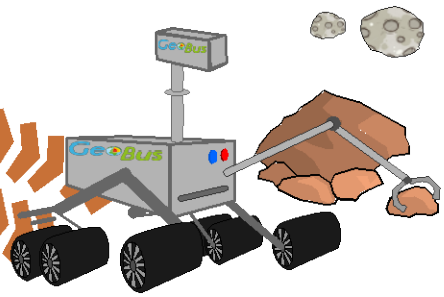
Mars' Moons

Teacher instructions



Activity title:	Mars' Moons: Phobos and Deimos
Target Age Group:	S3-S4
Preparation:	Download "Mars' Moons" GeoBus PowerPoint
Activity Description:	Mars has two small moons: Phobos and Deimos. Phobos (fear) and Deimos (panic) were named after the horses that pulled the chariot of the Greek war god Ares, the counterpart to the Roman war god Mars. Both Phobos and Deimos were discovered in 1877 by American astronomer Asaph Hall. The moons appear to have surface materials similar to many asteroids in the outer asteroid belt, which leads most scientists to believe that Phobos and Deimos are captured asteroids. This activity goes into a bit of detail on the two moons and acts as a follow up exercise to the geology in a minute video – Mars' moons. If you enjoyed the video and want to know more this exercise goes into more detail. Also, there is a balloon exercise which acts as a good summary between differences/similarities been Earth, Mars and moons
Time:	10mins introduction, 30mins activity, 5mins reflection. **Total: 45minutes**.
Learning Outcomes:	Understand the similarities and differences between Mars' two moons Evaluate the different formation theories and discuss which one is the most feasible Understand some of the possible benefits and challenges that could occur if a moon base is developed on Phobos. Analyse the differences and similarities between Earth, Mars and their moons.
Materials Needed:	"Mars' Moons: Phobos and Deimos" Worksheet, 1 bag blue balloon (at least 9 per bag), 1 bag white balloons, 1 bag red balloons, Copies of Planetary Data Handout, rulers/measuring devices in both inches and centimeters.
Student Organisation:	Whole class (introduction), Individual (worksheet) and small group balloon activity or can be done as a demonstration.

Instructions: Give lesson on Phobos and Deimos outlined by the "Mars' Moons" GeoBus PowerPoint. Consider brainstorming the last question on the worksheet as a whole class to generate more discussion about technological innovations that will be necessary, etc.

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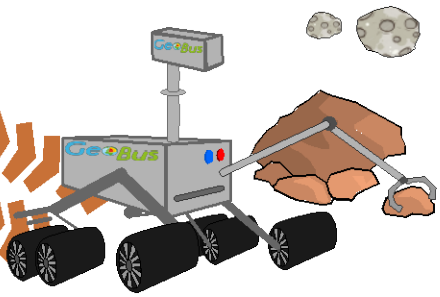


How big is the Moon; how far is it relative to Earth? Earth science and astronomy books depict a moon that is much closer and much larger than in reality. The example below is typical of what is found in textbooks:

The balloon activity will allow students the opportunity to construct a scale model of the Earth-Moon system, both in terms of planetary sizes and distances. In addition, students make a scale model of Mars, and discover how far one might have to travel to visit the most Earth-like planet in our Solar System. It is also a good icebreaker at the beginning of a semester, to get students to interact with each other.

Step - By - Step Instructions:

1. Obtain balloons. The best are balloons with 2 1/2 inch diameter when deflated, but any balloons will work. An easy way to do this activity is to purchase balloons that are coloured. The red, white, and blue balloons can be used for Mars, Moon, and Earth. (using green for Earth and yellow for the Moon are also fine).

2. Discuss the question of size of the Earth relative to the Moon. Determine what misconceptions the students may have.

3. Distribute balloons. It is best to provide one third of the class with "Earth" (i.e. blue), one third with "Moon" (i.e. white), and one third with "Mars" (i.e. red).

4. Distribute Planetary Data Handout, one per student.

5. Tell students that the Earth balloon will have a diameter of 20 cm. Have them figure out the scale (divide the Earth's actual diameter by 20 cm. Earth is about 63,800,000 times larger than 20 cm). Ask students with Earth balloons to inflate their model approximately 20 cm (obviously the balloon is not a perfect sphere, but neither is the Earth).

6. Ask students to look at the handout and calculate the size that the Moon and Mars should be, at the same scale as the Earth model. (Note the teacher's copy has the answers: the Moon should be about 5 cm, Mars about 11 cm).

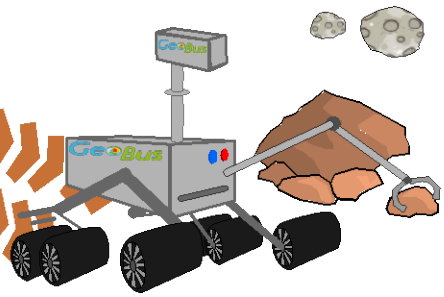
7. Have students inflate the Mars and Moon balloons.

8. Ask students, at this scale, how far apart are the Earth and Moon? The diagrams seen in common textbooks might lead many of them to suggest that the Moon balloon should be held less than a meter from the Earth balloon.

9. Have students calculate the distance from Earth to the Moon at the same scale as the balloon models. The distance is about 6 meters. Have students holding the Earth models stand at one side of the room, and a partner holding a Moon model about 6 meters away.

Mars' Moons

Teacher instructions



10. Point out to students that they now have a scale model of the Earth-Moon system. Earth and its Moon are considered a double planet. The distance between the two is the distance traversed by the Apollo astronauts who went to the Moon in the 1960's and 70's. (Have students recall the film Apollo 13).

11. Compare the size of the Mars model with the Earth and Moon model. Look at the distance between Earth and the Moon.

12. Ask students how far away they think Mars will be at this scale. Have students attempt to demonstrate it in the classroom.

13. Have students calculate the distance to Mars at this scale. The answer is about 12,000 cm, which in more familiar terms is 3/4 of a mile! Have students identify a local landmark that is about 3/4 of a mile away.

14. Discuss the relative distance between Earth and Mars in the context of a human trip. How long did it take for Apollo astronauts to get to the Moon? (3 days) How long would it take for astronauts using similar technology to get to Mars? Mars Pathfinder, which launched in December 1996, arrived at Mars on July 4,1997 (7 months). Mars Global Surveyor, which launched in November 1996, arrived at Mars in September 1997 (11 months)

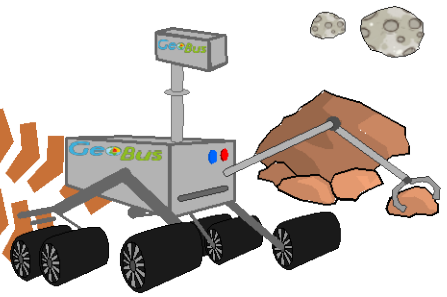
Tip: It may also be useful to discuss the answers to the first question as a group to create a whole class set of data for the Venn diagram!

Extension: Watch the GeoBus "Geology in a Minute: The Moons of Mars" video on the GeoBus website!

Ask students to make models of Mars and Martian moons, Phobos and Deimos, at the correct scale using balloon models. They can calculate their scale diameters from the enclosed chart (step by step instructions above).

Planetary data

Student handout



	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
Distance from the Sun (AU)	0.387	0.723	1	1.524	5.203	9.537	19.191	30.069	39.481
Approximate Distance from the Sun (10^3km)	57,910	108,200	149,600	227,940	778,400	1,429,725	2,870,980	4,498,250	5,906,370
Radius	2,439.7	6,051.8	6,378.14	3,397.2	71,492	60,268	25,559	24,764	1,195
Mass (Earth = 1)	0.054	0.88	1	0.149	1,136	755	52	44	0.005
Density (gm/cm^3)	5.43	5.24	5.515	3.94	1.33	0.70	1.30	1.76	1.1
Rotation Period (day length)	58.65	-243.02	0.99	1.03	0.41	0.44	-0.72	0.67	-6.39
Orbital Period (year in days)	88	225	365	687	4,333	10,760	30,685	60,190	90,800
Sideral Period (length of year in Earth years)	0.24	0.62	1	1.88	11.86	29.42	83.75	163.72	248.02
Orbital Tilt (degrees)	0	177.3	23.45	25.19	3.12	26.73	97.86	29.58	119.61
Satellites	0	0	1	2	16	18	15	8	1

Glossary

AU - astronomical unit, the distance between Earth and Sun (~1.495 * 10^8).

Rotation Period - the length of the day.

Orbital Period - the length of the year in Earth days.

Retrograde - when a celestial body rotates in the opposite direction of the Earth or clockwise.

Satellite - another name for a moon.

Sideral Period - the length of a planet's year in Earth years.

Tilt - how a far a planet is tilted sideways on its axis, measured in degrees.

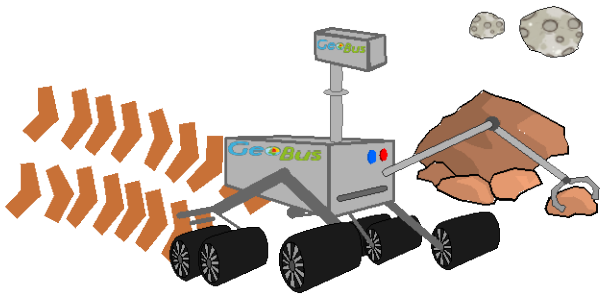
Balloon Exercise

Body	Diameter (km) / 638 =	Approximate Scale (cm)
Earth	12,756	~20 cm
Moon	3,476	~5 cm
Mars	6,794	~11 cm
Phobos	22	~0.03 cm

Scale Distances		(km)	/ 638 = (cm)
Earth	Moon	3.84 x 10^5	600 cm = 20 ft
Earth	Mars	7.80 x. 10^7	1.2 x 105 cm = 3/4 mi

Mars' Moons

Teacher answers



Fill in the gaps:

ASAPH HALL discovered the moons of Mars in 1877

The moons are named after the Greek mythological sons of ARES

PHOBOS has a smaller orbit than DEIMOS

CARBON is the primary element comprising the moons

Mars has the SMALLEST moons in the solar system

Phobos and Deimos may have started out as ASTEROIDS

MARINER 9 was the first technology sent to observe Mars' moons

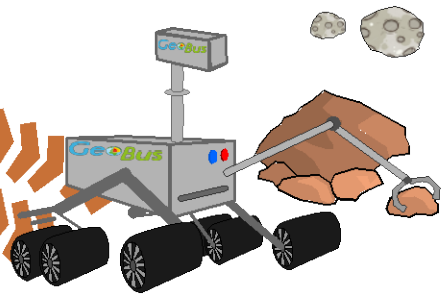
If astronauts made a home base on Phobos, Mars would block potentially harmful radiation due to the Sun's COSMIC RAYS

Moon balloon exercise:

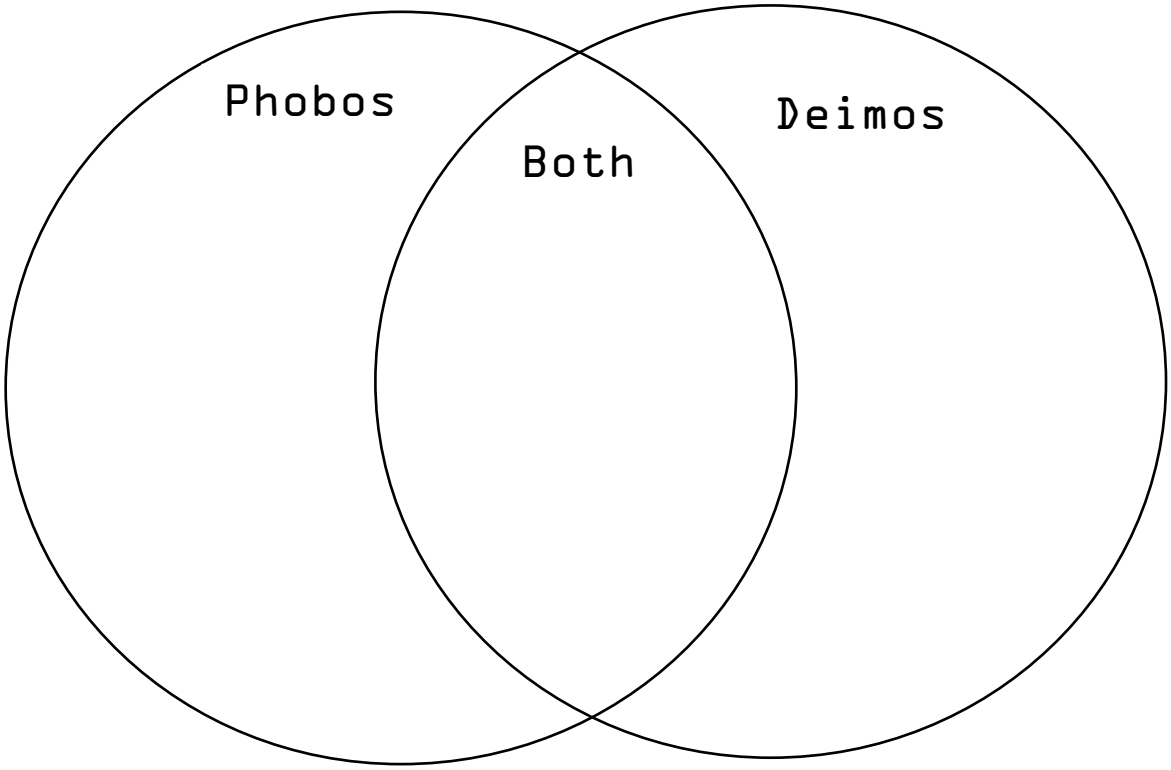
It turns out that they are about the same size of a small grain of sand!

Mars' Moons

Student worksheet



1. Complete the following Venn diagram to compare and contrast Phobos and Deimos



2. Which of the three theories of formation discussed do you think is correct? Write a few sentences explaining your choice.

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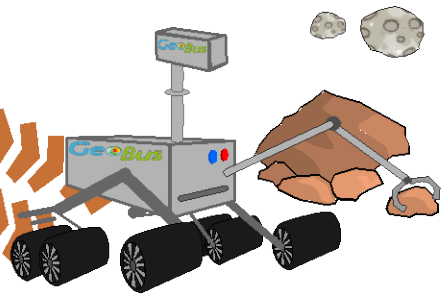
Mars' Moons

Student worksheet



3. What would be some of the challenges that astronauts would encounter if Moon bases were developed on Phobos?

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4. Use the word bank below to fill in the blanks.

ASAPH HALL	CARBON	DEIMOS
MARINER 9	PHOBOS	ASTEROIDS
ARES	SMALLEST	COSMIC RAYS

…… …….. discovered the moons of Mars in 1877.

The moons are named after the Greek mythological sons of ……

…….. has a smaller orbit than ……

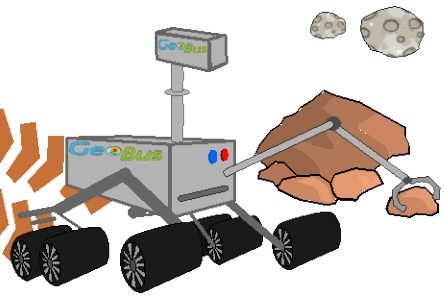
…….. is the primary element comprising the moons

Mars has the …….. moons in the solar system

Phobos and Deimos may have started out as ……..

Mars' Moons

Student worksheet



…….. was the first technology sent to observe Mars' moons

If astronauts made a home base on Phobos, Mars would block potentially harmful radiation due to the Sun's …… ……..

5. Extension activity: Illustrate your balloon diameters below. Describe your findings with your experiment.