AP Physics-1 Summer Assignment

2016

Instructions:

1. Solve all problems on separate paper making certain to <u>show all work</u>. This means that all givens should be listed, appropriately selected equations, manipulation of these equations to isolate the unknown, substitute in known values and then solve. All units must be shown.

> **No credit is awarded for just providing the correct answer.**

2. This assignment is due the first scheduled class of the 2016-2017 school year.

3. Separately there is an equation sheet and answer key for your use. Make sincere attempts at a solution prior to sending an email requesting help. If you do require assistance state what question you are working on and specifically what steps/thoughts you have toward a solution.

   a.   www.njctl.org; courses/science/algebra-based physics.

   b.   email:

   Dr. Cartegna @ ncartegna@longbranch.k12.nj.us

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 boy throws a ball vertically up and catches it after 3 s. What height did the ball reach?

4. An object is moving at a velocity of 5.8 m/s. It accelerates to a velocity of 25 m/s over a time of 3.3 s. What acceleration did it experience?

5. 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?

6. A marble is projected vertically up by a spring gun, and reaches the maximum height of 9.8 m. What is the initial speed of the marble? How long was the marble in the air?

7. An arrow is shot vertically up by a bow, and after 8 s returns to the ground level. What is the initial velocity of the arrow? How high did it go?

8. Starting at the position, x_0 = 10 m, you travel at a velocity of 4 m/s for 2 s.
   a. Determine your position at the times of 0s; 0.5s; 1s; and 1.5s.
   b. Draw the Position versus Time for your travel during this time.
   c. Draw the Velocity versus Time graph for your trip.

9. The velocity versus time graph, 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 during its 6 s trip.

   c. Calculate the distance traveled by each car during its 6 s trip.


Velocity versus Time
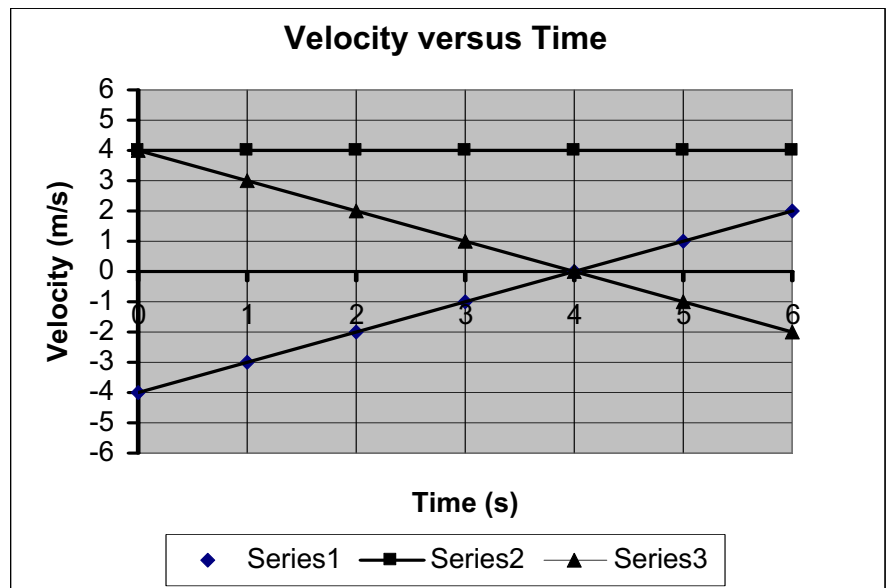
Dynamics

10. A 12 kg load hangs from one end of a rope that passes over a small frictionless pulley. A 15 kg counterweight is suspended from the other end of the rope. The system is released from rest.
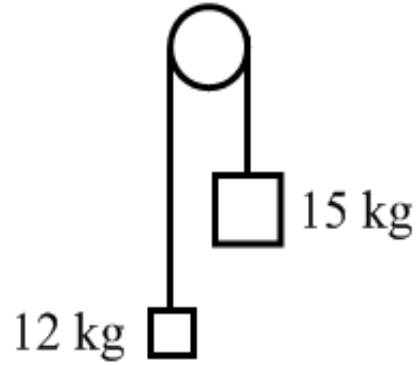

a. Draw a free-body diagram for each object showing all applied forces in relative scale. Next to each diagram show the direction of the acceleration of that object.
b. Find the acceleration each mass.
c. What is the tension force in the rope?
d. What distance does the 12 kg load move in the first 3 s?
e. What is the velocity of 15 kg mass at the end of 5 s?

11. A 500 g block lies on a horizontal tabletop. The coefficient of kinetic friction between the block and the surface is 0.25. The block is connected by a massless string to the second block with a mass of 300 g. The string passes over a light frictionless pulley as shown above. The system is released from rest.
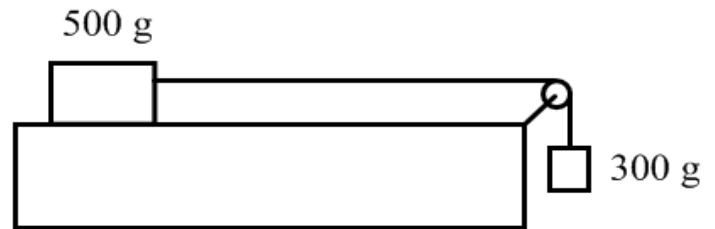
a. Draw clearly labeled free-body diagrams for each of the 500 g and the 300g masses. Include all forces and draw them to relative scale. Draw the expected direction of acceleration next to each free-body diagram.
b. Use Newton's Second Law to write an equation for the 500 g mass.
c. Use Newton's Second Law to write an equation for the 300 g mass.
d. Find the acceleration of the system by simultaneously solving the system of two equations.
e. What is the tension force in the string?

12. A 2000 kg car travels in a straight line on a horizontal road. The relationship between car's velocity and the time are given by the above graph.
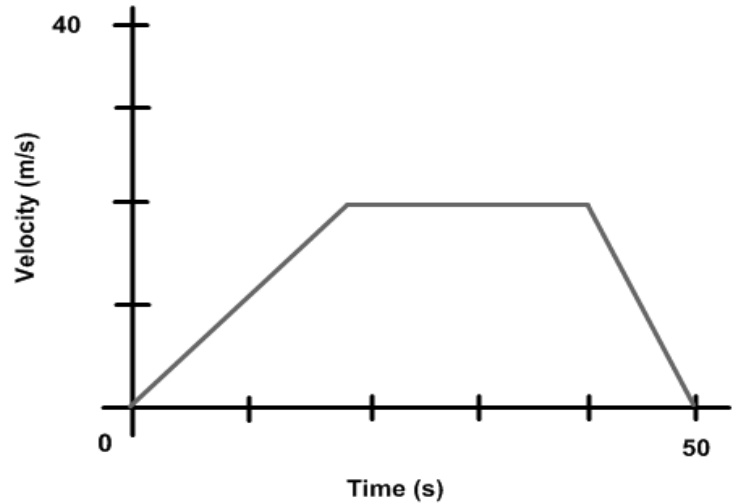
a. What is the car's acceleration during first 20 s?
b. What is the net force applied by the engine during the first 20 s?
c. What is the car's acceleration from 20 s to 40 s?
d. What is the net force applied by the engine during this time?
e. What is the car's acceleration from 40 s to 50 s?
f. What is the net force applied by an engine during this time?

Uniform Circular Motion

13. A 0.65 kg ball is attached to the end of a string. It is swung in a vertical circle of radius 0.50 m. At the top of the circle its velocity is 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. Use that free body diagram to set up the equations needed to determine the Tension in the string.

c. Solve those equations for the Tension in the string.

14. A 0.65 kg ball is attached to the end of a string. It is swung in a vertical circle of radius 0.50 m. At the bottom of the circle its velocity is 2.8 m/s.

a. 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.

b. Use that free body diagram to set up the equations needed to determine the Tension in the string.

c. Solve those equations for the Tension in the string.

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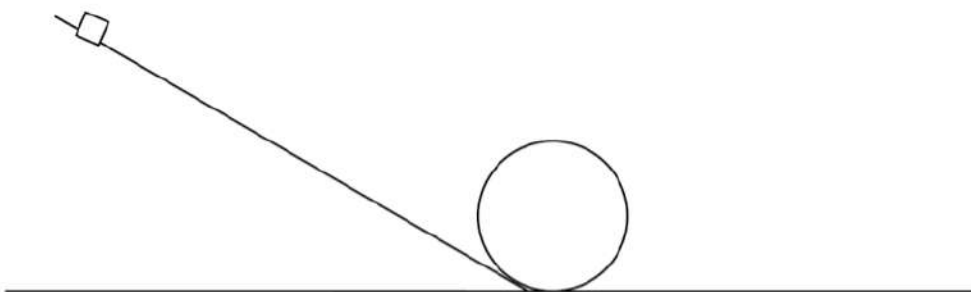
15. A small block, with a mass of 250 g, starts from rest at the top of the apparatus shown above. It then slides without friction down the incline, around the loop and then onto the final level section on the right. The maximum height of the incline is 80 cm, and the radius of the loop is 15 cm.

    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 lowest point of the loop?
    e. What is the normal force on the block at the highest point of the loop?
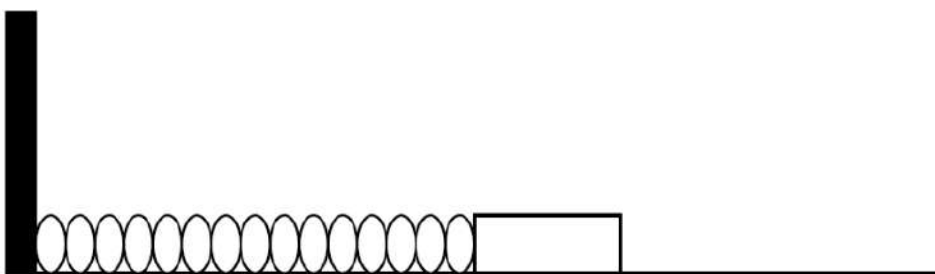
16. A 0.8 kg block is attached to the end of a spring whose spring constant is 85 N/m. The block is placed on a frictionless tabletop, given an initial displacement of 3.5 cm and then released.

    a. What type of energy did the block-spring system initially have?
    b. Find the magnitude of this energy.
    c. How does the total energy of the block-spring system change as the block is pushed across the frictionless surface? Explain.
   d. Find the maximum velocity of the block.

Momentum
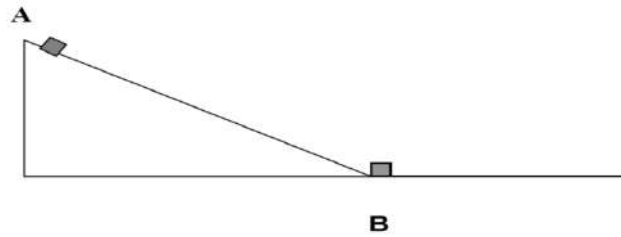
17. A track consists of a frictionless incline plane, which is a height of 0.5 m, and a rough horizontal section with a coefficient of kinetic friction 0.02. Block A, whose mass is1.5 kg, is released from the top of the incline plane, slides down and collides instantaneously and inelastically with identical block B at the lowest point. The two blocks move to the right through the rough section of the track until they stop.

    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.
    e.   How far will the two blocks travel on the rough section of the track?
    f.   How much work will the friction force do during this time?


18. A bullet of mass 0.01 kg is moving horizontally with a speed of 100 m/s when it hits a block of mass 2 kg that is at rest on a horizontal surface with a coefficient of friction of 0.4. After the collision the bullet becomes embedded in the block.

    a.   What is the net momentum of the bullet-block system before the collision?
    b.   What is the net momentum of the bullet-block system after the collision?
    c.   What is the speed of the bullet-block system after the collision?
    d.   Find the total energy of the bullet-block system before the collision?
    e.   Find the total energy of the bullet-block system after the collision?
    f.   Is the total energy conserved during the collision?
    g.   Find the maximum traveled distance of the bullet-block after the collision?

Electric Charge and Force

Q_1 Q_2 Q_3

-10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10

X (m)
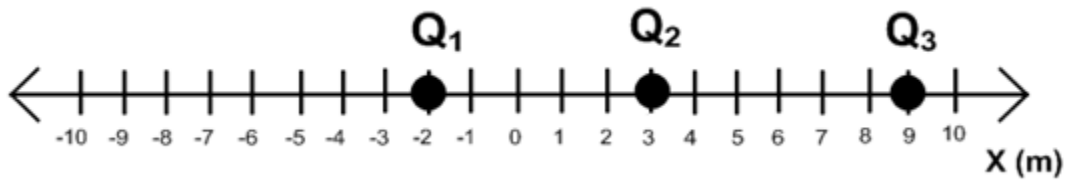
19. A positive charge Q_1 = 7.4 µC is located at a point X_1 = -2 m, a negative charge Q_2 = -9.7 µC is located at a point X_2 = 3 m and a positive charge Q_3 = 2.1 µC is located at a point X_3 = 9 m.

    a.   Draw free body diagrams for the electric force acting on Q_1, Q_2 and Q_3.
    b.   Find the magnitude of the force between Q_1 and Q_2.
    c.   Find the magnitude of the force between Q_1 and Q_3.
    d.   Find the magnitude of the force between Q_2 and Q_3.
    e.   Find the magnitude and direction of the net electric force on charge Q_1.
    f.   Find the magnitude and direction of the net electric force on charge Q_2.
   g.   Find the magnitude and direction of the net electric force on charge Q_3.

A

B

C
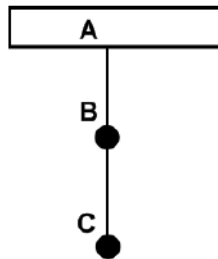
20. Two identical balls (B and C) with a mass of 0.5 g are suspended from two strings as show above. The balls carry equal charges +10 nC each and are separated by a distance of 4 cm.

    a.   Draw free-body diagram and show all forces applied to ball C.

    b.   Find the tension force in the string BC.

    c.   Draw free-body diagram and show all forces applied on ball B.

    d.   Find the tension force in string AB.

    e.   Answer questions a, b, c, d for the situation when the balls have equal but opposite charges (charge on B is positive and charge on C is negative).

Magnetic Force

$$\longrightarrow$$

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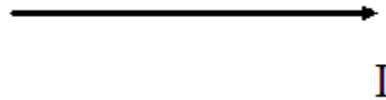
21. A thin 2.4 m long aluminum wire has a mass of 0.15 kg and is suspended by a magnetic force due to a uniform magnetic field of 1.2 T.

    a. On the diagram above 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 above show the direction of the magnetic field.

    d. What is the magnitude of the current flowing through the wire?

X X X X X

v

p $\oplus \longrightarrow$ X X X X X

X X X X X

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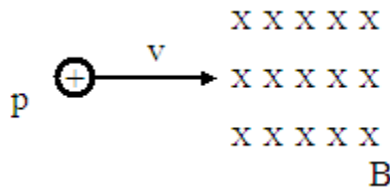
22. A proton is traveling horizontally at a constant speed of $7.4*10^6$ m/s when it enters a uniform magnetic field of 0.46 T (see figure above).

    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.

    e. Calculate the radius of the path that the proton follows in the magnetic field.

Simple Harmonic Motion

23. A bullet m = 0.001 kg moves with a speed of 500 m/s and strikes a block M = 2 kg at rest. After the collision the bullet becomes embedded into the block. The block is attached to the end of a spring k = 120 N/m.

    a. What is the initial kinetic energy of the bullet?
    b. What is the speed of the bullet-block system after the collision?
    c. What is the kinetic energy of the bullet-block system after the collision?
    d. What is the maximum elastic potential energy when the block comes to rest?
    e. What is the maximum compression of the spring?
    f. What is the period of oscillations?
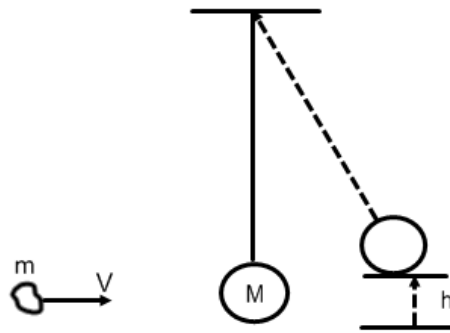
24. A piece of clay m = 0.04 kg has a speed of 15 m/s as shown above. The clay strikes a pendulum bob M = 0.5 kg and sticks to it. The pendulum bob is attached to a string that is 0.5 meters long. As a result of the collision the pendulum swings to the right and the bob moves up by distance h.

    a. What is the initial kinetic energy of the clay?
    b. What is the speed of the clay-bob system after the collision?
    c. What is the kinetic energy of the clay-bob system after the collision?
    d. What is the maximum gravitational potential energy of the clay-bob system?
    e. Find the maximum height of the bob after the collision.
    f. What is the period of oscillations?
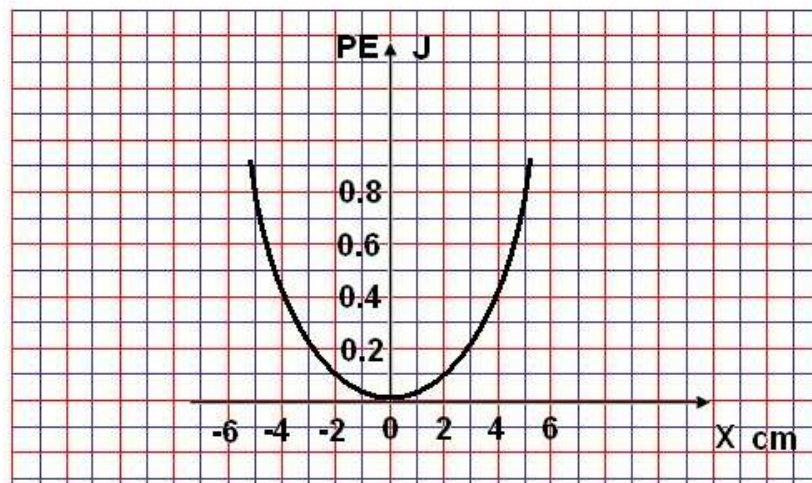
25. A 0.5 mass is attached to a horizontal spring which undergoes SHM. The graph of EPE as a function of position show above. The total energy of the oscillating system is 0.8 J.

    a. Draw the graph of total energy as a function of position.
    b. Draw the graph of kinetic 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 0.7 J.
    g. What is the period of oscillations?

Geometric Optics
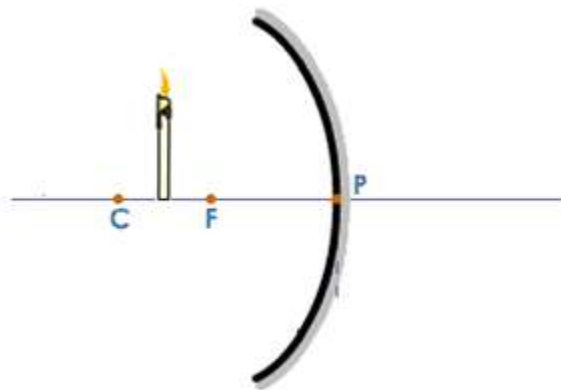
26. A candle is placed at a distance of 15 cm from of a concave mirror with a focal length of 10 cm. The candle is 4 cm tall.

    a. On the diagram below 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?
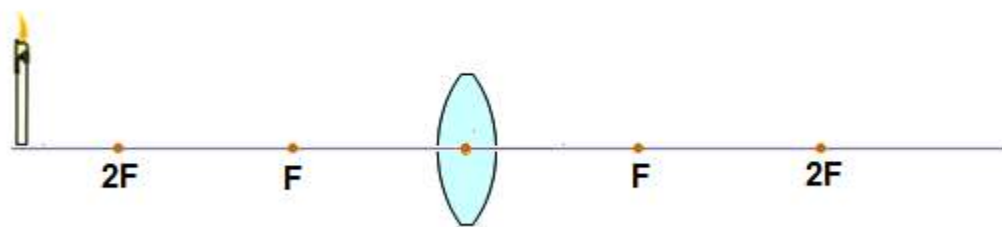
27. An object is placed at a distance of 80 cm from a converging lens with a focal length of 30 cm.

        a. On the diagram below 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?