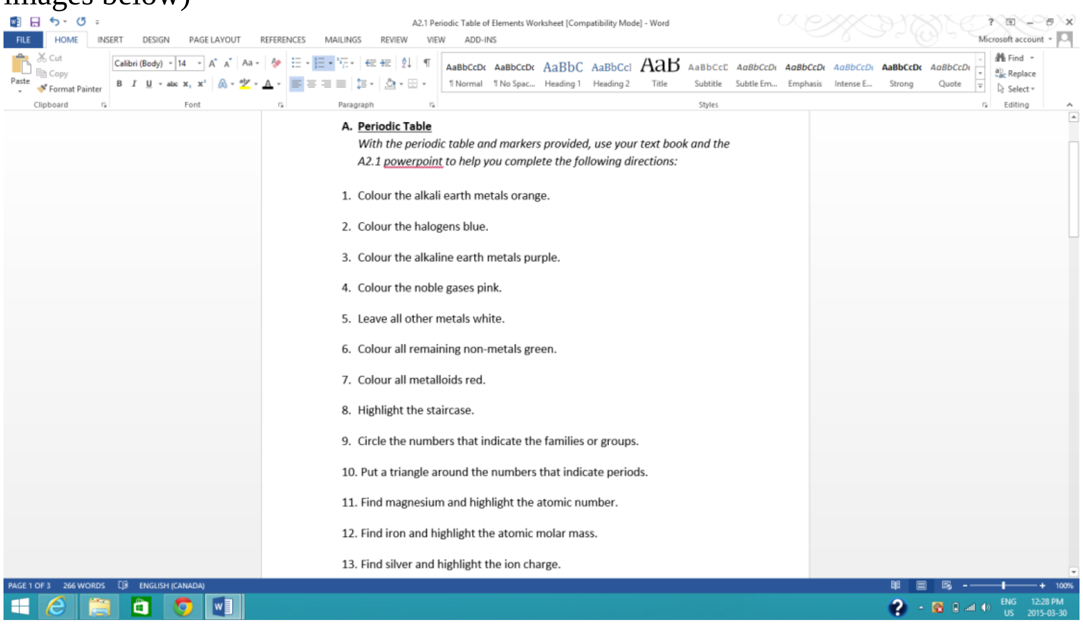
3) The mass number of a zinc atom with 37 neutrons is:

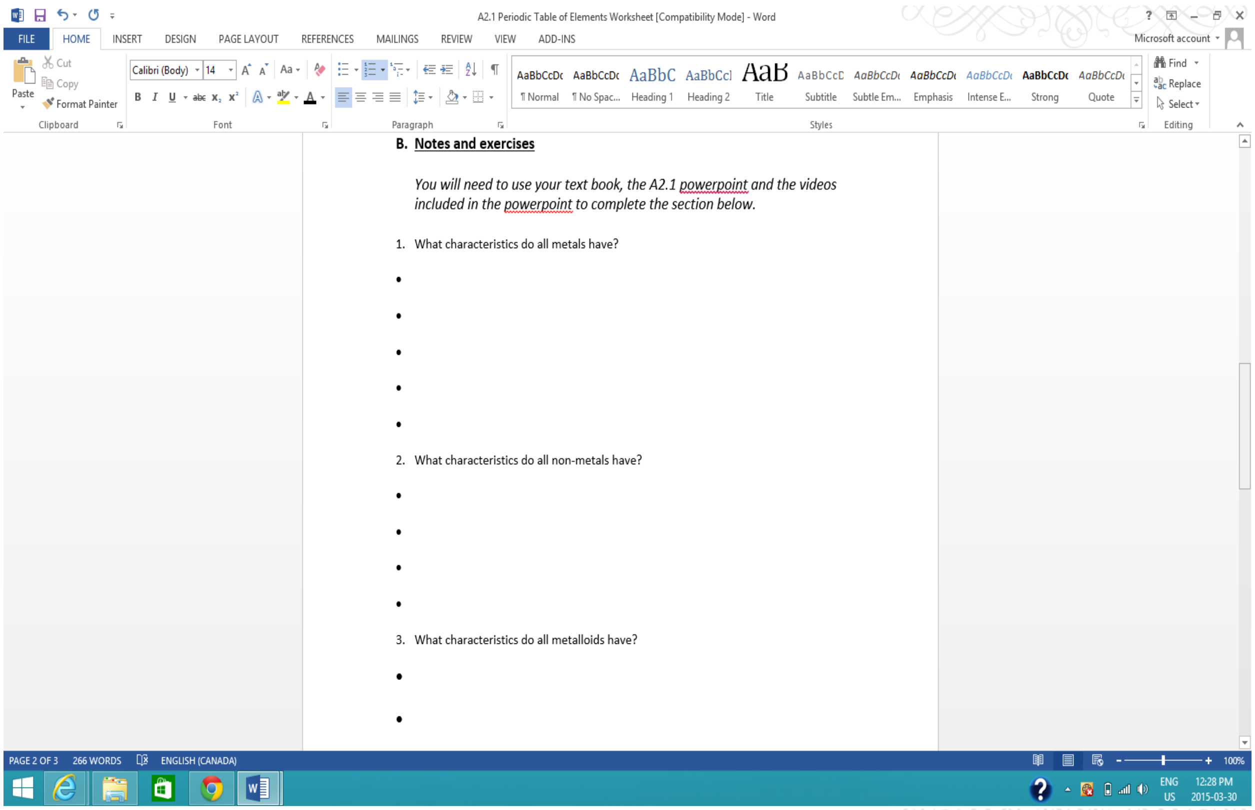
A) 37 B) 65 C) 67



Assignment Sheet – 30 minutes

- Students colour/label periodic table according to assignment sheet to identify various key terms, items and information on the periodic table as highlighted in the PowerPoint (see images below)





B. Notes and exercises

You will need to use your text book, the A2.1 powerpoint and the videos included in the powerpoint to complete the section below.

1. What characteristics do all metals have?

•

•

•

•

•

2. What characteristics do all non-metals have?

•

•

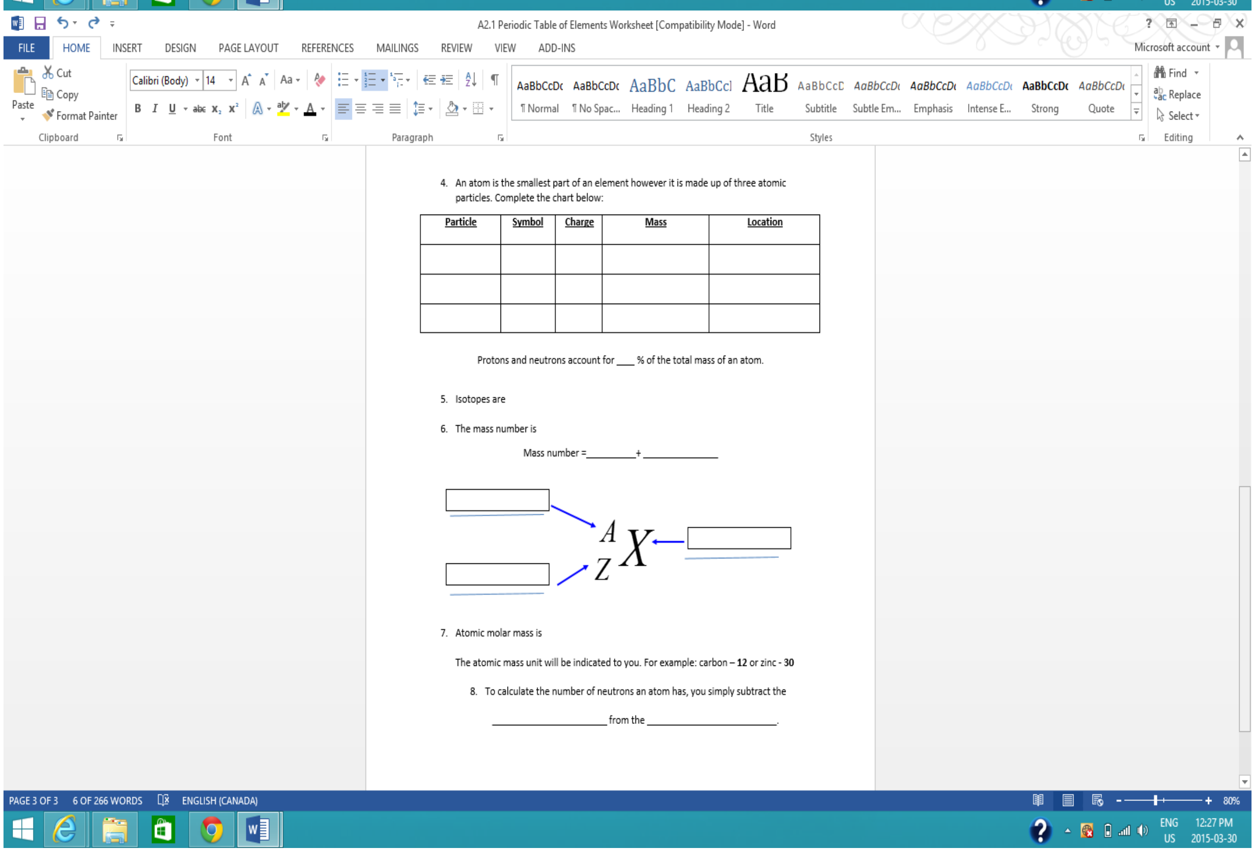
•

•

3. What characteristics do all metalloids have?

•

•



4. An atom is the smallest part of an element however it is made up of three atomic particles. Complete the chart below:

Particle	Symbol	Charge	Mass	Location

Protons and neutrons account for ____ % of the total mass of an atom.

5. Isotopes are

6. The mass number is

Mass number =__________+ _______________

7. Atomic molar mass is

The atomic mass unit will be indicated to you. For example: carbon – **12** or zinc - **30**

8. To calculate the number of neutrons an atom has, you simply subtract the

_______________________ from the _________________________.

Homework (5 minutes)

- Students are assigned to read pages 28-39 and are given the opportunity to do additional practice questions from the text book if needed. All of the answers to these items are found in the back of the textbook

SDL Lesson Plan

80 minute class

- Show students that they are responsible for covering all of the outcomes in section one and two over the course of seven eighty minute classes (Appendix A)
- Show students how to access all of the online materials, study guides etc. (Appendix G)
- Discuss with students your role as a teacher; there to support and guide but not to supply or deliver information
- Discuss alternative resources and how to evaluate if they are reliable and accurate resources such as websites, peers, experts in the field, literature etc.
- Ask students to come up with a timeline to cover the assigned outcomes so that they will be able to complete all outcomes in order to write the quiz seven classes from now
- Discuss a check in process that will occur each class where each student will meet briefly with the teacher to ensure they are on track to complete the upcoming quiz
- Students are then able to work on the outcomes as they see fit for the next seven classes.

Appendix D

Quiz

Part A - Multiple Choice [15 marks]

1. The periodic table organizes all the elements according to

A. date of discovery
C. chemical properties
B. physical properties
D. chemical importance

2. Which of the following pieces of information is not shown on the periodic table?

A. the mass number
C. the atomic number
B. the element name
D. the element symbol

3. Noble gases are stable and unreactive because their outer energy level

A. is full of electrons
C. contains pairs of electrons
B. has a low amount of energy
D. has little electron movement

4. The substance that has the characteristics of a metalloid is

A. calcium B. barium C. sulfur D. silicon

5. The atomic mass of an element does not include the mass of electrons because the electrons are

A. in constant motion negating the effect of their mass
B. so small that they contribute a negligible amount to the mass
C. located outside the nucleus and thus are not included in the mass
D. so distant from the nucleus that they are not included in the mass

6. The subatomic particle that cannot change without changing the type of element itself is the

A. neutrons B. protons C. nucleus D. electrons

7. Which of the following applies to metallic elements when they form positive ions?

A. they lose electrons and become anions
C. they lose electrons and become cations
B. they gain electrons and become anions
D. they gain electrons and become cations

8. The IUPAC name for PbO_2 is

A. lead oxide B. lead dioxide C. lead (II) oxide D. lead (IV) oxide

9. The IUPAC name for CH_4 is

A. methane B. ammonia C. natural gas D. carbon tetrahydride

10. Sometimes when ionic solutions are mixed, they form a precipitate. A precipitate is

A. an electrolyte

B. a mixture of dissolved ions

C. a solid substance that forms when two liquids are mixed

D. an aqueous substance that forms when two liquids are mixed

11. The IUPAC system rule that applies to naming molecular compounds but not ionic compounds is

A. writing the entire name of the first element

B. writing the names of the elements in lower case letters

C. changing the ending on the name of the second element to –*ide*

D. using a prefix to indicate the number of each type of atom in the formula.

12. Molecular compounds are characterized by

A. sharing of electrons

B. electrons changing energy levels

C. positive and negative ions repelling each other

D. positive and negative ions attracting each other

13. Which of the following is an acid?

A. $H_2O_{(l)}$ B. $NaOH_{(aq)}$ C. $H_2SO_{3(aq)}$ D. $Na_2SO_{3(aq)}$

14. An acid has the following properties:

A. tastes sour and has no reaction with Mg

B. tastes sour and reacts with Mg to produce bubbles

C. tastes bitter and has no reaction with Mg

D. tastes bitter and reacts with Mg to produce bubbles

15. Which of the following are typical of a solution having a pH of 12?

A. litmus is red; solution conducts electricity

B. litmus is blue; solution conducts electricity

C. litmus is red; solution does not conduct electricity

D. litmus is blue; solution does not conduct electricity

Part B - Written Response [15 marks]

16. Explain the *octet rule*. How is it related to the filling of energy levels? [2 marks]

Write the formula or name of the compounds in questions 17 to 24. [8 marks]

17. sodium sulfide ______________________

18. iron (III) nitrate ______________________

19. dinitrogen trioxide ______________________

20. boric acid ______________________

21. AlN *(s)* ______________________

22. P_4O_{10}*(s)* ______________________

23. $(NH_4)_2CrO_4$*(s)* ______________________

24. H_2SO_4*(aq)* ______________________

25. Water is a polar molecule. Explain what is meant by that term and how it relates to the fact that water is a good solvent for ionic compounds. [3 marks]

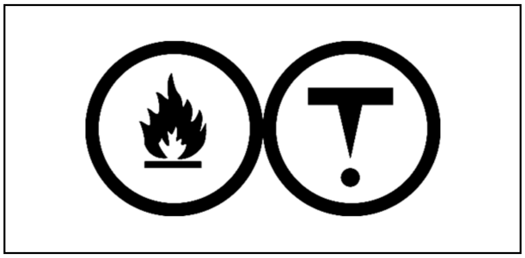
26. What is a drug addiction? In a few sentences, explain some of the health hazards of long-term alcohol use. [2 marks]

Appendix E

Unit Exam

Multiple Choice and Numerical Response

Use the following information to answer the first question.



1. The WHMIS symbols shown above are displayed on a can of solvent. They indicate that the solvent is

A. flammable and toxic
C. dangerously reactive and toxic
B. flammable and corrosive
D. dangerously reactive and corrosive

2. Which of the following is a physical property of a substance?

A. corrosion B. solubility C. combustion D. tendency to tarnish

3. A chemical change is demonstrated by

A. hailstones forming inside a storm cloud

B. ice floating on the surface of a lake in winter

C. clothes drying on an outdoor line in the bright sunshine

D. lime water turning milky when carbon dioxide is blown into it

Use the following information to answer the next question.

Chemical and Physical Properties Used to Classify Substances

1. ductility
2. malleability
3. conductivity
4. flammability (flash point)

Numerical Response

1. Use the properties from the list above to complete the sentences.

A measure of a substance's

- ability to conduct heat or electricity is its __________.
- ability to be stretched without breaking is its __________.
- tendency (temperature needed) to ignite a flame is its __________.
- ability to be beaten or rolled into sheets without crumbling is its __________.

(Record your **four digit** answer in the numerical-response section of the answer sheet.)

Use the following information to answer the next question.

A student identified a number of substances.

1. gold
2. distilled water
3. coffee
4. chicken vegetable soup

4. The examples of pure substances are

A. 1 and 2 B. 1 and 3 C. 2 and 3 D. 3 and 4

5. Salting is a food preservation technique that is actually a method of

A. sterilizing B. freezing C. drying D. fermenting

6. The scientist who proposed that atoms of different elements can combine in specific, fixed ratios to form new substances was

A. Dalton B. Thomson C. Lavoisier D. Rutherford

7. Ernest Rutherford fired tiny positive particles at a thin sheet of gold foil. Most of these particles passed through the foil, but some bounced back at sharp angles. From a study of these observations he concluded that

A. electrons are negatively charged

B. neutrons possess no electric charge

C. most of the mass of an atom is in one small region within the atom

D. most of the negative charge of an atom is in one small region within the atom

8. In the periodic table, the chemical family that magnesium and calcium belong to is called the

A. halogens B. noble gases C. alkali metals D. alkaline-earth metals

9. Which column in the periodic table contains elements that have one electron in their valence energy level?

A. first on the left C. second from the left

B. first on the right D. second from the right

Numerical Response

2. If a neutral isotope of an element has an atomic number of 20 and a mass number of 41 the number of electrons present in the atom of this isotope is __________.

(Record your **two digit** answer in the numerical-response section of the answer sheet.)

10. The magnesium ion, Mg^{2+}, has

A. 10 electrons and 10 protons C. 12 electrons and 10 protons.

B. 10 electrons and 12 protons D. 12 electrons and 12 protons

11. The organized array formed by the grouping of two kinds of ions is called a

A. formula unit B. crystal lattice C. polyatomic ion D. multivalent structure

12. When metallic elements form positive ions,

A. they lose electrons and become anions C. they gain electrons and become anions

B. they lose electrons and become cations D. they gain electrons and become cations

13. The name of the ionic compound with the chemical formula $CuCl_{2(s)}$ is

A. copper chlorate C. copper (I) chloride

B. copper dichloride D. copper (II) chloride

14. The name of the compound with the formula $PCl_{5(s)}$ is

A. phosphorus chloride C. phosphorus pentachloride

B. monophosphorus chloride D. monophosphorus pentachloride

Use the following information to answer the next question.

Arrangement of Atoms

The arrangement of atoms may occur in various ways:

1. may form more than one stable ion
2. may form molecules made up of only one type of atom
3. may form a substance that contains two elements held together by a covalent bonds
4. may form an association of several non-metallic atoms that together behave as a charged particle

Numerical Response

3. Match the terms with the descriptions as numbered above. Use each number only once.

______	______	______	______
polyatomic ion	multivalent element	molecular element	binary molecular compound

(Record your **four digit** answer in the numerical-response section of the answer sheet.)

15. Sometimes when ionic solutions are mixed, they form a precipitate. A precipitate is

A. an electrolyte

B. a mixture of dissolved ions

C. a solid substance that forms when two liquids are mixed

D. an aqueous substance that forms when two liquids are mixed

Use the following information to answer the next question.

Properties of Some Compounds and Their Solutions

I Melting point is high.

II Solutions are electrolytes.

III Melting point is relatively low.

IV Aqueous solutions do not conduct electricity.

16. Which of the following are true with regard to molecular compounds?

A. I and II B. I and IV C. II and III D. III and IV

17. Which of the following are typical of a solution having a pH of 12?

A. litmus is red; solution conducts electricity

B. litmus is blue; solution conducts electricity

C. litmus is red; solution does not conduct electricity

D. litmus is blue; solution does not conduct electricity

18. Which of the following substances is an acid?

A. $H_3PO_{4(aq)}$ B. $K_3PO_{4(aq)}$ C. $CH_{4(g)}$ D. $NaOH_{(aq)}$

19. Physical and psychological dependence, high-risk behaviour, and chronic high blood pressure can result from excessive use of

A. alcohol B. benzene C. nicotine D. chlorofluorocarbons

20. Which of the following diatomic elements is a liquid at room temperature?

A. oxygen B. bromine C. nitrogen D. hydrogen

21. The combustion of coal is a chemical reaction used in the production of electricity. This reaction

A. absorbs energy and is exothermic

B. absorbs energy and is endothermic

C. releases energy and is exothermic

D. releases energy and is endothermic

22. From the law of conservation of mass it can be concluded that

A. all reactions involve the flow of energy

B. all reactions are accompanied by one or more phase changes

C. the total number of atoms involved in a chemical reaction remains constant

D. all reactions involve the production of new substances with their own characteristic properties

23. To produce a properly balanced chemical equation, the

A. formulas of the reactants are altered to balance the atoms in the products

B. number of molecules of reactants must be equal to the number of molecules of products

C. total number of reactant atoms must be equal to the total number of product atoms

D. the number atoms of each element in the reactants must be equal to the number of atoms of each element in the products

24. Chemical substances written to the right of the arrow in an equation are called

A. products

B. reactants.

C. subscripts

D. coefficients

Numerical Response

4. Which set of coefficients correctly balances the following reaction?

__ $S_{8(s)}$ + __ $P_{4(s)}$ → __ $P_4S_{3(s)}$

(Record your **three digit** answer in the numerical-response section of the answer sheet.)

25. Which type of reaction is shown in the following equation?

$2\ AlCl_{3(s)} \rightarrow 2\ Al_{(s)} + 3\ Cl_{2(g)}$

A. a single replacement reaction

B. a double replacement reaction

C. a synthesis reaction

D. a decomposition reaction

26. The characteristics of a combustion reaction are that it is fast,

A. requires oxygen, and is endothermic

B. requires oxygen, and is exothermic

C. does not require oxygen, and is endothermic

D. does not require oxygen, and is exothermic

Use the following information to answer the next question.

Consider the following reaction equation.

__ $AlCl_{3(aq)}$ + __ $NaOH_{(aq)}$ → __ $Al(OH)_{3(s)}$ + __ $NaCl_{(aq)}$

Numerical Response

5. When this reaction equation is balanced, the coefficient for sodium hydroxide is ____.

(Record your answer in the numerical-response section of the answer sheet.)

27. An equation for a double replacement reaction is

A. $Fe_{(s)} + CuSO_{4(aq)} \rightarrow FeSO_{4(aq)} + Cu_{(s)}$

B. $2\ K_{(s)} + 2\ H_2O_{(l)} \rightarrow 2\ KOH_{(aq)} + H_{2(aq)}$

C. $C_3H_{8(g)} + 5\ O_{2(g)} \rightarrow 3\ CO_{2(g)} + 4\ H_2O_{(l)}$

D. $(NH_4)_2CO_{3(aq)} + Ca(OH)_{2(aq)} \rightarrow 2\ NH_4OH_{(aq)} + CaCO_{3(s)}$

28. Avogadro's number, N_A, is

A. 3.06×10^{23}

B. 3.02×10^{32}

C. 6.02×10^{23}

D. 6.03×10^{32}

Numerical Response

6. The mass of 6.50 mol of potassium sulfate is ________ kg.

(Record your **three digit** answer in the numerical-response section of the answer sheet.)

29. The mass of one mole of an element is called

A. the atomic molar mass

B. the elemental molar mass

C. the periodic mass

D. the molar mass ratio

30. The molar mass of nitric acid is

A. 31.02 g/mol

B. 47.02 g/mol

C. 54.03 g/mol

D. 63.02 g/mol

Science 10 **Unit A Final Exam** **Written Response**

- Write your responses on this answer sheet as neatly as possible.
- Your responses must be presented in a well-organized and easy-to-follow manner.
- Please use *complete sentences* unless otherwise instructed.
- Descriptions and/or explanations of concepts must include pertinent ideas, diagrams, calculations, formulas, correct units and correct significant digits where appropriate.

1. Compare chemical change and physical change. Give an example of each type of change. [2 marks]

____

____

____

____

2. Compare the formation of cations and anions. Your answer should include ideas about: charge, valence electrons, energy levels and stability. [3 marks]

____

____

____

____

Use the following information to answer the next question.

If water were not a polar molecule, life on Earth would be non-existent or completely different from what we see today.

3. Explain this statement, citing at least two specific examples. [3 marks]

____

____

____

____

Use the following information to answer the next question.

When liquid bromine is poured into an aqueous solution of iron (III) iodide and the mixture is stirred, aqueous iron (III) bromide and solid iodine are produced.

4. a) What type of reaction is involved? [1 mark]

___

___

b) Write the balanced equation for the reaction. Include state symbols. [2 marks]

___

___

c) What amount of iodine, expressed in moles, is produced in the equation of the balanced chemical reaction? [1 mark]

___

___

d) How many molecules of iodine does the amount of iodine in question c) represent? Record your answer in scientific notation, to three significant digits.

[2 marks]

___

___

Appedix F

Self-Reflective Survey (Wood, 1975)

Self-Directed Behavior Rating Scale

1. *Amount of Teacher Direction:*

I am totally dependent on the teacher for directing my work—I need to be told what to do.	I use the teacher to direct part of my time, but take the lead with some activities.	I work independently using the teacher only when needed for special assistance.

1 2 3 4 5

2. *Seeking Answers Independently:*

I rely on the teacher and the textbook as my major source for answers to questions.	I usually seek answers to questions using teacher, other students, and outside information sources.	I usually seek answers to questions without teacher assistance.

1 2 3 4 5

3. *Using Class Time:*

I frequently waste class time and seldom address myself to the assigned tasks.	I usually use class time to do the assigned tasks.	I almost always spend class time working on the assigned tasks, I have little, if any, wasted time.

1 2 3 4 5

4. *Planning a Work Schedule:*

I do not develop a plan my work. I lack organization and have no set pattern of attacking learning experiences.	I develop a plan for most learning activities marily when told to do so.	I independently set up an efficient plan for completing my work each time I encounter a new learning experience.

1 2 3 4 5

5. *Using Study Skills:*

I lack basic study skills and/or do not use those I have mastered.	I use basic study skills when told to do so.	I use basic skills as a natural part of my work routine.

1 2 3 4 5

6. *Using Self-Teaching Curriculum Materials and Packages:*

I am unable to use the learning materials or packages in the course without the teacher's constant assistance.	I can follow the learning materials or packages in the course with limited assistance from the teacher.	I can proceed through the learning materials or packages in the course without assistance from the teacher.

1 2 3 4 5

7. *Adapting Curriculum:*

I never skip an activity and/or assignment regardless of whether I need it or not, or never skip activities I know I need.	I skip some activities and/or assignments that deal with goals already mastered.	I always skip activities and assignments that deal with goals already mastered and sometimes design my own activities.

1 2 3 4 5

8. *Pace of Learning:*

I work well at a pace well below my ability.	In most cases, I work at a pace commensurate with my ability.	I always work at a pace commensurate with my ability.

1 2 3 4 5

Appendix G

Online Classroom Materials