Engineering Dynamics
Homework 3 Notes

Energy due to

Change in height: mgh

Change in velocity: $\frac{1}{2}mv^2$

Stored spring: $\frac{1}{2}kx^2$

Friction: Fx

Power can be described by $\frac{Fx}{t}$ which can be thought of as Fv, force times velocity, or energy (Fx) divided by time (t).

1.
To get the towing force, you need the acceleration. There are two ways to get the acceleration using the values given. One way is to use the equation

$$v^2 = v_o{}^2 + 2a(x - x_o)$$

Solve for the acceleration, a, and go from there.

2.
The key here is to draw a free body diagram. There is a pulling tension, part of which goes up. The frictional force is a function of the normal force, so don't forget to have that going to the left, with the horizontal component of the towing force going to the right.

Remember that the work done is the towing force times the distance.

3.
A straight forward energy problem. Energy will be lost as the box slides across the rough surface. Personally, I like to put lost energy on the left side of the equation because it gets a negative sign, and will remind me that it is energy loss. But that is up to you.

But don't forget that that the box is still sliding across rough surface as it is compressing the spring.

4.
Truly an ugly looking free body diagram, but do-able. Because of the pulleys, block B moves twice as far (and fast) as block A. The tension on block A will be twice that on block B, again because of the pulleys. Remember that the frictional force is normal to the surface.

5.
Pre-compressed springs can be confusing because you may not know how to deal with them. If you ignore the fact that they are initially compressed, you will get things wrong. This is because they initially have a potential energy of $\frac{1}{2} kx^2$. When a load hits them and compresses them, they now have a potential energy of $\frac{1}{2} k(x+y)^2$ where y is the additional compression. In this problem there is, again, frictional looses.

6.
Force times velocity divided by time? Looks too easy, and it is. Power would be force times velocity (but the velocity is changing), or force time distance (energy) divided by time, but we have too much here. This one is a little sneaky.
We are given the <u>mass</u>, not the force. To get force, we need acceleration. Given the final velocity and the time, we can get acceleration. That gives us the force. To get the distance, use $x= \frac{1}{2}at^2$, not vt, because velocity is not constant. Divide by time.

7.
Calculate the power needed to lift the elevator. Efficiency is the power needed/required divided by the power actually used.

8.
Power is force times velocity.

9.
A classic energy problem, the key with this one is to determine the minimum requirements. It looks like the velocity at the top of loop B is it. To *just* keep the car from falling, the normal acceleration need to be $a_n = \frac{v^2}{r}$ where a_n is equal to gravitational acceleration. The rest is arithmetic.

10.
A pre-compressed spring where you want to look at the problem in three states or positions. One, where the spring is compressed by the block and the cables have no holding force. Two, where the block has upward motion and the cables are just starting to hold the spring (velocity of the block is maximum). And three, where the cables constrain the spring and the block is at perigee (highest point) and its velocity is zero.