Work, Energy and Momentum Test

AP Physics 1 2014 – V1

You have 48 hours from the delivery of this document to complete it and return it to me. You may return it by scanning it or by photographing the pages and returning them to me.   
\*All parts of your returned work must be legible or you will not receive points!!

Solve the following problems. Your solution may use the theories of Conservation of Energy, the Work-Energy Theorem, Impulse Theorem, the Conservation of Momentum, **or any combination of these**. Best of luck!

1. (20pts) A 60kg pressure cooker is initially moving to the right with a speed of 4 m/s. It explodes, sending the main body of the pot (mass 40 kg), and the lid (mass 20 kg) flying in different directions. After the explosion, the main body of the pot flies away with a speed of 13.4 m/s at an angle of 26.56◦ from the original direction as shown in the figure.
   1. **What is the velocity (both magnitude and direction) of the lid?**

V

13.4m/s



4m/s

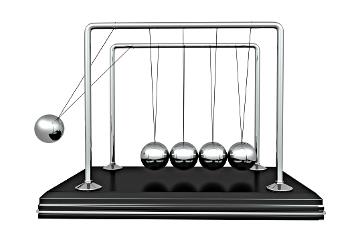


Θ

26.56°

* 1. After the explosion, the main body of the crockpot slides across a rough surface and comes to a stop in 2.1m. **Find the coefficient of friction of the surface.**

1. (20pts) A Newton’s Cradle is a popular desk toy where energy is transferred from one mass to another. When an outer mass is lifted and released, the ball swings like a pendulum and strikes the group of stationary masses. The opposite mass is seen to rise on the other side (see diagram). **In the Newton’s Cradle below, the mass on the far right (5) is three times larger than the mass on the left (1).**   
   1. Assume that all energy is transferred from mass to mass along the Newton’s Cradle. Give that this is true, you can omit the interior masses (2,3 & 4) from you mathematical model and focus only on masses 1 & 5. All masses have a string length of 10cm. Mass one is raised to an angle of 30° and released. **Find the change in height mass 5 undergoes**.   
      *Figure is not to scale.*



**1**

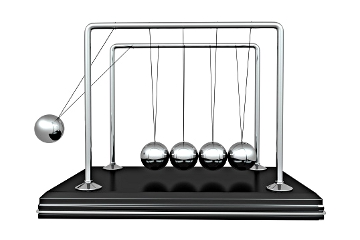
**2**

**3**

**4**

**5**

30°



Δh=?

**5**

* 1. In actuality, energy is not conserved in the system – air resistance does work on the system at a rate of 6.52x10-4 Watts (put another way, the power rating of air resistance is 6.52x10-4 Watts). Find the time it takes for the Newton’s Cradle to stop completely.

1. (20pts) Baldwin Street, in Dunedin, New Zealand, is considered the world's steepest residential street.
   1. Suppose a car (Car A) is intially parked some vertical distance *h* up the hill. The car is shifted into neutral and allowed to roll freely into an intersection at the base of the hill, where it collides with and sticks to a car (Car B) with **doube its mass** and an initial velocity of 10m/s exactly perpendicular to the rolling car. After the collision, the two cars move away with a velocity of 8.14m/s at 34.99° from Car B’s original path. Find the initial vertical height of the rolling car on the hill.



*h*

34.99°

* 1. Given all information in part A, if the two cars slide a distance of 12m post-collision before coming to rest, find the coefficient of friction between the cars and the ground.

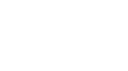
1. (20pts) A brand new Corvette (mass 1700kg) has a power rating of 650hp.
   1. How much longer (in seconds) will it take a Corvette driven by three 135kg linebackers to accelerate to 70m/s than a single solitary 65kg driver?
   2. Both drivers reach a velocity of 70m/s and slam on their brakes, locking the wheels and beginning to skid. The coefficient of friction between the tires and the road is μ=1.9. Which car skids further? By how much?
2. (20 points) In the event an approaching train’s brakes fail, most train stations have large springs which aim to absorb a train’s energy so it doesn’t plow into the station.

![](data:None;base64,)

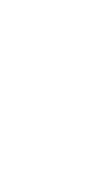
* 1. If a track has **two** springs at the end, which each have a K value of   
     60,000N/m and have a maximum compression of 2 meters, find the   
     maximum velocity a 80,000kg train can hit the springs with and have   
     all of its energy absorbed into the springs.
  2. Consider a train approaching the springs with a velocity of 50m/s. Forty meters from the springs, the train throws on its’ brakes and its’ wheels lock. The coefficient of friction between the wheels and the tracks are μ=0.79. Find the compression of the springs (remember, there are two) when the train strikes them.

1. (20pts) A pinball machine is inclined at an angle of 7° above the horizontal. Inside the game, a   
   spring is compressed by the user, and when released strikes the pinball causing it to move. Consider the dimensions of a game below:
   1. If the game has a sensor (red dot) directly across from the spring that allots a   
      player 500pts if the ball (50g) strikes it at 5m/s or greater, find the minimum K value   
      of the spring that will generate the necessary velocity at the sensor. Assume the spring   
      is cocked 10cm back all the way into the front of the machine, and the distance along   
      the bottom of the machine from the ball to the sensor is 1m.

7°



1m



* 1. A jerk attempts to cheat the game by bringing his own modified pinball. He places ball in the machine and fires it (with the K value found in part A), but it only strikes the sensor at 4m/s. Find the mass of the modified pinball.