**Connecting to STEM Summer 2014**

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| **NCES Objectives Covered**Psc.3.1 Explain work in terms of the relationship among the applied force to an object, the resulting displacement of the object and the energy transferred to an object. | **Course Physical Science****Grade Level High School 9-12** |
| **Unit title****Work and Motion** | **Time required****Block: 90 minutes class time plus home research****Traditional: two 55 minute classes plus home research** |
| **Essential Questions**  | How can work be demonstrated by applying force ? |
| **“I can” statements** | I can explain work by engineering a mobile sculpture. |
| **Materials required** | Paper, thread or fishing line, dowel rod or coat hanger or other object 25-50 cm in length to create mobile. |
| **Resources required** | Balances, paper punch, scissors, clinometer app on mobile devices, rulers with metric measurements |
| **Vocabulary** | Work, force, mass, acceleration, displacement, kinetic energy, potential energy, convection currents |
| **Guiding questions for the teacher**  | * How can work be used in our daily lives?
* How can work be used to create art?
* If work is how far a force moves, then what is balance?
* What force do we need to consider when we try to balance two objects?
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| **Activating Strategies** | * Engineers, architects and artists use the concept of displacement and balance in every design.
* Read the information about Alexander Calder.
* How can an engineer use displacement when designing something?
* How do architects use displacement when designing a building or bridge?
* How does an artist use these same concepts in their work?
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| **Teaching Strategies****(include science, technology, engineering, mathematics which apply)** | Students will accurately measure mass of objects.Students will calculate distances using the formula for work.Students will design a mobile based upon calculations.Students will test their design by using technology applications. |
| **Science inquiry and problem-based, or engineering skills**  | See lab below |
| **Instructional Materials**  | **Pre-math assessment**[**http://www.teachengineering.org/collection/cub\_/activities/cub\_art/cub\_art\_lesson01\_activity1\_mobilemath.pdf**](http://www.teachengineering.org/collection/cub_/activities/cub_art/cub_art_lesson01_activity1_mobilemath.pdf) |
| **Summarizing Strategies and Follow-up**Students will write a paragraph on how work may be used in their potential career.  |
| **Differentiation strategies*** For struggling students: provide precut and massed objects. Have students verify the mass of the objects by re-massing.
* For struggling students: Have completed examples readily available for them to examine.
* For gifted students, increase the number of objects and require the number to be an odd number suspended.
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| **Assessment(s) or Products (please include a rubric if needed)****Product Assessment:**Create mobile with at least 6 suspended objects. (10 points)Accurately record the mass of each object (20 points)Calculate the center point (30 points)Balance the mobile (0 degrees on the clinometer) with less than 2 adjustments (40 points)Balance the mobile (0 degrees on the clinometer) with 3-4 adjustments (30 points)Balance the mobile (0 degrees on the clinometer) with 5-6 adjustments (20 points)**Math assessment:** <http://www.teachengineering.org/collection/cub_/activities/cub_art/cub_art_lesson01_activity1_giantmobile.pdf> |
| **STEM career information or Post-secondary**Students will research the educational requirement of their potential career. What courses or training will they need to get beyond high school that may require a basic understanding of work. |
| **The Art of Science**Alexander Calder (1898-1976) was the son of a famous sculpture. Both father and son were gifted artists. When Alexander turned 18, he chose to study engineering instead of following the arts as his father wished. Alexander received an engineering degree at age 21 and worked in a series of engineering jobs including the military.Alexander continued his love for art in every aspect and in every avenue of his career. While on assignment to the New York police, he observed the aerial acts from Ringling Brothers Circus and started his fascination for balance the performers exhibited. Alexander created toys in his spare time and sold many of his designs that eventually became the cast iron movable toy banks. These banks were highly collectable in the 1930’s and 40’s.Alexander Calder experimented with suspending items from rods and wires to simulate the balance he observed from the circus. His coined this type of sculpture “stabiles” and later his designs were called mobiles. A **mobile** is a type of kinetic sculpture constructed to take advantage of the principle of equilibrium. Alexander Calder is credited to be the founder of the mobile art form and used his engineering and math skills to create art pieces that now hang in over 100 art galleries around the world. **Reflection**1. What was the ‘family business’ and what career path did Alexander Calder choose instead of the ‘family business?’
2. How did Calder incorporate the family business in his career?
3. Which was a more accurate term for the art form: the one Calder coined or the current name? Why do you think that name is more accurate?
4. Do you believe Calder was more successful at this chosen career or the family business? Why?
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Calculate the center point (30 points)

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Remember: Force = mass x acceleration (Newton’s second law)

Work = force x distance

So, Work = mass x acceleration x distance.

For balance, Work1 = Work2

Mass1 x acceleration1 x distance1 = Mass2 x acceleration2 x distance2

If the acceleration due to gravity in one location is constant (9.8 m/s/s), then acceleration on each side cancels out.

 Mass1 x distance1 = Mass2 x distance2

Mass1 = Distance2

Mass2 Distance1

Objective: create a mobile with no fewer than 6 suspended objects.

Procedure:

1. Cut at least 6 geometric shapes from the construction paper.
2. Use the paper punch and punch a hole near the edge of each piece of paper.
3. Using the balance, mass each piece of paper to at least 2 decimal points. Write the mass on each piece as you measure them.
4. Using the information above, divide your shapes into two piles, one for each side of the balance point on the mobile.
5. Calculate the center point using the proof above.
6. Create your mobile.
7. Use the clinometer app to measure the balance. Remember: a balanced object will not ‘move’ and will have a reading of 0 degrees on the clinometer.