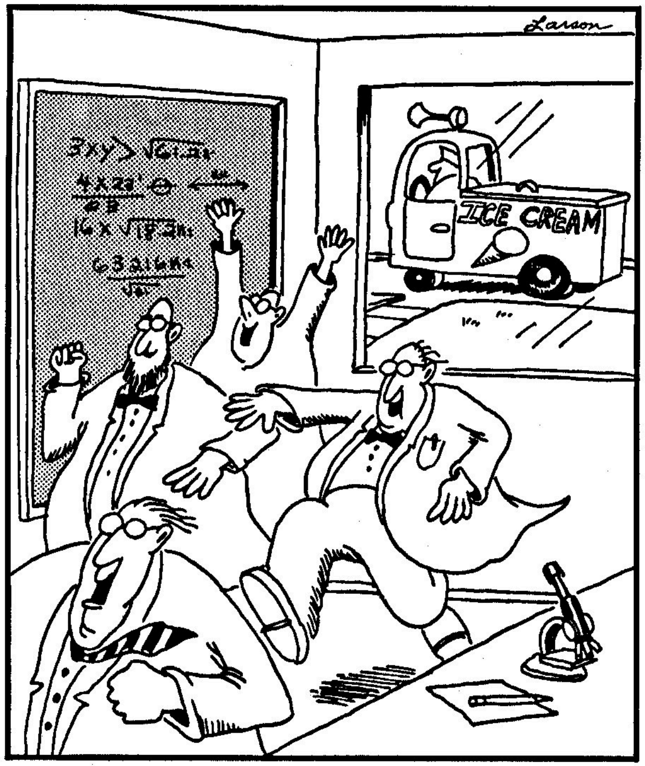
St. Michael Catholic
Senior/AP Physics Summer 2024

Welcome to Physics!



Congratulations! I am excited about your decision to enroll in Physics for your senior year. Senior physics will be fast-paced and challenging, but at the same time it will also be a rewarding, fun class that will prepare you for the rigors of college level work.

This course focuses on the principles of mechanics, which describes and explains the motion of particles in our world and universe through the study of the concepts of kinematics; Newton's laws of motion; work, energy, and power; systems of particles and linear momentum; circular motion and rotation; oscillations; and gravitation. These principles are often expressed as mathematical equations and models that can be experimentally tested and applied to predict the motion of particles.

(Note: Students enrolled in AP Physics C - Mechanics will be presented with calculus-based mathematical problems, in addition to algebra-based mathematical problems. Students enrolled in Honors Physics will be presented solely with algebra-based mathematical problems.)

Summer Assignments

The attached assignments are designed to introduce you to the world of mechanics and give you some insight into the concepts, topics, and experimentation that you will be exposed to throughout the coming school year. All assignments are required for all incoming Senior Physics students for the 2023-24 school year (except where indicated). All assignments are to be completed/submitted as indicated below.

***NOTE: If you procrastinate until the day or week before school starts you will not be able to adequately complete the assignment. Nor do you possess the proper mindset/motivation to be a successful St. Michael Senior Physics student.

There are 4 parts to the summer assignment (Details for each part follow):

I. **Join the St. Michael Senior Physics 2024 Google classroom page**
II. **6 Conceptual Questions**
III. **5 Mathematical Problems (6 for AP Physics)**

DETAILED INFORMATION:

I. **Join the St. Michael Senior Physics 2024 Google classroom page**

Go to: www.classroom.google.com and use code **7djoyhu** to join the class. You must use your school gmail account to join the class. We will use Google classroom throughout the school year. All class information and assignments will be posted here. I will be posting and updating information throughout the summer including the course syllabus, which may already be uploaded by the time you receive this document. Please check the classroom page periodically throughout the summer so that you can be up to date and ready for the first day of class. If you have difficulty logging in to Google classroom, please contact me by gmail (walt.dupre@stmichaelchs.org) for assistance.

II. **Respond to the following conceptual questions.** ****(***Due the first day of class***)****

For each of the 6 questions you are to do the following:

(a) List the major concepts (directly related to the question) and vital background information (indirectly related to the question) that must be understood (or at least be aware of) in order to respond correctly to the question posed.
(b) Answer the question.
(c) Give reasons for your response. (ie. Why do you think that is the correct answer?)

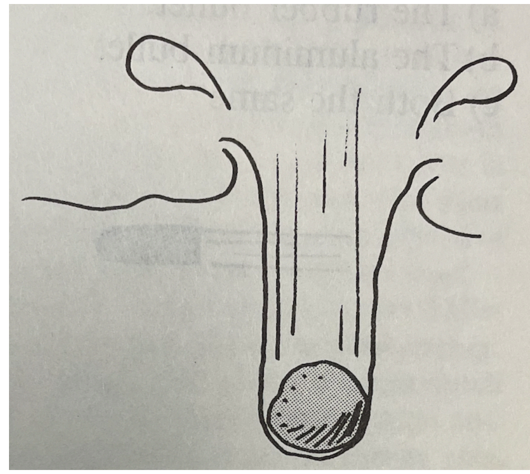
Format for responding to questions:

- Complete on looseleaf with proper class heading using black/blue ink or pencil.
- You do not need to rewrite the questions. Provide the question number and title.
- Your responses are to be submitted the first day of class.

Below is an example of how to complete this part of the assignment:

Example Question: GUSH

You throw a stone into some nice soft gushy mud. It penetrates one inch. If you wanted the stone to penetrate four inches, **how much faster would you have to throw the stone?**



Example Question: GUSH

(a) Concepts:

1) **Kinetic Energy**
2) **Work-Energy Theorem**
3) **Mass**
4) **Speed**

(b) Answer:

The stone must be thrown twice (2x) as fast in order for it to penetrate into the mud a distance four times (4x) greater.

(c) Reasoning:

$W = Fd$ **(Work formula: W = work, F = force, d = distance)**

$KE = \frac{1}{2} mv^2$ **(Kinetic Energy formula: KE = kinetic energy, m = mass, v = speed)**

$\Delta KE = \Delta W$ **(Work - Energy Theorem)**

$\therefore \Delta(\frac{1}{2} mv^2) = \Delta(Fd)$

$\therefore d \propto v^2$ **This illustrates that distance is proportional to the square of speed; therefore in order for the stone to penetrate 4x farther (distance) one only needs to increase the speed of the stone by a factor of 2.**

YOUR TURN

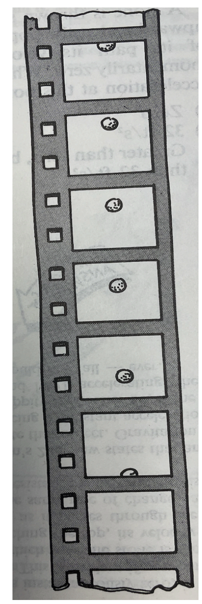
Question #1: SPEED on SPEED

The St. Charles Street streetcar is approaching Canal Street at 144 inches per second. A person in the streetcar is facing forward and walking forward in the car with a speed of 36 inches per second relative to the seats and things in the car. The person is also eating a Roastbeef Po'boy which is entering his mouth at 2 inches per second (he eats fast). An ant on the po'boy is running to the end of the po'boy, away from the person's mouth. The distance between the ant and the end of the po'boy towards which it is running is closing at 1 inch per second. Now the question is:

How fast is the ant approaching Canal Street? (show your calculations)

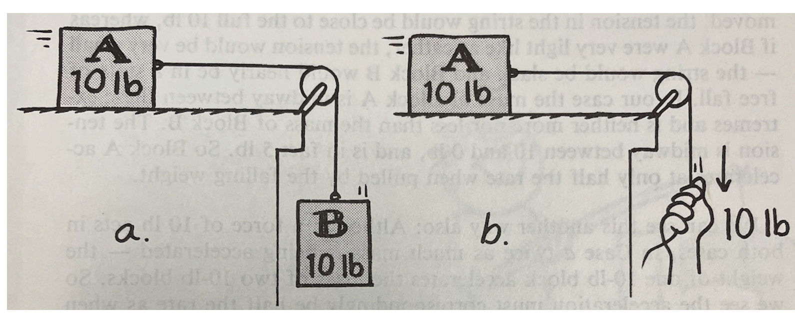
Question #2: TIME REVERSAL

A motion picture film is made of a falling object which shows the object accelerating downwards. The projectionist accidentally loads the film backwards. As the film runs backwards, **in which direction is the object now accelerating?**



Question #3: PULL

In both *Case a* and *Case b* shown here a net force of 10 pounds (lbs) results in the acceleration of Block A across the table toward the pulley. Disregarding friction, **the acceleration of Block A is**:

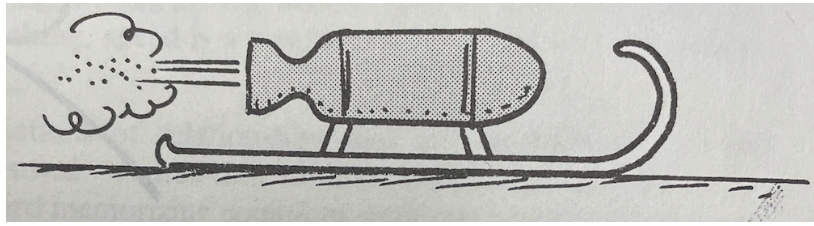


(a) Greater in *Case a*
(b) Greater in *Case b*
(c) The same in both cases

Question #4: ROCKET SLED

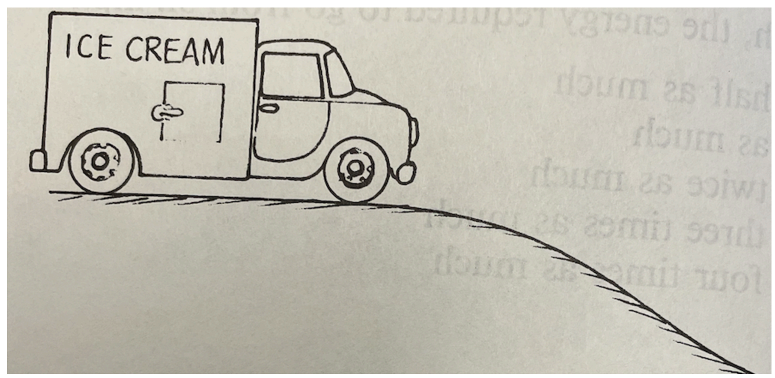
A little sled weighs one pound. It is set in motion over frictionless ice by a toy rocket motor. After the rocket fuel is expended, the sled is coasting over the ice at one foot per second. **How much force did the rocket exert on the sled to make it go?**

a) One pound
b) 4 pounds
c) 16 pounds
d) 32 pounds
e) There is no way to tell from the information given



Question #5: DOWN HILL

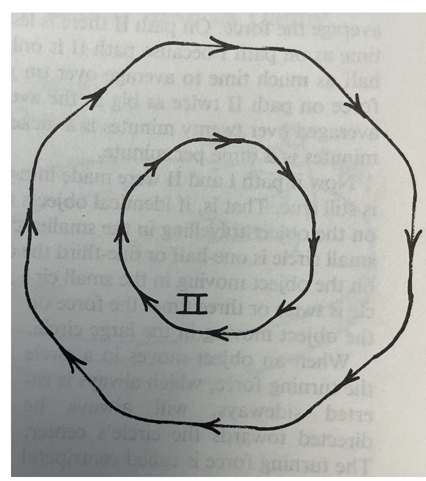
A truck initially at rest at the top of a hill is allowed to roll down. At the bottom its speed is 4 mph. Next, the truck is again rolled down the hill, but this time it does not start from rest. It has an initial speed of 3 mph on top, even before it starts going down the hill. **How fast is it going when it gets to the bottom?**



Question #6: SHARPER TURN

An object goes around bent path I with a speed of 1 mph. An identical object goes around bent path II with the same speed. The diameter of path II is ½ the diameter of path I. The average force required to keep the object moving along path II is:

(a) The same as the average force on the object in path I
(b) Half the average force on the object in path I
(c) Double the average force on the object in path I
(d) 4X the average force on the object in path I
(e) ¼ of the average force on the object in path I



III. **Solve the following mathematical problems.** ****_**(Due the first day of class)**_****

Steps to solving physics problems successfully.

1) Identify all given information (knowns and unknowns) with proper units
2) Identify what values you are being asked to solve and any additional questions you are being asked
3) Sketch a model of the problem**(optional - unless specified - but usually helps)
4) List original formulas, equations, concepts, theories you will use to solve* (only variables and constants)
5) Substitute given information into formulas/equations
6) Solve/simplify
7) Clearly indicate your answer with proper units

Format for responding to problems:

- Complete on looseleaf with proper class heading using black/blue ink or pencil.
- You do not need to rewrite the problem. Provide the problem number and title.
- Your responses are to be submitted the first day of class.

Below is an example of how to complete this part of the assignment:

Note that in the example:

Red text represents the minimum that should be included in the solution to a physics problem.

Blue text represents mathematical steps between the initial substitution and the final solution. These steps are not required, but may prove important for partial credit. Also used here because I wanted to show my solution step by step.

Black text is just for informational purposes and is not required.

Example Math Problem: Alligator

For a period of time as an alligator grows, its mass is proportional to the cube of its length. When the alligator's length changes by 15.8%, its mass increases by 17.3 kg. Find its mass at the end of this process.

This is a proportionality problem.

Example Math Problem: Alligator

Given Information			Equation/Concept:
Knowns:	Unknowns:	Key:	$m \alpha l^3$
mass increased 17.3 kg ∴ $m_f = m_i + 17.3$ kg length changed by 15.8% ∴ $l_f = l_i + 0.158l_i = 1.158l_i$	m_i = ? l_i = ?	m_f = final mass m_i = initial mass l_f = final length l_i = initial length α = proportional to (Greek letter alpha)	$\frac{m_i}{m_f} = \left(\frac{l_i}{l_f}\right)^3$
Question: What is the actual final mass of the alligator? (solving for m_f)			

Solution:		
$\frac{m_i}{m_f} = \left(\frac{l_i}{l_f}\right)^3$ $\frac{m_f - 17.3kg}{m_f} = \left(\frac{l_i}{1.158l_i}\right)^3$ $\frac{m_f - 17.3kg}{m_f} = \left(\frac{l_i}{1.158l_i}\right)^3$ [l_i's will cancel]	$\frac{m_f - 17.3kg}{m_f} = \left(\frac{1}{1.158}\right)^3$ $\frac{m_f - 17.3kg}{m_f} = \left(\frac{1}{1.55}\right)$ $m_f - 17.3kg = \left(\frac{1}{1.55}\right) m_f$ $m_f - 17.3kg = \left(\frac{m_f}{1.55}\right)$	$1.55(m_f - 17.3kg) = m_f$ $1.55m_f - 26.8kg) = m_f$ $-26.8kg = m_f - 1.55m_f$ $-26.8kg = -0.55m_f$ $\frac{-26.8kg}{-0.55} = m_f$ 48.75kg = m_f

YOUR TURN

Math Problem #1: Simultaneity

From the set of equations:

$$p = 3q$$

$$pr = qs$$

$$\tfrac{1}{2}pr^2 + \tfrac{1}{2}qs^2 = \tfrac{1}{2}qt^2$$

involving the unknowns p, q, r, s, and t, find the value of the ratio of t to r.

Math Problem #2: Relationship to Graphs

In a particular set of experimental trials, students examine a system described by the equation

$$\frac{Q}{\Delta t} = \frac{k\pi\, d^2\,(T_h - T_c)}{4L}$$

For experimental control, in these trials all quantities except *d* and Δt are constant.

(a) If *d* is made three times larger, does the equation predict that Δt will get larger or smaller? By what factor?
(b) What pattern of proportionality of Δt to *d* does the equation predict?
(c) To display this proportionality as a straight line on a graph, what quantities should you plot on the horizontal and vertical axes? (Using graph paper, show how the graph would appear.)
(d) What expression represents the theoretical slope of this graph?

Math Problem #3: Unit Conversions

The consumption of natural gas by a company satisfies the empirical equation

$V = 1.50t + 0.008\,00t^2$

where: V = volume in millions of cubic feet
T = time in months.

Express this equation in units of cubic feet and seconds.
Assign proper units to the coefficients.
Assume a month is 30.0 days.

Math Problem #4:Trig

A high fountain of water is located at the center of a circular pool as shown in Figure P1.53. Not wishing to get his feet wet, a student walks around the pool and measures its circumference to be 15.0 m. Next, the student stands at the edge of the pool and uses a protractor to gauge the angle of elevation of the top of the fountain to be 55.0°. How high is the fountain?

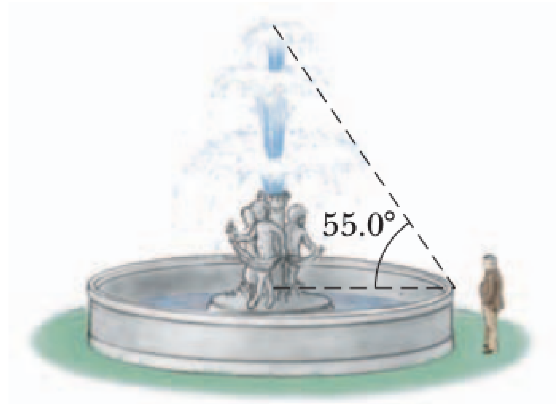


Figure P1.53

Math Problem #5: Shampoo

A child loves to watch as you fill a transparent plastic bottle with shampoo. Horizontal cross sections of the bottle are circles with varying diameters because the bottle is much wider in some places than others. You pour in bright green shampoo with constant volume flow rate 16.5 cm^3/s. At what rate is its level in the bottle rising (a) at a point where the diameter of the bottle is 6.30 cm and (b) at a point where the diameter is 1.35 cm?

Math Problem #6: (AP Physics ONLY) Density

A rod extending between *x* = 0 and *x* = 14.0 cm has uniform cross-sectional area *A* = 9.00 cm^2. It is made from a continuously changing alloy of metals so that along its length its density changes steadily from 2.70 g/cm^3 to 19.3 g/cm^3.

(a) Identify the constants *B* and *C* required in the expression $\rho = B + Cx$ to describe the variable density.

(b) The mass of the rod is given by:

$$m = \int_{\text{all material}} \rho\, dV = \int_{\text{all } x} \rho A\, dx = \int_0^{14\text{ cm}} (B + Cx)\ (9.00\text{ cm}^2)\ dx$$

Carry out the integration to find the mass of the rod.