

# AP Physics 1 Summer Assignment

---

2019

**Instructions:**

1. Solve all problems on separate paper making certain to show all work. 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 2019-2020 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](http://www.njctl.org); courses/science/algebra-based physics.
  - b. email:

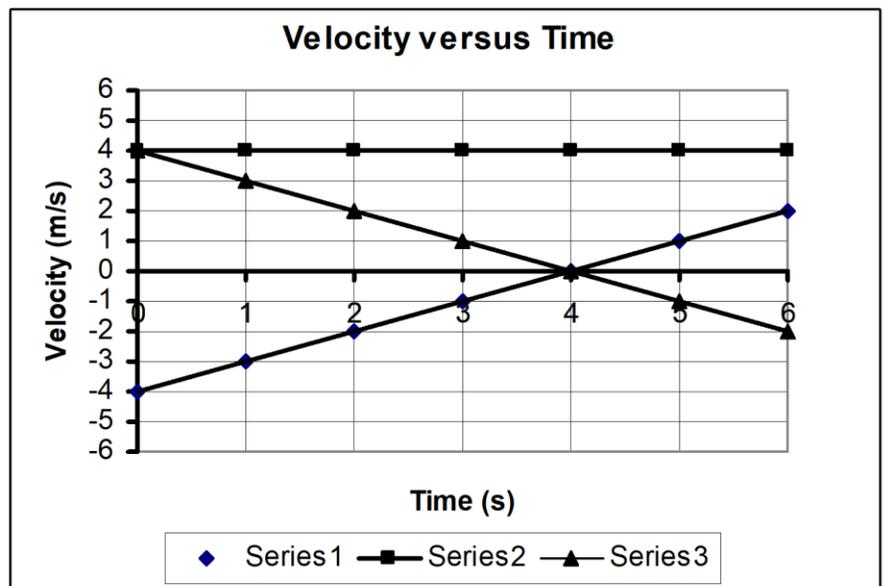
Dr. Cartegna @ [ncartegna@longbranch.k12.nj.us](mailto:ncartegna@longbranch.k12.nj.us)

**Kinematics**

1. An object is traveling at a constant velocity of 11 m/s when it experiences a constant acceleration of  $1.5 \text{ m/s}^2$  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  $4.2 \text{ m/s}^2$  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,  $x_0 = 10 \text{ m}$ , 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.

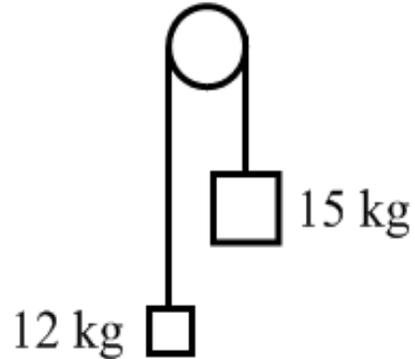
9. The velocity versus time graph, right, describes the motion of three different cars moving along the x-axis.

- 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.



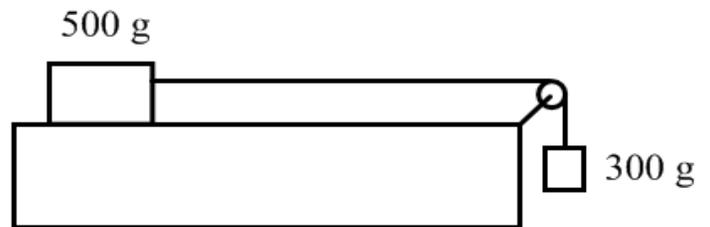
**Dynamics**

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.



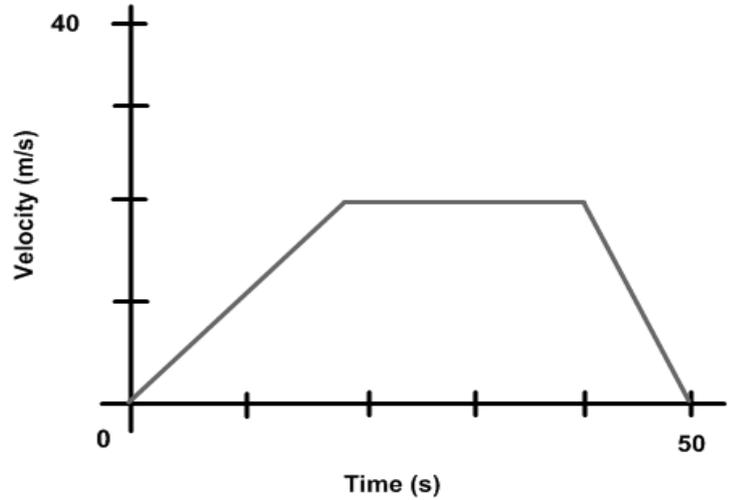
- Draw a free-body diagram for each object showing all applied forces in relative scale. Next to each diagram show the direction of the acceleration of that object.
- Find the acceleration each mass.
- What is the tension force in the rope?
- What distance does the 12 kg load move in the first 3 s?
-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



- 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.
- Use Newton's Second Law to write an equation for the 500 g mass.
- Use Newton's Second Law to write an equation for the 300 g mass.
- Find the acceleration of the system by simultaneously solving the system of two equations.
- 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.



- What is the car's acceleration during first 20 s?
- What is the net force applied by the engine during the first 20 s?
- What is the car's acceleration from 20 s to 40 s?
- What is the net force applied by the engine during this time?
- What is the car's acceleration from 40 s to 50 s?
- 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.

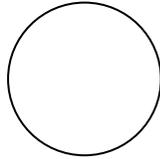
- Draw a free body diagram for the ball when it is at the top of the circle. Next to that diagram indicate the direction of its acceleration.
- Use that free body diagram to set up the equations needed to determine the Tension in the string.
- Solve those equations for the Tension in the string.

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.

- 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.
- Use that free body diagram to set up the equations needed to determine the Tension in the string.
- Solve those equations for the Tension in the string.

### Universal Law of Gravitation

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



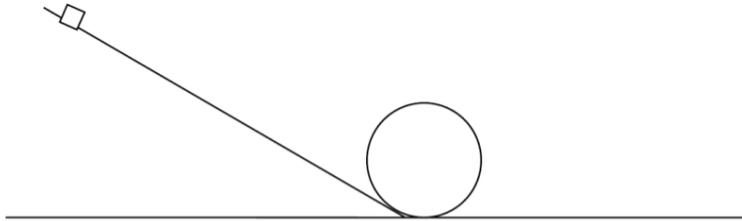
Mars



Asteroid

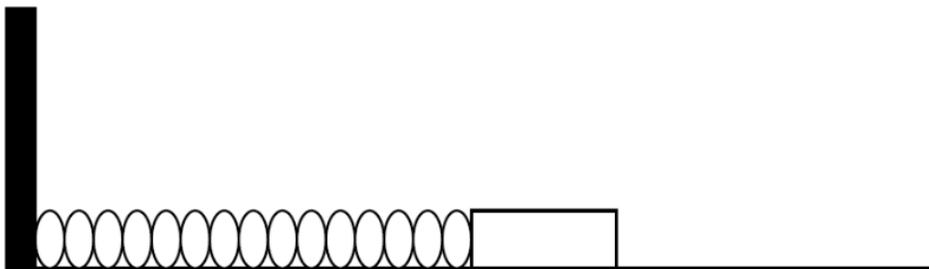
- Determine the force of gravity acting on the asteroid, due to the Mars. Calculate the magnitude and state the direction.
- Compare your answer in a) to the force of gravity acting on the Mars, due to the asteroid. Indicate that force on the diagram above.
- On the diagram above, indicate the direction the asteroid would accelerate if released. Label that vector "a".
- Calculate the acceleration the asteroid would experience.
- 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".
- Calculate the velocity the asteroid needs to be in a stable orbit.
- Calculate the period of the asteroid orbiting the earth.

**Work and Energy**



16. 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.

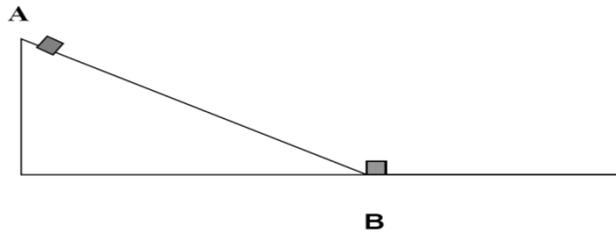
- a. Find the initial potential energy of the block
- b. Find the velocity the block at the bottom of the loop
- c. Find the velocity of the block at the top of the loop.
- d. What is the normal force on the block at the lowest point of the loop?
- e. What is the normal force on the block at the highest point of the loop?



17. 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**

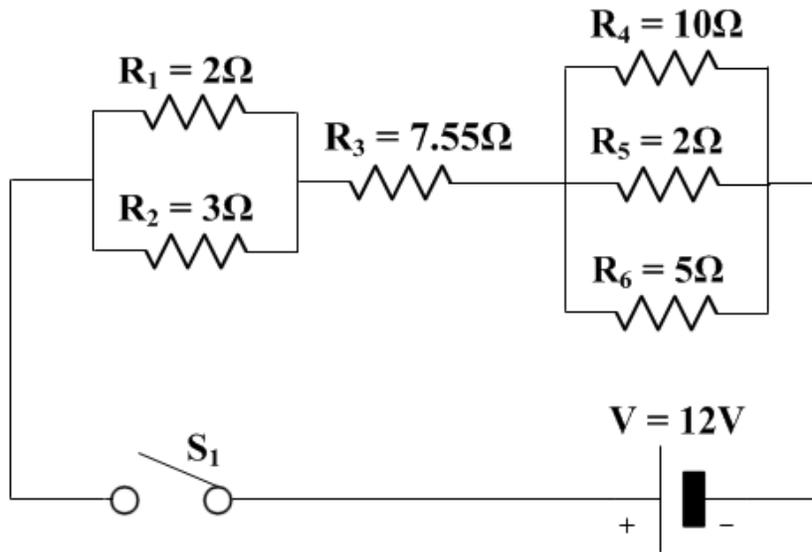


18. A track consists of a frictionless incline plane, which is a height of 0.5 m, and a rough horizontal section with a coefficient of kinetic friction 0.02. Block A, whose mass is 1.5 kg, is released from the top of the incline plane, slides down and collides instantaneously and inelastically with identical block B at the lowest point. The two blocks move to the right through the rough section of the track until they stop.
- Determine the initial potential energy of block A.
  - Determine the kinetic energy of block A at the lowest point, just before the collision.
  - Find the speed of the two blocks just after the collision.
  - Find the kinetic energy of the two blocks just after the collision.
  - How far will the two blocks travel on the rough section of the track?
  - How much work will the friction force do during this time?

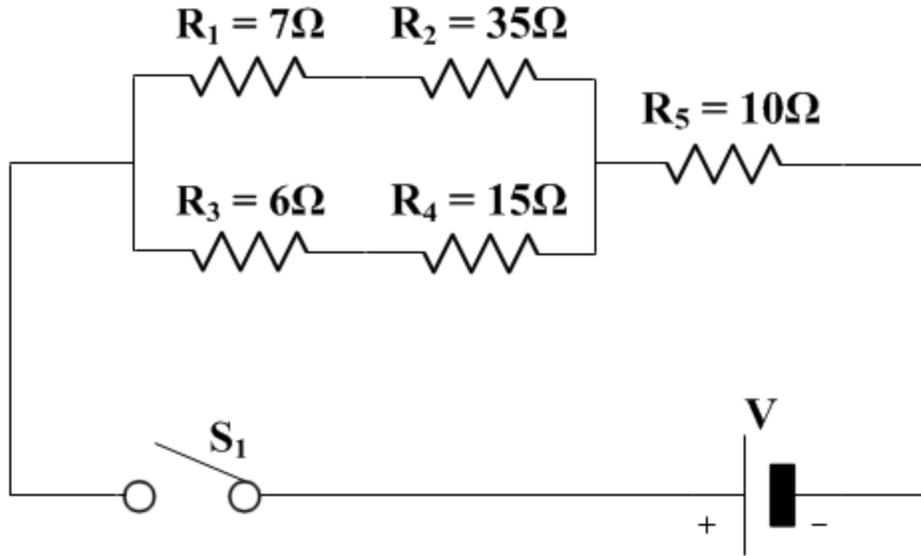


19. A bullet of mass 0.01 kg is moving horizontally with a speed of 100 m/s when it hits a block of mass 2 kg that is at rest on a horizontal surface with a coefficient of friction of 0.4. After the collision the bullet becomes embedded in the block.
- What is the net momentum of the bullet-block system before the collision?
  - What is the net momentum of the bullet-block system after the collision?
  - What is the speed of the bullet-block system after the collision?
  - Find the total energy of the bullet-block system before the collision?
  - Find the total energy of the bullet-block system after the collision?
  - Is the total energy conserved during the collision?
  - Find the maximum traveled distance of the bullet-block after the collision?

**Current and Circuits**



20. Determine the following for the above circuit:
- The equivalent resistance of  $R_1$  and  $R_2$ .
  - The equivalent resistance of  $R_4$ ,  $R_5$  and  $R_6$ .
  - The equivalent resistance of all six resistors.
  - The current through the battery.
  - The voltage drop across  $R_1$  and  $R_2$ ?
  - The voltage drop across  $R_3$ ?
  - The voltage drop across  $R_4$ ,  $R_5$  and  $R_6$ ?
  - The current through each resistor?



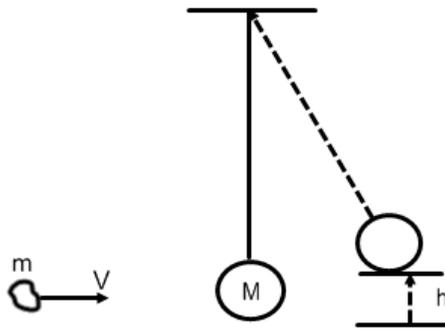
21. In the above circuit, the current through the  $7\text{-}\Omega$  resistor is  $5\text{ A}$ . Determine:
- The voltage across the  $7\text{ }\Omega$  resistor.
  - The voltage across the  $35\text{ }\Omega$  resistor.
  - The current through the  $6\text{ }\Omega$  resistor.
  - The voltage across the  $15\text{ }\Omega$  resistor.
  - The current through the  $10\text{ }\Omega$  resistor.
  - The terminal voltage of the battery.
  - The total power dissipated in the circuit.

**Simple Harmonic Motion**



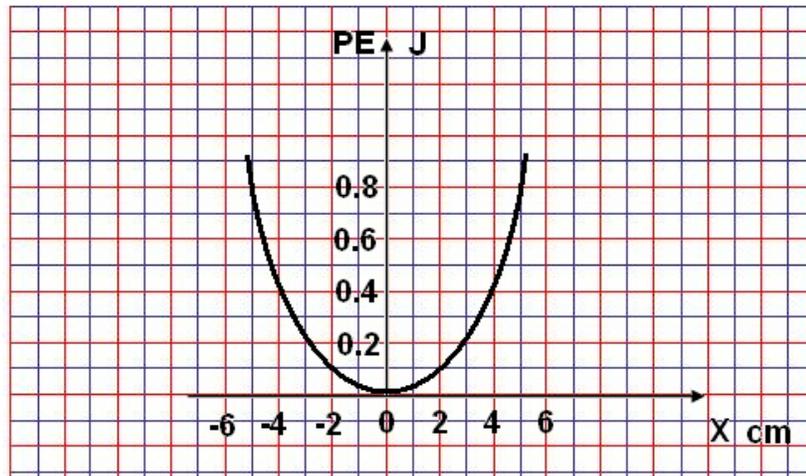
22. A bullet  $m = 0.001$  kg moves with a speed of 500 m/s and strikes a block  $M = 2$  kg at rest. After the collision the bullet becomes embedded into the block. The block is attached to the end of a spring  $k = 120$  N/m.

- What is the initial kinetic energy of the bullet?
- What is the speed of the bullet-block system after the collision?
- What is the kinetic energy of the bullet-block system after the collision?
- What is the maximum elastic potential energy when the block comes to rest?
- What is the maximum compression of the spring?
- What is the period of oscillations?



23. 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  $h$ .

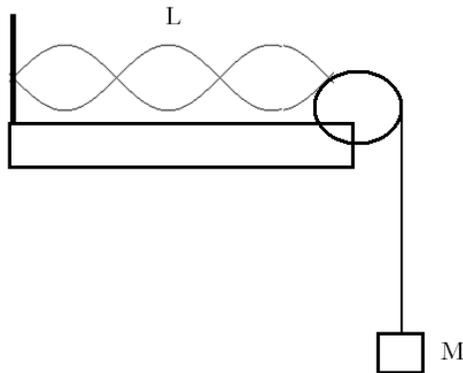
- What is the initial kinetic energy of the clay?
- What is the speed of the clay-bob system after the collision?
- What is the kinetic energy of the clay-bob system after the collision?
- What is the maximum gravitational potential energy of the clay-bob system?
- Find the maximum height of the bob after the collision.
- What is the period of oscillations?



24. 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.

- Draw the graph of total energy as a function of position.
- Draw the graph of kinetic energy as a function of position.
- What is the maximum displacement of the oscillating mass?
- What is the potential energy at the position of 2 cm?
- What is the kinetic energy at the position of 2 cm?
- Find the location of the oscillating mass when its potential energy is 0.7 J.
- What is the period of oscillations?

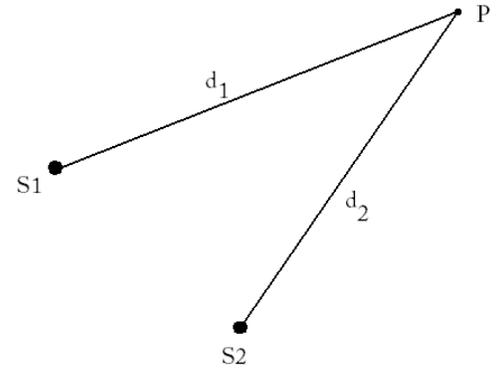
### Waves



25. A string with a length of 1.5 m resonates in three loops as shown above. The string linear density is 0.03 kg/m and the suspended mass is 1.2 kg.

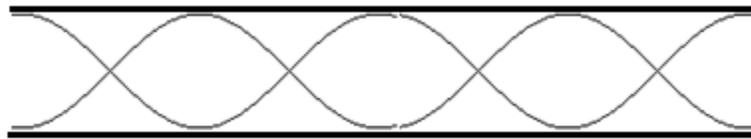
- What is the wavelength?
- What is the wave speed?
- What is the frequency of oscillations?
- What will happen to the number of loops if the suspended mass is increased?

26. Two waves on the surface of water are generated by two independent sources vibrating at the same frequency 4.0 Hz. The waves travel at a speed of 3.2 m/s. A point P is located 4.2 m from source 1 and 4.6 m from source 2.



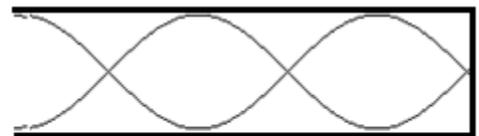
- What is the wavelength of the waves?
- What is the extra distance traveled by the second wave before it reaches point P?
- What is the result of the interference at the point P?
- What will be the result of interference at the point P if source 2 is moved 1.2 m further back?
- What will be the result of interference at the point P if source 2 is moved 1.6 m further back?

### Sound Waves



27. A sound wave resonates in a pipe open on both ends as shown above. The length of the pipe is 2.4 m.
- Which harmonic is shown in the pipe?
  - What is the wavelength of the sound?
  - What is the fundamental frequency?
  - What is the third harmonic?

28. A sound wave resonates in a pipe closed on one end as shown. The length of the pipe is 1.5 m.



- Which harmonic is shown in the pipe?
- What is the wavelength of the sound?
- What is the fundamental frequency?
- What is the fourth harmonic?