AP Physics 2 - Summer Assignment

This assignment is due on the first day of school. You must show all your work in all steps.

This material is review of First Year Physics and will be covered in its entirety in the first three weeks of school.

Summer Help Sessions:

Via Schoology this year: Group Code: 2XS9-6XQ9-MZ5QC

Physics, and AP Physics in particular, is a science course that will demand an exceptional knowledge of algebra-based mathematics, trigonometry, and geometry. It will sometimes feel as if you are in another mathematics class that consists of only word problems. Because much of physics requires application of algebraic mathematics, it is strongly recommended that students have a solid foundation before entering this class to be successful.

Things to know about AP Physics:

1. This is the continuation of AP Physics 1. If you took AP 1, you know what is in store for you as regards to homework, quizzes, tests, and class style.
    a. Therefore, you should read the below statements but should remember them from last year.

2. You are not taking AP 2 for the "AP GPA Grade Booster". You are taking it to better prepare yourself for college physics/engineering/medical fields.
3. Ignore your grade: if you focus on the content, do your work on time with the course pacing, ask questions as often as needed and you will do well.
4. Conceptual knowledge is more important than the math. You will need to justify all your answers with scientific support via Laws, Theories, Experiments, etc.
    a. This means you need to be involved in the course and study regularly. If you do so, you can build upon your knowledge and gain a deeper understanding of the concepts.
5. Your book is your friend. When told to read a chapter or two (or more), you *NEED* to do it. To say you do not understand it or it does not make sense means you need to read it again (and again and again). Remember to read and understand the words in bold, the diagrams and their captions and review the practice problems done for you as well as the chapter summary.
    a. When you are in college (which you are now thanks to AP), reading and taking notes are the key to success in the hard sciences.
6. We now live in the technology era. You have THE INTERNET! I am making resources for you as fast as I can but you have THE INTERNET! You will find hundreds of videos teaching you everything and it will be worth it to find good sites and bookmark them.
7. If you are spending an exceptionally large amount of time on one problem, skip it. You will realize that the answer will come to you later when you take a break and refer back to #1.
8. Your peers are guiding light. Rely on one another so that you can help each other when the time comes and use your time wisely (i.e. socializing during class means you will be doing work for class when you want to socialize outside of class).
9. Do not cram. If the course was primarily a memorization-based content, then you could most likely get away with this but unfortunately, AP Physics is completely application-based. Therefore, after cramming for eight hours on a certain scientific law and sample problems and you are certain you will do well, the test will have questions asked in a way you have never seen before and now you do not know what to do.

Kinematics

1. An object is traveling at a constant velocity of 11 m/s when it experiences a constant acceleration of 1.5 m/s^2 for a time of 14 s. What will its velocity be after that acceleration?

2. An object is thrown vertically up with a velocity of 35 m/s. What was the maximum height it reached?

3. A car which is traveling at a velocity of 9.6 m/s undergoes an acceleration of 4.2 m/s^2 over a distance of 450 m. How fast is it going after that acceleration?

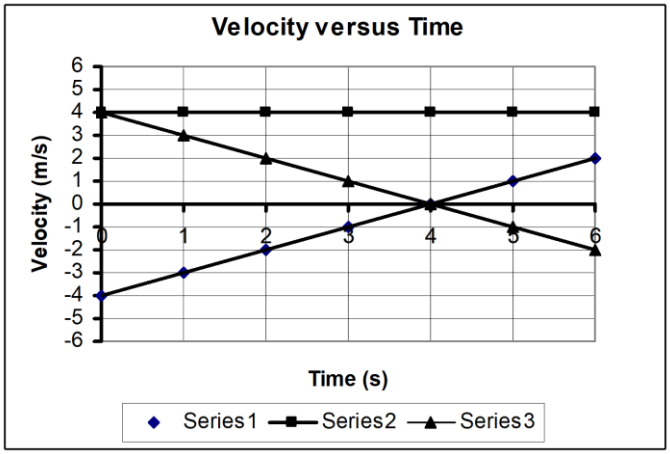
4. A marble is projected horizontally from a ledge that is 2.8 m up from the ground. How far does it travel horizontally with respect to the floor and how long is it in the air if it is moving at 4.0 m/s?

5. The velocity versus time graph, on the right, describes the motion of three different cars moving along the x-axis.

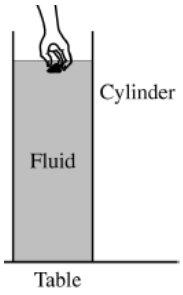
    a. Describe, in words, the velocity of each of the cars. Make sure you discuss each car's speed and direction.

    b. Calculate the displacement of each car.

    c. Calculate the distance traveled by each car.

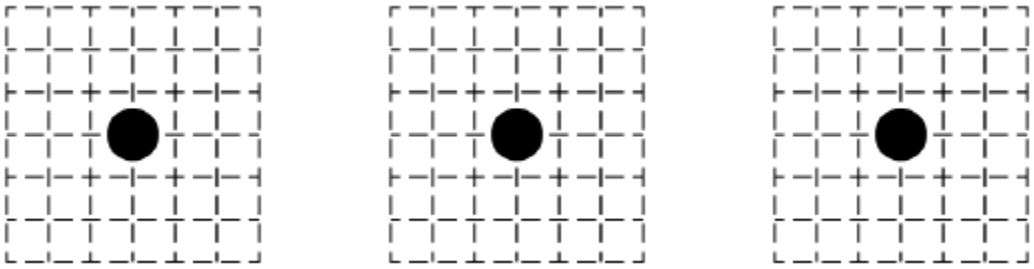


Dynamics



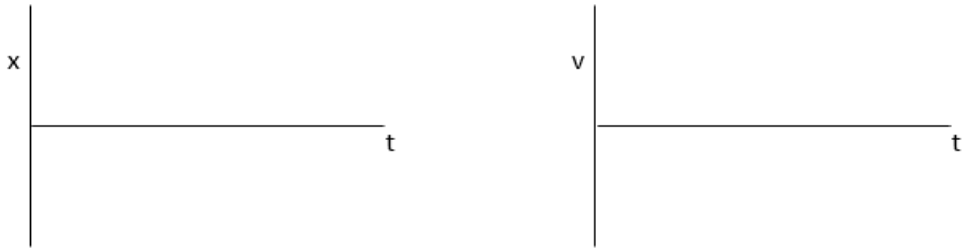
6. An object of mass *m* is dropped from rest at the top of a cylinder containing a uniform dense fluid. While travelling through the fluid, it has an increasing magnitude of resistance, F_{fl}, until it reaches the bottom. This simple procedure is repeated again with objects of larger volume. As the objects sink, ignore the effects of viscosity and pressure changes. Answer the following questions using provided terms and universal constants.

    a. Clearly, draw a free-body diagram for the mass at the moment it is released, after dropping a short distance and then finally when nearing the bottom.



    b. Use Newton's Second Law write an equation for the acceleration of the object(s).

    c. Complete the following two graphs for an object with small volume and then a second with a larger volume.

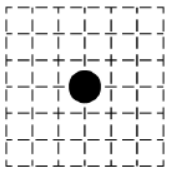


    d. At the end of the experiment, the teacher provides the groups with a round, flat object and tells the students to drop the item such that its surface lays parallel to the table. The students observe it drop and slow to a complete stop near the exact middle of the cylinder.
        i. What forces are acting on the object now that it is completely at rest?
        ii. Write and solve a net force equation for this identified force.

Uniform Circular Motion

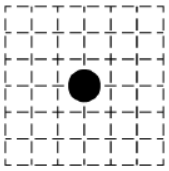
7. A 0.65 kg ball is on a string and swung in a vertical circle of radius 0.50 m with a constant speed of 2.8 m/s.

   a. Draw a free body diagram for the ball when it is at the top of the circle. Next to that diagram indicate the direction of its acceleration.

   b. Solve for the Tension.

   c. Draw a free body diagram for the ball when it is at the bottom of the circle. Next to that diagram indicate the direction of its acceleration.

   d. Solve for the Tension.

Universal Law of Gravitation **(Although this won't be tested exclusively, the synthesis of equations will be similar to electrical forces)**

8. As shown in the diagram, a 1000 kg asteroid is located 6.8×10^6 m from the center of the Mars. The mass of the Mars is 6.4×10^{23} kg.

   a. Determine the force of gravity acting on the asteroid, due to the Mars. Calculate the magnitude and state the direction.

   b. Compare your answer in a) to the force of gravity acting on the Mars, due to the asteroid. Indicate that force on the diagram above.

   c. On the diagram above, indicate the direction the asteroid would accelerate if released. Label that vector "*a*".

   d. Calculate the acceleration the asteroid would experience (Newton Synthesis!!).

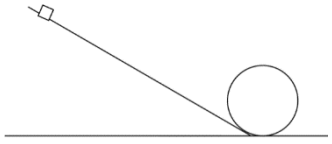
e. If instead of falling, the asteroid were in a stable orbit, indicate on the diagram above a possible direction of its velocity. Label that vector "v".

f. Calculate the velocity the asteroid needs to be in a stable orbit (Newton Synthesis again!!).

g. Calculate the period of the asteroid orbiting the planet (Newton Synthesis for the last time).

Work and Energy

9. A small block, with a mass of 250 g, starts from rest at the top of the apparatus shown above. It then slides without friction down the incline, around the loop and then onto the final level section on the right. The maximum height of the incline is 80 cm, and the radius of the loop is 15 cm.



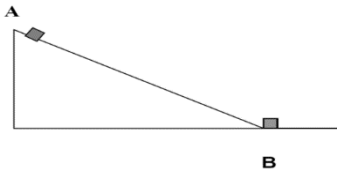
a. Find the initial potential energy of the block

b. Find the velocity the block at the bottom of the loop

c. Find the velocity of the block at the top of the loop.

d. What is the normal force on the block at the highest point of the loop?

Momentum



10. A track consists of a frictionless incline plane, which is a height of 0.5 m. Block A, whose mass is 1.5 kg, is released from the top of the incline plane, slides down and collides instantaneously and completely inelastically with the identical block B at the lowest point. The two blocks move together to the right.

    a. Determine the initial potential energy of block A.

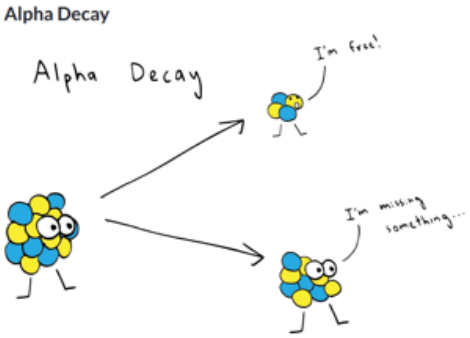
    b. Determine the kinetic energy of block A at the lowest point, just before the collision.

    c. Find the speed of the two blocks just after the collision.

    d. Find the kinetic energy of the two blocks just after the collision.

11. An atom undergoes alpha decay such that the remaining nucleus recoils from the alpha particle expelled. The original atom had an atomic mass unit (amu) of 238 and was at rest. The alpha particle, amu of 4, is propelled to the right with a speed of 3,000 m/s.

    a. What is the net momentum of the system before the collision?
    b. What is the net momentum of the system after the collision?
    c. What is the mass of the remaining 'daughter' nucleus?
    d. What is the *velocity* of the daughter nucleus after the collision?
    e. Find the total energy of the system before the collision?
    f. Find the total energy of the system after the collision?
    g. What type of collision has occurred?



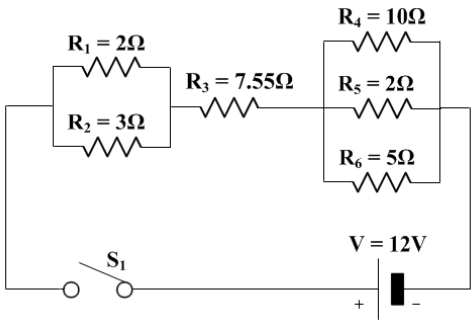
https://www.khanacademy.org/science/in-in-class-12th-physics-india/nuclei/in-in-nuclear-physics/a/radioactive-decay-types-article

Electric Charge, Force, Field and Potential

12. A positive charge, $Q_1 = +4.6\ \mu C$, is located at point $x_1 = -4$ m and a negative charge, $Q_2 = -3.8\ \mu C$, is located at a point $x_2 = 5$ m.
    a. Find the magnitude of the electric force between the charges.
    b. Find the magnitude and *direction* of the net electric field at the origin.
    c. Find the electric potential at the origin due to charge Q_1.
    d. Find the electric potential at the origin due to charge Q_2.
    e. Find the net electric potential at the origin.
    f. How much work must be done to bring a 1-μC test charge from infinity to the origin?

c-f are new so please ask questions when and if they arise

Current and Circuits

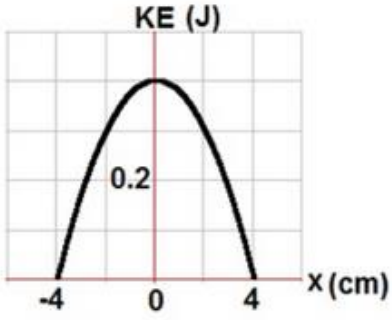


Assume switch S_1 is closed

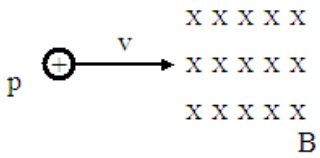
13. Determine the following for the above circuit:
    a. The equivalent resistance of R_1 and R_2.
    b. The equivalent resistance of R_4, R_5 and R_6.
    c. The equivalent resistance of all six resistors.
    d. The current through the battery.
    e. The voltage drop across R_1 and R_2?
    f. The voltage drop across R_3?
    g. The voltage drop across R_4, R_5 and R_6?
    h. The current through each resistor?
    i. The total power dissipated in the circuit.

Simple Harmonic Motion

14. A 0.5 kg mass is attached to a horizontal spring which undergoes SHM and its graph of *K* as a function of position is shown on the right. The total energy of the oscillating system is 0.4 J.



    a. Draw the graph of total energy as a function of position.
    b. Draw the graph of potential energy as a function of position.
    c. What is the maximum displacement of the oscillating mass?
    d. What is the potential energy at the position of 2 cm?
    e. What is the kinetic energy at the position of 2 cm?
    f. Find the location of the oscillating mass when its potential energy is 0.1 J.
    g. What is the period of oscillations?



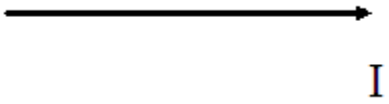
Magnetic Force

15. A proton is traveling horizontally at a constant speed of $7.4*10^6$ m/s when it enters a uniform magnetic field of 0.46 T (see figure above).

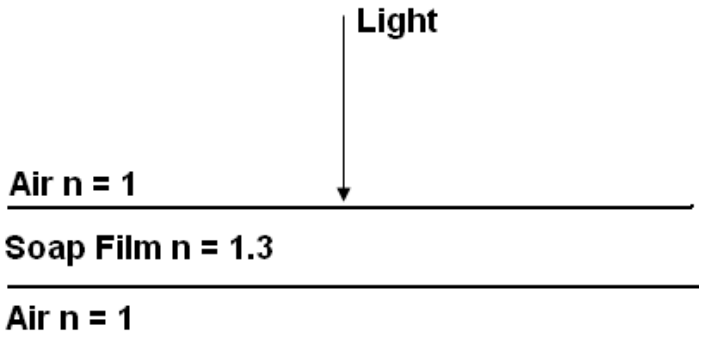
    a. On the diagram above, show the direction of the magnetic force on the proton as it enters the magnetic field.
    b. On the diagram above show an approximate path of the proton.
    c. Calculate the magnitude of the magnetic force on the proton.
    d. Calculate the acceleration of the proton ($m_p = 1.66 \cdot 10^{-27}$ kg).
    e. Calculate the radius of the path that the proton follows in the magnetic field.

16. A thin 2.4 m long aluminum wire has a mass of 0.15 kg and is suspended by a magnetic force due to a uniform magnetic field of 1.2 T.

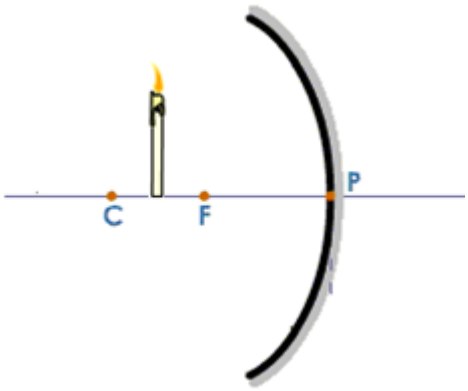
    a. On the diagram, show all the applied forces on the wire.
    b. What is the net force on the wire if it is in equilibrium?
    c. On the diagram, show the direction of the uniform magnetic field.
    d. What is the magnitude of the current flowing through the wire?



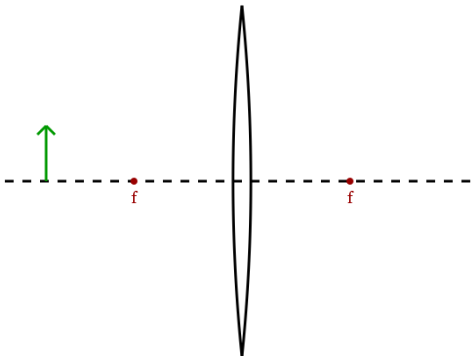
Electromagnetic Waves



17. A soap film is illuminated with monochromatic light wavelength of 600 nm as shown above.
    a. What is the frequency of the incident light in vacuum?
    b. What is the frequency of light in the film?
    c. What is the speed of light in the film?
    d. What is the wavelength of light in the film?



18. A candle is placed at a distance of 15 cm from of a concave mirror with a focal length of 10 cm. The candle is 4 cm tall.
    a. On the diagram above use ray-tracing to show the image produced by the mirror.
    b. Find the image distance. Is the image real or virtual?
    c. Find the size of the image. Is the image upright or inverted?



19. An object is placed at a distance of 80 cm from a converging lens with a focal length of 30 cm.

    a. On the diagram above use ray-tracing to show the image formed by the lens.
    b. Calculate the image distance. Is the image virtual or real?
    c. If the object is 8 cm tall, what is the size of the image?