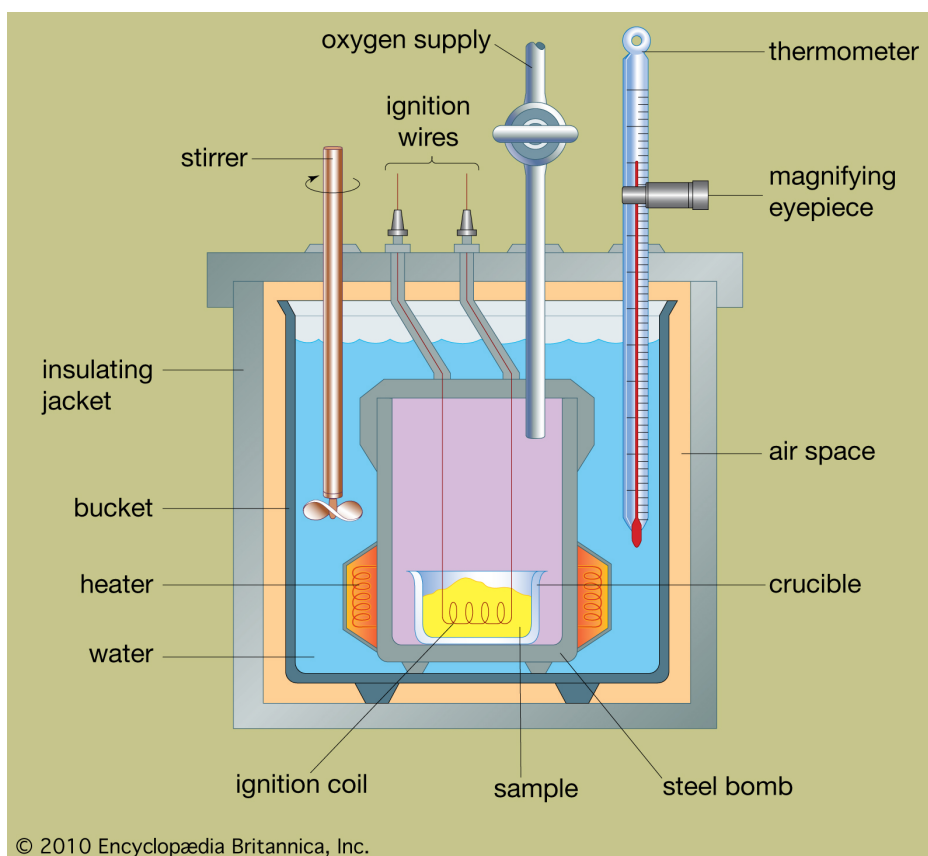


1. Calorimetry is an experimental method to determine the enthalpy of reactions in an isolated system. A reaction is allowed to react in a calorimeter (an example is shown below) and the heat released is transferred to the water and the change in the temperature of the water measured is then used to calculate the enthalpy of the reaction using the formula

$$q = m \times c \times \Delta T$$

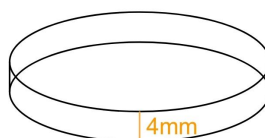
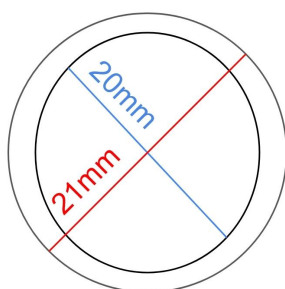
where q is the heat released, m is the mass of the water, c is the specific heat capacity of water and ΔT is the change in temperature of the water.



Which one of the following scenarios would result in an overestimation of the enthalpy of the reaction?

- A. The insulating jacket is faulty and allows heat transfer
 - B. Not all reactants have reacted
 - C. Using lukewarm water (40 °C) in the calorimeter instead of room temperature water (25 °C)
 - D. The recorded value of the mass of the reactants is less than it actually is
2. Electrolysis is a good method of covering rings with gold, silver and other expensive metals. In this process, the ring acts as a cathode and metal atoms in the solution evenly cover the ring.

"StemGold" jewelry wants to try this method and cover a ring with silver. The ring has a 20 mm inner diameter and a 21 mm outer diameter. In order to prepare the solution, the jeweler used 20 grams of AgNO_3 . Electrolysis stopped after all of the silver was deposited onto the ring. Density of silver is 10.49 g/cm^3 . Sizes of the ring are provided in the picture below.



Size of the ring

What is the new inner diameter of the ring after the electroplating process?

- A. 14.00-14.99 mm
 - B. 15.00-15.99 mm
 - C. 16.00-16.99 mm
 - D. 17.00-17.99 mm
3. Pesticides are important compounds that are used for protection of crops from insects and microorganisms. Usage of pesticides highly increases crop production, but at the same time may result in food toxicity. In order to ban or approve pesticides, the United States Environmental Protection Agency (EPA) does research and evaluates the risks. EPA tests compounds on the rats and mice and evaluates the LD50 value - amount of substance per kilogram body weight required to lead to the lethal consequences of 50% of the test animals. LD50 value for artrazine (frequently used pesticide) is 1-4 g/kg depending on the animal species, that is why artrazine remains unbanned.



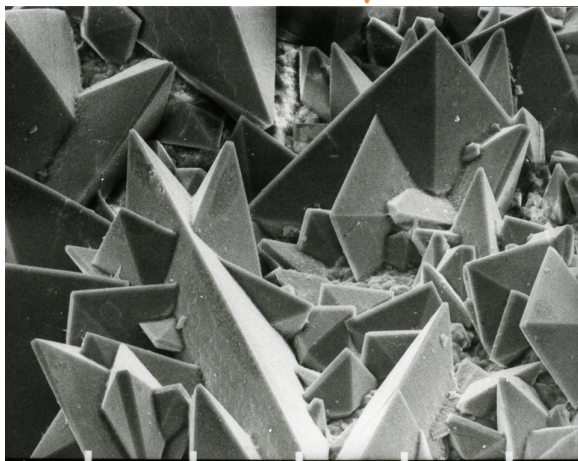
The table below represents LD50 values of different compounds for mice:

Compound	LD50 (g/kg)
Arsen Trioxide	0.013
Ascorbic Acid	12.589
Batrachotoxin	1.995×10^{-6}
Ibuprofen	0.631
Nicotine	0.050
White phosphorus	3.162×10^{-6}

Which compound is the most dangerous based on the LD50 value?

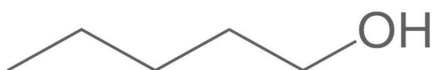
- A. Batrachotoxin
 - B. White phosphorus
 - C. Ascorbic Acid
 - D. Ibuprofen
4. Hypercalciuria refers to high concentration of calcium ions present in the urine. This is a risk factor for the formation of kidney stones when insoluble calcium salts become supersaturated in the urine.

To treat kidney stones, it is proposed to use chelating agents to reduce the concentration of free calcium ions in the urine and thereby reducing the saturation. Chelating agents are typically molecules or ions which are capable of forming multiple dative bonds with the metal cation.

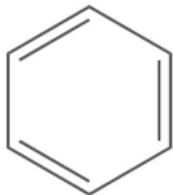


High resolution microscopy image of the kidney stone crystalline surface

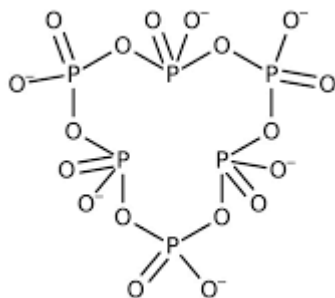
Which of the following substances is most likely able to prevent the formation of calcium stones in the urine?



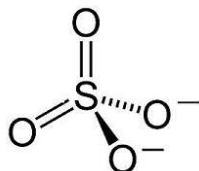
A.



B.



C.



D.

5. Organic chemistry has its roots in the mid 1700s, when thousands of alchemists around the world were experimenting with chemical compounds. Alchemists divided Chemistry into two main parts - "Inorganic Chemistry" and "Organic Chemistry". They believed that the two Chemistries do not have anything in common and have different principles from one another. In order to prove that theory, "vital force" ("live force") rules were developed:

Chemical compounds coming from animals or plants are strongly connected to the soul and do not obey rules of inorganic chemistry.

It may sound strange, but this theory was accepted by the vast majority of alchemists at the time.



Which of the suggested reactions below is the most impossible according to the "vital force" theory?

- A. Ammonium Cyanate \rightarrow Urea
- B. Glycerine + Fatty Acid \rightarrow Animal Fat
- C. Sodium + Chlorine \rightarrow Sodium Chloride
- D. Hydrogen Chloride + Potassium \rightarrow Potassium Chloride + Hydrogen

Answers

1. D
2. B
3. A
4. C
5. A