Work, Energy and Momentum Test

AP Physics 1 2014 – V2

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) In a particularly intense Mario Cart game, a blue shell is traveling at 50m/s when it spontaneously explodes.
   1. The top half of the shell (mass 60kg) is spotted moving at 70m/s at an angle of 31° above its former trajectory. Find the magnitude and direction of the bottom of the shell, if it’s mass is 38kg.

70m/s



31°



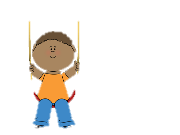
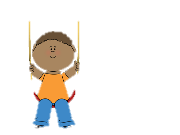
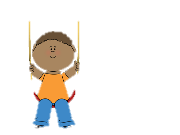
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50m/s

* 1. After the explosion, the top half of the shell slides across a rough surface (μ=0.61). Find the distance until it comes to rest.

1. (20pts) On a playground, a physicist conducts an experiment with children of equal masses. She places one child on the left hand swing (chain length 1.2m) and stacks three children on the right hand swing (chain length 1.2m).
   1. She lifts the left hand children to an angle of 17° and allows them to crash into the other child. Assume the collision happens at the apex of the right hand children’s path (x=0). Find the maximum height the left hand child achieves after the collision.



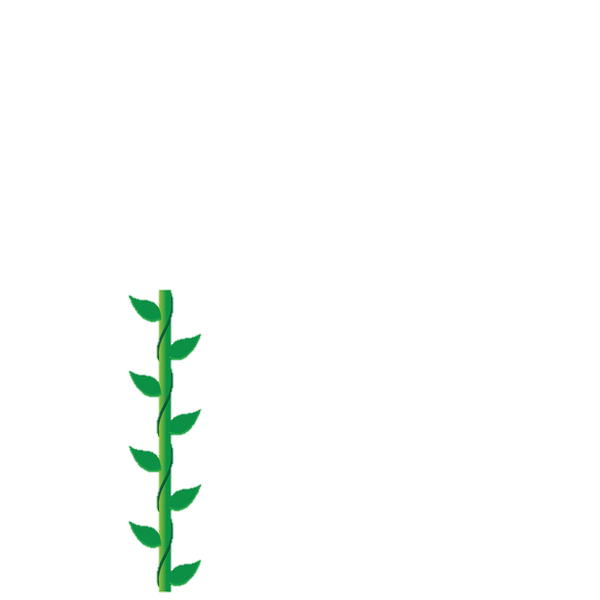
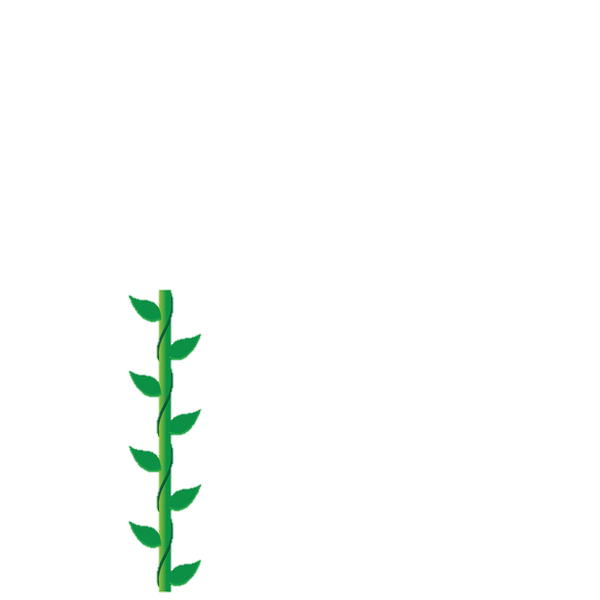
17°

* 1. If the mass of each child is 45kg, and the system of children and swings comes to rest after two minutes, find the power rating in Watts (J/s) of the air resistance force.

1. (20pts) Tarzan hid on 1.4m high branch, laying in wait for a hippo (six times his mass) to run by. Tarzan swung from a vine and jumped onto the hippo, colliding with the hippo perpendicularly at the apex of his trajectory (at x=0. See diagram).
   1. If Tarzan and the hippo moved with a resultant velocity of 13.74m/s at 3.6° from the hippo’s original path, what was the initial velocity of the hippo?



3.6°



1.4m

* 1. Given the velocity in part A, and assuming that Tarzan has a mass of 85kg, what power will the hippo need to exert to stop itself and Tarzan in four seconds?

1. (20pts) Traditional Roman chariots are pulled by two horses (IE, two horsepower). In the prime of his life, a charioteer had a mass of 72kg.
   1. How much longer will it take his horses to accelerate him from rest to 15m/s when he is old and fat (mass 140kg) than when he was fit?
   2. Suppose he is thrown from the chariot at 15m/s and slides across the rough sand (μ=0.84). How far does he slide when he is fit? What about when he is fat?
2. (20pts) A trampoline is comprised of 25 springs all with a k value of 1200N/m which stretch and compress uniformly as a person jumps. A man (110kg) stands on a roof, 10m above the trampoline
   1. When the man jumps, how much will each spring stretch?
   2. The same man jumps on a trampoline where 17 springs are broken. Each spring can only withstand 1500N of force. Will the rest of the springs break?
3. (20pts) In a carnival game, an air rifle shoots pellets (30g) at a target 2m away.
   1. If the mass of the air rifle is 2.1kg and its recoil velocity is 0.5m/s, find the velocity of the pellet. .
   2. The target is mounted on a spring (k=450N/m) which registers a hit if it is compressed 0.3m. Assume the pellet travels in a straight line at a constant velocity (found above). Will the target ever register a hit? Or is it rigged?