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Astronomy & Space Science
2018 (Fall)

Lesson Implementation & Reflection

Description: The activity that was completed was very similar to the resource posted in week

three of this course entitled "Make a Crater." The activity can be found at this link:

https://www.jpl.nasa.gov/edu/teach/activity/make-a-crater/. As this specific activities is geared

toward the younger grades, a scaled up version was completed as a final course assessment by

my students in June. The activity completed was based on a formerly experiment that was

required by the state of Connecticut roughly 10 years ago which can be found on pages 14 & 15

of the PDF at the following link: http://phsgirard.org/CAPT/CAPT2003ReleasedItems.pdf The

final assessment used was expanded upon to include graphing, data analysis and a discussion of

both kinetic and potential energies. This can be seen in the student completed assignment below.

Artifact 1: Student Completed Activity/Report (STUDENT A)

Final Performance Assessment- Impact Craters- PS12:
Craters

When a meteor strikes the surface of a planet or a moon it may form a crater. There are many factors that may affect the size of the crater.

Your Task

You and your partner will design and conduct an experiment to determine how the speed of a meteor (as influenced by the height dropped) affects the size of a crater.

During this activity you will work with a partner (or possibly two partners). However you must keep your own individual lab notes because after you finish you will work independently to write a lab report about your investigation.

You have been provided with the following materials and equipment. It may not be necessary to use all of the equipment that has been provided. You may use additional materials and equipment if they are available.

MATERIALS:

1 Sand

1 Tray

1 Glass sphere

1 ruler (to measure crater)

1 Meter stick (to measure drop height)

Access to a balance

1 straw with a sharpie (to measure depth of crater)

Clearly state the problem you are going to investigate:

PROBLEM:

How does the speed of the meteor, influenced by height, affect the size of the crater

INDEPENDENT VARIABLE:

Height

DEPENDENT VARIABLE:

Size of crater

CONSTANT VARIABLE(S):

Same marble, same amount/type of sand, same force of drop (same person), same method of measuring

HYPOTHESIS:

If you drop the marble at a higher height, then it will have a greater impact and the size of the crater will be larger because the higher the height, the more potential energy, therefore energy of the total system.

PROCEDURE:

1. *Level out the sand*
2. *Drop marble from height of 10 cm*
3. *Record depth of the crater by measuring popsicle stick, put end of popsicle stick at bottom of crater, mark height with sharpie, measure in cm, record in data table*
4. *Do steps 1-3, for a second trial using the same height*
5. *Do steps 1-4, adding 10 cm to the height each time, do this 4 times more (2 trials for each attempt)*

DATA:

Data Table - Paste table from Logger Pro or Google sheets here - screenshots are fine too. Don't forget the Mass of your marble as well.

https://docs.google.com/spreadsheets/d/1zFqmxPCq3I8OZvRLR-4CGd1_Ia8xNN2r7lht7H3bAfM/edit?usp=sharing

A	B	C	D	E
	Depth (T1)	Depth (T2)	Avg Depth	Height (cm)
	1.3	1.25	1.275	10
	1.5	1.6	1.55	20
	1.7	1.6	1.65	30
	1.8	1.8	1.8	40
	1.9	1.9	1.9	50
Mass of Marble				
20.5g				
0.0205 kg				

Graph - Paste a screenshot of your graph including a best fit line ("trendline" in google sheets)

WITH the equation
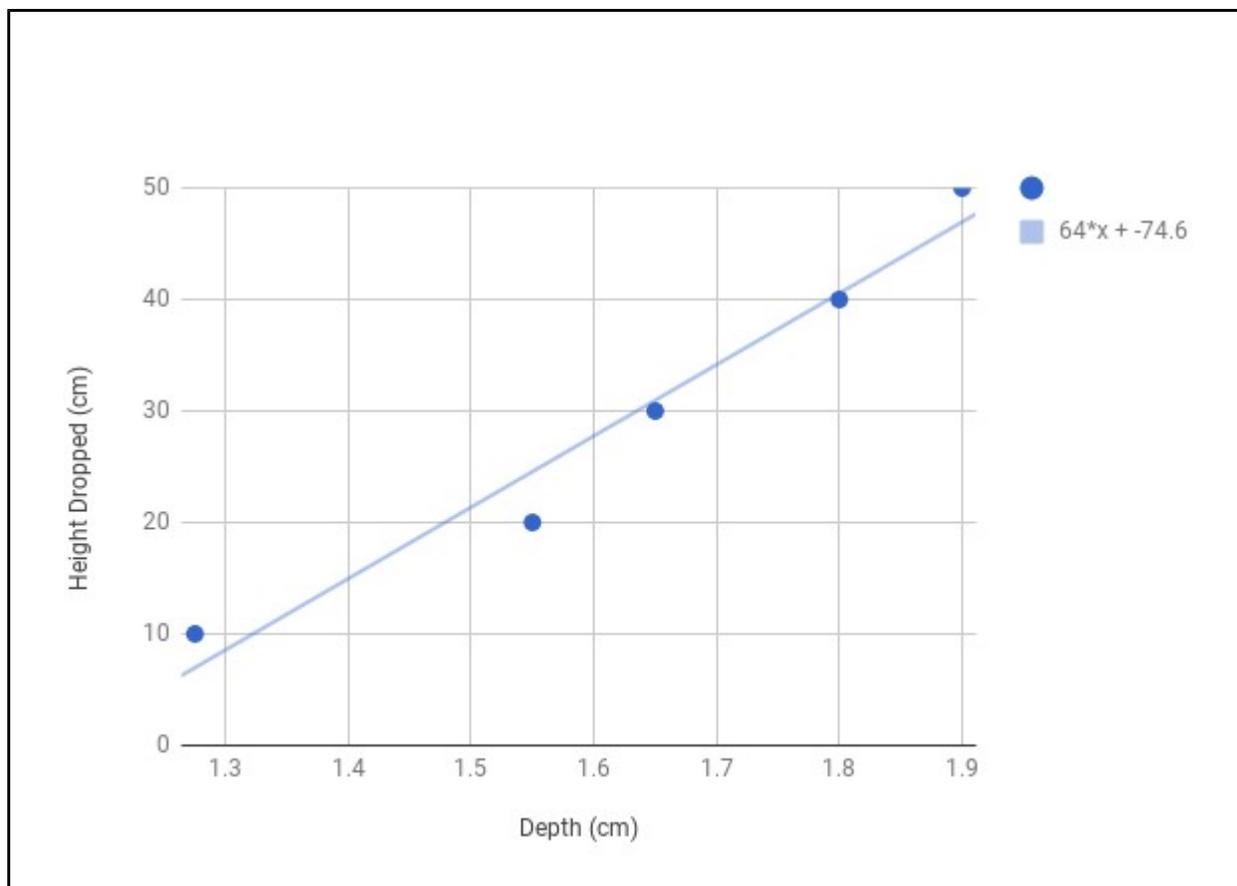
ANALYSIS QUESTIONS:

1. *Calculate the Potential Energy of your marble **at its highest Height**. (PE = mgh) (g=9.8m/s²). Do this by HAND and either attach a screenshot OR hand in directly to your teacher.*

   PE=mgh
   *PE= (0.025 g) * (9.8 m/s²) * (.5 m)*
   PE= 0.10045 joules

2. *Determine Kinetic Energy at the **point of impact** for your marble **dropped from its highest height**. Do this by HAND and either attach a screenshot OR hand in directly to your teacher.*

   PE = KE

KE= .10045 newtons

3. What is the Impact Velocity of the marble when dropped from its highest height?(solve for V using PE and KE) (KE = ½ mv²). Do this by HAND and either attach a screenshot OR hand in directly to your teacher.

$KE = PE$
$v^2 = KE/1/2 \ (o.0205)$
$v^2 = .10045/(½) \ (.0205)$
$v^2 = 9.8$
$v = 3.13 \ m/s^2$

4. What did you determine about the relationship of **HEIGHT** and **IMPACT** depth? (Direct/Indirect and Linear/Exponential). WRITE THE SCIENTIFIC EQUATION FOR YOUR DATA.

It is a direct linear relationship → h =64 (D) +10

5. Why is this the case?

It is a direct linear relationship because the higher the height you drop the marble from the deeper the crater is. As height increases the depth of the crater increases as well.

6. Describe the motion of the marble as it fell. (Acceleration? Constant Velocity? etc...)

It accelerated because of the force of gravity that was pulling on it. Potential Energy was at its highest at the highest point and kinetic energy was at its lowest at the lowest point. Potential energy was zero right before it hit the ground and kinetic energy was zero at the highest point.

7. What caused the marble to undergo the motion that it did as it fell?

Gravity caused the marble to accelerate as it got closer to the ground because gravity acts upon forces that attract each other so the closer the marble was the more force there was therefore it accelerated.

8. Given the following additional materials:
   3 glass marbles of different diameter/mass, (small, medium, large)
   3 wooden marbles of different diameter/mass, (small, medium, large)

3 plastic marbles of different diameter/mass, (small, medium, large)

NOTE: all small marbles have the same diameter- all medium marbles have the same

diameter- all large marbles have the same diameter

Describe another variable that you could test to see how it affects the size of the impact crater? Explain your reasoning.

You could test to see how the size of marble used affects the size of the crater

9. *What would the IV, DV and Constants be?*

IV	size of marble
DV	Size of crater
Constants (at least 2)	Height, type/amount of sand, force of drop (same person)

10. *What would your hypothesis be?*

If the marble dropped is bigger then it will have a greater impact and the size of the crater will be larger. The bigger the marble the more potential energy (PE=mgh), therefore the more energy of the total system.

Artifact 2: Video of Crater Impact Activity

https://drive.google.com/file/d/1SVB40HMzp0NoEzW11SJvoAvEhOgX3pBv/view?usp=sharing

Artifact 3: Photo of depth measuring process

https://drive.google.com/file/d/1fYCnPE_2Ek1IH8ub2BOcit6uzZZFI-3Z/view?usp=sharing

Reflection:

As stated above, this activity was assigned as the final assessment for all 6 sections of the

10th Grade Physical Science class. Overall, it was a success. Students enjoyed the activity as

they were able to complete an authentic performance assessment rather than a standard written

exam in order to show what they know. It was for this reason that an activity like this was chosen. Physical Science is a very hands on, STEM centered course with an activity based approach to learning and thus, it made sense to use a performance assessment at the conclusion of the course.

Personally, I like this activity as it is broad enough to fit anywhere in the curriculum and also allows for questioning student knowledge on a wide variety of physics topics. For example, we included potential and kinetic energy in this version of the activity, however, it could just as easily include momentum, impulse, Newton's Laws, or even Gravitation.

However, there were some problems with this version of the activity.   Again, we used this as final assessment and thus were limited to completing the activity including the lengthy write-up in 90 minutes or less. Many students found it difficult to finish in the allotted time and as teachers we had to improvise a solution to this. The time constraints also tied our hands a bit in what we could do as instructors. In fact, we chose to cut adding a powder to the top layer of sand in order to save a little time but sacrificing realistic ejecta effects. The original plan also included asking students to test a second variable by completing an entirely separate experiment. Again, this was cut for time.

If we plan to use the crater activity as the final again this year, I will suggest that we start it the week prior to final exams. This will make it possible to dig deeper into other concepts as well as allow us to include actual space data and terminology, which we failed to do this time around. Giving this activity more time will also make it possible for students to share their procedures and conclusions with one another as a closing exercise.

In doing some online research I came across a NASA crater activity that is geared much more toward the high school students. It can be found at the following link:

https://www.nasa.gov/pdf/180572main_ETM.Impact.Craters.pdf. I like the way that this activity

included terminology and can easily include graphing, mathematics and physics. While I find it

a nice touch that the authors included a data table template, I would prefer to leave what is being

tested up to my students. That being said, this activity will be a good way to start a revision of

the one we assigned in June 2018.

Sources:
(April 19, 2017) *Whip Up a Moon-Like Crater.* Retrieved from
https://www.jpl.nasa.gov/edu/teach/activity/make-a-crater/

(2003) *CAPT Science 2003 Administration*. Retrieved from
http://phsgirard.org/CAPT/CAPT2003ReleasedItems.pdf

(1997) *Exploring the Moon -- A Teacher's Guide with Activities, NASA EG-1997-10-116-HQ.*
Impact Craters. Retrieved from https://www.nasa.gov/pdf/180572main_ETM.Impact.Craters.pdf