Student Teaching Practicum at Worcester Technical High School

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Abstract:

As part of my Interactive Qualifying Project (IQP) at Worcester Polytechnic Institute (WPI) I had the opportunity to student teach at Worcester Technical Highschool (WT). As a Biology/Biotechnology Major at WPI, I was extremely excited to share my love of STEM education with high schoolers.

The purpose of this paper is to report my growth as an educator throughout this experience. First I will describe the educational environment of Worcester, MA, then of WT, and then of my own classes. Then I will explore the 6 Elements of the Candidate Assessment of Performance (CAP), by which teachers are judged in Massachusetts. I will show how I succeed in meeting proficient levels of all 6 elements through the use of documents used in my classroom, and through anecdotes that show the growth of myself and my students. I will conclude by highlighting how my prior education received at WPI helped inform my teaching experience.

Chapter 1:

Background

Massachusetts is a leader in the education of math and science in the country, and throughout the world. The most recent TIMSS report that includes Massachusetts was published in 2011, and includes information on math and science scores of 8th graders. In 2011, only one nation had a higher score than Massachusetts in science, which was Singapore. The US is the only country that reports race with the TIMSS data, however, among the states Massachusetts reports the highest average score among white not Hispanic, black not Hispanic, Hispanic, and Asian students. Compared to the other states, Massachusetts also scores consistently higher when scores are compared on the basis of parental education.

Worcester Technical Highschool (WT) is a public high school in Worcester, MA. It's enrollment is just under 1,500, and it serves grades 9-12. WT has a relatively large population of economically disadvantaged students. They have 44.1%, compared to the state's 31.2%, and the district's 57.9%. WT is a diverse school, its three chief populations being African American at 16.3%, Hispanic at 36.0% and White at 36.8% of the total student population. The 2018-19 year saw 45.4% female students and 54.6% male students.

In terms of MCAS scores, WT leads both the city and the state in Math, ELA and Science. This is judged through CPI scores, in which WT has a 99.3 in ELA, 95.8 in math, and 93.5 in science.

WT also scores well when one looks at the plans of its graduates. Over 50% of graduating students plan to attend a private or public 4 year university, with another 33% planning to attend a private or public 2 year university. This is higher than the district, but lower than the state.

WT reports that 95.6% of their students graduate in 4 years, and 99.1% of their students graduate in 5 years. After 4 years, the populations with the lowest graduation rates are African American or Black students at 91.3% graduating, English Learning students at 92.8%, and students with disabilities at 94% graduation rate. After 5 years however, the percent of students that graduated increases to 99.1% for all students, 100% for English Learning students, 98.0% for students with disabilities, and 100% for African American students.

	% Graduated in 4 years	% Graduated in 5 years
All students	95.6	99.1
English Learning students	95.8	100.0
Students with disabilities	94.0	98.0
African American/ Black students	91.3	100.0

Chapter 2:
My Classes

While teaching at Worcester Tech I taught Honors Biology to Freshmen, and College Level (refered to as CP) Physics to Juniors. As a technical high school, the students spend half the school year in their shops, and half the school year in academics. As a teacher, this means that we teach two groups of students the same lesson, one week after. The groups are referred to as “A Week” and “Z Week”. Regardless of the week, I taught freshmen for a double period from 7:30am, the beginning of the day, until 8:48; hence us referring to them as A or Z ½. I taught the juniors for a double period from 8:52 until 10:15, which is why we called them A or Z ¾ . My mentor teacher is the Science Department head, so she did not have any other classes. This is atypical, as all other non-department heads teach another double period on either A or Z week.

The personality and culture of my classes ranged wildly. This range forced me to adapt the way I teach, organized the class, and conducted myself. I am glad that I had such a wide range, however, as within my short teaching experience I had many different experiences.

My first class of every A/Z week cycle was my A ½. These students were Freshmen Honors Level Biology students. These students were an absolute pleasure to work with. I’ll be the first one to admit that my first few lessons were less than perfectly engaging, but these students were engaged and seemingly genuinely interested in the content from day one. The students asked incredibly high-level questions, sometimes to the point where myself, or my mentor teacher couldn’t answer them.

My A ½ class also taught me many important teaching lessons. The main lesson I learned from working with them is the art of crowd control. These students, though engaged, and excited to be in my class, were also very loud at times, and could handle very little freedom. Throughout my practicum, I tried many different lesson organizations in order to improve this behavior. The

techniques that ended up working the best were teacher-monitored activities that were engaging, and gave the students something more to do than just take notes. These activities included in person labs, virtual labs, worksheet guided videos, and in class drawings. Activities that didn't work for these students were activities that weren't timed, or didn't result in a product they would be required to turn in at the end of the period. In addition, lectures lasting longer than 30 minutes were ineffective, as the students, though they tried, couldn't stay on topic for much longer than that. However, I did find that if my lecture was accompanied by a worksheet or a chart they had to fill out while I was talking, they were more likely to stay interested than if they were just given lecture slides to copy down on their own. Please see Appendix H.2 to see the data received from the student survey that I distributed to these students.

The second class of my A/Z cycle was my A 3/4 class. These students were College Level Physics juniors. As I am not a physics major myself, these students were a great first physics class to have. These students were incredibly well behaved, autonomous, and dependable. Many, probably up to a third of the students in that class, could have handled an honors level curriculum and would have been placed in one if not for them being ELLs. However, the other students in the class, though well behaved, were very low.

The main lesson taught to me by this class was how to deal with shy and nervous students. In a sharp contrast to my other three classes, this class was not willing to ask questions in lecture. Even when I prompted them by asking if anyone had any questions, the students would not respond. At the beginning of my practicum, I incorrectly assumed that their lack of questions meant that they were all understanding the content, however I quickly learned this was not the case. When correcting their homework, I found the students leaving things blank or just

with a question mark, instead of asking me for help. My challenge with this class was coming up with a way to asses the knowledge of this class in an anonymous, yet efficient way.

My solution to having quiet and shy students was two fold. One method was the introduction of exit tickets to my lesson plans. At the end of each lesson, the students were asked to write down the answer to one question, and turn it in as they left. I would review these answers in anticipation of the next lesson with them, and it helped inform me of what concepts they were missing. The other solution to this challenge was the introduction of the PearDeck questions, as previously discussed. I started using them for another class, but soon saw the potential they had to help this quiet class as well. Please see Appendix H.3 to see the data received from the student survey that I distributed.

On Z weeks, I began my day with my Z ½ class. These students were Honors Level Biology Freshmen. In a sharp comparison to my A ½ class, these students were much quieter, and significantly harder to get engaged in content. These students could handle long lecture times with out beginning to act out and become visually distracted. This class was not likely to ask higher level questions from me, so I sometimes felt as though the lectures with this class reached a lower level of content depth than their A week counterpart. These students were very well behaved, and could handle 20 to 25 minutes of relatively undirected class time. I could tell these students that they had a couple worksheets for homework, and trust that they would spend the rest of class time diligently working on them.

The challenge I faced while working with this class was how to initiate healthy and deep class discussions of content. Due to the un-chatty nature of this class, I was able to put them in groups quite often. I used groupwork as an opportunity to indirectly check in with every student, and make sure everyone was able to answer these higher order thinking questions. I often had the

students work in randomized groups, and then had them present their findings or product out to the class. Another technique I started using was to ask the class discussion questions during lecture. I had to introduce the types of questions that A week asked me, in order to push the students further. Please see Appendix H.4 to see the data received from the student survey that I distributed.

The second class I had during Z weeks was my Z ¾ class. These students were College Level Physics juniors. This class, though very nice, were by far my most chaotic and chatty class. These students were loud, and hard to keep focused on any task. These students couldn't handle traditional notes in almost any capacity, nor could they handle free time of any kind. In addition, this class had many students who were genuinely very low in terms of previous knowledge. Despite this, I found myself looking forward to this class every week, as these students, with the exception of a few, were genuinely sweet, caring, and fun to interact with.

There were many challenges I faced while teaching this class, however the biggest one was how to keep the class on task during my lessons. As previously discussed, the introduction of PearDeck to my lessons allowed me to give the students a task while taking notes. I also found myself changing my lesson plans to allow for less free-time. Please see Appendix H.5 to see the data received from the student survey that I distributed.

Within these four groups of students, the range of ELLs I worked with was pretty limited. In both my honors and my CP level classes the lowest ELL was a 4 and the highest was a level 6. I attribute that to the organization of WT's classes. If students are lower than a 3 they are placed in an Inclusion Level class, so that instruction and pace can sufficiently serve the students. My mentor teacher does not typically teach Inclusion level classes, so I was unable to work with those students.

Although I ensured I was aware of which students were ELLs, most of them were indistinguishable from the rest of their peers. This is possibly attributed to the nature of my science classes. In biology, the vocabulary was new and tough to understand for every student, so I used many SEI practices anyway. In physics, there is less vocabulary, and much more mathematic calculations. As a result, the native English speakers had no more of an advantage over the ELLs.

Chapter 3:
1.A. 4: Well-Structured lessons

The first element of CAP is well-structured lessons. This element focuses on a teacher's ability to plan ahead. Teachers need to make sure they have effective and efficient lessons every day, as well as make sure they reach overarching content objectives. All teachers are held responsible by the standards given by the state and city in which they teach, and a well structured lesson and unit plan is how teachers ensure they are reaching these standards. Well structured lessons were especially important to me in my biology classes, as these students are taking the MCAS in the Spring, so their content knowledge absolutely needs to be at the level and depth expected by the state. At Worcester Tech, we tend to plan one week as a unit, as we see two groups of students every other week.

I achieved this CAP element through a two-fold approach. The first technique I used was filling out the standard lesson plan template given to me by the WPI TPP. I found that my mentor teacher uses a very similar template given to her by the state. While doing this, I focused on ensuring the 80 minute periods were broken up into 20 to 30 minute chunks, in order to keep the students engaged in, and excited about the material.

My first couple lesson plans were less successful at this, and were definitely more lecture heavy. In the beginning, I was more focused on ensuring the students were getting the material, and less comfortable with differentiating my methods of delivery. As the practicum went on, however, my lesson plans became more diverse and more engaging. Please see Appendix A for a sample week lesson plan that incorporates a myriad of different methods of delivery.

The second approach I used to ensure I had well planned lessons was making slide shows. I made a Google Slide PowerPoint for each week's lesson I was responsible for teaching.

Although PowerPoints are not always the most engaging method of delivery, the act of making them helped me plan out the order of my content, as well as allowing me to pre-plan in breaks. I used the PowerPoints to embed videos, projects, and drawings into the lessons in a planned way. They also served as a great reference for me and my students as we began to study for their mid-term.

Chapter 4:
2.B. 2: Adjustment to Practice

The second CAP element is adjustment to practice. Although making well structured lessons is important, possibly more important is the ability to change and adjust these lesson plans when the situation calls for it. A teacher who is not adjusting to the needs and reactions of her class is not teaching in the most effective way possible.

The schedule of WT allowed for much adjustment to practice. Due to this structure, I was able to adjust every one of my lessons. Based on the test scores from A week, I would change the amount of review, practice, homework and notes that I gave to Z week.

Please see Chapter 5 on meeting diverse needs for a in-depth description of how I often adjusted my lesson plans to better fit the needs of my students.

Adjustment to practice also happens on a much smaller, less formal scale. After teaching a full week's worth of lessons, I would have a pretty good idea of what the students would inherently understand, and what they wouldn't. I would also have a much better idea of which types of language and comparisons worked, and more importantly, which didn't. although these changes are hard to see on the physical lesson plan, they are something that I absolutely paid attention to, and adjusted as needed.

Chapter 5:
2.A.3: Meeting Diverse Needs

The third element of CAP is meeting diverse needs. Every class I had was composed of students who had drastically different needs, wants, tendencies, and mannerisms from my other classes. As a result, I found my self teaching four drastically different lessons for each of my four groups of students. The content was consistent, but the delivery and techniques varied wildly. There was almost nothing in common between the students in my A week and Z week classes, despite the fact that they were the same level, subject, and grade of students at the same school.

Sometimes in order to meet the needs of the class, I myself, needed to change. My A week ½ and Z week ¾ were very easily distracted in general, but particularly during long note taking sessions. I found myself being subjected to many off topic questions in an attempt to waste class time. At first, I found it as an opportunity to bond with the students, as I remember that the teachers from high school I liked and respected the most were those who allowed us to make connections with them. However, I quickly realized that the education of the students was suffering at the hand of these off-topic conversations. So, for these two classes, I had to restrain myself from discussing off topic material with them, in favor of having a consistent and effective use of class time.

This helped the A ½ class, but the Z ¾ class would just talk amongst themselves when I stopped responding. Through discussion with my mentor teacher, we decided that this class demanded an extra level of accountability added to the lesson, as they were not capable of doing it by themselves. Our solution was an online tool known as PearDeck.

Pear Deck is a Google Slides add-on that allows one to embed questions and tasks into a Google Slides presentation. From a Chrome Book, or their cellphone, the students can then respond to the questions during the lecture, and I can review the answers publicly but anonymously in front of the class. Later, I can review the answers with the students' names attached.

I introduced this program under the guise of a class participation grade, where if students were physically present in school, and tried to answer the questions to the best of their ability, they would get full credit for the day. In truth, the constant question and answer format of the class forced students to pay attention and stay on task. It also minimized the extra side conversations, as they were now being graded in a concrete way on their behavior and conduct during notes. This adjustment was made on a Monday afternoon of a Z week, after a particularly chatty and ineffective class. I modified the slideshow I had made and used for the A week lesson, and then made my lesson plans with PearDeck integrated from then on for all classes.

This introduction left my lesson drastically different from the one I had just taught A week, but it was an adjustment that was necessary if the students were to get anything out of my lectures. It was also an adjustment that was necessary for just one class, but once it was made, the needs of all of my classes were much closer to being fully and fairly met. See Appendix A and B for the original and adapted slideshows.

Chapter 6:
2.B.1: Safe Learning Environment

The fourth CAP element is the establishment of a safe learning environment for the students. This element is vital, as almost none of the other ones can happen if the student is not comfortable and confident in the classroom.

Students walk into the classroom having lived lives that put them through many situations that I as their teacher can't protect them from. But what I can do for them is make sure that they feel valued and important in my classroom. I worked very hard to ensure that.

My mentor teacher and I began this work on day one. We established very early on in the class progression what types of language and actions were appropriate and accepted in our classroom. We did this through the distribution of a classroom rules paper, that was signed by both the students and their parents.

Establishing a safe learning environment was something that I took very seriously on a one-on-one level with the students as well. One particular student and I grew very close over the course of my practicum, as I watched him struggle with a conflict that was external and social media based, but also clearly impacted his performance in my classroom.

This student began the year as a very positive, cheerful member of the class, and over the course of a couple weeks devolved in participation, attitude, and overall wellbeing. Where he was once engaged and responsible, the student was now sleeping through my class, doing very poorly on and sleeping through my tests, and not turning in any work. When questioned about his change in demeanor, the student seemed to be defensive, and uninterested.

My mentor teacher and I noticed this, and attempted to address the problem by moving the students' seats. I placed this student directly in front of where I stood to lecture, and

increased my direct communication to him, encouraging him through body language and verbal cues to make more eye contact, open up to me, and pay attention. This helped, as a few days into the new seating arrangement, the student actually asked me, “If someone posts something online that you sent them on accident, can I report them?”, since he had asked in the middle of a lesson, I didn’t have the time I would have liked to discuss with him, so I simply said “Yes of course”, and he seemed to find solace in that.

I took his question as a cry for help, and decided to further investigate the situation. My mentor teacher and I went to go speak to his shop teacher, to ask if he had also noticed the change in the student’s behavior and conduct. We thought his shop teacher would be a valuable resource, as being a junior, this student had dealt with the same shop teacher for the past 2 years. Unfortunately, the shop teacher’s input was not what we had expected it to be. The teacher expressed very explicitly his dislike for the student, and his belief that the student was lazy, and undeserving of his spot at WT. When I pushed him to asses if he had noticed a change in the student’s overall behavior as of late, the teacher made it very clear that he did not pay attention enough to notice something of that nature.

Unsatisfied, my mentor teacher and I sought out the student’s guidance counselor, and reexplained the situation. The guidance counselor was more receptive, and told us that he would take time to reach out to the student, and offer himself as a resource. Though I was glad to hear that, I quickly began to become nervous that I had ruined the small amount of trust the student had in me by “telling on him”. I knew what I had done was the right thing, but I spent the rest of that night very nervous.

The next day, however, the student appeared to be in better spirits, and was significantly more engaged with the content. Since then, the student has grown in both conduct and academic

success. On the test he took the week of my intervention, he scored an 87%, which is significantly better than the 54% he got on the test directly prior.

I don't attribute his mood shift to just myself, nor do I attribute it to the conversation the student had with the guidance counselor. However, I do attribute his mood shift to the overall efforts of myself, my mentor teacher, and the other administrative adults in his life who chose to care about him. This interaction with the student taught me a very important lesson about how the students come into my class with baggage, and what my job as a teacher is to make sure they're okay. Having a safe learning environment is something that a teacher must work every day to establish and maintain, and it goes well beyond just the 80 minutes a day the students are sitting in front of me. This situation also taught me that a safe learning environment for one student, is not always safe and inviting for another. It took a seat change, and a very deliberate alteration of my actions and mannerisms to pull this student out of his shell. This student's relationship with myself and my mentor teacher is something that is going to be a continuous point of work as the year progresses, however it has already come along way.

Chapter 7:
2.D.2: High Expectations

The fifth CAP element is high expectations. This element focuses on pushing the students to be the best they can be, despite their range in needs or abilities. In order to achieve this CAP element, one needs to have a close familiarity with the standards given by the state and the city, in addition to a large amount reflective practice at the hands of feedback from students.

There were two areas where I struggled with implementing high expectations. The first area was in reference to my freshmen. These students are taking a state mandated MCAS test in the Spring that will partially inform their graduation from high school as well as possible scholarships offered to them by the state. This pressure, which is undoubtably felt by the students, is felt 10-fold by their teachers. Every assessment given to them should prepare them in the most direct way possible for the MCAS test. This line of logic led my mentor teacher and myself to hold the students to extremely high expectations. Every exam we gave them was based solely of MCAS questions from previous years. This often resulted in very challenging exams, which students didn't always score highly on, however we found that to be okay. The practice and familiarly with the MCAS langue and style of question was the primary goal, with a MCAS-informed level of content knowledge being a close second. Although we never told the students we were going to, if the test scores were very low, we would scale the test, in order to boost the overall grades of the students.

This system of giving hard exams with high expectations, and scaling if necessary is something that my mentor teacher has done for many years, and is something that I very much also believe in. This structure should result in a class full of students who are used to and comfortable with the notoriously challenging MCAS biology exam, while still allowing us to ensure that the student's grades reflect the level of effort placed in our class. Please see

Appendix C for an example of an exam based entirely on old MCAS questions, and the scores of the students broken down by question.

The second area in which I struggled with enforcing high expectations was with the juniors. By nature of it being a CP level class, the student population tended to be more challenged at mathematics, both in basic skill, and in theory. This became very relevant as our physics content moved away from theory and deeper into applied mathematics. Very early on it became very clear to me that the students lacked the basic math skills involved in solving two step single variable equations, in addition to the logic required to pick the correct equation to use. It also, however, was very clear to me that it was fair of me to expect them to do that, as it is required within the physics curriculum.

In order to accommodate their variable levels of background knowledge, and still reach the high expectations asked of them by the state and myself, I worked very hard to design exams. The goal of my exams was to test their base knowledge of physics theory, as well as push them to complete as much of the math as they could. I accomplished this by starting exams off with multiple choice questions that required little to no math to complete, and finishing the exams with open response questions that were math problems taken almost directly from the homework or notes of that week. I further broke up the open response questions into three steps, “1) Given, 2)Find, 3)Solve”. These steps were used and modeled in class and through the homework, as well as being consistent from week to week. The open responses were graded in such a way that the majority of the points were in defining the variables involved in the problem, as well as picking the correct formula to use. Beyond that point, I often said that the physics was over, and only math was left. If students were able to complete the math and get the correct answers, there were points available for them to earn, but if the students were not able to complete the math

problems, and amount of points they would miss was small enough that they would still pass the exam. I thought this system was the best way to deal with the range of math skills, while still holding the students to the high expectations required in the state standards. Please see Appendixes D and E for a graded example of each type of student response.

Holding the entire class to high expectations is, in my opinion, meaningless unless one can hold individual students to high expectations as well. Throughout my practicum I interacted with one particular student quite a bit, as I struggled to help him understand the high expectations he was able of reaching.

After the conclusion of the first or second class we had with this student, he approached myself and my mentor teacher and expressed that he wished we taught an honors level of the physics class he was in. My mentor teacher has never taught honors level, so she informed him of this, and encouraged him to consider switching into an honors level class taught by another teacher. This type of conversation happened several times throughout the first weeks of the course, wherein myself or my mentor teacher would encourage this student to leave our college level class, and join one of higher difficulty and depth. Every conversation ended the same way, with this student expressing that he "liked us too much", or that switching classes was "too much work".

As a student who was always in higher level classes while in high school, I was shocked and slightly angered by the comments made by this student. I had multiple conversations with my mentor teacher about this topic, where she explained that often students chose to keep themselves in lower level courses to avoid the challenge presented by honors, or to stay with a friend. I found this very confusing, and angering, as myself and my mentor teacher could very easily tell that this student, as well as a couple others in that class, were more than capable of

handling the rigor presented by honors level classes. My mentor assured me that there was nothing I personally could do, except use my time with that student to push him further than the college level curriculum would usually.

I did so through multiple means. I did not want to single out or isolate the student, so he took the same exams, and did the same homework as his peers. I challenged him mainly through my grading of these exams and homework. I often wrote notes on his papers, asking for more analysis and higher thinking, since I knew he was capable. I also found myself less forgiving with late or missing assignments from this student, as again, I knew anything he didn't turn in was done out of laziness.

Unfortunately, even at the end of my practicum, this student was still in our CP level class. Though I thoroughly believe him and I both know what he is capable of doing, for one reason or another he has chosen to stay in an environment where minimal amounts of his effort is required to do well. I ended our last class by taking a moment to privately encourage him to challenge himself, and take academic risks we both know he is able to handle, and can only hope he takes my advice. The phenomenon of students who refuse to hold themselves to high expectations was one I did not expect to encounter as a student teacher, and one that really bothered me as a past student and as an educator. I now understand on a much deeper level how important high expectations are in the educational journey of students.

Chapter 8:
4.A.1: Reflective Practice

The 6th element of CAP is reflective practice. This is important in anything you do, but especially in teaching. I find it appropriate that this is listed as the last CAP element, as it is present and underlining in all other elements. If one is not constantly reflecting on themselves, and their peer teachers, then one is not going to be able to complete any of the other elements. The ability to remove one's ego and preconceptions to evaluate the progress and needs of their class objectively is imperative. Different levels, classes, grades, and demographics will have drastically different needs that the teacher will have to adapt to. However, before one can adapt to the different needs of their class, one needs to recognize them.

Every day after our lessons, my teacher and I would decompress, eat lunch, and discuss the happenings of the day. Our daily conversations ranged to include everything from the content, the methods of delivery, the conduct of the students, to the logistics of being a teacher in an urban school. I found these conversations to be very enlightening and helpful as I grew as a teacher during the practicum.

In addition, I drove home from school with another student teacher from WPI who was teaching biology to freshmen. We often discussed at length what techniques, activates, and methods of delivery worked best for our students. Our mentor teacher had wildly different teaching styles, so we found ourselves contrasting the advice and resources given to us. I found this practice very valuable, as we were both new to teaching and had similar struggles. Many of the activities I chose to implement in my classroom were ones recommended to me by her.

I think that reflection is something that must be present in every element of teaching, and as such, I have integrated my reflections into the other sections of this paper.

Chapter 9:
My WPI Education

I took several courses at WPI which prepared me for student teaching.

The first course I took was The Psychology of Education. This course was centered on the psychology behind how students learn, and what we, as teachers should do to best facilitate it. The majority of the class was spent analyzing and discussing Bloom's and other similar taxonomies. Despite the fact that these taxonomies are far from being at the forefront of my mind while I'm physically teaching, a deep understanding of them can help inform lesson plans and unit goals. Something I found particularly helpful while lesson planning was the knowledge that skills such as evaluation and synthesis are ones that students must build up to. With this information, I attempted to structure my lesson plans and homework in such a way as to help the student scale the ladder of Bloom's Taxonomy in a scaffolded and natural way. I set my expectations with the understanding that students need to be able to recall information if they are to apply it, and be able to analyze the information before they are able to evaluate and synthesize something new with it. I don't think everyone is conscious of all the planning and pedagogy that goes into teaching, I know I certainly wasn't, so I thank this class for bringing it to the forefront of my mind, and showing me how I can best structure my lessons for my students.

The next class I took in preparation for teaching was Sheltered English Immersion. I took this class to receive my SEI certification, as required by the state of Massachusetts. As a student, I was not an English Language Learner (ELL), so I found many aspects of the class to be new and interesting. I really appreciated the pedagogy behind SEI instruction. I absolutely believe that every student deserves the best education possible, regardless of where they're from or what language they speak. At first the idea of teaching content and English at the same time seemed

really daunting, and it is, but throughout the course I came to appreciate how it could be approached. As I mentioned before, I was able to work with very high ELL level students, so many of the techniques I learned in this class I was not able to use. I think the biggest lesson I learned during this course that I used in the classroom was how ELL's were identified, scored and treated by Massachusetts public school systems. I fully agree with Massachusetts policy, I think all teachers should receive this training, as ELLs are a demographic that are historically mis-serviced by the public-school system.

Another class I took in preparation for this teaching practicum was Developmental Psychology. This class focused on the developmental stages in a human's life, from birth to death. Since I knew I was going to be teaching, I paid special attention to the birth to high school stages while I was in the class. I found this class to be interesting, as I had never gotten a formal explanation of the physical and mental developmental stages of a growing person. The most important aspect I learned in that class, was how interconnected the stages of human development are. I think this is a vital lesson for all teachers to learn, as we both are dealing with behaviors that stem from other stages and aspects of our student lives. It is easy to forget that students have lives outside the classroom, and that these lives have a lot of influence over how they act in the classroom. The knowledge and acceptance of this made me a more compassionate, accepting teacher. Good or bad behavior comes from somewhere in the students past, and it is important to remember that often it is not the students' intention to act as rude or mean as they may come off. In addition, this class also reminded me that the lessons I teach, content related and otherwise, will affect the lives of my students well after I am done teaching them. This knowledge reminded me to always try to encourage them to be better people, and to teach them the social and emotional lessons they might not have learned elsewhere. This class

was an important addition to my pre-practicum education, as I feel it made me a more understanding and compassionate teacher.

The final class I took before my teaching practicum was ID 3100, or Teaching Methods in Math and Science. This class served as an overview and introduction to what the teaching practicum would really be like, as well as a way to summarize all the previous classes. I found this class the most enjoyable and the most helpful by far. In this class we tackled and openly spoke about many of the real-life struggles teachers face, both policy wise and student wise. I think this class really pushed me to be a better teacher, as the professor would often give us very hard hypothetical situations, and ask us to figure out a way to help the student as best we could. I often left this class saddened by the range and severity of struggles students and teachers face throughout their lives, but I am very glad I was exposed to them before I taught.

Another very important aspect of this class involved a serious and in-depth look at what it takes to write and execute a good lesson. We spent time making lesson plans, modifications, adaptations, worksheets, and labs for a variety of situations. We also got the opportunity to present our lessons, which helped me appreciate the importance of a well delivered lesson. The practice and experience I got through this class was absolutely very useful throughout my practicum.

Conclusion

I learned an unbelievable amount about myself and teaching through this experience. When I compare my lesson plans and delivery from the first couple lessons to the lessons I gave towards the end of the practicum, I almost don't recognize myself. I experienced a large amount of growth, both in terms of abilities and overall confidence. I was never afraid of public speaking, but I am now very confident in my ability to control a large room of people and demand their respect. I am also much more trusting of myself, and my ability to go off script but still express my intended message.

I also learned quite a bit about the logistics of being a teacher, and every aspect that is involved in it. I am not absolutely convinced that teaching is the career path I am meant to have, as the amount of joy it brought me is unequalled by anything else I have ever done.

I am extremely proud of every one of my students. They showed an amount f growth I could never had expected. There are a couple students who will be in my heart forever, as their struggles and successes meant an incredible amount to me.

I am so thankful that the students and teacher I interacted with at Worcester Tech allowed me into their lives and hearts, where in I grew as a person and an educator.

References

Chester, M. D. (2016, April). 2016 Massachusetts Science and Technology/Engineering Curriculum Framework. Retrieved December 9, 2018, from http://www.doe.mass.edu/frameworks/scitech/2016-04.pdf

Massachusetts DOE. (2016, June). Guidelines for the Candidate Assessment of Performance. Retrieved December 9, 2018, from https://view.officeapps.live.com/op/view.aspx?src=http://www.doe.mass.edu/edprep/cap/guidelines.docx

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Appendix A: A sample lesson plan

Lesson Plan Title: Week 5: Cellular Respiration and Photosynthesis
Teacher's Name: Kate Varteresian **Subject/Course:** Honors Biology
Unit: Cellular Respiration (CR) and Photosynthesis (P) **Grade Level:** 9th grade

Overview of and Motivation for Lesson:
Understand how CR and P transfer energy throughout the earth.

<table>
<tr><th colspan="2">Stage 1-Desired Results</th></tr>
<tr><td colspan="2">Standard(s):
HS-LS1-5. Use a model to illustrate how photosynthesis uses light energy to transform water and carbon dioxide into oxygen and chemical energy stored in the bonds of sugars and other carbohydrates. Clarification Statements: • Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. • Examples of models could include diagrams, chemical equations, and conceptual models. State Assessment Boundary: • Specific biochemical steps of light reactions or the Calvin Cycle, or chemical structures of molecules are not expected in state assessment.
HS-LS1-7. Use a model to illustrate that aerobic cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and new bonds form, resulting in new compounds and a net transfer of energy. Clarification Statements: • Emphasis is on the conceptual understanding of the inputs and outputs of the process of aerobic cellular respiration. • Examples of models could include diagrams, chemical equations, and conceptual models. • The model should include the role of ATP for energy transfer in this process. • Food molecules include sugars (carbohydrates), fats (lipids), and proteins. State Assessment Boundary: • Identification of the steps or specific processes involved in cellular respiration is not expected in state assessment.</td></tr>
<tr><td colspan="2">Aim/Essential Question:
How do CE and P relate to each other, and the rest of the energy in the ecosystem?</td></tr>
<tr><td colspan="2">Understanding(s):
Students will understand that . . .
All organisms perform CR
all energy in the biosphere comes from P
how CR and P fit into the carbon cycle</td></tr>
<tr><td>Content Objectives:
Students will be able to . . .
What are the reactants and products of CR
what are the reactants and products of P
what is the purpose of CE</td><td>Language Objectives:
ELD Level 4 Students will be able to . . . in English
Taking stances and defending them with evidence (e.g., using data or citations)
Integrating images, diagrams, formulas, or charts to describe phenomena</td></tr>
</table>

• what is the purpose of P
• which organisms rely on CE
• which organisms rely on P
	• Providing precise words and phrases to provide details, descriptions, classifications, comparisons, causes/effects, or procedures.
	ELD Level 5-6 *Students will be able to . . . in English*
	• Synthesizing information and details about phenomena from a variety of sources
	  • Integrating images, diagrams, formulas, or charts to describe phenomena
	  • Following discipline-specific organization (e.g., orienting the reader, details, conclusion) and supporting presentations with graphs, formulas, quotes or other media

Key Vocabulary
- reactant
- product
- cellular respiration
- photosynthesis
- autotroph
- heterotroph
- carbon cycle

Stage 2-Assessment Evidence

Performance Task or Key Evidence
- students will take an exam at the end of the week
- students will answer analysis questions about the connection between the lab and the system of P

Key Criteria to measure Performance Task or Key Evidence
- students will score above a 75 on the exam to prove they mastered the material
- Students will be able to establish a written connection in their own words that shows the connection between observable traits of plants and the rate of P that is occurring

Stage 3- Learning Plan

Monday
Learning Activities: (10 minutes)
Do Now/Bell Ringer/Opener: students will grab a packet on their way in and begin adding the vocab words to their notebook

Learning Activity 1: (30 minutes)
Review of Last weeks test
-students will be placed into groups of 5 using a random grouping program for a total of 5 groups
-each group will be given 2 questions from their last exam that a majority of the students got wrong
-the students will be asked to reanswer the two questions in their groups, using each other and their notes as resources

-when groups think they have both questions answered, they will come and check their answers with the teacher
-each group is responsible for NEATLY writing out the question, the correct answer and the rationale for the answer on a sheet of paper
-students will then break from their groups and gallery walk around the room. students will pick 2 questions that their group did not do, and take a picture of the poster made by the other group
-for homework students are responsible for making a poster that contains the question number, question, the correct answer, and the rationale for the answer in their own words, as well as drawing a picture that helps them remember and understand why they got that one wrong

5 minute break

Learning Activity 2: (30minutes)
.-Students will take a chromebook and watch a Bozeman Science video on cellular respiration and photosynthesis . (http://www.bozemanscience.com/cellular-respiration) (http://www.bozemanscience.com/photosynthesis) They will fill out an associated worksheet (from J. Schrodes)

Tuesday
Learning Activities: (10 minutes)
Do Now/Bell Ringer/Opener: students will begin adding the vocab words to their notebook

Learning Activity 1: (20 minutes)
Students will be given a short slide show presentation on the details of cellular respiration (see attached powerpoint)

Learning Activity 2: (20 minutes)
Students will be given baggies that contain cellular respiration kits. These kits will include a finite number of C, H, O atoms and they will be tasked with following the formula for cellular respiration all the way through.
Students will then diagram the formula of cellular respiration in a way of their choosing

Learning Activity 3: (rest of class)
-students will get a chromebook and open to the new MCAS program. Teacher will introduce the new format and lead the students through answering some of the questions. The students will then be allowed to play with it. The goal is NOT to get all or even may of the questions correct. The goal is to understand the tools and format of the new program

Wednesday

Learning Activities: (10 minutes)
Do Now/Bell Ringer/Opener: students will begin adding the vocab words to their notebook

Learning Activity 1: (20 minutes)
Students will be given a short slide show presentation on the details of photosynthesis (see attached powerpoint)

Learning Activity 2: (20 minutes)
Students will be given baggies that contain photosynthesis kits. These kits will include a finite number of C, H, O atoms and they will be tasked with following the formula for photosynthesis all the way through.
Students will then diagram the formula of photosynthesis in a way of their choosing

Learning Activity 3: (rest of class)
-students will get a chromebook and open to the new MCAS program. Teacher will introduce the new format and lead the students through answering some of the questions. The students will then be allowed to play with it. The goal is NOT to get all or even may of the questions correct. The goal is to understand the tools and format of the new program

Thursday:
Lab day
http://www.glencoe.com/sites/common_assets/science/virtual_labs/LS12/LS12.html

http://www.reading.ac.uk/virtualexperiments/ves/preloader-photosynthesis-full.html (https://www.northernhighlands.org/cms/lib5/NJ01000179/Centricity/Domain/38/photosynthesis-virtual-labs.pdf)
(See other files for Lab sheets)

Friday:
Review and Test

Multiple Intelligences Addressed:

☐ Linguistic	☐ Logical-Mathematical	☐ Musical	Bodily-kinesthetic
X Spatial	X Interpersonal	☐Intrapersonal	Naturalistic

Student Grouping

☐ Whole Class	X Small Group	X Pairs	X Individual

Instructional Delivery Methods

X Teacher Modeling/Demonstration	X Lecture	X Discussion	
XCooperative Learning	X Centers	X Problem Solving	

<table>
<tr><td colspan="2">☐ Independent Projects</td></tr>
<tr><td>Accommodations
Click here to enter text.</td><td>Modifications
Click here to enter text.</td></tr>
<tr><td colspan="2">Homework/Extension Activities:
M-pg 11 in packet and cut out molecule models
T- pg 1-3 in the packet
W-pg 4-6 in packet
Th-finish lab questions
F/shop week-Ameba sisters video about prokaryotes vs eukaryotes</td></tr>
<tr><td colspan="2">Materials and Equipment Needed:
molecule paper models (in drive)
packet (in drive)
question sheets for videos (in drive)
virtual lab sheets (in drive)
powerpoint (in drive)</td></tr>
</table>

Adapted from Grant Wiggins and Jay McTighe-*Understanding by Design*

Appendix B: A slideshow on Newton's Laws without a high number of PearDeck questions

Newton's Laws
Part 1

Week 6

Goals for the Week

- Understand Newton's Three laws of motion
- Use free-body diagrams
- Distinguish the differences between static and kinetic forces and thier effects on objects

Newton's Three Laws of Motion

1. An object in motion tends to stay in motion and an object at rest tends to stay at rest unless acted upon by an unbalanced force.
2. Force equals mass times acceleration (F=ma)
3. Or every action there is an equal and opposite reaction

Newton's First Law

An object in motion tends to stay in motion and an object at rest tends to stay at rest unless acted upon by an unbalanced force.

Can you think of an example of this?

What does this mean?

- An object will keep doing what it's doing unless it's acted upon by a force
- If an object is still, it will stay still
- If an object is moving, it will keep moving
  - Think about moving around in space, there is no air resistance and no gravity
- It takes a force to change the motion of an object

Definitions

- Equilibrium: the state in which all forces are balanced, so that there is no acceleration
- Interia: the tendency of all objects to maintain a state of equilibrium

Inertia

- Inertia depends on the mass of the object
- Which is harder to move from rest
  - A refrigerator magnet
  - A whole refrigerator
- More mass= more inertia

How can we tell is an object is in equilibrium?

- Look at all the forces involved, determine if they are balanced
- We do this by drawing Free Body Diagrams
- Free Body Diagram: a diagram of all the forces acting on an object at a single instant of time

How to make a Free Body Diagram

Five key things:

1. Never draw the actual object, draw a box or just a dot
2. Draw forces as vectors (arrows) in the direction the force is acting on the object
3. Label all arrows with the proper force symbol
4. The size of the arrow should relate to the size of the force (bigger arrows=bigger forces)
5. If the object is at equilibrium, them all the forces should balance, but if it's accelerating then the forces shouldn't balance

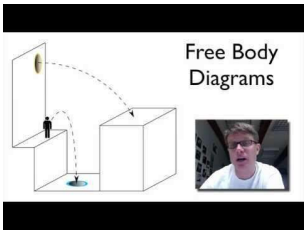
Common Forces

- Force Due to gravity: always acts STRAIGHT DOWN, F_g
- Friction force: always acts in the opposite direction the object is moving F_f
- Air Resistance: acts in the same direction as friction, we can use the same arrow as F_f and label it F_{ar}
- Normal Force: the supporting force that acts perpendicular to the surface the object is sitting on F_N
- Tension: the force from ropes, cables, ect and can only pull F_T

Exit Slip

On a blank piece of paper, draw a free body diagram to represent the forces acting on you as you sit in your chair, and another one to represent you as you are standing up

Lets Practice



NEWTON'S SECOND LAW:

Force is equal to the mass of the object multiplied by the acceleration of the object.

Force = Mass x Acceleration

What does it mean?

- F = ma basically means that the force of an object comes from its mass and its acceleration.
- Something very massive (high mass) that's changing speed very slowly (low acceleration), like a glacier, can still have great force.
- Something very small (low mass) that's changing speed very quickly (high acceleration), like a bullet, can still have a great force. Something very small changing speed very slowly will have a very weak force.

FORCE = MASS X ACCELERATION

CONCEPTUAL QUESTIONS: Copy in your notes and answer here

1. If I doubled the mass (keep acceleration constant), what happens to the force?
2. If I double the acceleration (keep the mass constant), what happens to the acceleration?
3. If I cut the mass in half, what happens to the force?
4. If I cut the acceleration in half, what happens to the force?
5. If I doubled the mass and the acceleration, what happens to the force?

More about F=ma

- If you double the mass, you double the force
  - ma=F
  - (2m)a=2f
- If you double the acceleration, you double the force
  - ma=F
  - m(2a)=2F
- If you double the mass and the acceleration, the force is quadrupled
  - (2m)(2a)=4F
- What if I cut mass in half? What would happen to the force?

Newton's Second Law

F=MA

Force=Mass x Acceleration

A. What are the units for Mass?
B. What are the units for acceleration

Students, write your response!

Pear Deck Interactive Slide
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Newton's Second Law

F=MA

Force=Mass x Acceleration

Q: So what do you think the units will be for Force? (Hint, put them together)

Students, write your response!

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Newton's Third Law

For every action there is an equal and opposite reaction.

If I were to punch a wall with a force of 15N what would happen?

Students, write your response!

Pear Deck Interactive Slide
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Sooo if I were to punch a wall with a force of 15N what would happen?

Students, write your response!

Pear Deck Interactive Slide
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What does this mean?

- Right now, gravity is pulling you down in your seat, but Newton's Third Law says your seat is pushing up against you with equal force. This is why you are not moving. There is a balanced force acting on you– gravity pulling down, your seat pushing up.

The reaction force is the resulting force in the interaction

As you're sitting in your chair, what is the reaction force?

Students, write your response!

The action force is the force that is causing the interaction

As you're sitting in your chair, what is the action force?

Students, write your response!

Some definitions

- Action-reaction pair: the set of forces that occur at the same time, as described in the law
- Action force: the cause of the interaction
  - [object 1] pushes on [object 2]
- Reaction force: the resulting force due to the action force
  - [object 2] pushes back on [object 1]

The Space Shuttle engines push out hot gases, and the hot gases put a force on the shuttle engines so the shuttle lifts

a) What is the action force?
b) What is the reaction force?

Students, write your response!

Problem 1

A tractor of mass m is connected to a trailer by a rope. The rope can carry 7,000 N before it breaks.

Part 1

Draw a free-body diagram of the trailer before the tractor starts pulling it. Be sure to label the different forces acting on the trailer.

Part 2

The tractor now starts pulling the trailer with a force (let's call it F_{app}).

Draw a free-body diagram of this situation. (Be sure to include friction.)

Part 3

The trailer accelerates at 3 m/s^2. As it drags across the ground, the rope breaks.

Using the rope's breaking strength of 7,000 N, what can you say about the mass of the trailer?

The comic strip will involve a kinematic problem and a free body diagram. It's up to you to create the subject and situation of the comic, the characters and the illustration. Be as creative as possible! Just make sure it's school appropriate! You will have all day in class on Friday to work on it!

Your comic will be judged on 4 categories for a total of 40 points

1. Creativity: is the project creative, unique, colorful and show signs of effort? (10 pts)
2. Accuracy of knowledge: are the descriptions of terms, facts, concepts, math correct? (10pts)
3. Depth of knowledge: are concepts explained clearly, in detail, and in your own words (10pts)
4. Presentation: is the project legible, cohesive, and easy to follow (10pts)

What you need to do:

1. Include a title (can be its own panel or can just be along the top)
2. Make a comic ctrip that is at least 8 panels long (title panel doesn't count)
   a. 6 (or more) panels should be characters/objects in situations
   b. 1 panel will be a solved equation
   c. 1 panel will be a freebody diagram that explains all the forces acting on the object
3. You can draw it by hand or use this link to make one online. (https://app.pixton.com/) If you make it online please upload it to Schoology.
4. You will be given partners to work with, but please create your own individual comic with unique characters and math
5. You can use any of the acceleration, free-fall, or forces equations we've used so far this year

Appendix C: A sample lesson plan that was adapted to include PearDeck Questions

Newton's Laws
Part 1

Week 6

Goals for the Week

- Understand Newton's Three laws of motion
- Use free-body diagrams
- Distinguish the differences between static and kinetic forces and thier effects on objects

Newton's Three Laws of Motion

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Definitions

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- Interia: the tendency of all objects to maintain a state of equilibrium

Inertia

- Inertia depends on the mass of the object
- Which is harder to move from rest
  - A refrigerator magnet
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How can we tell is an object is in equilibrium?

- Look at all the forces involved, determine if they are balanced
- We do this by drawing Free Body Diagrams
- Free Body Diagram: a diagram of all the forces acting on an object at a single instant of time

How to make a Free Body Diagram

Five key things:

1. Never draw the actual object, draw a box or just a dot
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3. Label all arrows with the proper force symbol
4. The size of the arrow should relate to the size of the force (bigger arrows=bigger forces)
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Common Forces

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- Friction force: always acts in the opposite direction the object is moving F_f
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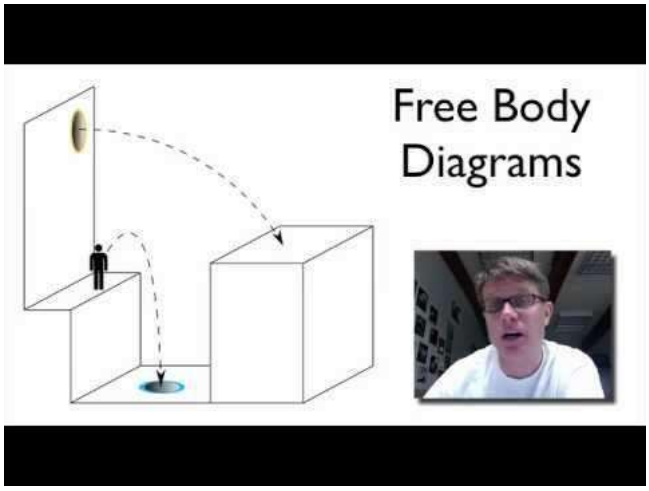
- Normal Force: the supporting force that acts perpendicular to the surface the object is sitting on F_N
- Tension: the force from ropes, cables, ect and can only pull F_T

Lets Practice



Exit Slip

On a blank piece of paper, draw a free body diagram to represent the forces acting on you as you sit in your chair, and another one to represent you as you are standing up

DO NOW: Draw a free body diagram to represent the forces acting on you as you sit in your chair. Label your Forces

Students, draw anywhere on this slide!

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REVIEW: What was Newton's First Law?

Students, write your response!

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WHAT IS A FORCE?

Type your definition of “A FORCE”

Students, write your response!

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A FORCE IS…..
A PUSH OR A PULL

Explain

List all the Force Vectors that you can think of.
(Example: Force due to Gravity: Fg)

Students, write your response!

Pear Deck Interactive Slide
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NEWTON'S SECOND LAW:

Force is equal to the mass of the object multiplied by the acceleration of the object.

Force = Mass x Acceleration

What does it mean?

- F = ma basically means that the force of an object comes from its mass and its acceleration.
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FORCE = MASS X ACCELERATION

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4. If I cut the acceleration in half, what happens to the force?
5. If I doubled the mass and the acceleration, what happens to the force?

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F=MA

Force=Mass x Acceleration

A. What are the units for Mass?
B. What are the units for acceleration

Students, write your response!

Newton's Second Law

F=MA

Force=Mass x Acceleration

Q: So what do you think the units will be for Force? (Hint, put them together)

Students, write your response!

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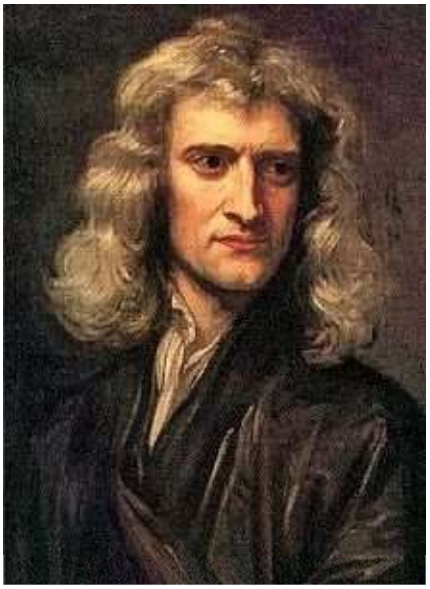
Sooooooooo would you rather:

$kg*m/s^2$?

Or

NEWTONS (N)?



Students choose an option

Pear Deck Interactive Slide
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Let's Practice

Complete Questions:

1. Turn to page 9 in your packet.
2. Complete the following questions in the correct format (see below)
3. Questions: 1 & 2
4. I will be calling on you at random to help solve step by step.

ALL WORK MUST BE IN THIS FORMAT:

GIVEN / Find / Formula & Solve

EXIT TICKET

Complete Question:

Questions 1 under Newton's second law on page 2

ALL WORK MUST BE IN THIS FORMAT (in packet)

GIVEN / Find / Formula & Solve

In the Pear deck solve for acceleration

Homework:

Finish page 9, complete last page “page1”, Second page “Newton’s second law problems.

ALL WORK MUST BE IN THIS FORMAT:

GIVEN / Find / Formula & Solve

Review from Yesterday

What is Newton’s Second Law?

Students, write your response!

If I were to push an object that is 10kg with a force of 10N, what would happen?

Students, write your response!

Pear Deck Interactive Slide
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If I were to punch a wall with a force of 15N what would happen?

Students, write your response!

Pear Deck Interactive Slide
Do not remove this bar

Newton's Third Law

For every action there is an equal and opposite reaction.

Sooo if I were to punch a wall with a force of 15N what would happen?

Students, write your response!

What does this mean?

- Right now, gravity is pulling you down in your seat, but Newton's Third Law says your seat is pushing up against you with equal force. This is why you are not moving. There is a balanced force acting on you– gravity pulling down, your seat pushing up.

The action force is the force that is causing the interaction

As you're sitting in your chair, what is the action force?

Students, write your response!

The reaction force is the resulting force in the interaction

As you're sitting in your chair, what is the reaction force?

Students, write your response!

Pear Deck Interactive Slide
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Some definitions

- Action-reaction pair: the set of forces that occur at the same time, as described in the law
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The Space Shuttle engines push out hot gases, and the hot gases put a force on the shuttle engines so the shuttle lifts

a) What is the action force?
b) What is the reaction force?

Students, write your response!

Pear Deck Interactive Slide
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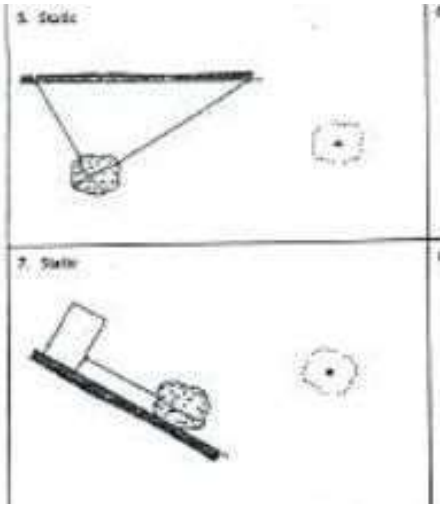
Warm up

Draw 2 FBD in your notes for these two situations.

Remember: draw them in reference to the rock



Problem 1

A tractor of mass *m* is connected to a trailer by a rope. The rope can carry 7,000 N before it breaks.

Part 1

Draw a free-body diagram of the trailer before the tractor starts pulling it. Be sure to label the different forces acting on the trailer.

Part 2

The tractor now starts pulling the trailer with a force (let's call it F_{app}).

Draw a free-body diagram of this situation. (Be sure to include friction.)

Part 3

The trailer accelerates at 3 m/s^2. As it drags across the ground, the rope breaks.

Using the rope's breaking strength of 7,000 N, what can you say about the mass of the trailer?

The comic strip will involve a kinematic problem and a free body diagram. It's up to you to create the subject and situation of the comic, the characters and the illustration. Be as creative as possible! Just make sure it's school appropriate! You will have all day in class on Friday to work on it!

Your comic will be judged on 4 categories for a total of 40 points

1. Creativity: is the project creative, unique, colorful and show signs of effort? (10 pts)
2. Accuracy of knowledge: are the descriptions of terms, facts, concepts, math correct? (10pts)
3. Depth of knowledge: are concepts explained clearly, in detail, and in your own words (10pts)
4. Presentation: is the project legible, cohesive, and easy to follow (10pts)

What you need to do:

1. Include a title (can be its own panel or can just be along the top)
2. Make a comic ctrip that is at least 8 panels long (title panel doesn't count)
   a. 6 (or more) panels should be characters/objects in situations
   b. 1 panel will be a solved equation
   c. 1 panel will be a freebody diagram that explains all the forces acting on the object
3. You can draw it by hand or use this link to make one online. (https://app.pixton.com/) If you make it online please upload it to Schoology.
4. You will be given partners to work with, but please create your own individual comic with unique characters and math
5. You can use any of the acceleration, free-fall, or forces equations we've used so far this year

Appendix D: Biology Test on Cell Parts

Question 1 (5 points)

20 The table below provides information about nutrition and cellular structure for organisms in different kingdoms.

Kingdom	Nutrition	Nucleus	Unicellular or Multicellular
Fungi	heterotrophic	yes	unicellular and multicellular
Plantae	autotrophic	yes	multicellular
Animalia	?	?	?

What information **best** completes the table?

- a autotrophic, yes, multicellular
- b heterotrophic, no, unicellular
- c autotrophic, no, unicellular
- d heterotrophic, yes, multicellular

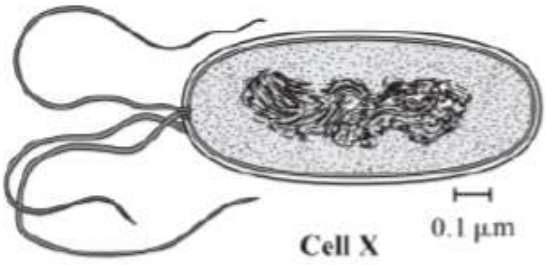
Question 2 (5 points)

A student looks at a cell under a microscope. Which of the following observations would indicate that the cell is from a plant rather than an animal?

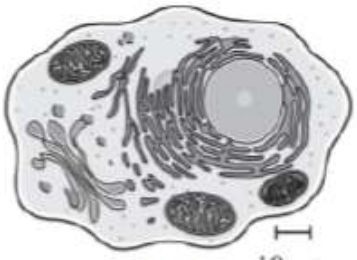
- a numerous cilia on the outside of the cell
- b a thin membrane around the edge of the cell
- c chloroplasts in the cytoplasm of the cell
- d a nucleus located inside of the cell

Question 3 (5 points)

The illustrations below represent two different cells.



Cell X



Cell Y

Which of the following statements **best** identifies these two cells?

- a Cell X is a plant cell and cell Y is an animal cell.
- b Cell X is an archae cell and cell Y is a eubacterial cell
- c Cell X is a red blood cell and cell Y is a muscle cell.
- d Cell X is a prokaryotic cell and cell Y is a eukaryotic cell.

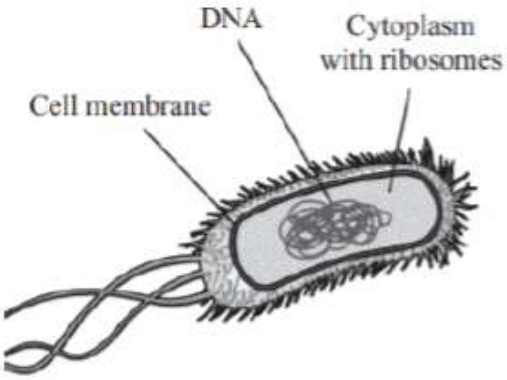
Question 4 (5 points)

A student prepared the following list of characteristics about a cellular organelle.
-- present in animal cells
-- present in plant cells
-- helps make energy available to the cell
Which of the following cellular structures is the student describing?

- a chloroplast
- b mitochondria
- c nucleus
- d cell wall

Question 5 (5 points)

The diagram below shows the structure of a bacterial cell.



Which of the following distinguishes this bacterial cell from eukaryotes?

- a The bacterial cell is a unicellular organism, and all eukaryotes are multicellular
- b DNA in the bacterial cell is always in contact with the cytoplasm, and all eukaryotes have DNA located inside a nucleus.
- c Ribosomes are found in the cytoplasm of the bacterial cell, and eukaryotes do not have ribosomes
- d The bacterial cell has both a cell membrane and a cell wall, and eukaryotes have only cell membranes

Question 6 (5 points)

Organism A is eukaryotic, is unicellular, and lacks a cell wall. Organism B is eukaryotic, is multicellular, has a cell wall, and contains chloroplasts. In which kingdoms should these organisms be classified?

- a organism A in Animalia and organism B in Fungi
- b organism A in Fungi and organism B in Fungi
- c organism A in Animalia and organism B in Plantae

Question 7 (5 points)

Lithops are multicellular organisms found in sandy soil in deserts. They have large, central vacuoles in their cells that store water. Which of the following best classifies lithops?

- a They are plants because they have large, central vacuoles.
- b They are animals because they are multicellular
- c They are fungi because they are found in sandy soil.
- d They are bacteria because they store water.

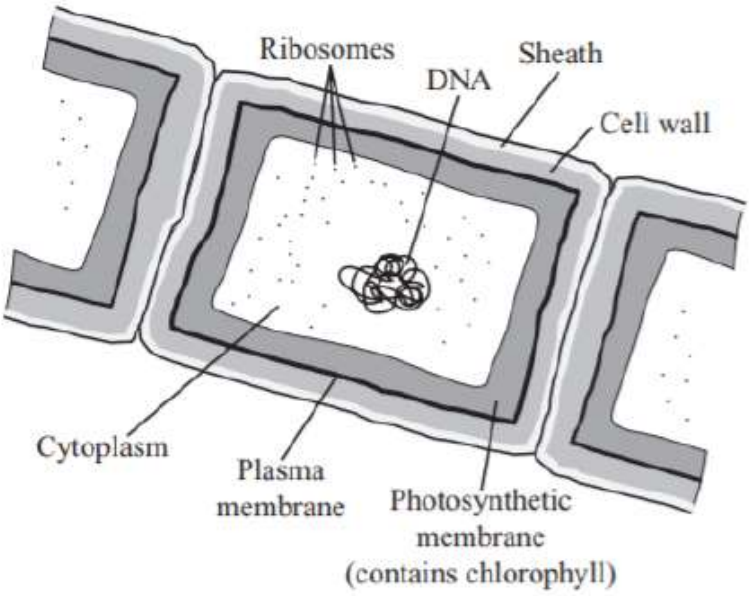
Question 8 (5 points)

The answer to which of the following questions would be most useful in determining whether to classify an organism is a plant or an animal?

- a Is the organism unicellular or multicellular?
- b Is the organism able to respond to stimuli?
- c Is the organism made of cells with or without nuclei?
- d Is the organism able to make its own food?

Question 9 (5 points)

Cyanobacteria are prokaryotic organisms commonly found in streams and ponds as chains of cells. A portion of a chain of cyanobacteria cells is shown in the diagram below. The major parts of a cyanobacteria cell are labeled.



Which is the main difference between the cyanobacteria cell and a plant cell?

- a The cyanobacteria contains ribosomes, but plant cells don't.
- b The cyanobacteria has a cell wall, but plant cells don't.
- c The cyanobacteria cell does not have a nucleus, but plant cells do.
- d The cyanobacteria contains chlorophyll, but plant cells don't.

Question 10 (5 points)

The table below compares some characteristics of bacterial cells and animal cells.

	Bacterial Cell	Animal Cell
Cell Membrane	**?**	yes
Lysosomes	no	yes
Cell Wall	yes	**?**

Which of the following best completes the table?

a

	Bacterial Cell	Animal Cell
Cell Membrane	**no**	yes
Lysosomes	no	yes
Cell Wall	yes	**no**

b

	Bacterial Cell	Animal Cell
Cell Membrane	**yes**	yes
Lysosomes	no	yes
Cell Wall	yes	**yes**

c

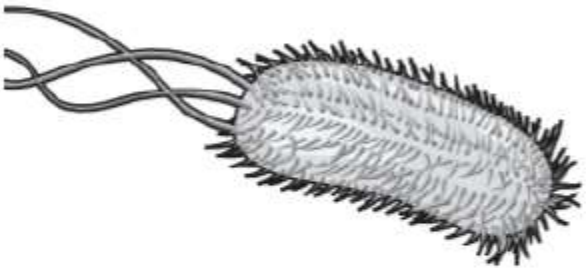
	Bacterial Cell	Animal Cell
Cell Membrane	**yes**	yes
Lysosomes	no	yes
Cell Wall	yes	**no**

d

	Bacterial Cell	Animal Cell
Cell Membrane	**no**	yes
Lysosomes	no	yes
Cell Wall	yes	**yes**

Question 11 (5 points)

The illustration below shows the external features of a prokaryotic organism.



Which of the following can be concluded about the internal cellular contents of this prokaryote?

- a The cell contains a vacuole
- b The cell contains mitochondria
- c The cell does not contain ribosomes
- d The cell does not contain a nucleus.

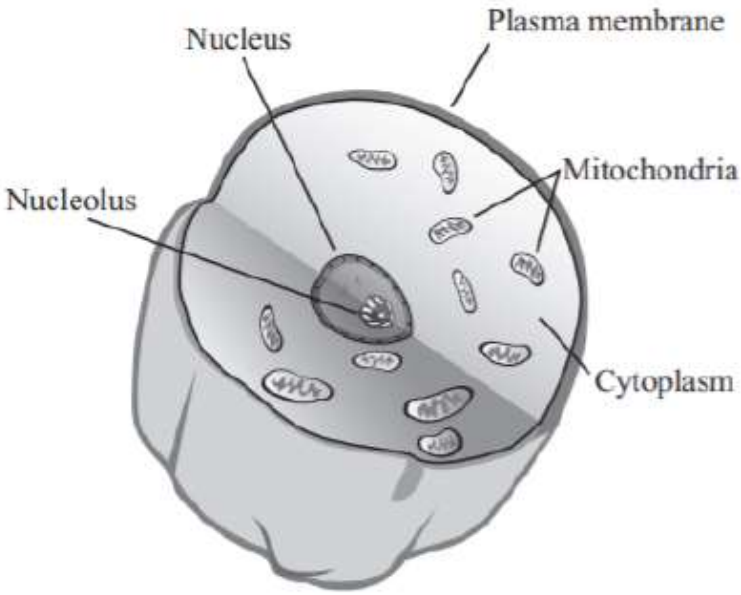
Question 12 (5 points)

Structures called microtubules are found in the cytoplasm of most eukaryotic cells. Microtubules are made up of proteins and help shape and support the cell. Which of the following elements are most abundant in microtubules?

- a iodine and magnesium
- b lead and zinc
- c sodium and chlorine
- d nitrogen and carbon

Question 13 (15 points)

Clara made a model of an animal cell for science class. Her model is shown below.



a. Identify **two** animal cell structures that are missing from Clara's model.

b. Describe the function of **each** cell structure you identified in part (a).

The model contains a large number of mitochondria.

c. Identify the main role of mitochondria in animal cells.

d. Identify one type of animal cell that typically contains large numbers of mitochondria.

Question 14 (5 points)

---

7 A lab technician needs to determine whether cells in a test tube are prokaryotic or eukaryotic. The technician has several dyes she could use to stain the cells. Four of the dyes are described in the table below.

Dye	Test
acridine orange	stains DNA and RNA
osmium tetroxide	stains lipids
eosin	stains cell cytoplasm
Nile blue	stains cell nuclei

Which dye could the technician use to determine whether the cells are prokaryotic or eukaryotic?

- a acridine orange
- b Nile blue
- c osmium tetroxide
- d eosin

Question 15 (5 points)

Muscle cells need to quickly convert energy from food molecules into a usable form. For this reason, which of the following do muscle cells have in greater numbers than most other types of cells?

- a nuclei
- b mitochondria
- c vacuoles
- d chromosomes

Question 16 (5 points)

To enter a plant cell, a substance must pass through which structure?

- a nucleus
- b chloroplast
- c vacuole
- d cell wall

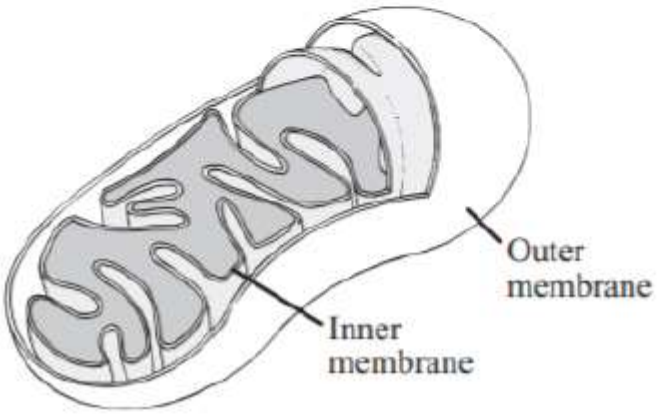
Question 17 (5 points)

Which of the following parts of a plant cell has a function that is most similar to the function of an animal skeleton?

- a chloroplast
- b cell membrane
- c nucleus
- d cell wall

Question 18 (5 points)

37 A mitochondrion has two membranes. The inner membrane is highly folded, as shown in the diagram below.



The folds greatly increase the membrane's surface area. This improves the ability of the mitochondrion to do which of the following?

- a produce ATP during cellular respiration
- b move the cell through water
- c digest metabolic wastes in the organelle
- d convert solar energy to chemical energy

Question 19 (5 points)

Which of the following describes plant cells but not animal cells?

- a Mitochondria produce energy through respiration.
- b The nucleus contains the chromosomes.
- c Plastids store starch made during photosynthesis.
- d The ribosomes assist in protein synthesis.

Question 20 (5 points)

Prokaryotes are structurally simple organisms that have existed for over two billion years. Which of the following are prokaryotes?

- a plants
- b fungi
- c bacteria
- d protists

Appendix E: Results of the Cell Parts test

Question	Answer stats
Question 1: Multiple Choice - 5 points Points Earned - **Most:** 5 · **Least:** 0 · **Avg:** 3	See stats
Question 2: Short-Answer/Essay Question - 15 points - Subjective Points Earned - **Most:** 15 · **Least:** 7 · **Avg:** 12.56	See stats
Question 3: A student looks at a cell under a microscope. Which of the following observations would indicate that the cell is from a plant rather than an animal? Multiple Choice - 5 points Points Earned - **Most:** 5 · **Least:** 0 · **Avg:** 4.4	See stats
Question 4: Multiple Choice - 5 points Points Earned - **Most:** 5 · **Least:** 0 · **Avg:** 3.6	See stats
Question 5: Lithops are multicellular organisms found in sandy soil in deserts. They have large, central vacuoles in their cells that store water. Which of the following best classifies lithops? Multiple Choice - 5 points Points Earned - **Most:** 5 · **Least:** 0 · **Avg:** 4.4	See stats
Question 6: Structures called microtubules are found in the cytoplasm of most eukaryotic cells. Microtubules are made up of proteins and help shape and support the cell. Which of the following elements are most abundant in microtubules? Multiple Choice - 5 points Points Earned - **Most:** 5 · **Least:** 0 · **Avg:** 3	See stats
Question 7: Multiple Choice - 5 points Points Earned - **Most:** 5 · **Least:** 0 · **Avg:** 3.6	See stats

Question 8: Which is the main difference between the cyanobacteria cell and a plant cell? See stats

Multiple Choice - 5 points
Points Earned - **Most:** 5 · **Least:** 0 · **Avg:** 4.4

Question 9: See stats

Multiple Choice - 5 points
Points Earned - **Most:** 5 · **Least:** 0 · **Avg:** 3.6

Question 10: Which of the following parts of a plant cell has a function that is most similar to the function of an animal skeleton? See stats

Multiple Choice - 5 points
Points Earned - **Most:** 5 · **Least:** 0 · **Avg:** 2.8

Question 11: Muscle cells need to quickly convert energy from food molecules into a usable form. For this reason, which of the following do muscle cells have in greater numbers than most other types of cells? See stats

Multiple Choice - 5 points
Points Earned - **Most:** 5 · **Least:** 0 · **Avg:** 4

Question 12: A student prepared the following list of characteristics about a cellular organelle.-- present in animal cells-- present in plant cells-- helps make energy available to the cellWhich of the following cellular structures is the student describing? See stats

Multiple Choice - 5 points
Points Earned - **Most:** 5 · **Least:** 0 · **Avg:** 4.4

Question 13: To enter a plant cell, a substance must pass through which structure? See stats

Multiple Choice - 5 points
Points Earned - **Most:** 5 · **Least:** 0 · **Avg:** 4.2

Question 14: The answer to which of the following questions would be most useful in determining whether to classify an organism is a plant or an animal?

See stats

Multiple Choice - 5 points
Points Earned - **Most:** 5 · **Least:** 0 · **Avg:** 4.62

Question 15: Organism A is eukaryotic, is unicellular, and lacks a cell wall. Organism B is eukaryotic, is multicellular, has a cell wall, and contains chloroplasts. In which kingdoms should these organisms be classified?

See stats

Multiple Choice - 5 points
Points Earned - **Most:** 5 · **Least:** 0 · **Avg:** 4.42

Question 16:

See stats

Multiple Choice - 5 points
Points Earned - **Most:** 5 · **Least:** 0 · **Avg:** 3.46

Question 17: Which of the following describes plant cells but not animal cells?

See stats

Multiple Choice - 5 points
Points Earned - **Most:** 5 · **Least:** 0 · **Avg:** 3.85

Question 18:

See stats

Multiple Choice - 5 points
Points Earned - **Most:** 5 · **Least:** 0 · **Avg:** 4.23

Question 19: Prokaryotes are structurally simple organisms that have existed for over two billion years. Which of the following are prokaryotes?

See stats

Multiple Choice - 5 points
Points Earned - **Most:** 5 · **Least:** 0 · **Avg:** 3.27

Question 20:

See stats

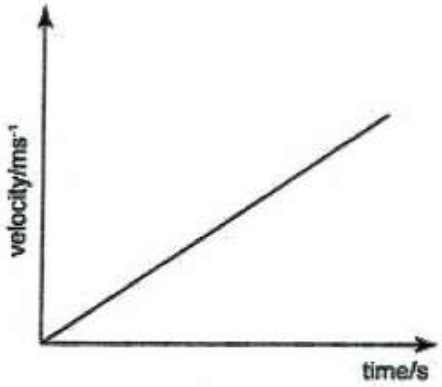
Multiple Choice - 5 points
Points Earned - **Most:** 5 · **Least:** 0 · **Avg:** 3.27

Appendix F: A test on Free-Fall acceleration where the student was able to complete the math problems

Free-Fall Acceleration

100
8
92

1. What are the SI units for gravity?
   a. m/s
   b. cm/s
   c. m/s^2
   d. ft/s^2
2. Mars has about 1/3 of Earth's gravity. If you were to weigh yourself on Earth and then on Mars would you would weigh _____ on Mars.
   a. Less
   b. More
   c. The same
3. Which of the following is **not involved** when calculating the velocity of a falling object
   a. Height the object fell from
   b. time it fell
   c. mass of the object
   d. initial velocity of the object
4. What does the slope of the graph below represent?
   a. the object has a constant speed
   b. The object has a constant acceleration
   c. The object's acceleration is increasing
   d. The object's speed is decreasing



5. Impact velocity is another term for
    a. Initial velocity
    b. Average velocity
    c. Average speed
    d. Final velocity
6. The speed of a falling object_____ as the object falls further and further
    a. Decreases
    b. Stays the same
    c. Increases
7. When we calculated velocity in class, air resistance (*hint: think about the day I dropped a piece of paper and a textbook)*
    a. Was ignored
    b. Had no effect
    c. Was taken into our calculations
    d. Does not exist on Earth
8. An object is dropped. What is its speed after 4 seconds?
    a. 9.8 m/s^2
    b. 39.2 m/s^2
    c. 35.6 m/s^2
    d. We can't calculate that with the given information
9. Acceleration due to gravity is also called
    a. Negative velocity
    b. Displacement
    c. Free-fall acceleration
    d. Instantaneous acceleration

10. If I dropped a leaf and a stone in a vacuum (a room with no air) which would hit the ground first
    a. The leaf
    b. The stone
    c. They would hit the ground at the same time
    d. Not enough information to tell

OPEN RESPONSE QUESTIONS

1. A penny dropped into a wishing well reaches the bottom in 1.50 seconds. What was the velocity at impact?
    a. Step 1:

$t = 1.50\ s$
$V_i = 0\ m/s$
$g = 9.8\ m/s^2$

    b. Step 2:

We finding V_f

    c. Step 3 and final answer:

$V_f = V_i + gt$

$V_f = 0 + 9.8(1.50)$

$V_f = 14.7\ m/s$

2. Someone drops a penny down a wishing well. 6 seconds later they hear it hit the bottom of the well. How deep is the well?

   a. Step 1:

   $t = 6s$ $g = 9.8\ m/s$

   $V_i = 0\ m/s$

   b. Step 2:

   We finding y

   c. Step 3 and final answer:

   $y = V_i t + (0.5) g t^2$

   $y = 0(t) + (0.5) 9.8 (6^2)$

   $y = 4.9(6^2)$

   $y = 4.9(36)$

   $y = 176.4\ m$

3. A child drops a baseball off of a roof. If the ball hit the ground at 19 m/s, how tall was her house?

   a. Step 1:

   $V_f = 19\ m/s$

   $V_i = 0\ m/s$

   $g = 9.8$

   b. Step 2:

   We find y (height)

   c. Step 3 and final answer:

   $V_f^2 = V_i^2 + 2gy$

   $19^2 = 0^2 + 2(9.8)(y)$

   $\frac{361}{19.6} = \frac{19.6\ y}{19.6}$

   $y = 18.4\ m$

4. A camera is dropped from the edge of a cliff and 7 seconds later it hits the bottom. How fast was it going before it hit the bottom of the cliff?

   a. Step 1:

   $t = 7s$
   $V_i = 0 m/s$
   $g = 9.8 m/s$
   $V_f = ?$

   b. Step 2:

   We finding V_f

   c. Step 3 and final answer:

   $V_f = V_i + gt$
   $V_f = 0 + 9.8(7)$
   $V_f = 68.6 m/s$

5. A stone falls from rest for 10 seconds. How far did the stone go?

   a. Step 1:

   $V_i = 0$
   $g = 9.8$
   $t = 10 s$

   b. Step 2:

   We finding y

   c. Step 3 and final answer:

   $y = V_i t + (0.5) g (t^2)$
   $y = 0(t) + (0.5)(9.8)(10^2)$
   $y = 4.9(100)$
   $y = 490 m$

6. A tennis ball is dropped from 20 meters up. How long does it take for the ball to reach the ground?

   a. Step 1:

   $y = 20\text{ m}$
   $v_i = 0$
   $g = 9.8$
   $t = ?$

   b. Step 2:

   We finding time

   c. Step 3 and final answer:

   $y = v_i t + (0.5) g t^2$
   $20 = 0(t) + (0.5)(9.8)(t^2)$
   $\frac{20}{4.9} = \frac{4.9}{4.9}(t^2)$
   $\sqrt{t^2} = \sqrt{4.08}$
   $t = 2.02\text{ sec}$

7. An object is dropped from the top of a building and hits the ground at 40 m/s. How tall was the building?

   a. Step 1:

   $v_f = 40$
   $v_i = 0$
   $g = 9.8$
   $y = ?$

   b. Step 2:

   We finding y

   c. Step 3 and final answer:

   $v_f^2 = v_i^2 + 2gy$
   $40^2 = 0^2 + 2(9.8)(y)$
   $\frac{1600}{19.6} = \frac{19.6}{19.6}(y)$
   $81.6\text{m} = y$
   $y = 81.6\text{m}$

Appendix G: A test on Free-fall acceleration where the student wasn't able to get the math points but still passed the exam

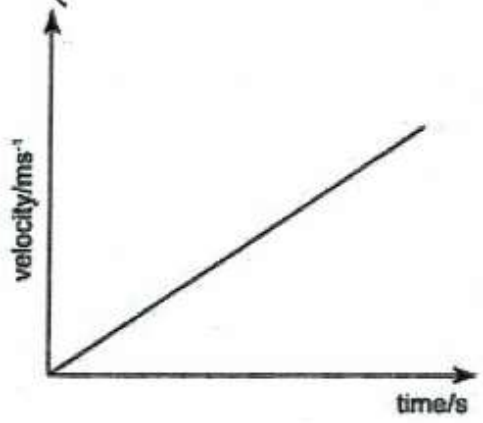
Free-Fall Acceleration

1. What are the SI units for gravity?
   a. m/s
   b. cm/s
   c. m/s^2
   d. ft/s^2

2. Mars has about 1/3 of Earth's gravity. If you were to weigh yourself on Earth and then on Mars would you would weigh Less on Mars.
   a. Less
   b. More
   c. The same

3. Which of the following is **not involved** when calculating the velocity of a falling object
   a. Height the object fell from
   b. time it fell
   c. mass of the object
   d. initial velocity of the object

4. What does the slope of the graph below represent?
   a. the object has a constant speed
   b. The object has a constant acceleration
   c. The object's acceleration is increasing
   d. The object's speed is decreasing



5. Impact velocity is another term for
    a. Initial velocity
    b. Average velocity
    c. Average speed
    d. Final velocity
6. The speed of a falling object_____ as the object falls further and further
    a. Decreases
    b. Stays the same
    c. Increases
7. When we calculated velocity in class, air resistance (*hint: think about the day I dropped a piece of paper and a textbook)*
    a. Was ignored
    b. Had no effect
    c. Was taken into our calculations
    d. Does not exist on Earth
8. An object is dropped. What is its speed after 4 seconds?
    a. 9.8 m/s^2
    b. 39.2 m/s^2
    c. 35.6 m/s^2
    d. We can't calculate that with the given information
9. Acceleration due to gravity is also called
    a. Negative velocity
    b. Displacement
    c. Free-fall acceleration
    d. Instantaneous acceleration

10. If I dropped a leaf and a stone in a vacuum (a room with no air) which would hit the ground first
    a. The leaf
    b. The stone
    c. They would hit the ground at the same time
    d. Not enough information to tell

OPEN RESPONSE QUESTIONS

1. A penny dropped into a wishing well reaches the bottom in 1.50 seconds. What was the velocity at impact?
    a. Step 1:

$t = 1.50$ seconds
$v_i = 0$ m/s
$g = -9.8$ m/s^2

    b. Step 2:

$V_f = ?$

    c. Step 3 and final answer:

$V_f = v_i + gt$
$V_f = 0 + -9.8(1.50)$
$V_f = 14.7$ m/s

2. Someone drops a penny down a wishing well. 6 seconds later they hear it hit the bottom of the well. How deep is the well?

a. Step 1:

$t = 6$ seconds $\quad g = -9.8\ m/s^2$

$v_i = 0\ m/s$

b. Step 2:

$y = ?$

c. Step 3 and final answer:

$y = v_i t + (0.5) g t^2$

$y = 0(6) + (0.5)(9.8)(6)^2$ $\quad y = 176.4$ meters

$y = 0 + 176.4$

3. A child drops a baseball off of a roof. If the ball hit the ground at 19 m/s, how tall was her house?

a. Step 1:

$v_f = 19\ m/s \quad t = 1.10$

$g = 9.8\ m/s^2$

b. Step 2:

$y = ?$

c. Step 3 and final answer:

wrong equation! (-2)

$y = v_i t + (0.5) g$

$y = 19(1.10) + 0.5($

$y = 20.9 + 4.9$

$20.9 + 24.0$

$y = 44.91$ m/s (-1) (-1)

4. A camera is dropped from the edge of a cliff and 7 seconds later it hits the bottom. How fast was it going before it hit the bottom of the cliff?

a. Step 1:

$t = 7\,sec$

$g = 9.8\ m/s^2$

$g = 0$

b. Step 2:

$V_f = ?$

c. Step 3 and final answer:

$V_f = V_i + gt$

$(9.8)(0)(7)$

$V_f = 68.6\ m/s$

5. A stone falls from rest for 10 seconds. How far did the stone go?

a. Step 1:

$t = 10\ sec$

$V_i = 0$

$g = 9.8$

b. Step 2:

$y = ?$

Plugged into equation wrong!

$y = v_i t + (0.5)gt^2$

$y = 0(10) + 0.5(9.8)$

$y = 0.5(9.8)^2$

$y = 4.9^2$

c. Step 3 and final answer:

$y = 24.01$ meters

(-1)

6. A tennis ball is dropped from 20 meters up. How long does it take for the ball to reach the ground?

   a. Step 1:

   $v_i = 0$ ✓ $y = 20$ meters ✓

   $g = 9.8 \text{ m/s}$

   b. Step 2:

   $v_f = ?$

   $t = ?$

   c. Step 3 and final answer: wrong equation!

   $v_f^2 = v_i^2 + 2gy$

   $v_f^2 = 0^2 + 2(9.8)(20)$

   $2(196)$

   $v_f^2 = 392$ (-1)

7. An object is dropped from the top of a building and hits the ground at 40 m/s. How tall was the building?

   a. Step 1:

   $v_F = 40 \text{ m/s}$ $t = 1.10$? we don't know this $g = 9.8 \text{ m/s}^2$

   $v_i = 0$

   b. Step 2:

   $y = ?$

   c. Step 3 and final answer: wrong equation!

   $y = v_i t + (0.5) g t^2$

   $y = 40(1.10) + (0.5)(9.8)2$

   $y = 44 + 4.92$

   $y = 48.92$

   $44 + 24.01$

   $y = 68.01$ (-1) (-1)

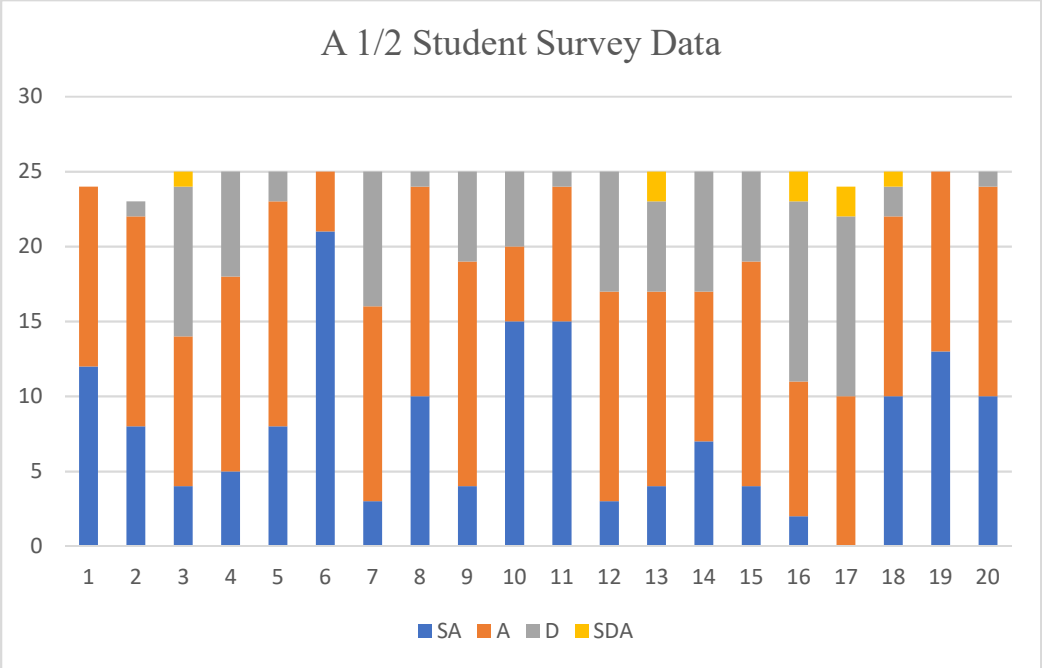
Appendix H: Student Survey data. Given on 10/31/19 (Z week) and 11/4/19 (A week)

H.1: Key:

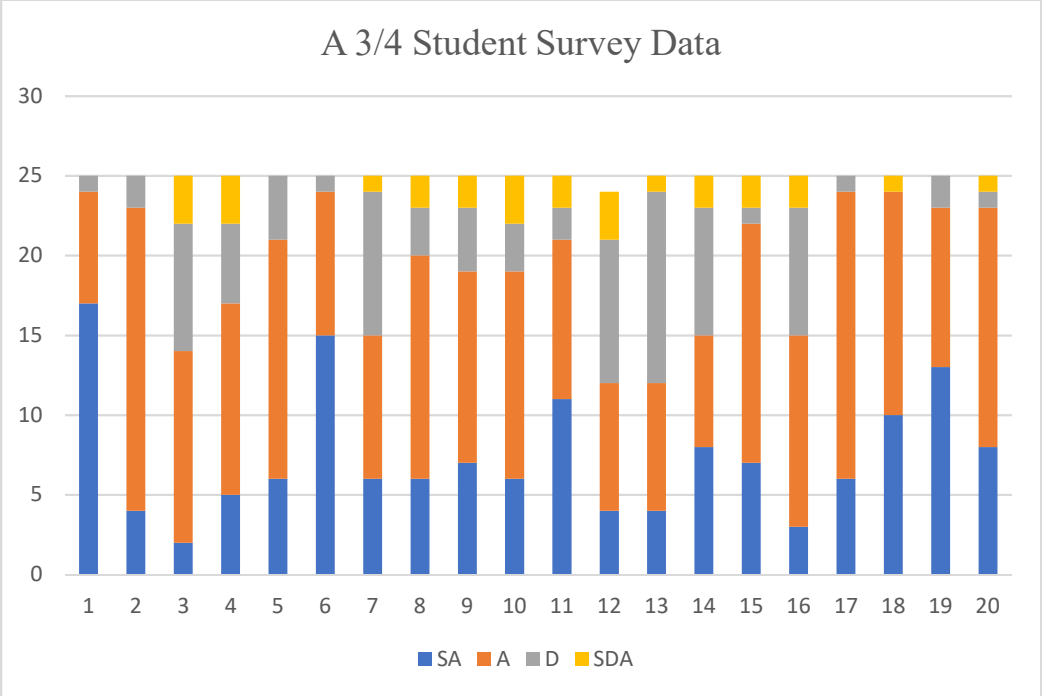
Question Number	Prompt Given to Students	CAP element it relates to
1	My teacher demonstrates that mistakes are a part of learning	2.B Learning Environment
2	My teacher asks us to summarize what we've learned in each lesson	1.A Curriculum and Planning
3	Students push each other to do better work in this class	2.D Expectations
4	I am able to connect what I learn in this class to other subjects	1.A Curriculum and Planning
5	My teacher uses open ended questions that enable me to think of multiple answers	1.A Curriculum and Planning
6	In discussing my work, my teacher uses a positive tone even when my work needs improvement	2.B Learning Environment
7	In this class, students review each other's work and provide each other with helpful advice	1.C Analysis
8	When asked, I can explain what we're learning and why	2.D Expectations
9	In this class, other students take time to listen to my ideas	2.C Cultural Proficiency
10	The level of work in this class goes well beyond what I thought I was able to do	2.D Expectations

11	The material in this class is clearly taught	1.A Curriculum and Planning
12	If I finish my work early, my teacher has more challenging work for me to do	2.C Cultural Proficiency
13	My teacher asks to rate my understanding of what we have learned in class	1.A Curriculum and Planning
14	To help me understand, my teacher uses my interests to explain difficult ideas to me	2.B Learning Environment
15	In this class, students work together to help each other learn	2.C Cultural Proficiency
16	In this class, students are asked to teach or model to other classmates as part o whole lesson	2.A Instruction
17	Our class stays on task and does not waste time	2.B Learning Environment
18	During a lesson, my teacher is quick to change how she teacher if the class does not understand	2.D Expectations
19	My teacher encourages us to accept different points of view when they are expressed in class	2.C Cultural Proficiency
20	I can show my learning in many ways	2.A Instruction

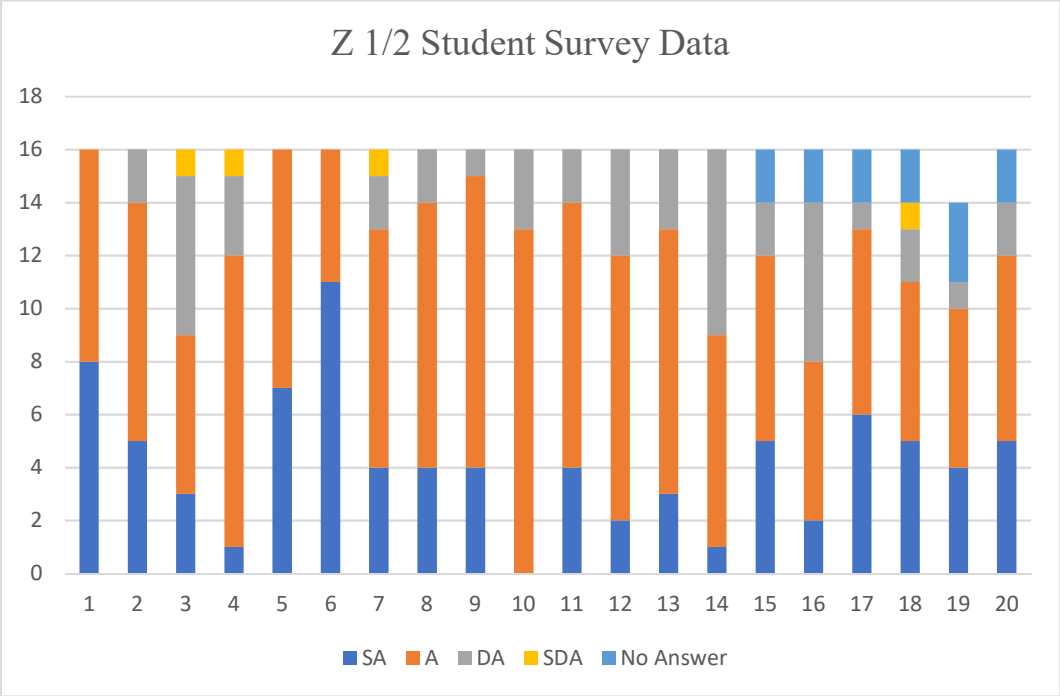
H.2 Data from A ½



H.3 Data from A ¾



H.4 Data from Z ½



H.5 Data from Z ¾