Mathematical Extra Credit

February 11, 2011

1 Equations of motion(100pts.)

A cannon that is 10m long is designed to launch a 10kg ball over a castle wall. In order to do this the ball must have a speed of at least 50m/s as it exits the cannon. For every 10kg of explosives used, the force on the ball in the cannon increases by 1000N. How many kg of explosives should they use?

2 Gravitation(100pts.)

You throw a bowling ball off the empire state building(381m high) 10m/s downward. How long does it take to get to the bottom?

3 Electromagnetic Fields(150pts.)

A singly ionized molecule with mass of 1000amu is released from rest on a plate with potential 0V. Another singly ionized molecule with mass of 4000amu on the same plate is released from rest at the same time. 1m away is a plate with potential of 10V. Which mass gets to the 10V plate first and by how much time does it win?

4 Projectile motion(150pts.)

A baseball is crushed from 1m high at an angle of 36 degrees above the ground. It just barely made it over the center field wall which is 3m tall and 120m away. What was the initial speed?

5 Archimedes Principle(100pts.)

Franky claims he has a mass of 65kg. He is sitting on a spherical bouy that floats just barely submerged under water. When he gets off it rises halfway out of the water. What must the radius R in centimeters of the sphere be for him to be telling the truth?

6 Special Relativity(100pts.)

David's clock ticks once for every two of Phil's clock ticks. How fast is Phil moving by David?

7 Conservation of Momentum(80pts.)

You are stranded 100m away from your space shuttle. You have a 1kg physics book and decide to throw it away from the shuttle to get back. You and your space suit have a combined mass of 200kg. You only have 10min of oxygen left in your tank. How fast must you throw this book to live?

8 Conservation of Energy(80pts.)

A 100kg skier at the top of a 2km high mountain tucks the whole thing but only gets a final speed of 50m/s. How much energy was lost to friction?

9 Sound Waves(80pts.)

A man redlines his Kawasaki Ninja at 9000 rpm. You hear 12000 rpm as he drives towards you. How fast is he going?

10 Light Waves(100pts.)

A laser is bent as it enters water. You shine the laser at an angle of 45 degrees above a swimming pool. The laser travels 2m underwater before it hits the bottom of the pool. How deep is the pool?