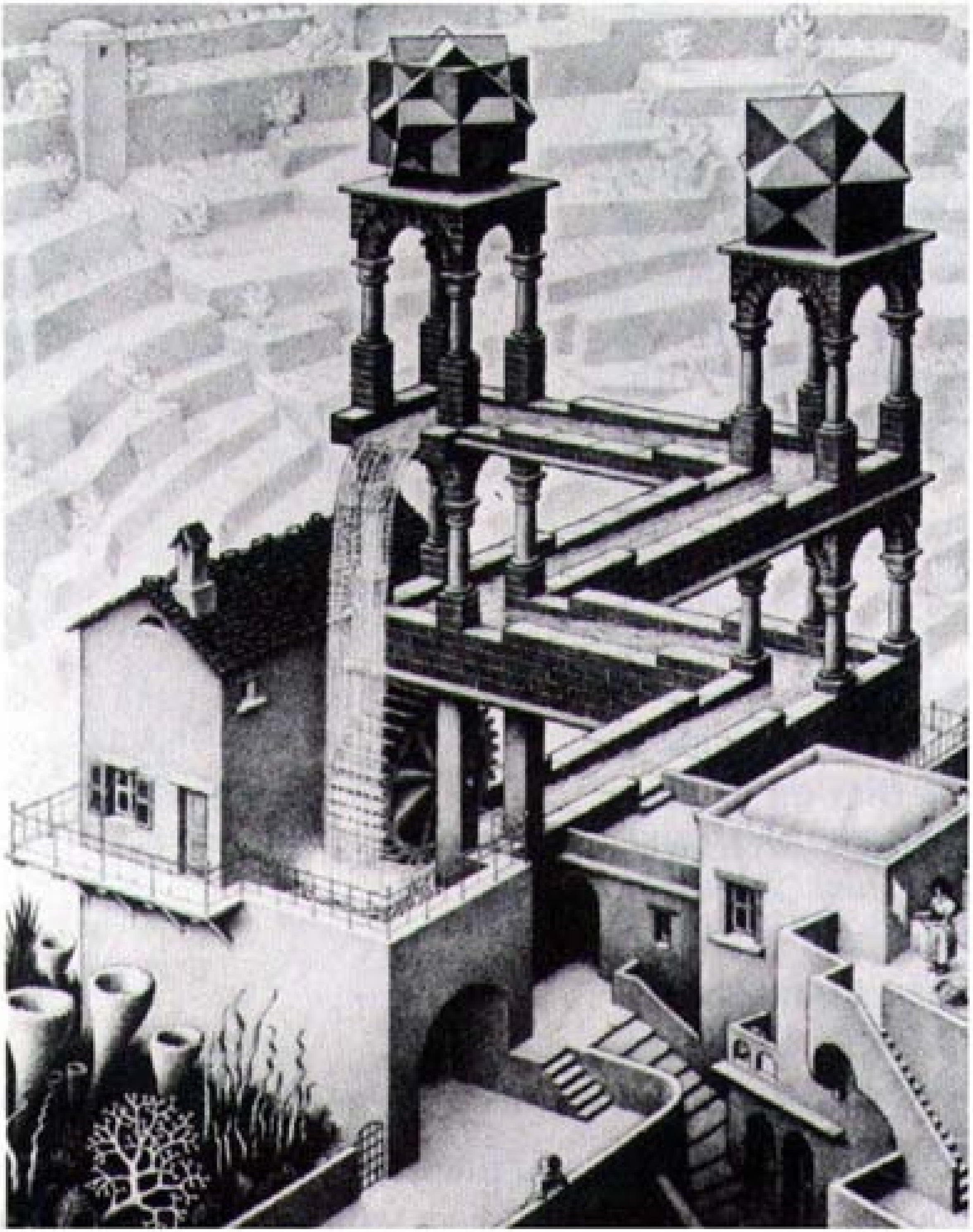
Energy Conservation, perpetual motion and the first law of thermodynamics.

The first law of thermodynamics states that energy cannot be created or distroyed, only changing forms. From that statement, does this picture make sence.



According to the first law of thermodynamics energy cannot be created or distroyed. This means the energy of a system must be converted from one form to another. What is often difficult to understand and calculate is the energy may start out all as one form of energy and finish being shared by several forms

ENERGY FORMS

Work -W = F x d - an applied force over a distance results in energy being added to an object. Friction acting on an object over a distance results in an energy loss.

Kinetic Energy - Ek $=1/2\ m\ v^2$

-Any mass that has a velocity.

Gravitational Potential Energy
-Ep = mgh -this canbe thoughtof in two ways.
1. As the energy above a reference point.
2. The energy lost or gained as an object is lowered or raised.

Elastic Potential Energy -Ep $= 1/2kx^2$
-a spring or elastic stretched or compressed from it's equlibriumposition has energy.

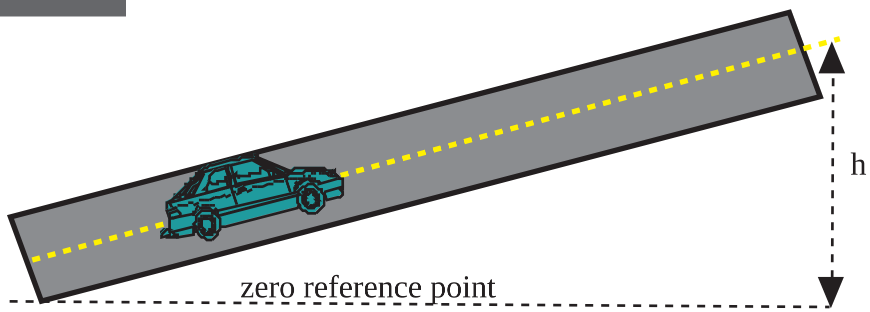
To solve problems of energy conservation total the kinetic energy gravitational and elastic potential energies of an object in one position or point in time (this is called the mechanical energy) add any work added to the object as it moves to a second position. Make this equal to the mechanical energy of the object in a second position added to any energy lost in moving from position 1-2.

$$(E_{mechanical} + W_{added})_{position\ 1} = (E_{mechanical} + W_{lost})_{position\ 2}$$

THIS WORKS FOR ALL QUESTIONS PLEASE USE IT!!!

Topic 5
Question 1

Energy conservation Kinetic energy to Potential energy



If a car traveling at 100 km/h loses power while traveling up hill, how high will the car rise?

$$(E_{mechanical} + W_{added})_{position\ 1} = (E_{mechanical} + W_{lost})_{position\ 2}$$

$$(E_k + \cancel{E_p} + \cancel{W_{added}})_{position\ 1} = (\cancel{E_k} + E_p + \cancel{W_{lost}})_{position\ 2}$$

$$E_k = E_p$$

$$\frac{1}{2} mv = m g h$$

$$h = \frac{v}{2 g}$$

$$h = \frac{(27.8 m/s)}{2 \times 9.81 m/s}$$

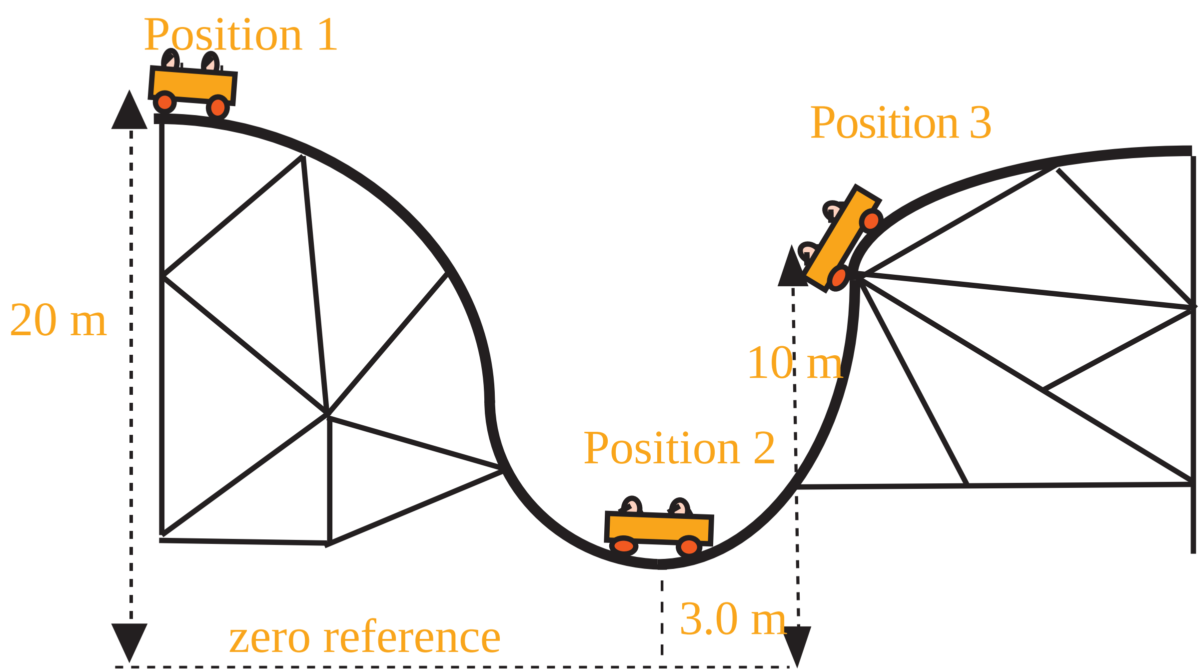
$$h = 39.4 m$$

Note: the mass of the car did not matter as it cancels out in the equation

Topic 5
Question 2

Energy Conservation

Unit 1, ENERGY



If our roller coaster had a mass of 1000 kg and started with a speed of 5.00 m/s what would the roller coaster's speed be at position 2 and position 3 assuming that no energy is lost.

To determine this you can say that the sum of the mechanical energy (KE +PE) is equal at all points.

Topic 5 Question 2 continued

Energy Conservation example continued

Unit 1, ENERGY

$$(E_{mechanical} + W_{added})_{position\ 1} = (E_{mechanical} + W_{lost})_{position\ 2}$$

$$(E_k + E_p + \cancel{W_{added}})_{position\ 1} = (E_k + E_p + \cancel{W_{lost}})_{position\ 2}$$

$$\frac{1}{2}mv \quad + \quad mgh \quad = \quad \frac{1}{2}mv \quad + \quad mgh$$

since m appears in all parts it cancels

$$v = \sqrt{2\left(\left(\frac{1}{2}v^2\right) + (gh) - (gh)\right)}$$

$$v = \sqrt{2\left(\frac{1}{2}(5.0\,m/s)^2 + (9.81\,m/s \text{ x } 20m) - (9.81\,m/s \text{ x } 3.0\,m)\right)}$$

$$v = 18.9\,m/s$$

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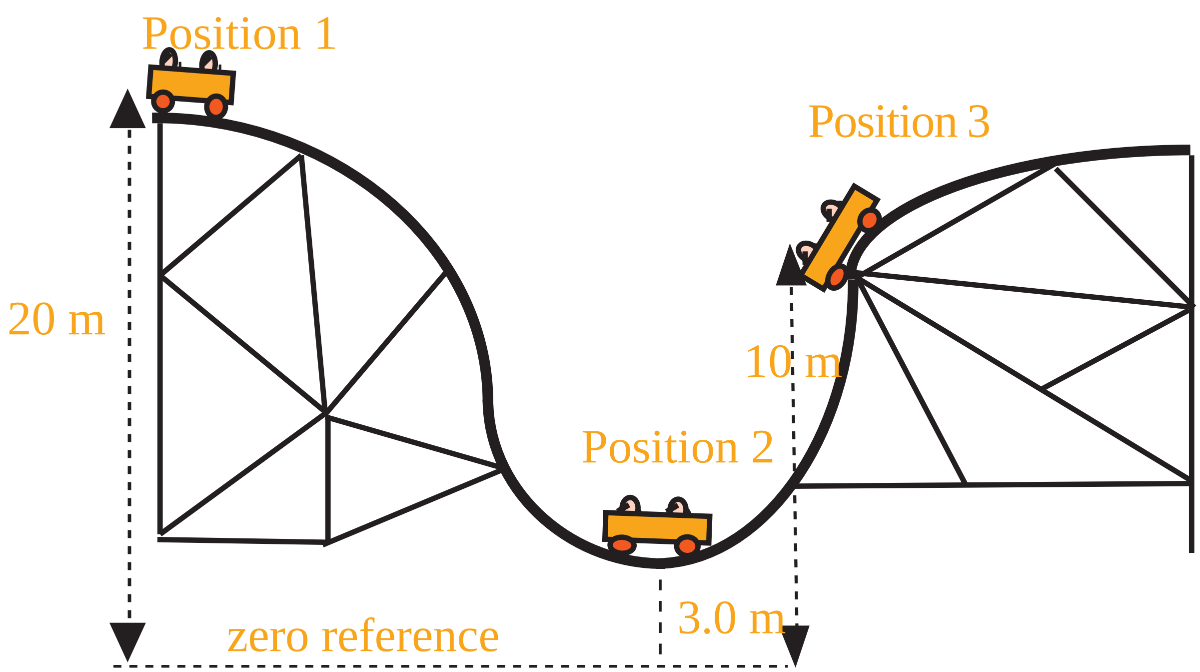
Topic 5
Question 3

Energy Conservation

Unit 1, ENERGY

If we actually record the roller coaster at position 2 to be 14 m/s we now know the sum of the mechanical energies at position 1 and at position 2, any difference must have be lost to FRICTION. By finding the lost energy and dividing by the 100 m distance traveled, the average force of friction can be found



Topic 5 Question 3 continued

Energy Conservation example

Unit 1, ENERGY

$$(E_{mechanical} + W_{added})_{position\ 1} = (E_{mechanical} + W_{lost})_{position\ 2}$$

$$(E_k + E_p + \text{W}_{added})_{position\ 1} = (E_k + E_p + W_{lost})_{position\ 2}$$

$$\frac{1}{2}mv_1^2 + mgh_1 = \frac{1}{2}mv_2^2 + mgh_2 + Fd$$

Note: since mass is not in all parts of the equation it cannot cancell out.

$$F = \frac{\left(\frac{1}{2}mv_1^2 + mgh_1\right) - \left(\frac{1}{2}mv_2^2 + mgh_2\right)}{d}$$

Note: see how the equation becomes energy at position 1 energy at position 2

$$F = \frac{\left(\frac{1}{2}1000\ kg \times 5.0\ m/s^2\right)_1 + \left(1000\ kg \times 9.81\ m/s^2 \times 20m\right)_1 - \left(\frac{1}{2}1000\ kg \times 14\ m/s^2\right)_2 + \left(1000\ kg \times 9.81\ m/s^2 \times 3.0m\right)_2}{100\ m}$$

$$F = 126\ N$$

Topic 5 Question 3 continued

Con't From last overhead

Energy Conservation example

Unit 1, ENERGY

This step could have been shortened by taking a change in speed and elevation

$$F = \frac{\frac{1}{2} m \Delta v^2 + mg\Delta h}{d}$$

$$F = \frac{\frac{1}{2} 1000\,kg\,((14\,m/s)^2 - (5.0\,m/s)^2) + (1000\,kg \times 9.81\,m/s^2(3.0m - 20m))}{100\,m}$$

Note: Δ *means change* $h_2 - h_1$ *and* $v_2 - v_1$ *therefore in our example the change in potential is negative - we lost potential energy to kinetic and friction*

$$F = -126\ N$$

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