1. An extreme skater (m = 59.0 kg) uses a giant kite to pull herself along a smooth surface. She is pulled from rest to a speed of 11.3 $^{m}/\_{s}$ before letting go of the kite and heading for a curved skate ramp. Using ENERGY equations calculate how high she goes.

$$E\_{K(1)}+E\_{P(1)}=E\_{K(2)}+E\_{P(2)}$$

$$\frac{1}{2}mv\_{1}^{2}+mgh\_{1}=\frac{1}{2}mv\_{2}^{2}+mgh\_{2}$$

$$\frac{1}{2}(59.0 kg)\left(11.3^{m}/\_{s}\right)^{2}+0=0+(59.0 kg)(9.80^{m}/\_{s^{2}})h\_{2}$$

$$$$



1. The Swedish Koenigsegg supercar CCR is the second most powerful series-produced car today. It is 1,180 kg of raw power! Gus is an extreme test car driver and finds out that this car can go from 0-100 mph (0 - 44.7$ ^{m}/\_{s}$) in 7.90 seconds.
	1. How much kinetic energy does the car have at the end of 7.90 seconds?

$$E\_{K}=\frac{1}{2}mv^{2}=\frac{1}{2}(1180 kg)(44.7^{m}/\_{s})^{2} $$

$$$$

* 1. How far does the car travel in the 7.90 seconds assuming a uniform acceleration? *(Hint: You need to go back to your Unit 2 motion equations for this!)*

$$a=\frac{∆v}{t}=\frac{v\_{2}-v\_{1}}{t}=\frac{44.7 ^{m}/\_{s}-0}{7.90 s}=5.66^{m}/\_{s^{2}}$$

$$d=v\_{1}t+\frac{1}{2}at^{2}=0+\frac{1}{2}(5.66^{m}/\_{s^{2}})(7.90 s)^{2}$$

$$$$

1. Now suppose that Shawn (mass = 75 kg) decides to head over to the local ski jump. He takes the lift up and gets ready to jump as shown.

**A**

**B**

**C**

**100.0 m**

**30.0 m**

**EK = 15,000 J**

* 1. What is Shawn’s potential energy, kinetic energy and mechanical energy at points A, B and C?

**Point A:**

$$E\_{P}=mgh=\left(75 kg\right)\left(9.80 ^{m}/\_{s^{2}}\right)\left(100 m\right)=$$

$$E\_{K}=\frac{1}{2}mv^{2}=$$

$$$$

**Point B:**

$$\overline{ME=constant=73,500 J}$$

$$E\_{P}=mgh=\left(75 kg\right)\left(9.80 ^{m}/\_{s^{2}}\right)\left(30 m\right)=$$

$$ME=E\_{K}+E\_{P}↝E\_{K}=ME-E\_{P}=73500 J-22050 J=$$

**Point C:**

$$ME=constant=\overline{73,500 J}$$

$$\overline{E\_{K}=15,000 J}$$

$$ME=E\_{K}+E\_{P}↝E\_{P}=ME-E\_{K}=73500 J-15000 J=$$

* 1. How fast is Shawn going at point B?

$$E\_{K\left(B\right)}=51,450 J=\frac{1}{2}mv\_{B}^{2}$$

$$v\_{B}=\sqrt{\frac{2E\_{K(B)}}{m}}=\sqrt{\frac{2(51450 J)}{(75 kg)}}$$

$$$$

* 1. If Shawn’s kinetic energy is 15,000 J at point C, how high up from the baseline level is he?

$$E\_{P\left(C\right)}=58,500 J=mgh\_{C}$$

$$h\_{C}=\frac{E\_{P\left(C\right)}}{mg}=\frac{\left(58500 J\right)}{\left(75 kg\right)\left(9.80 ^{m}/\_{s^{2}}\right)}$$

$$$$

1. A car (mass = 1200 kg) is crash tested against a rigid wall. The car is accelerated from rest by a cable underneath it; just before impact the kinetic energy of the car is 7500 J. The car’s “crumple zone” crumples up 2.3 meters upon impact.
	1. Calculate the velocity of the car before impact.

$$E\_{K}=\frac{1}{2}mv^{2}$$

$$v=\sqrt{\frac{2E\_{K}}{m}}=\sqrt{\frac{2(7500 J)}{(1200 kg)}}$$

$$$$

* 1. If the average impact force is 3300 N, calculate (using impulse equations) the time it took the car to stop.

$$I=m∆v=F∙∆t↝∆t=\frac{m∆v}{F}=\frac{(1200 kg)(3.5^{m}/\_{s})}{3300 N}$$

$$$$

* 1. How is momentum conserved in this case? How is energy conserved?

***Momentum is conserved within the system; the momentum of the car is transferred to the wall. The kinetic energy of the car is transformed into different forms such as thermal and sound energy, as well as transferred to the wall.***

1. **CHALLENGE PROBLEM!!** *(Hint, break the initial velocity vector into a horizontal and a vertical velocity, before you solve this problem.)*

You are watching the Billiard Championships on ESPN18. A top down view shows 2 billiard balls (each with a mass = 0.400 kg), Ball A (dark) is at rest and Ball B (light) has a velocity of 2.00 $^{m}/\_{s}$ at 45° to the horizontal.

**2.00** $^{m}/\_{s}$

**45°**

$$p\_{TOTAL(before)}=p\_{A(before)}+p\_{B(before)}=0+m\_{B}v\_{B}=(0.400 kg)(2.00 ^{m}/\_{s})$$

$$

After the collision, Ball A is moving at 1.41 $^{m}/\_{s}$ and the balls are moving at a right angle to each other as shown below:

**1.41** $^{m}/\_{s}$

Calculate the resulting velocity of Ball B.

$$$$

**Since Ball B is the x-component of the momentum:**

$$p\_{B(after)}=p\_{TOTAL(after)}\cos(θ)=0.800 ^{kg∙m}/\_{s}\cos(45°)=\overline{0.566 ^{kg∙m}/\_{s}}$$

$$p\_{B(after)}=m\_{B}v\_{B}↝v\_{B}=\frac{p\_{B\left(after\right)}}{m\_{B}}=\frac{0.566 ^{kg∙m}/\_{s}}{0.400 kg}$$

$$$$