Down to Earth
KS3

Student worksheet

Creating Craters

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Creating Craters!

Equipment (Per Group)

- One set of projectiles either SET A or SET B

SET A: four marbles, ball bearings, or similar of identical size and weight

SET B: three spheres of equal size but different materials so that they have different mass

- Ruler and metre rule
- Digital balance
- Data Chart

Method

1. Choose at least three projectiles from SET A or SET B.
2. Write a description of each projectile on your Data Chart.
3. Measure the mass, and diameter across the longest side of each projectile and record these on the Data Chart.
4. Prepare dry material layers according to directions from your teacher.
5. Drop the projectiles into the dry material.

Depending on which projectiles you are using this will be different:

SET A:

Drop the projectiles from different heights. The projectiles should be dropped one at a time into an undisturbed area of the tray. Record each height selected and your crater observations (see Crater Features below).

SET B:

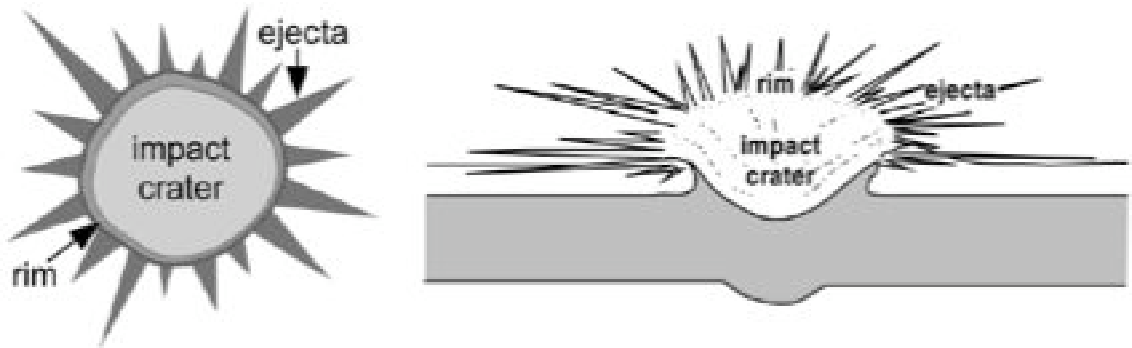
Drop all projectiles from the same height. The projectiles should be dropped one at a time into an undisturbed area of the tray. Record the height selected, the mass of each projectile, and your crater observations.

6. Discuss the effects caused by changing the variables of height (and so velocity) and mass of an object on the crater it forms.

Crater Features

The energy of an impact vaporises and displaces material creating the impact crater, a basin surrounded by the crater rim.

The ejected material falls back to Earth to form a carpet of ejecta and a pattern of rays.



This diagram shows two views of a typical impact crater. The left view shows the circular crater with its rim and scattered ejecta. The right view shows that the rim is above and the crater floor is below the original surface. The ejecta are thickest closest to the rim

Options:

- Using results from Set A- Plot ray length vs. height when the mass of the projectiles are equal. Measure ray length from the centre of a crater to the end of the longest ray for each crater.
- How would we expect the height from which each projectile is dropped to affect its velocity? Remember, the Set A projectiles are identical in size.
- Using results from Set B- Plot a graph of ray length vs. mass of projectiles when the height and size of the projectiles (and therefore their velocities) are equal.
- Experiment with different velocities by throwing projectiles into dry materials. You must first consider any safety concerns!

Questions

1. What evidence was there that the energy of the falling projectile was transferred to the ground?

2. How does the velocity of a projectile affect the cratering process?

3. How does the mass of a projectile affect the cratering process?

4. If the projectile exploded just above the surface, as often happens, what changes might you see in the craters?

Energy Calculations for Advanced Classes

The following formulae allow more able pupils to calculate the K.E. involved in each impact. This might allow the pupils to, for example, plot the kinetic energy of an impactor against crater diameter or ray length.

K.E.	=	kinetic energy
M	=	mass of impacting object (projectile)
g	=	gravity constant for Earth (980 cm/sec^2)
v	=	velocity of impacting object (projectile)
h	=	height of release of impacting object
erg	=	grams x cm^2 x sec (measure of K.E.)
K.E.	=	1/2 Mv^2 (meteorite impacts like Meteor Crater)
v	=	√2gh (free fall)
K.E.	=	Mgh (for classroom experiments)

Classroom Experiment Example

projectile	-	10 grams	=	M
drop height	-	2 metres	=	h
gravity effect	-	980cm/sec^2	=	g

K.E. = 1/2 x 10 grams x 2 x 980 cm/ sec^2 x 200 cm

Meteor Crater Estimate

Projectile was 30 metres in diameter.

It was an iron nickel sphere (a meteorite with a density of 8 g/cm^3)

Projectile mass was 1.1 x 1011 grams = M

4/3 Π (1.5 x 103) 3 cm^3 = v

(1.4 x 1010 cm^3) = v

K.E. = 1/2 x 1.1 x 1011 grams x (2 x 106)^2

K.E. = ~ 2 x 1023 ergs

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