AP Physics 1
Unit 3 Test

Directions: **You must show all steps** required to arrive at the correct answer for the problem below. Every question other than #1 requires a free body diagram for full credit.

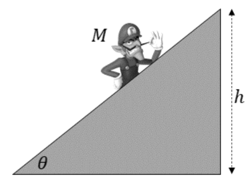
1. A motor lifts Waluigi, who has a mass of M = 80 kg, up a frictionless escalator at constant speed. The motor lifts Waluigi up a height of h = 20 m in 2 minutes.

a) Calculate the power developed by the motor powering the escalator.

b) Suppose the motor now lifts Waluigi up the escalator in 3minutes instead of 2. You don't need to justify your answers.

i. Does the work done by the motor increase, decrease, or remain the same?

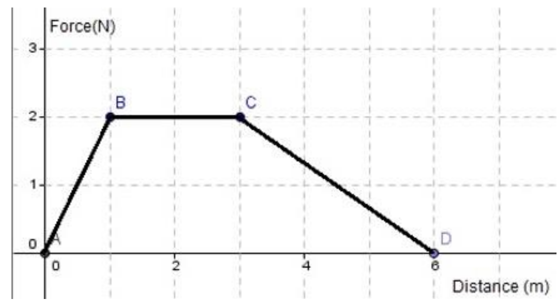
ii. Does the power developed by the motor increase, decrease, or remain the same?



2. A 4.0 kg object is moving at 2 m/s at time position x = 0 m when a force is applied that varies with distance according to the graph on the right.

a) At what positions is the object speeding up

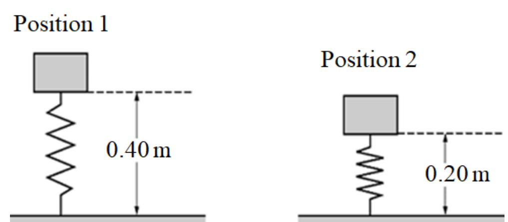
b) Calculate the speed of the object when it reaches position x = 6 m.



3. A block of mass $m = 2.0\ kg$ is held at Position 1 as shown shown in contact with an uncompressed vertical spring with a spring constant of 200 N/m. The block is held 0.3 m above the ground. The mass is gently lowered from rest while compressing the spring until it is 0.15 m above the ground as shown in Position 2.

a) Calculate the change in energy of the block-spring-Earth system between Position 1 and 2.

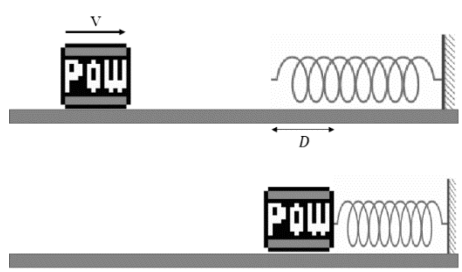
b) Does gravity do positive or negative work on the block? Briefly justify your answer.



4. A POW block of mass M is traveling on a frictionless surface with a speed of v when it hits a spring. The spring compresses a maximum distance of D before the block momentarily stops. Answer the following in terms of M, v, D and fundamental constants, as appropriate.

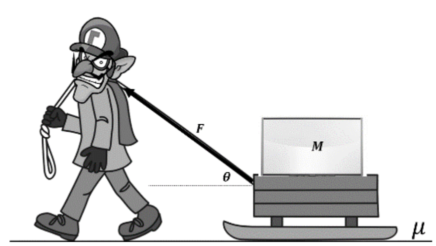
a) Determine an expression for the elastic constant, k, of the spring.

b) Suppose the initial speed of the block, v, is doubled. Determine an expression for the new distance that the spring is compressed.



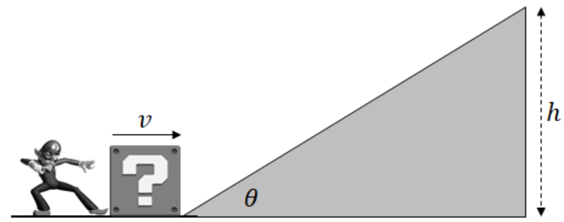
5. Waluigi pulls a smartboard on a sled out to the garbage where it belongs. Waluigi pulls with a force of $F = 100\ N$ directed an angle of $\theta = 60°$ above the horizontal as shown. The smartboard and sled have a combined mass of $M = 20\ kg$. Waluigi pulls the sled a distance of $D = 4\ m$ across a horizontal surface with a coefficient of sliding friction $\mu = 0.20$ between the surface and sled.

a) Draw a free-body diagram of all forces acting on the sled.

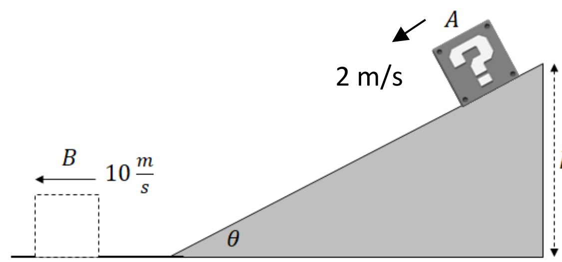


b) Calculate the work done by the following as it's pulled a distance of D across the surface (including a + or – sign to indicate the sign of work).
i. Work done by Waluigi
ii. Work done by friction
iii. Work done by the normal force
c) Calculate the kinetic energy the sled gains as it is pulled a distance of D.

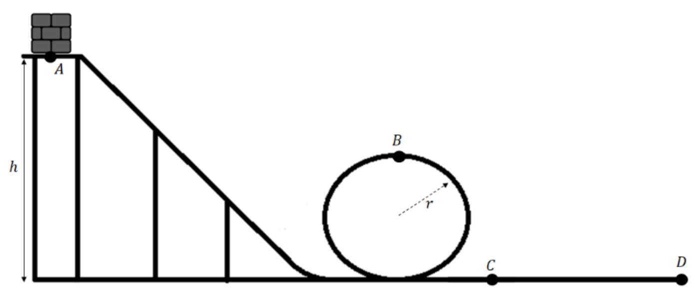
6. Wah!
a) Waluigi pushes a block and gives it an initial speed of $v = 40\frac{m}{s}$ up a rough incline, which makes an angle of $\theta = 40°$ with the horizontal. The coefficient of friction between the block and the incline is $\mu = 0.30$. Calculate the max height h that he block reaches.



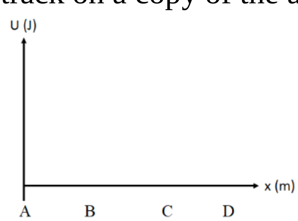
b) A second incline has the same angle of incline, $\theta = 40°$, but a different coefficient of friction. A block of mass m = 20 kg is released from a height of h = 8 m at an initial speed of 2 m/s. It reaches the bottom with speed of 10 m/s. Calculate the work done by friction.

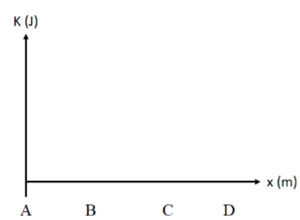


7. A 2.0 kg block is released from rest at point A, which is a height of $h = 10\ m$ above the ground as shown. It slides down a frictionless track and goes through a vertical loop with a radius of $r = 2.0\ m$. Point B is the top of the loop. It encounters friction at point C. From point C to D, the coefficient of friction between the block and the surface is $\mu = 0.3$. The block stops at point D due to friction.



a) Calculate the normal force on the block at point B
b) Sketch the potential and kinetic energy of the block as a function of distance as it slides along the track on a copy of the axes below.





c) Calculate the distance that the block slides between points C and D before stopping.