DP Physics Year 1 Summer Assignment

Welcome to DP Physics! It is a college level physics course that is fun, interesting and challenging on a level you've not yet experienced. This summer assignment will review all of the prerequisite knowledge expected of you as well as help you review some of the topics you learned in MYP. There are 6 parts to this assignment. It is quantity not the difficulty of the problems that has the potential to overwhelm, so do it over an extended period of time. It is designed to take you about 6 hours. By taking the time to review and understand all parts of this assignment, you will help yourself acclimate to the rigor and pacing of DP Physics. The summer assignment will be due the first day of class. If you have any questions as you're working on this assignment, please reach out to me at lesch@carrollwooddayschool.org or send me a message on Schoology.

Good luck! ☺

Mrs. Esch

Part 1: Scientific Notation and Dimensional Analysis - NO CALCULATOR

Many numbers in physics will be provided in scientific notation. You need to be able read and simplify scientific notation. (This section is to be completed without calculators...all work should be done by hand.)

Express the following the numbers in scientific notation. Keep the same unit as provided. ALL answers in physics need their appropriate unit to be correct.

1. 7,640,000 kg   2. 8327.2 s
3. 0.000000003 m   4. 0.0093 km/s

Often times multiple numbers in a problem contain scientific notation and will need to be reduced by hand. Before you practice, remember the rules for exponents.

When numbers are multiplied together, you *(add / subtract)* the exponents and *(multiply / divide)* the bases. When numbers are divided, you *(add / subtract)* the exponents and *(multiply / divide)* the bases. When an exponent is raised to another exponent, you *(add / subtract / multiply / divide)* the exponent. Using the three rules from above, simplify the following numbers in proper scientific notation:

5. $(3 \times 10^6) \cdot (2 \times 10^4) =$ 6. $(1.2 \times 10^4) / (6 \times 10^{-2}) =$

7. $(4 \times 10^8) \cdot (5 \times 10^{-3}) =$ 8. $(7 \times 10^3)^2 =$

9. $(8 \times 10^3) / (2 \times 10^5) =$ 10. $(2 \times 10^{-3})^3 =$

Fill in the power and the symbol for the following unit prefixes. Look them up as necessary.
Kilo- has been completed as an example.

Prefix	Power	Symbol
Giga-		
Mega-		
Kilo-	10^3	k
Centi-		
Milli-		
Micro-		
Nano-		
Pico-		

Not only is it important to know what the prefixes mean, it is also vital that you can convert between metric units. If there is no prefix in front of a unit, it is the base unit which has 10^0 for its power, or just simply "1". Remember if there is an exponent on the unit, the conversion should be raised to the same exponent as well.

Convert the following numbers into the specified unit. Use scientific notation when appropriate.

1. 24 g = _____ kg

2. 94.1 MHz = _____ Hz

3. 6 Gb = _____ kb

4. 640 nm = _____ m

5. 3.2 m² = _____ cm²

6. 40 mm³ = _____ m³

7. 1 g/cm³ = _____ kg/m³

8. 20 m/s = _____ km/hr

For the remaining scientific notation problems you may use your calculator.
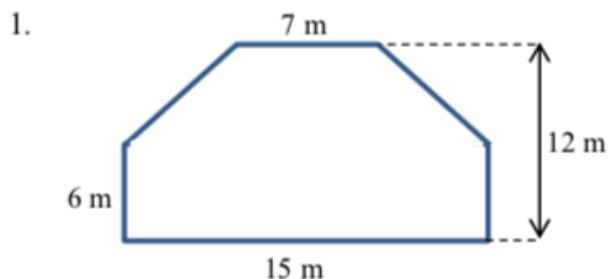
9. $(3.67 \times 10^3)(8.91 \times 10^{-6}) =$
10. $(5.32 \times 10^{-2})(4.87 \times 10^{-4}) =$
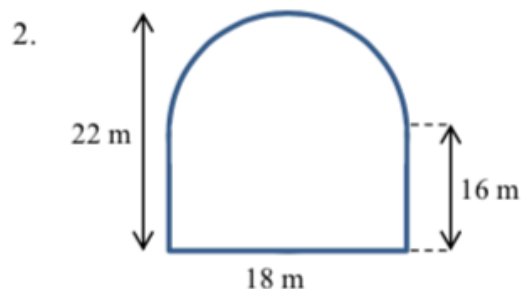11. $(9.2 \times 10^6) / (3.6 \times 10^{12}) =$
12. $(6.12 \times 10^{-3})^3$

Part 2: Geometry

Calculate the area of the following shapes. It may be necessary to break up the figure into common shapes.
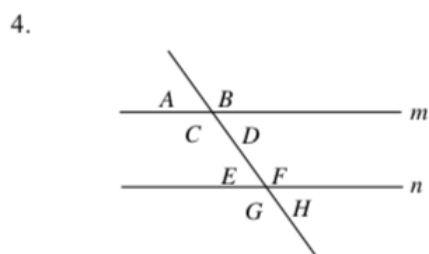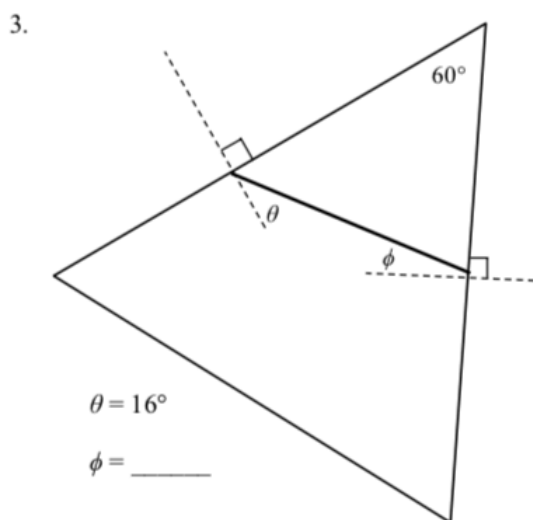
1.

7 m

6 m

12 m

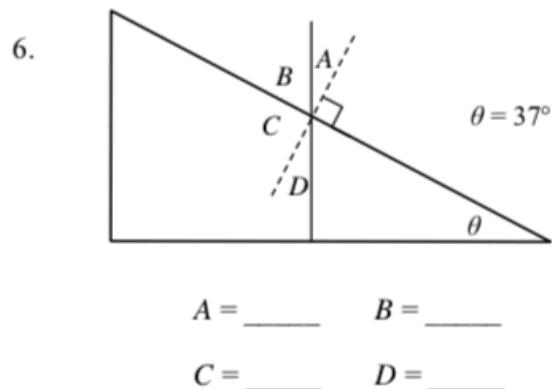15 m

Area = _____

2.

22 m

16 m

18 m

Area = _____

Calculate the unknown angle values for questions 3-6.

3.

60°

θ

ϕ

$\theta = 16°$

$\phi =$ _____

4.

A   B   m
C   D
E   F   n
G   H

Lines m and n are parallel.

A = 75°   B = _____   C = _____   D = _____

E = _____   F = _____   G = _____   H = _____

5.

θ_5
θ_4
θ_2
θ_3
70°
θ_1 θ_1

$\theta_1 =$ _____

$\theta_2 =$ _____

$\theta_3 =$ _____

$\theta_4 =$ _____

$\theta_5 =$ _____

6.

B   A
C
D

$\theta = 37°$

θ

A = _____   B = _____

C = _____   D = _____
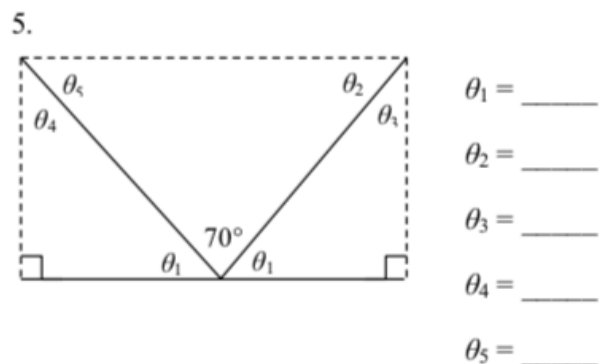
Part 3: Trigonometry

Write the formulas for each one of the following trigonometric functions. Remember SOHCAHTOA!
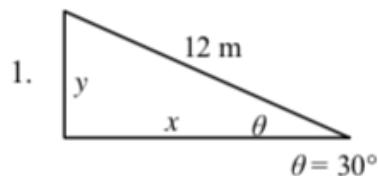
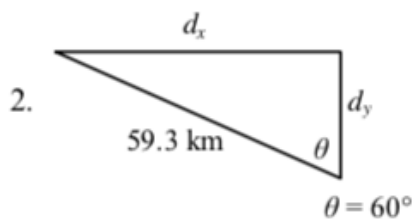$\sin\theta =$ $\cos\theta =$ $\tan\theta =$

Calculate the following unknowns using trigonometry. Use a calculator, but show all of your work. Please include appropriate units with all answers. (Watch the unit prefixes!)
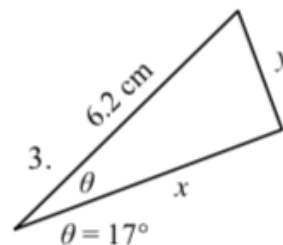
1.

12 m

y x θ

$\theta = 30°$

$y = $ _____

$x = $ _____

2.

d_x

59.3 km d_y θ

$\theta = 60°$

$d_x = $ _____

$d_y = $ _____

3.

6.2 cm y

θ x

$\theta = 17°$

$x = $ _____

$y = $ _____

4.

c θ 2.3 mm

1.4 m

$c = $ _____

$\theta = $ _____

5.

39.8 m θ

17 m R

$R = $ _____

$\theta = $ _____

6.

θ d

4.3 m

15.1 m

$d = $ _____

$\theta = $ _____

7.

48.2 km

y θ

21.6 km

$y = $ _____

$\theta = $ _____

8.

2 mm d

$\theta = 26°$

x θ

$x = $ _____

$d = $ _____

9.

13.7 m

6.7 m θ R

$R = $ _____

$\theta = $ _____
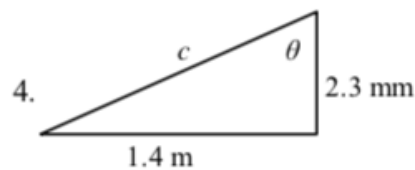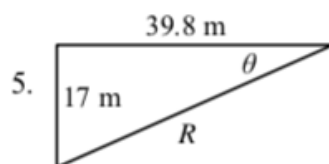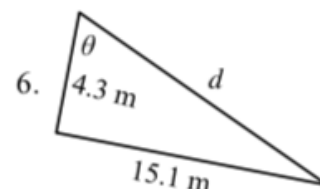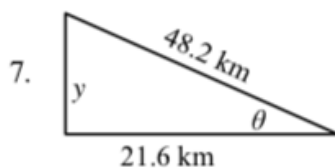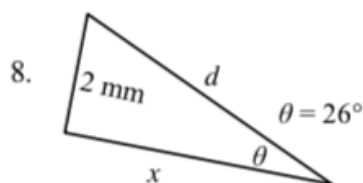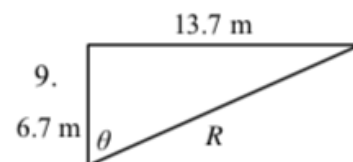
Use the figure below to answer problems 10 and 11.
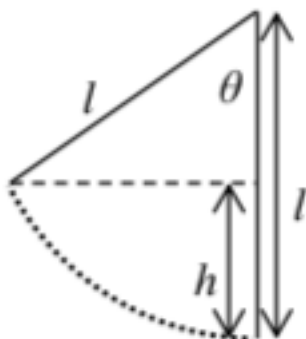
10. Find an expression for h in terms of l and θ.

11. What is the value of h if l = 6 m and θ = 40°?

Part 4: Algebra

Solve the following (almost all of these are extremely easy – it is important for you to work independently). Units on the numbers are included because they are essential to the concepts, however they do not have any effect on the actual numbers you are putting into the equations. In other words, the units do not change how you do the algebra. Show every step for every problem, including writing the original equation, all algebraic manipulations, and substitution! You should practice doing all algebra before substituting numbers in for variables.

Section I: For problems 1-5, use the three equations below:

$$v_f = v_0 + at \qquad x_f = x_0 + v_0 t + \frac{1}{2}at^2 \qquad v_f^2 = v_0^2 + 2a(x_f - x_0)$$

1. Using equation (1) solve for t given that $v_0 = 5$ m/s, $v_f = 25$ m/s, and a = 10 m/s^2.

2. a = 10 m/s^2, $x_0 = 0$ m, $x_f = 120$ m, and $v_0 = 20$ m/s. Use the second equation to find t.

3. $v_f = -v_0$ and a = 2 m/s^2. Use the first equation to find t / 2.

4. How does each equation simplify when a = 0 m/s^2 and $x_0 = 0$ m?

Section II: For problems 6 – 11, use the four equations below.

$$\Sigma F = ma \qquad\qquad f_s \le \mu_s N$$

$$f_k = \mu_k N \qquad\qquad F_s = -kx$$

5. If $\Sigma F = 10$ N and a = 1 m/s^2, find m using the first equation.

6. Given $\Sigma F = f_k$, m = 250 kg, $\mu_k = 0.2$, and N = 10m, find a.

7. $\Sigma F = T - 10m$, but a = 0 m/s^2. Use the first equation to find m in terms of T.

8. Given the following values, determine if the third equation is valid. $\Sigma F = f_s$, m = 90 kg, and a = 2 m/s^2. Also, $\mu_s = 0.1$, and N = 5 N.

9. Use the first equation in Section I, the first equation in Section II and the givens below, find ΣF. m = 12 kg, v_0 = 15 m/s, v_f = 5 m/s, and t = 12 s.

10. Use the last equation to solve for F_s if k = 900 N/m and x = 0.15 m.

Section III: For problems 11 and 12 use the equation below.

$$a = \frac{v^2}{r}$$

11. Given that v is 5 m/s and r is 2 meters, find a.

12. Originally, a = 12 m/s², then r is doubled. Find the new value for a.

Section IV: For problems 13-19 use the equations below.

$$K = \frac{1}{2}mv^2 \qquad\qquad W = F(\Delta x)\cos\theta$$

$$\Delta U_g = mgh \qquad\qquad U_s = \frac{1}{2}kx^2$$

13. Use the first equation to solve for K if m = 12 kg and v = 2 m/s.

14. If ΔU_g = 10 J, m = 10 kg, and g = 9.8 m/s², find h using the second equation.

15. K = ΔU_g, g = 9.8 m/s², and h = 10 m. Find v.

16. The third equation can be used to find W if you know that F is 10 N, Δx is 12 m, and θ is 180°.

17. Given U_s = 12 joules, and x = 0.5 m, find k using the fourth equation.

18. For P = 2100 W, F = 30 N, and θ = 0°, find v_{avg} using the last equation in this section.

Section V: For problems 19 - 20 use the equation below.

$$F_g = -\frac{GMm}{r^2}$$

19. Find F_g if $G = 6.67 \times 10^{-11}\ \text{m}^3\,\text{kg}^{-1}\,\text{s}^{-2}$, $M = 2.6 \times 10^{23}$ kg, m = 1200 kg, and r = 2000 m.

20. Using the first equation above, describe how F_g changes if r doubles.

Part 5: Graphing and Functions

Below you will find a few example concept questions that review foundational knowledge of graphs. Ideally you won't need to review, but you may need to review some math to complete these tasks. At the end of this part is a section covering graphical analysis that you probably have not seen before: linear transformation. This analysis involves converting any non-linear graph into a linear graph by adjusting the axes plotted. We want a linear graph because we can easily find the slope of the line of best fit of the graph to help justify a mathematical model or equation.

Key Graphing Skills to remember:

1. Always label your axes with appropriate units.

2. Sketching a graph calls for an estimated line or curve while plotting a graph requires individual data points AND a line or curve of best fit.

3. Provide a clear legend if multiple data sets are used to make your graph understandable.

4. Never include the origin as a data point unless it is provided as a data point.

5. Never connect the data points individually, but draw a single smooth line or curve of best fit

6. When calculating the slope of the best fit line you must use points from your line. You may only use given data points IF your line of best fit goes directly through them.

Conceptual Review of Graphs
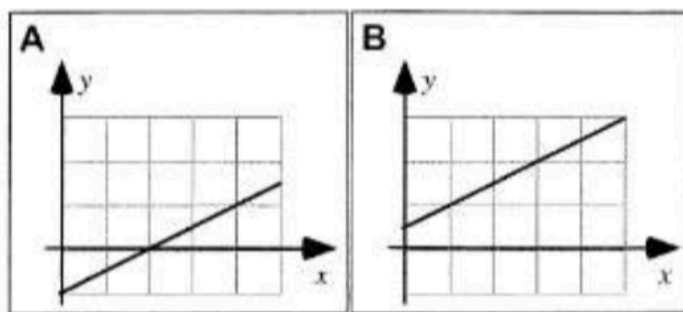
Shown are several lines on a graph.
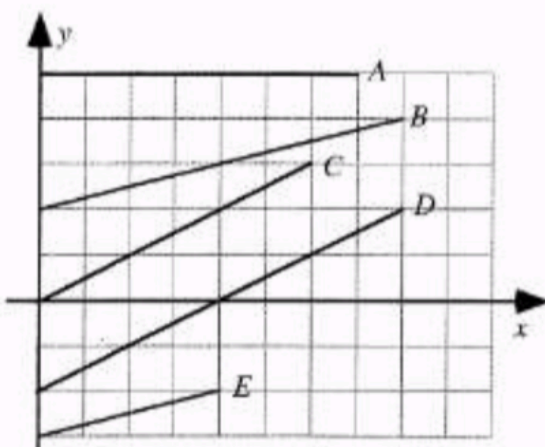
Rank the slopes of the lines in this graph.

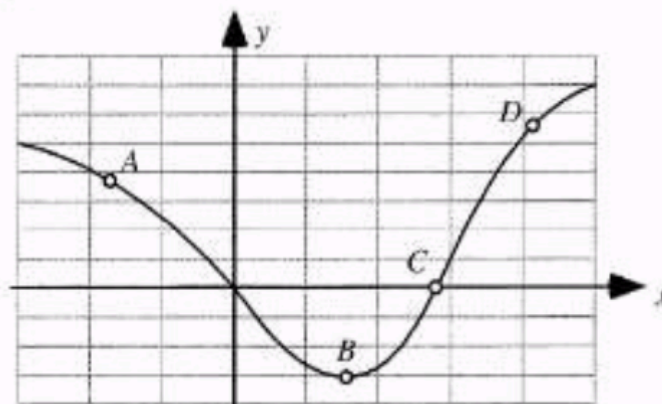|					OR			
1 Greatest	2	3	4	5 Least		All the same	All zero	Cannot determine

Explain your reasoning.

Shown are two graphs.

Is the slope of the graph (i) *greater in Case A*, (ii) *greater in Case B*, or (iii) *the same in both cases?* _____

Explain your reasoning.

Four points are labeled on a graph.

Rank the slopes of the graph at the labeled points.

				OR			
1 Greatest	2	3	4 Least		All the same	All zero	Cannot determine

Explain your reasoning.

Linear and Non-Linear Functions

You must understand functions to be able linearize. First let's review what graphs of certain functions looks like. Sketch the shape of each type of y vs. x function below. k is listed as a generic constant of proportionality.

Linear $y = kx$ Inverse $y = \frac{k}{x}$ Inverse Square $y = \frac{k}{x^2}$ Power $y = kx^2$

You will notice that only the linear function is a straight line. We can easily find the slope of our line by measuring the rise and dividing it by the run of the graph or calculating it using two points. The value of the slope should equal the constant k from the equation.

Finding k is a bit more challenging in the last three graphs because the slope isn't constant. This should make sense since your graphs aren't linear. So how do we calculate our constant, k? We need to transform the non- linear graph into a linear graph in order to calculate a constant slope. We can accomplish this by transforming one or both of the axes for the graph. The hardest part is figuring out which axes to change and how to change them. The easiest way to accomplish this task is to solve your equation for the constant. Note in the examples from the last page there is only one constant, but this process could be done for other equations with multiple constants. Instead of solving for a single constant, put all of the constants on one side of the equation. When you solve for the constant, the other side of the equation should be in fraction form. This fraction gives the rise and run of the linear graph. Whatever is in the numerator is the vertical axis and the denominator is the horizontal axis. If the equation is not in fraction form, you will need to inverse one or more of the variables to make a fraction. First let's solve each equation to figure out what we should graph. Then look below at the example and complete the last one, a sample AP question, on your own.

State what should be graphed in order to produce a linear graph to solve for k.
Inverse Graph

Vertical Axis:_____   Horizontal Axis: _____

Inverse Square Graph

Vertical Axis:_____   Horizontal Axis: _____

Power (Square) Graph

Vertical Axis:_____   Horizontal Axis: _____

Chemistry Example

Let's look at an equation you should remember from chemistry. According to Boyle's the law, an ideal gas obeys the following equation $P_1V_1 = P_2V_2 = k$. This states that pressure and volume are inversely related, and the graph on the left shows an inverse shape. Although the equation is equal to a constant, the variables are not in fraction form. One of the variables, pressure in this case, is inverted. This means every pressure data point is divided into one to get the inverse. The graph on the left shows the linear relationship between volume V and the inverse of pressure 1/P. We could now calculate the slope of this linear graph.
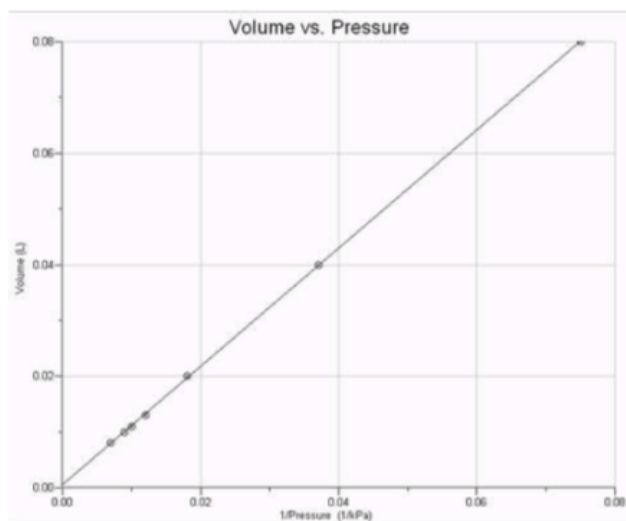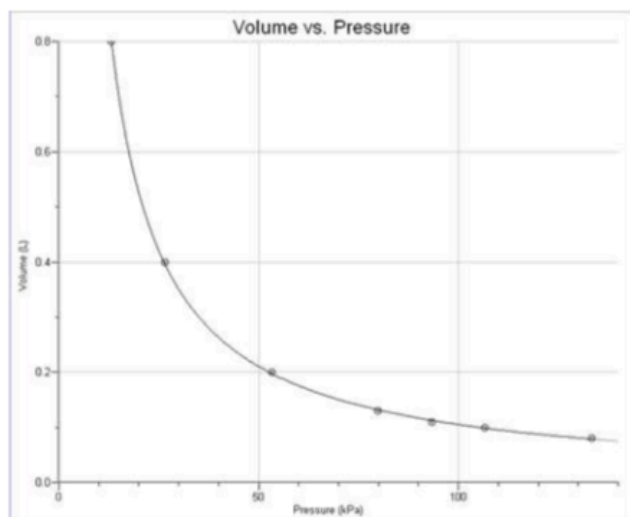
Sample graphing exercise

A steel sphere is dropped from rest and the distance of the fall is given by the equation $D = \frac{1}{2}gt^2$. D is the distance fallen and t is the time of the fall. The acceleration due to gravity is the constant known as g. Below is a table showing information on the first two meters of the sphere's descent.
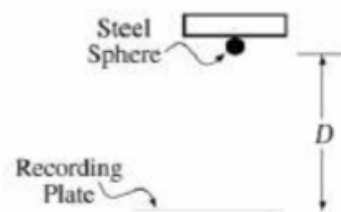

Distance of Fall (m)	0.10	0.50	1.00	1.70	2.00
Time of Fall (s)	0.14	0.32	0.46	0.59	0.63
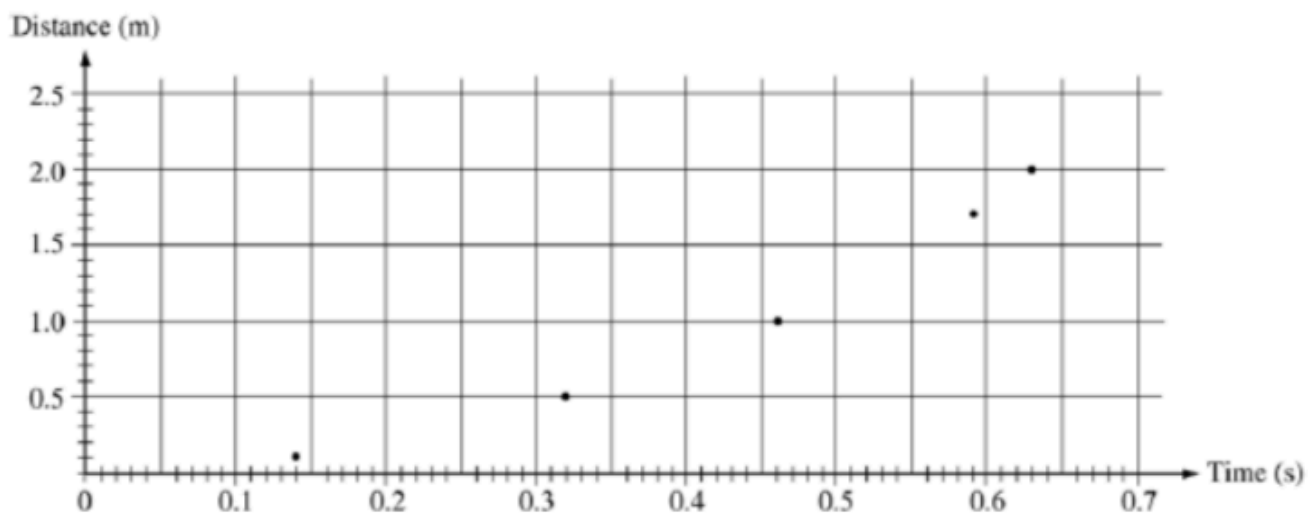
Distance (m)

a) Draw a line of best fit for the distance vs. time graph above.

b) If only the variables D and t are used, what quantities should the student graph in order to produce a linear relationship between the two quantities?

c) On the grid below, plot the data points for the quantities you have identified in part (b), and sketch the straight-line fit to the points. Label your axes and show the scale that you have chosen for the graph.
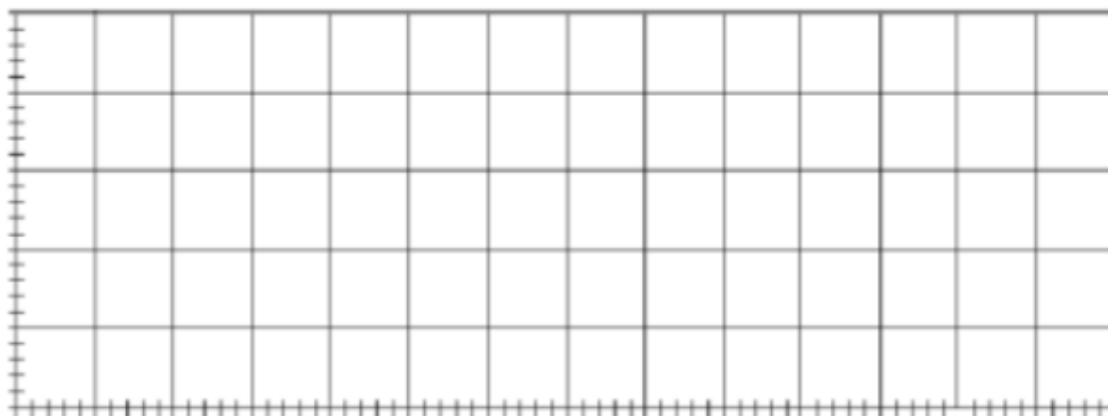
d) Calculate the value of g by using the slope of the graph.

Part 6: Sample IB problems

Below you will find a few problems from past IB exams. The IB exam is the exam that you will be taking at the end of the second year of this course. It will cover all 2 years of material, and you will notice that my test questions will reflect the style of question that you'll be seeing on the exam. These questions are VERY different than the questions you saw in MYP. Because it takes time to acclimate to these IB style questions, I wanted to get you started by giving you a few past IB exam questions on material that we covered in the MYP course.

1. A man wants to cross a river with a motor boat. The speed of the motor boat in still water is 4.0 m/s. The river is 30 m wide. There is a current whose speed with respect to the shore is 3.0 m/s.
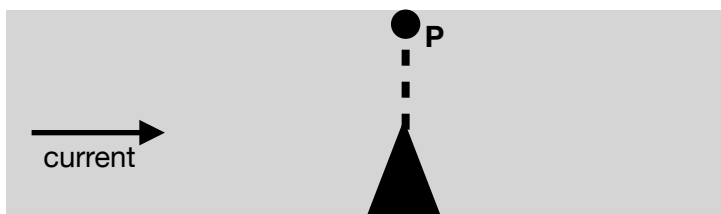
       a. The man aims the boat towards P. Determine the distance from P at which he will reach the shore.

       b. A woman in an identical boat leaves from the same spot as the man but wants to land at P. Determine the direction in which she has to turn her boat to do this.

       c. Determine which person reaches the shore in the least time.

2. A stone of mass 0.20 kg is thrown with speed 22 m/s from the edge of a cliff that is 32 m above the sea. The initial velocity of the stone makes an angle of 35° with the horizontal. Air resistance is neglected.
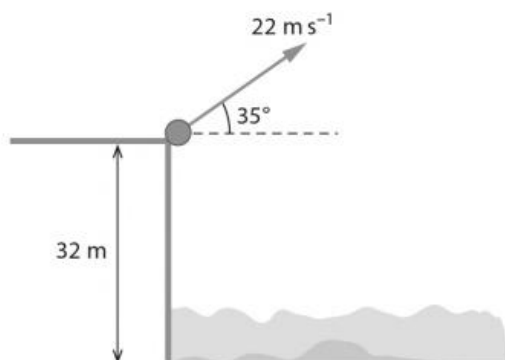
a.   i. Determine the horizontal and vertical components of the initial velocity.

       ii. Sketch graphs showing the variation with time of the horizontal and vertical components of velocity.

b.   i. Calculate the maximum height above the cliff reached by the stone.

       ii. State the net force on the stone at the highest point in its path.

c.   i. Using conservation of energy, determine the speed of the stone as it hits the sea.

       ii. Hence or otherwise, determine the time it took the stone to reach the surface of the sea.

3. This question is about the electric field due to a charged sphere and the motion of electrons in that field.

The diagram below shows an isolated, metal sphere in a vacuum that carries a negative electric charge of 9.0 nC.

a) On the diagram draw arrows to represent the electric field pattern due to the charged sphere.

b) The electric field strength at the surface of the sphere and at points outside the sphere can be determined by assuming that the sphere acts as though a point charge of magnitude 9.0 nC is situated at its centre. The radius of the sphere is 4.5×10^{-2} m. Deduce that the magnitude of the field strength at the surface of the sphere is 4.0×10^4 N/C.

4. Four point charges of equal magnitude are held at the corners of a square as shown below. The length of each side of the square is 2a and the sign of the charges is as shown. The point P is at the centre of the square.

a) On the diagram below, draw an arrow to represent the direction of the resultant electric field at point P.

b) Find the magnitude of the resultant electric field at point P.
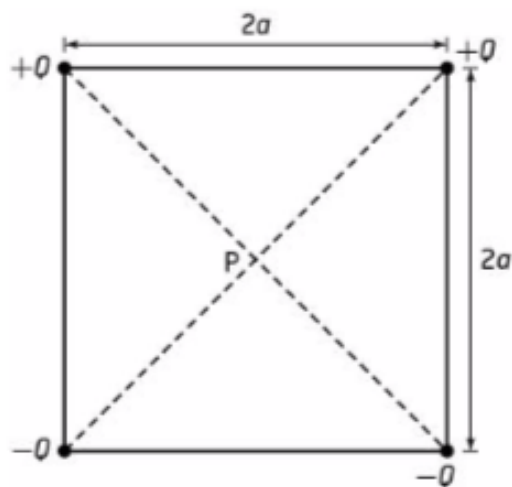
Congratulations! You're finished!

That wasn't so bad was it? Trust me... the blood, sweat, and tears it took to get through all of those problems will make everything later on a lot easier. Think about it as an investment with a guaranteed return.

This course is a wonderful opportunity to grow as a critical thinker, problem solver and great communicator. This course will require hard work, but so does anything that is worthwhile. You would never expect to win a race if you didn't train. Similarly, you can't expect to do well if you don't train academically. DP Physics is immensely rewarding and exciting, but you do have to take notes, study, and read the book (gasp!). I guarantee that if you do what is asked of you that you will look back to this class with huge sense of satisfaction! I know I can't wait to get started...

Let's learn some SCIENCE!!!