You are planning a trip after school ends and you have $593 for the trip (which is in your bank account). At the beginning of your trip we can lay out your financial situation like this:

\[
\text{Spent} + \quad \text{Bank account} = \quad \text{Estimated Budget}
\]

\[
$0 + \quad $593 = \quad $593
\]

At the end of your trip your financial situation is:

\[
\text{Spent} + \quad \text{Bank account} = \quad \text{Estimated Budget}
\]

\[
$504 + \quad $89 = \quad $593
\]

So we see that your Estimated Budget will always be the same (unless you work during the trip or get robbed).

Two days into your week your trip you figure out how much you’ve spent (you keep all your receipts) and find that you spent $157 at that point.

How much is in your bank account at that point?

\[
\text{Estimated Budget} - \text{Spent} = \text{Bank Account}
\]

\[
$593 - $157 = \boxed{$436}
\]

Three days into your one week trip you are curious how much you've spent - but all the receipts are back at the hotel. However you spot a cash machine - and when you check your balance you find that there is $321 in your account.

How much have you spent at that point in your trip?

\[
\text{Estimated Budget} - \text{Bank Account} = \text{Spent}
\]

\[
$593 - $321 = \boxed{$272}
\]
Now we are going to do something similar in physics using energy. We don't have receipts to count, but anytime we want to know how much the object has "spent" on Kinetic Energy (KE) we can figure it out as long as we know how fast it is moving using this equation.

\[ KE = \frac{1}{2} mv^2 \]  
(Equation 1)

We also don't have a bank balance, but we do have Gravitational Potential Energy (PE). As long as we know "how high up" (h) then we can figure out PE using this equation:

\[ PE = mgh \]  
(Equation 2)

We also don't have an estimated budget, but we do have something called the Total Mechanical Energy (E) which works the same way. Putting this in mathematics we have:

\[ (KE) + (PE) = E \]  
(Equation 3)

This is just like:

Spent + Bank account = Estimated Budget

As far as physics goes we need to remember that gravity is outside our considerations of “doing work” (or getting robbed). Everything gravity does is taken care of in the gravitational potential energy (PE).

We are going to take a look at a situation in which an object slides down a slope. We will use the “energy approach” to figure out how fast the object is moving, or where it is on the slope. This will give the same results that we could get using things we did previously in the semester – but this is easier!
The block in the picture begins (position A) at \( h = 5.29 \text{m} \) moving at a speed of \( v = 13.5 \text{m/s} \).

What is the kinetic energy (KE) of the block at position A?

\[
KE_A = \frac{1}{2} m v_A^2
\]

\[
KE_A = \frac{1}{2} (3.75 \text{kg}) (13.5 \text{m/s})^2 = 342 \text{J}
\]

What is the gravitational potential energy (PE) of the block at position A?

\[
PE_A = m g h_A
\]

\[
PE_A = (3.75 \text{kg}) (9.8 \text{m/s}^2) (5.29 \text{m}) = 194 \text{J}
\]

What is the total mechanical energy (E) of the block at position A? (Hint: Use Equation 3)

\[
E = KE + PE
\]

\[
E = 342 \text{J} + 194 \text{J} = 536 \text{J}
\]

Since no other forces give or take energy from the object (i.e. "do work") this will be the same E for the rest of the problem.
What is the PE of the block at position B? (Hint: Use equation 2)

\[ P_{EB} = mgh \]

\[ P_{EB} = (3.75kg)(9.8m/s^2)(2.15m) \]

\[ P_{EB} = 79.0J \]

Use the PE at position B calculated above to find KE at position B. (Hint: Use Equation 3 and the value for E)

\[ KE_B = E - P_{EB} \]

\[ KE_B = 536J - 79.0J \]

\[ KE_B = 457J \]

Use Equation 1 to calculate the speed v at position B.

\[ KE_B = \frac{1}{2}mv^2 \]

\[ 457J = \frac{1}{2}(3.75kg)v^2 \]

\[ v = 15.6m/s \]

Find the speed at position C using the same method you used for position B.

\[ P_{EC} = mgh_c \]

\[ P_{EC} = (3.75kg)(9.8m/s^2)(0) \]

\[ P_{EC} = 0 \]

\[ KE_C = E - P_{EC} \]

\[ KE_C = 536J - 0J \]

\[ KE_C = 536J \]

Position D is the reverse situation. We are told that the speed at position D is 24.7m/s. What is KE at position D?

\[ KE_D = \frac{1}{2}mv_D^2 \]

\[ KE_D = \frac{1}{2}(3.75kg)(24.7m/s)^2 \]

\[ KE_D = 1144J \]

What is PE at position D? (Hint: use the KE you just calculated and Equation 3 to calculate PE at position D).

\[ PE_D = E - KE_D \]

\[ PE_D = 536J - 1144J \]

\[ PE_D = -608J \]
Use Equation 2 and the PE at position D to calculate h at position D.

\[ PE_0 = mg h_0 \]

\[ -608 J = (3.75 \text{ kg}) (9.8 \text{ m/s}^2) h_D \]

\[ h_D = -16.5 \text{ m} \]