SPH4U – Physics, Grade 12
University Preparation

Course Website: http://mrohrling.yolasite.com

An Inquiry-Based Course
Welcome to the wonderful world of physics! SPH3U is an introduction to the world of physics and a prerequisite for the grade 12 course, SPH4U. This course is designed according to the principles of Physics Education Research which clearly demonstrate the power of learning through inquiry in a collaborative group format. Major Canadian and American universities (U of T, McGill, McMaster, MIT, Harvard, Stanford and more) are transforming their introductory physics courses by reducing or eliminating traditional lectures and replacing them with engaging activities that have a deep conceptual and practical focus.

Homework
The majority of the class time will be spent doing activities and discussing physics with your colleagues. At home you will be responsible for solving problems using our solution format. You should expect about 45 minutes of physics homework per day on average. Homework problems will be randomly submitted for assessment and must be present at the time of collection. Optional textbook readings, online lessons and resources are listed in the syllabus for each lesson.

Assessment and Evaluation
Due to the central role of group work in this course, the work you do in in class will account for an important portion of your mark. Daily work will be randomly handed-in and assessed. To help ensure that individual students are pulling their weight in groups, there will be regular quizzes and tests. There is a final exam that covers the entire course material.

Mark Breakdown
The basic mark breakdown for the course is 70% term work and 30% final examination.

Attendance and Punctuality
Students who are absent or late for class without a valid reason will not be eligible to submit any missed work or write any missed quizzes. Students who are absent are responsible for determining what was missed and making sure that they are caught up *before* the following class.

Missed Tests
If you miss a test you **must**:

- Let me know in advance if it is due to a pre-arranged reason (i.e. appointment for surgery)
- Call in to the school so your name goes on the daily “Absent List” in the main office.
- Contact me immediately after setting foot in the school upon your return.
- Provide a doctor's note if the reason is illness.
- Do not discuss the test by any means with your colleagues.
- Be prepared to write the test immediately, at my discretion.

Failure to do any of these will result in a zero for the test.

Please Read This Document!
Please sign below signifying that you have read this course description.

________________________________ ________________________________

Signature of parent, or student if 18 and over — Print name

SPH4U: Course Syllabus

Course Website: http://mrohrling.yolasite.com

This syllabus contains a list of all classes, topics and homework in the Gr. 12 physics course. You are strongly encouraged to explore the simulations and videos listed for each lesson – they are optional but quite interesting!

Day	Topics	Homework	Extras
	Introduction		
1	Course Introduction, How to Answer a Question	Sign-up with course website Have parents sign course outline Handbook: *How to Answer a Question* Video: Top 10 Amazing Physics Videos	
2	Groups Work	Homework: *Thinking about Your Brain* Video: Dysfunctional Group Video: Functional Group	
3	Measurement and Numbers	Handbook: *Measurement and Numbers*	Video: Scientific Notation
4	Fermi Problems	Handbook: *Fermi Problems*	Lesson: Fermi Problems
5	Short quiz on Introduction	Read: pg. 18-23	Gr. 11 Review Questions: 1-D Kinematics Gr. 11 Review Lessons: Kinematics

SPH4U Homework: How to Answer a Question Name:

Go to the course website and follow the *Course Introduction* link. For day 1, click on the link to: *Top 10 Amazing Physics Videos*. Explore the videos and select one to focus on when you answer the questions below. Remember the four criteria for high quality responses!

A: Watch Videos and Earn Marks! What a Deal!

1. **Record.** What is the title of your chosen video?

2. **Describe**. Describe what you observed in the video (what you saw or heard, but not any explanations).

3. **Reason**. Which unit from grade 11 physics does the video connect most closely to? (Kinematics, Forces, Energy, Sound and Waves, Electricity and Magnetism)

4. **Explain.** What was one interesting or surprising thing from the video?

B: Assess Your Responses

1. **Evaluate.** Use the questions below to help decide if your answers to the video questions are complete. Use the four criteria to assess your responses to the questions above and give yourself a mark. Be honest!

Question	Follow-Up Question	Mark
A#2	Would your description be useful for someone who did **not** see the video? **Explain**.	
A#3	Did you cite evidence from the video and connect it to **specific** ideas from a grade 11 unit? **Explain**.	
A#4	Did you explain **why** the "thing" you mentioned was interesting **to you? Explain**.	

SPH4U: How to Answer a Question?

Recorder: ___________________
Manager: ___________________
Speaker: ___________________
0 1 2 3 4 5

Sign up for your group roles today. Adjust your seating. Go through introduction below together with your group.

High quality responses to any physics question must be **correct**, **clear**, **concise** and **complete**. We will routinely use these terms and the notation explained below for the evaluation of your daily written work.

Criteria	Description	Notation
Correct	The physics is correctly stated. Conclusions follow logically from the evidence and the definitions or laws. Technical details are all present and correct.	Incorrect sections are underlined and given an "__X__". Correct ideas are just checked " √ "
Clear	The explanation is precisely stated with a good choice of physics vocabulary. The explanation is straight forward with no awkward or unclear phrases. Spelling and grammar are correct.	Unclear sections are underlined with a wiggly line and given a "?" A poor word choice is indicated by a wiggly line. Spelling errors are cirlced.
Concise	There are no extraneous or distracting statements which may or may not be correct.	Phrases that are not relevant are crossed out. ~~Like this~~.
Complete	No important parts of the explanation are missing. The evidence supporting the conclusion is mentioned along with the relevant definitions or laws.	Where an explanation is missing or incomplete we will write ". . . ." or "and …" or "more …" or give a clear hint at what is missing: "force?"

A: Marking-Up

1. Below is a question from Gr. 11 physics. As a group, read each response and use the notation explained above to mark-up the sample student answers that follow.

> **Explain.** In a road test, the driver of a car slams on the brakes of a fast moving car and brings the car to a stop. An accelerometer in the car measures the magnitude of the acceleration and gives a reading 5.0 m/s^2[backwards]. Interpret the acceleration reading to help explain the effect of braking on the car.

Response 1: The car slows down because of the brakes at a rate of 5.0 m/s^{2}in the backwards direction. The velocity gets slower.

Response 2: The car is slowing down by - 5.0 m/s backwards. So the velocity gets more negative until it stops because of the brakes force. If it wasn't for the brakes force, the car would not change its speed.

Response 3: For every second of time, the car decelerates by 5.0 m/s. This helps us to understand the effect.

Response 4: The brakes exert a stopping force on the car that acts in the backward direction (opposite to it's motion). This is due to the kinetic friction between the rubber of the tires and the road surface. This causes the car to slow down until it comes to a complete stop.

Response 5: The velocity of the car becomes more negitive, since the acceleration is negitive, which means it is stopping. Since the definition of acceleration is the change of velocity per second it gets more negative and slows down.

Group Check-Up
When marking the responses above did your group:
(1) Hear from **each** group member before moving to the next response? Yes ____ No ____
(2) Agree on how to mark-up each response before moving to the next one? Yes ____ No ____

*** check with your teacher before moving on ***

2. **Record.** Write up one response (selected by your teacher) with your markings on a large whiteboard. Write large enough so that everyone can easily read it.

3. **Reason**. List the key **physics** ideas (in point form) that should appear in a high quality response to the **acceleration question.**

4. **Explain.** Work with your group to create a high quality answer to the original question. Make sure it satisfies the four criteria! (Correct, clear, concise, complete)

B: Evaluation

Your daily work in physics will be marked based on the four criteria for high quality responses. An overall mark will be assigned on a scale of 0 to 5 depending on how your responses meet the four criteria according to the rubric below.

0-2	3	4	5
Responses are missing, fundamentally incorrect, or challenging to understand. A "yes or no" answer is given.	Response is basically correct, but contains problems or omissions.	Response is correct, but minor details could be improved or clarified.	Response is thoughtful, clear and complete. If another physics teacher saw it they would say, "Wow! A grade 12 student wrote this?"

1. **Evaluate.** As a group, use the rubric above to evaluate each of the five student responses that you marked above. Record your mark beside each response.

2. **Record.** Write your group's response to the braking question on a big whiteboard. Make sure you write large enough so everyone can read it from a distance.

*** check with your teacher before moving on ***

3. **Evaluate.** Exchange whiteboards with a neighboring group (your teacher will pick which). Use a different colour to mark up the other group's response using the four criteria. Give it a mark. Do this in a respectful, constructive way. When done, return the whiteboard.

4. **Evaluate.** Do you agree with the assessment of your group's response? Explain.

SPH4U: Groups Work

Recorder: ___________________
Manager: ___________________
Speaker: ___________________
0 1 2 3 4 5

Your group has a challenge: use the elastic attached to three strings (the "flux capacitor") to stack the cups into a pyramid. There are two rules: (1) only the elastic can move the cups, and (2) each group member must hold only one string by its very end. Start!

A: Skills for the 21st Century

1. **Reflect.** What skills did your group make use of to accomplish (or partially accomplish!) this task?

2. **Explain.** Highlight one skill that you think was (or should have been!) the most important. Provide a simple rationale. Record this on your group's whiteboard and move on.

Here is a reminder of what we learned in grade 11about how groups in physics will work:

Roles

- **Recorder / Checker:** The recorder's copy of the group work receives the detailed feedback. Help the recorder write high quality responses. The recorder also checks with each group member for understanding before the group continues on.
- **Manager**: Organizes and leads the group through the investigation and helps keep members focused on the same task.
- **Speaker**: Speaks to the class or responds to the teacher on behalf of the group.

If there are four people in a group, the recorder/checker role is broken up. If there are two, both members are also the speaker.

Set-Up

Sit in a triangle formation, facing one another. Take out a whiteboard and markers and have them ready for the group discussions. Each group member is responsible for writing in their own words high quality responses for the investigations.

B: It's All About Me?

Let's think back to your group work experience in grade 11.

1. **Reflect.** (*individually*) Complete the survey below about your experience in gr. 11 physics. If you are new to our program, think back to any experiences you had with group work. Check off how often each statement applies to you. Think about your personality and try to explain why you think that is the case. You don't need to share these responses.

	Often	Occasionally	Rarely	Why
I follow the steps and instructions of an investigation carefully.				
I stayed focused on each question with the other group members.				
I respond to questions thoroughly and thoughtfully.				
I offer ideas to the group discussions.				
I ask for the ideas of my other group members.				
I make sure the group agrees on each response before moving on.				
I help explain ideas to the other group members.				

2. **Reflect.** (*individually)* Of all the statements listed above, which do you think would be the most important for you to improve on? Explain why and how you might bring about the improvement in yourself.

C: It's All About the Group

1. **Reason.** *(as a group)* Of all the statements listed in the survey, which statement does your group think is the **most** important for the good functioning of a group in our physics class? Explain.

2. **Reason.** If a group is doing poorly at your chosen statement, what could group members do to help the situation? Include examples of actions and phrases a group member might do or say.

3. **Reason.** Does a student need to "know all the answers" in order to be a good member of a physics group? Explain.

4. **Explain.** Emmy, who is in your group, says, "*I shouldn't ask my group members questions because it will slow the group down or it might get annoying.*" How should you respond (constructively) to Emmy?

5. **Explain.** Isaac, who is also in your group, says, "*The others in my group figure things out much faster than I do which makes me feel less smart. I'm not sure if I belong here.*" How should you respond (constructively) to Isaac?

6. **Explain.** Marie says, "*I just want to hurry up and get the investigation done. I don't think all this group stuff helps me much."* How should you respond (constructively) to Marie?

7. **Record.** On your whiteboard help your Recorder summarize your responses to question C#1 and C#2.

SPH4U Homework: Thinking About Your Brain! Name:

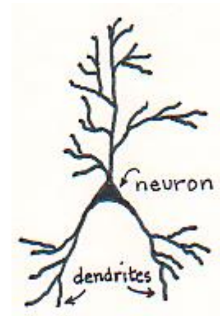
How Your Brain Learns and Remembers

Minneapolis Community & Technical College

Part 1: What Happens Inside Your Brain When You Learn Something New?

Meet Your Brain

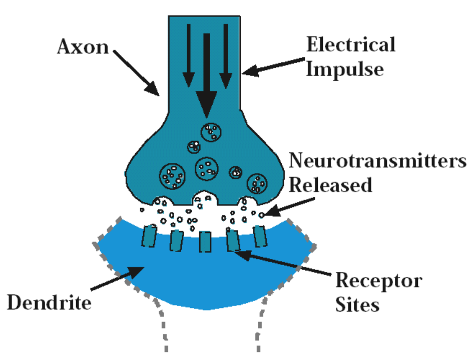
Brain cells are called neurons. You are born with at least 100 billion neurons. Dendrites (fibers) grow out of the neurons when you listen to/write about/talk about/ practice something. Learning is natural. Neurons know how to grow dendrites, just like a stomach knows how to digest food. Learning is growth of dendrites. New dendrites take time to grow; it takes a lot of practice for them to grow.

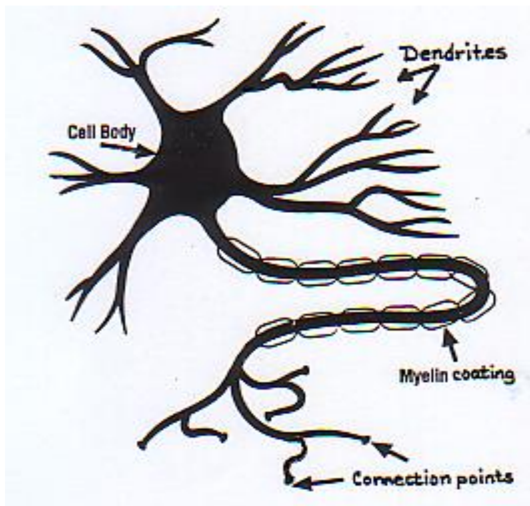


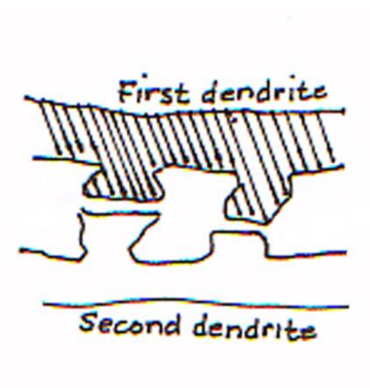
Connections Form between Neurons

When two dendrites grow close together, a contact point is formed. A small gap at the contact point is called the synapse. Messages are sent from one neuron to another as electrical signals travel across the synapse.

Synapse







Practice Improves Connections

Special chemicals called neurotransmitters carry the electrical signals across the synapse. When you practice something, it gets easier for the signals to cross the synapse. That's because the contact area becomes wider and more neuro-transmitters are stored there. When you practice something, the dendrites grow thicker with a fatty coating of myelin. The thicker the dendrites, the faster the signals travel. The myelin coating also reduces interference. With enough practice, the dendrites build a double connection. Faster, stronger, double connections last a very long time. You remember what you learned!

Short-term memory is VERY short!

If you learn something new and do it only once or twice, the dendrite connection is very fragile and can disappear within hours. Within 20 minutes, you remember only 60%. Within 24 hours, you remember only 30%. But if you practice within 24 hours, and then practice again later, you remember 80%.

Make the Most of Practice Time…

You grow dendrites for exactly the same thing you are practicing. If you listen or watch while math problems are solved, you grow dendrites for listening or for watching. If you read over your notes, you build dendrites for reading. If you actually solve the problems yourself, you grow dendrites for solving.

Part 2: Brain Friendly Ways to Learn Better

A: Grow Your Intelligence

You can grow your intelligence, because your brain knows how to grow dendrites just like your stomach knows how to digest food. Think about a baby who learns to speak in its native language without any special classes or training!

B: Do Something Active to Learn

You must do something active to learn, like explaining, solving, drawing, or writing. That's because dendrites grow ONLY when you are actively doing something. No one else can grow dendrites for you!

C: Grow Off of What You Know
Dendrites cannot grow in a void. New dendrites can only grow off of what is already there. New skills must connect to, and grow off of, previously learned skills. If you do not have the necessary dendrites in place, new material will seem to go "right over your head".

D: Give It Time and Practice
Learning takes time, because it takes a lot of practice for dendrites to grow. This is why you do homework. This is why trying to cram everything into your brain the night before a test doesn't work.

E: Mistakes Are Essential
Making mistakes, and getting feedback so you can correct them, allows you to check the accuracy of the connections in your brain. Be sure to get feedback quickly so you don't practice the wrong thing and build a strong, but wrong, connection!

Emotions Affect Learning and Memory
Anxiety floods your body with adrenaline ("fight or flight").Adrenaline makes it hard for the neurotransmitters to carry messages across the synapses in your brain. That causes "blanking out" on a test.

How can emotions help you?
Endorphins make you feel calm. Your body produces endorphins when you relax, exercise, laugh, or learn new things. If you practice producing calming hormones, it will help when you are under stress.

Part 3: What Does All This Mean For Me?

Use your understanding from this article to answer the following questions. (Remember to give a 5/5 response!)

1. **Explain.** Marie says, "I understand what's going on in the class just fine. But when I get home and start on the homework assignment, why am I lost?" Explain to Marie why.

2. **Explain.** Isaac says, "I attend class and do all the homework and feel like I understand everything. Then why do I just 'blank out' on the test and can't do anything?" Help Isaac understand why.

3. **Explain.** Emmy says, "Why should I do all this homework? It's just the same thing over and over." Respond to Emmy.

4. **Explain.** Albert says, "I've been absent for a week and there's a test tomorrow. I'll be fine if I cram tonight."

So What Should You Do?

1. Do some of the homework as soon as possible after class, before you forget.
2. Try to practice new skills every day.
3. To manage anxiety, set aside regular study-time in your schedule, get lots of sleep and exercise, and learn simple relaxation techniques such as slow, deep breathing.
4. Make sure you are actively DOING something when you study: draw pictures or diagrams, solve lots of problems, check your answers
5. Check your understanding by explaining how to do a problem to another student.
6. Create a practice test for yourself. Work it in the same amount of time you'll be given in class.

SPH4U: Measurement and Numbers

Recorder: __________________
Manager: __________________
Speaker: __________________
0 1 2 3 4 5

Measurements form the backbone of all science. Any theory, no matter how slick, is only as good as the measurements that support it. Without careful measurements, science becomes guess work, hunches and superstition.

A: The Meter Stick

Our most basic scientific tool is the meter stick. But, do you know how to use it? Really? For this investigation you will need one meter stick

1. **Observe.** Each member of your group will independently (and secretly!) measure the height of your table. Don't share the results until everyone has made the measurement. Record everyone's measured values here.

The number we read from a measurement device is the *indicated value*. The *readability* of a device is the smallest increment or change in a quantity that you can discern from the measuring device. The readability is sometimes called the reading error, but the term "error" is very problematic so we will avoid it. When we record a measurement, we should also record the readability with a statement like: "scale readable to ± 1.0 cm". The reported readability may vary from person to person. If you think you can estimate a reading between the lines of a scale, do so. Always record a measurement as carefully as you can.

2. **Reason.** What is the readability of your measuring device? Your estimation of the readability may be different from the others in your group, and that can be OK as long as you are using the device appropriately. Explain how you decided on your readability.

3. **Reason.** Now think about the height measurements your group has made. How do they compare with one another? Would you say, roughly speaking, that there is a lot of uncertainly or little uncertainty in your group's measurements? Explain.

The *true value* is the actual, ideal value for a quantity that we are trying to measure. The true value of a quantity is usually **never known:** in science this is simply not possible (welcome to science)! Through hard work and ingenuity, we try to get our measurements (our indicated values) closer to the true value, but there is always some *uncertainty* in this since we never get to know the true value!

4. **Reason.** Some groups find differences of ± 0.1 cm amongst their height measurements. What are some suggestions for a future group to reduce the differences in their height measurements? (This is the ingenuity we mentioned.)

B: The Stopwatch

Now we will examine another common measuring device. You will need one stop watch

1. **Observe.** Measure the amount of time for the pencil to drop from a 1 m height. Write this reading as a number in decimal notation with units of seconds.

2. **Reason.** What is the readability of the stopwatch? Explain.

3. **Observe.** Perform the pencil drop seven times and record your data below.

4. **Reason.** Examine the individual measurements in your data above. You probably notice quite a bit of variation in them. What might be responsible for the spread in these values?

All repeated measurements (except simple counting) will produce a range of values or a *distribution of values*. The size or width of this distribution is a measurement of the uncertainty in our result. One technique to find the width of the distribution is the *standard deviation,* but we will not use this in grade 12 physics. Instead we will define the *uncertainty*(σ) by making a **very crude** estimation of the width (really the half-width) of the distribution:

$$\sigma = (\text{high value} - \text{low value})/2$$

5. **Reason.** What is your best estimation of the true value for the time for the pencil drop? What is the uncertainty in this result?

When we present a calculated result based on our measurements we typically report two numbers, the mean value (m) and the uncertainty (σ) written as: $m \pm \sigma$. This expression represents a *distribution of values* centred at the mean value m and with a width of σ on each side – it is not an ordinary number. We interpret this expression by saying, "m is our best estimation of the true value, but we wouldn't be surprised if the true value was as high as $m + \sigma$ or as low as $m - \sigma$."

6. **Reason.** When you computed the mean value, the calculator likely displayed many digits. Use your uncertainty to help decide how to write the digits of your final result in the form $m \pm \sigma$.

The uncertainty in a result determines which digits are useful to keep. In the past you may have learned rules about significant digits. These rules are flawed and unhelpful. Only the uncertainty in a value determines which digits have significance (usefulness). In many situations we don't have information about the uncertainty, but we should not pretend that it does not exist. Here are our **rules about uncertainty and significant digits for grade 12 physics**.

- We will often estimate the uncertainty in simple situations rather than ignore it.
- When recording results, use three significant digits to avoid too much rounding error (3 digits determined by how it would be written in scientific notation, ex. calculator reads: 1 056 428, you write: 1 060 000 or 1.06×10^6).
- For middle steps in calculations, keep one or two extra *guard digits* to help reduce the amount of rounding error.
- When we are given a quantity like 5 km, we will assume it has 3 significant digits unless we know its uncertainty

7. **Calculate.** Make a calculation to predict the time for the pencil to drop (use the equation $\Delta y = v_1\Delta t + \frac{1}{2}a\Delta t^2$ and $a = 9.8$ m/s^2).

A fundamental process in science is to decide whether a measured result "agrees" with a result calculated from a theory or model. We will adopt a simplified decision rule for this. Two results *agree* with one another if one lies within the uncertainty distribution of the other. In more advanced studies, you will refine and greatly strengthen this rule.

8. **Evaluate.** Does this calculated value agree with your measured result? Explain.

SPH4U Homework: Measurement and Numbers Name:

A: The Pebble Drop

It is sunset. You and a friend walk on to a bridge that passes over a river. After gazing off into the distance and into each other's eyes you both arrive at the same question: How high are we above the water? Luckily you have your smartphone with a timer app. Your friend finds a few rocks which he releases ($v_1 = 0$). You time the fall until you see them splash in the water below. Your data is shown below.

1.73 s	1.79 s	1.82 s	1.69 s	1.81 s	1.77 s	1.74 s

1. **Calculate**. Find the time for the rock to fall. Express your result in the form $m \pm \sigma$ with an appropriate number of digits.

2. **Calculate.** Use your mean time result to calculate the distance the rocks fell (use $\Delta y = v_1\Delta t + ½a\Delta t^2$).

3. **Reason.** How certain are you in the result of this calculation? Explain.

The calculations we routinely make in physics are based on values that have uncertainties – we have just ignored this in the past. However, when we use measured results with an uncertainty we know (like the time result above) and perform a calculation with them, we would like to see the uncertainty reflected in our calculated result. To do this we will use the *crank three times* technique. We repeat the final step of the calculation three times, inputting the high, middle and low values from our measured result. This yields a range of values for the calculated result which we can write in the form $m \pm \sigma$.

4. **Calculate.** What are the high and low values for your time result? Use these in your calculation to find the range of distance values. Show the work here.

Note: We emphasize showing work in our physics program, but the crank three times technique is meant to be quick and not onerous. In your calculation steps you should have done the work to simplify your equation as much as possible before the substitution of your values ($\Delta y = ½\, a\Delta t^2$). In your calculator, plug in the high and low values and record the results. We don't need to see this work in the future – just report the resulting uncertainty (the next step below).

5. **Interpret.** Report your results for the distance in the form $m \pm \sigma$. Provide an interpretation for this distribution of values.

In our gr. 12 physics work, **we will always tell you when to use the crank three times technique**. If we don't, you should simply estimate the uncertainty in a final result. This is quite crude, but sometimes is desirable to avoid too many complications.

SPH4U Homework: Fermi Problems Name:

1. Write a complete solution (don't skimp on the steps) for the Fermi problem: How many postage stamps would it take to completely cover a soccer field?

Physicists think about numbers in different ways compared with most people and even mathematicians. For example, if you think about the idea of the size of numbers (quantity), there are really three kinds: BIG numbers (greater than one), unity (equal to one), and small numbers (less than one). It is important to know how these numbers behave under mathematical operations. **All your work on this page should be done without a calculator!**

2. Estimate whether the result of each expression is BIG, small, or close to one.
   a) 1 / BIG b) 1 × BIG c) 1 / small d) 1 × small
   e) BIG + small f) BIG – small g) BIG × small h) BIG / small
   i) small / BIG j) BIG / (small + BIG) k) BIG ×BIG

Physicists are often interested in the general patterns illustrated by numbers rather than their specific values. Students and even some teachers rely too much on calculators to do their thinking about numbers. As a physicist you should feel comfortable thinking about and using numbers in scientific notation without a calculator in sight!

3. Describe an easy way to compute: $6\times10^6 + 5\times10^6$ without a calculator.

4. Compute these expressions. No calculators!
   a) $6.5\times10^5 + 3\times10^5 =$
   b) $6.4\times10^{12} + 2.9\times10^{12} =$

5. Describe an easy way to compute: $(3\times10^2)(6\times10^6)$ without a calculator.

6. Compute these expressions.
   a) $3\times10^4\times2\times10^4 =$
   b) $6\times10^2\times 8\times10^2 =$
   c) $4.9\times10^{340} \div 7\times10^{90} =$

7. Describe how to use **estimations** and scientific notation to **easily** compute: 2 168 222 × 4 937 without a calculator.

8. Estimate the results of these expressions.
   a) 1 168 222 × 6 900 000= b) 0.0529 × 8.0036=

SPH4U: Fermi Problems

Recorder: __________________
Manager: __________________
Speaker: __________________
0 1 2 3 4 5

Enrico Fermi is a legend in the world of physics. He had a remarkable ability to find rough but reliable answers to complex problems use simple reasoning and skilful estimations. We want to be like Fermi and solve "Fermi Problems"!

A: Feeling Hungry?

Here is your first Fermi problem: What mass of food do Torontonians eat in one year?

1. **Reason.** Imagine you had a truly smartphone that would allow you to look up the information you need to solve this problem. What information would be helpful to know for your solution? Record these on your whiteboard. You will share these with the class.

2. **Record.** We will call these pieces of information our *key ideas* for the Fermi problem solution. Record them here.

In Fermi problems, we don't usually know the values for our key ideas so we will need to estimate them. Because of this, we won't have many reliable or significant digits. Use just one digit to write number in scientific notation whenever it is helpful. You should be able to do all the math without a calculator! When you write the values for the key ideas, assign a variable for each.

3. **Reason.** One key idea is the number of days per year. A sample is shown below of how you should write this. Write the value for this key idea using one digit in scientific notation.

   Number of days per year: d = days/year (common knowledge)

Every number you use in a Fermi problem needs to be justified or explained. If a number is well known, indicate it as common knowledge. If it is not, you need to explain how you come up with it. The starting point for all estimations should be some number that you do know. You work from that number to get the value of your key idea.

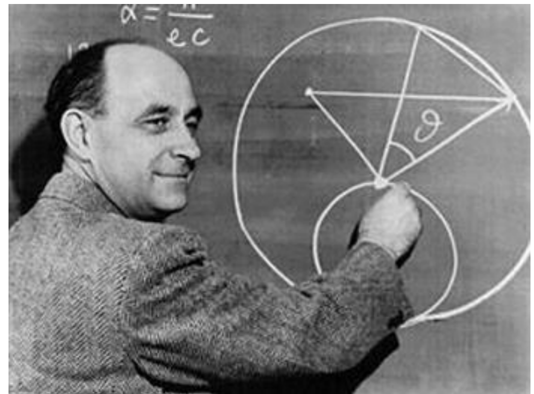
4. **Reason.** Another key idea is the mass of food eaten by one person each day. You have seen many numbers associated with the food you eat. Use this to start your estimation. Explain your estimation using words or simple calculations.

   Mass of food per person per day: m =

5. **Calculate**. Create an equation that will give a solution to the problem. Substitute the values (including units!) into the equation. State a final answer with one digit in scientific notation.

B: Your Turn!

1. How many litres of water are used for drinking purposes each year in Canada?



Fermi estimating the size of his bald spot.

2. How many breaths would Julius Caesar have taken if he were still living today?

3. A car travels on the highway and collides with the concrete pillar of an overpass. What is the acceleration of the passenger (buckled in) during the collision? Estimate the quantities you will need in order to **calculate** the acceleration. Show your reasoning and justify any quantities you estimate.

Fermi about to press a button

SPH4U: How Noteworthy!

An important part of our course is creating good quality physics notes. These notes will be based on what you do each day based on the daily class work and any assigned textbook readings. Creating good daily notes has two benefits: you solidify what you have learned during that day's lesson and you help prepare yourself for the unit test and final exam. You will hand in your notes for the unit on the day of your unit test.

A: Format

Your notes should clearly follow the outline shown below. They are meant to be brief, yet thorough enough that when you look at them again in four months as you study for the exam, they are a useful reminder. The notes include all the textbook and handbook page numbers, any sample problems and longer descriptions you think might be useful and can easily be looked up – don't copy these out. When complete, notes for a whole unit are often about 2 pages double sided, but this is just a rough guideline. Please **write in your own words** as much as possible. Copying (from any source) leads to very little learning. Do not share your notes with friends – the temptation to plagiarize is often too great. Do not under any circumstances share electronic copies of your work. Plagiarism will be dealt with according to the school rules.

Unit: Kinematics

Idea: Uniform Acceleration (text pg . 18-23, handbook pg. 3-4)

Definitions / Equations:

Details / Tricks:

} Repeat as necessary

B: Process

- Read the entire section first – beginning to end. Don't skip the boxes in the margins or the sample problems! Always ask the question, "OK, but why?" Try this now for the pages listed above.
- Identify what you think the key physics ideas are. These are usually **concepts**, such as "uniform acceleration" or "the inertia principle". In point form, briefly explain each key idea.
- Record the definitions of important physics ideas or quantities. This should be both verbal and mathematical whenever possible. Include the defining equations.
- Note any important details, tricks or reminders for that key idea. Examples are things that might be easy to forget, or warnings about common errors or handy strategies for problem solving.
- Sample problems – don't copy or summarize these, simply read through them.
- Homework problems – do these on a separate page according to the required solution process. Don't include them with the unit notes.

C: Evaluation

Your notes will be handed-in at the time of your test (they will not be accepted afterwards!) They should be neat, complete, well-laid out and useful for studying for the final exam.

0 – 2: Unacceptable work. Not useful for future studying.
3: Major topics are covered, but minor ones may be missing. Somewhat useful for future studying, but may be disorganized or messy. Does not use the format described above.
4: Important topics are included from both the text and the daily lessons. Notes are neatly organized with clear headings. Ideas, definitions and details are included. Some minor topics or details may be missing.
5: Unit is covered in a thorough yet concise way. Notes are carefully cross-referenced with textbook and handbook page numbers. Notes are very neatly written and organized including colour. Careful attention and though is given to the ideas and details.