STEM Sims™

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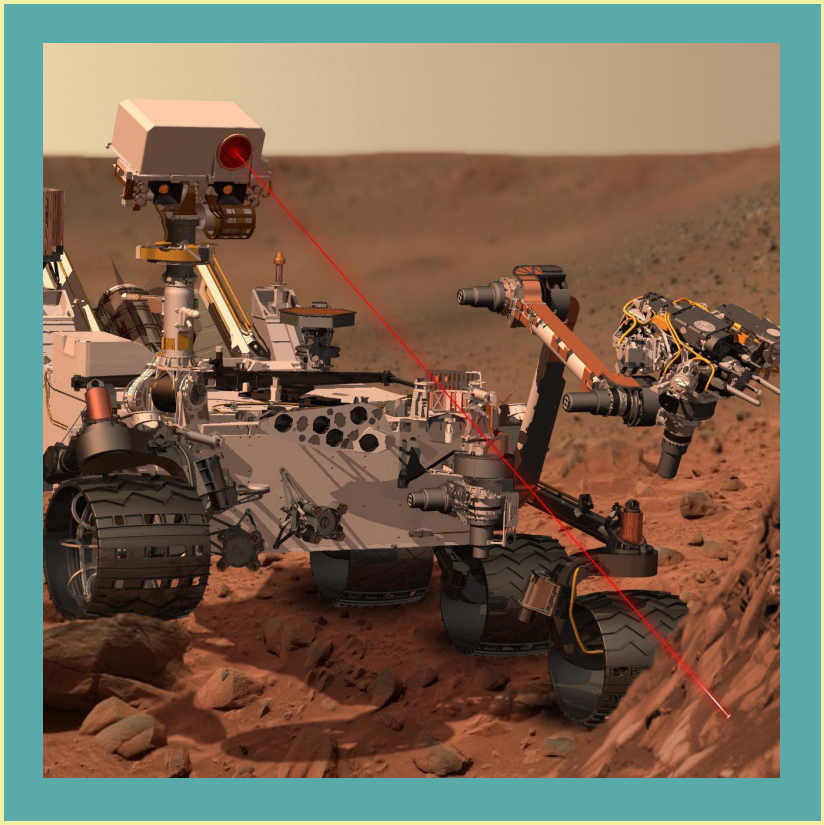

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Do you need an idea for a scientific study?
Try out one of our ideas or make one of your own.

Start learning right now about laser-induced breakdown spectroscopy and mining. Take the following brief quiz to see how much you already know about spectography. See the bottom of page 4 to check your answers.

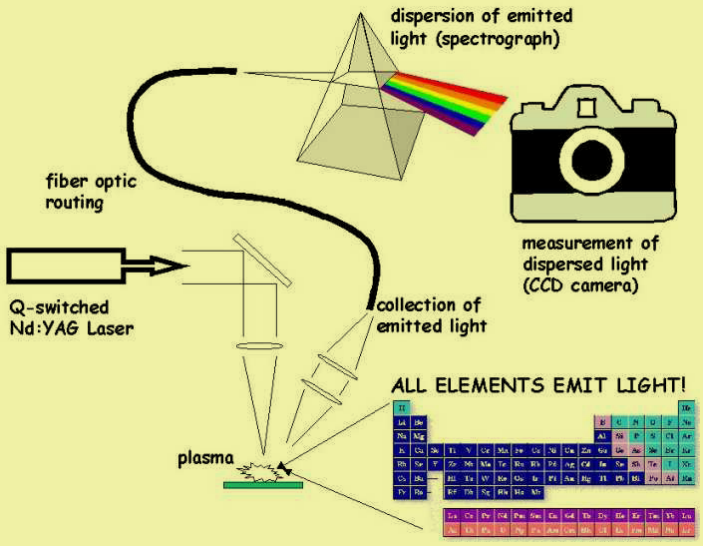
1. Which state of matter can laser-induced breakdown spectroscopy (LIBS) analyze?
   a. solid
   b. liquid
   c. gas
   d. all of the above

2. At which wavelength does the Nd:YAG laser operate?
   a. 270 nm (ultraviolet)
   b. 594 nm (visible)
   c. 1064 nm (near infrared)
   d. 3.3 µm (mid-infrared)

3. How much energy is usually required for the laser pulses of LIBS?
   a. 10-100 nanojoules
   b. 10-100 millijoules
   c. 10-100 joules
   d. 10-100 kilojoules

4. When was spectroscopy first invented?
   a. 1814
   b. 1904
   c. 1941
   d. 2004

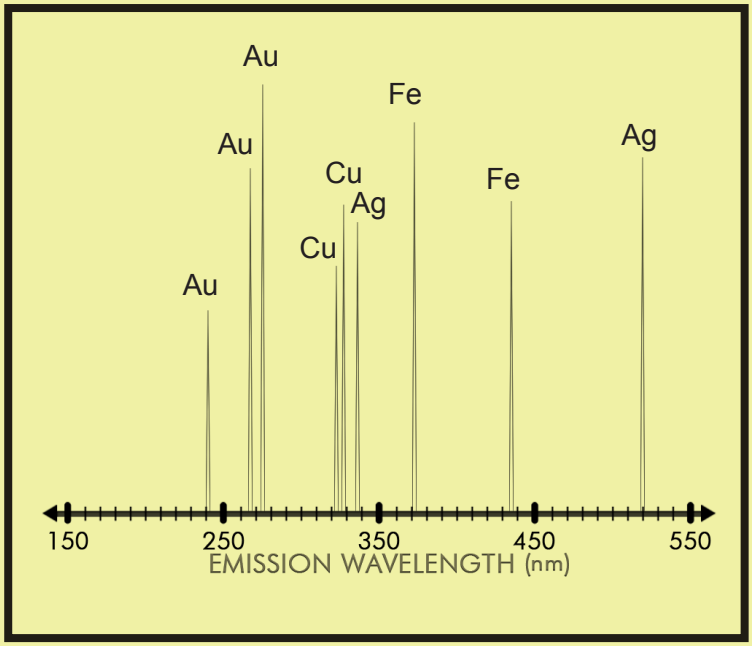
5. How do museums use LIBS?
   a. to scan visitors for weapons
   b. to analyze paint layers
   c. to laser cut frames for paintings
   d. to advertise for their exhibits



Breaking Down Figures of Speech

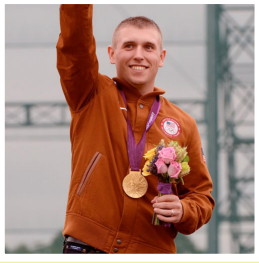
The process of laser-induced breakdown spectroscopy is fascinating. First, a laser blasts the sample in pulses; a microscopic bit is broken down into plasma and, as soon as it cools, emits a spectra. Each spectra of wavelengths is unique to a specific element.

The puzzle below is two-fold: first find the element's symbol on the spectra with the numbers given in italics, and then refer to a periodic table of elements to see which element the two-letter symbol represents. The images should give you some hints!



1. Expression: She is *(324, 327)*-bottomed, and a remarkable fine ship.
Figuratively means: genuine and trustworthy

2. Expression: The man in the *(371, 438)* mask
Figuratively means: something that disguises your true nature



3. Expression: Go for the *(242, 267, 275)*!
Figuratively means: Try your hardest!

4. Expression: born with a *(338, 520)* spoon in his mouth
Figuratively means: being born into a rich family

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Curiosity, Chemistry, and Cameras

In 2012, the United States National Aeronautics and Space Administration (NASA) equipped the Mars rover, *Curiosity*, with a chemistry and camera complex, known as ChemCam (pictured below). ChemCam utilizes laser-induced breakdown spectroscopy (LIBS) to analyze the elements found on Mars' surface. This analysis will help the Mars Science Laboratory (MSL) accomplish their goals of determining just how toxic the planet is and if humans will ever be capable of inhabiting Mars.

The process of LIBS is deemed to be nearly harmless for the sample, as the portion of the sample that is heated up by the laser is microscopic. What's really cool about the process is that the material is heated to the point of altering its state of matter to plasma (the fourth fundamental state of matter, after the more commonly known solid, liquid, and gas). When the plasma reaches a certain temperature (thermodynamic equilibrium), it emits a light, which is then captured by the camera, and interpreted by a spectrometer. The spectrometer, depending on its level of sophistication, should be able to evaluate every element known to man. However, the elements are not a one-to-one ratio of wavelengths like colors in visible light; each spectrogragh of an element will look different (see p. 3).

As part of the team's quest to see if biology is capable on Mars, the ChemCam tested for levels of methane in the planet's atmosphere. In 2012 and 2013, the team tested multiple times and found no trace of methane. However, scientists will still investigate the surface and atmosphere of Mars for other signs of life. But what about treasures? Will future exploration find new "goldmines" of useful resources?

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Answers: Page 2 Answers: 1) d. 2) c. 3) b. 4) a. 5) b. **Page 3 Answers:** 1) copper. 2) iron. 3) gold. 4) silver.

The Green Engineering Magnet (GEM) project was funded in part under the National Science Foundation grant contract #IIP-1127544. Its contents are solely the responsibilities of the authors and do not necessarily represent the official views of the National Science Foundation.