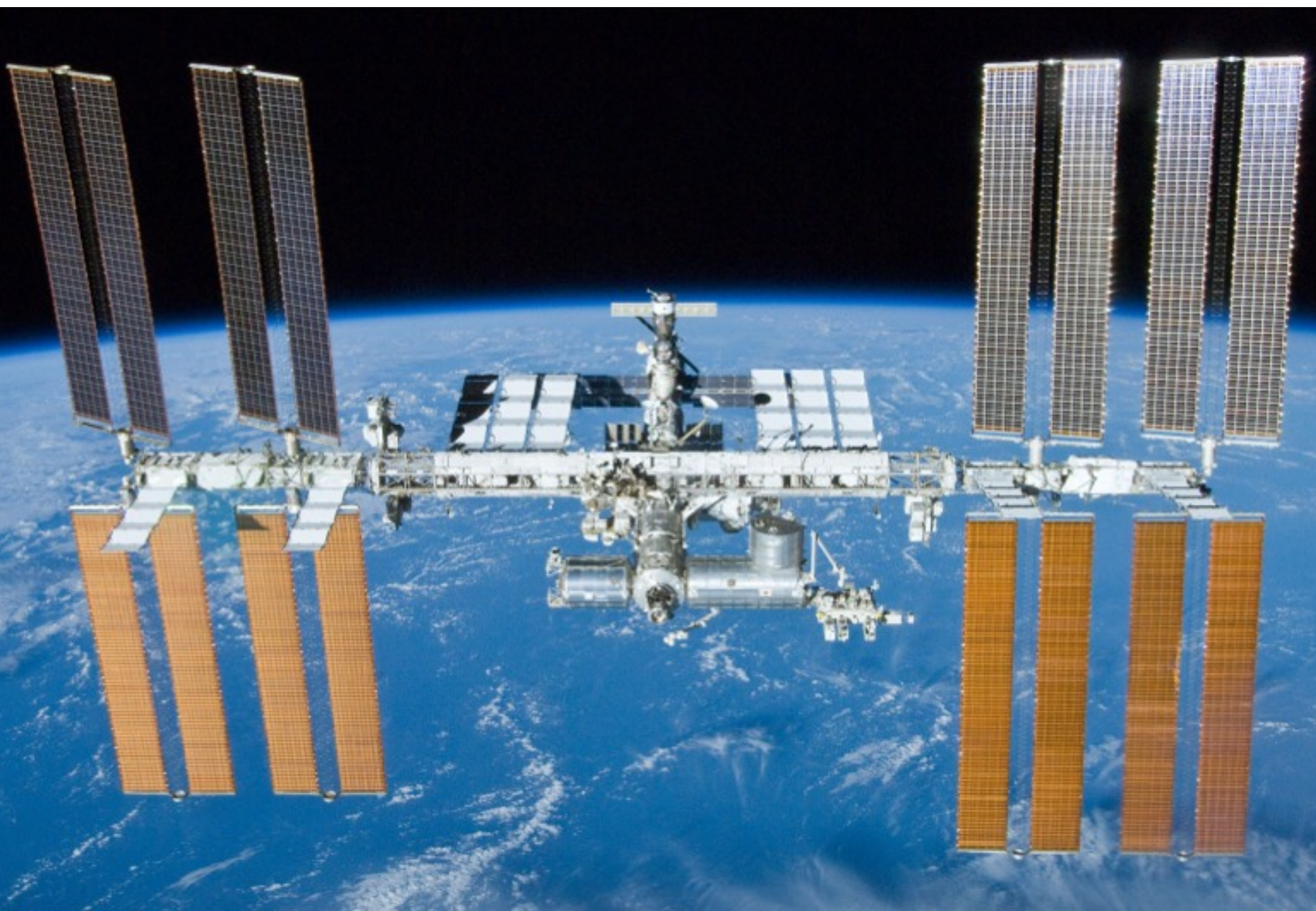




SOS... Fire on the ISS



1

INTRODUCTION

NASA is playing with fire on the International Space Station — literally.

Since March 2009, the space agency's Flame Extinguishment Experiment has conducted more than 200 tests to better understand how fire behaves in **microgravity**, which is still not well understood. "We hope to gain a better knowledge of droplet burning, improved spacecraft fire safety and ideas for more efficient utilization of liquid **fuels** on Earth," project leader Forman Williams, of the University of California, San Diego, said in a statement.

OLYMPIC GAMES

The 2014 Olympic Winter Games were the first time that the Russian Federation hosts the Winter Games.



Figure 1-1. Logo for Sochi

The host city **Sochi** has a population of 400,000 people and is situated in Krasnodar, which is the third largest region in Russia.

The Sochi Olympic Park was built along the Black Sea coast in the Imeretinskaya Valley. The Park ensured a very compact concept with an average distance of 6km between the Olympic Village and the other coastal venues.



Figure 1-2. Map: Sochi in Russia

OLYMPIC FLAME



Figure 1-3. Olympic flame handed over to Russia for Sochi Winter Olympics.

Picture: AFP Source: AFP

Actress Ino Menegaki plays a high priestess as she lights a **torch** with the Olympic flame at the Panathenaic stadium in Athens during the ceremony handing over the flame for the the Sochi 2014 Olympic Winter Games.

What is fire?

movie 2-1. What is fire?



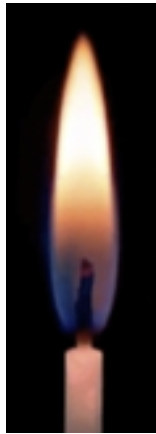
Fire starts when a flammable material in combination with an oxygen-rich compound is exposed to a temperature above the flash point for the fuel-oxidizer mix. This is commonly called the fire tetrahedron.

When it's able to keep on a rate of rapid oxidation, then the fire produces his own chain reaction.

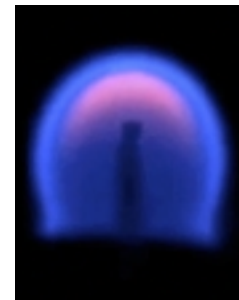
Fire cannot exist without all three of these elements in the right proportions. Consequently fire can be extinguished by removing any one of these elements. Without sufficient heat, a fire cannot begin, and it cannot continue. Heat can be removed by the application of a substance which reduces the amount of heat available to the fire reaction. This is often water, which requires heat for phase change from water to steam.

Once ignited, a chain reaction must take place whereby fires can sustain their own heat, which is needed for the further reaction.

Fire on the ISS



gravity



microgravity



Figure 3-1.



Figure 3-2.

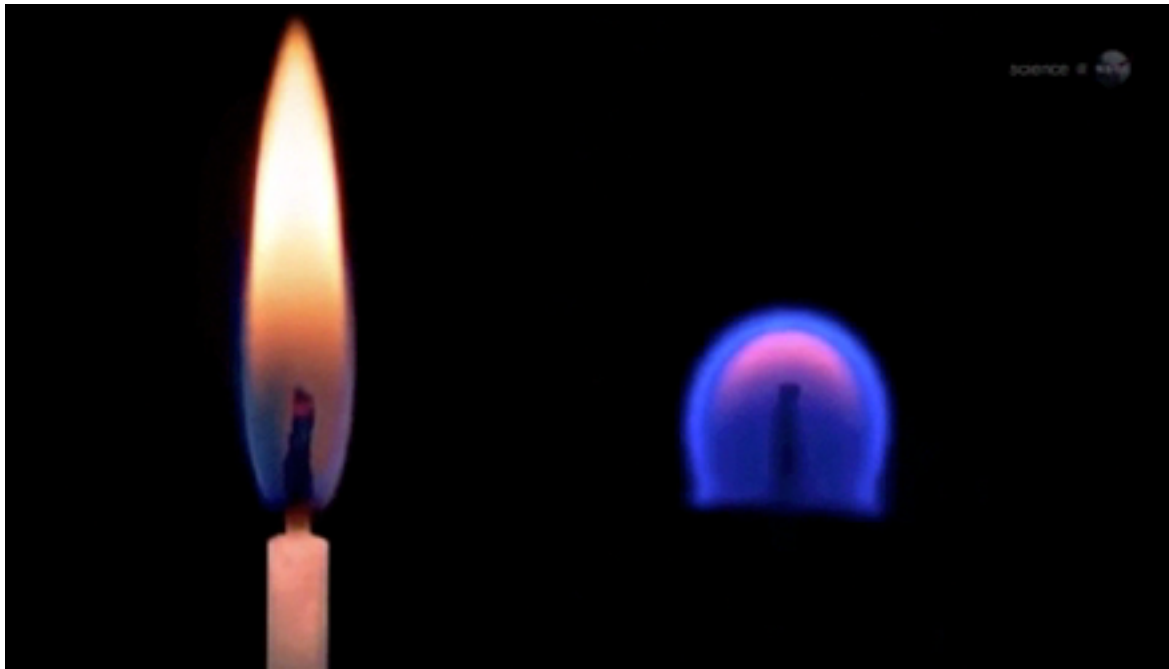
Flames are hard to understand because they are complicated. **Soot particles** can themselves burn or simply drift away as smoke. The familiar **teardrop** shape of the flame is an effect caused by gravity. Hot air rises and draws fresh cool air behind it. This is called **buoyancy** and is what makes the flame shoot up and flicker.

But what happens when you light a candle on the ISS?

In microgravity, flames burn differently—they form little spheres!

SECTION 1

movie 3-1. Fire on the ISS



If the oxidizer is oxygen from surrounding air. The presence of a force of gravity is necessary to produce **convection**, which removes combustion products and brings a supply of oxygen to the fire. Without these force, a fire rapidly surrounds itself with its own combustion products and non-oxidizing gases from the air, which exclude oxygen and extinguish it.

FIRE ON THE ISS

movie 3-2. Handover of the Olympic Flame



While in space the torch was not alight as flames are not permitted on the ISS. It arrived on the International Space Station on a Soyuz spacecraft, November 7. The torch has been relit with gas once it had returned to Earth on November 11.

CANDLE LIGHT

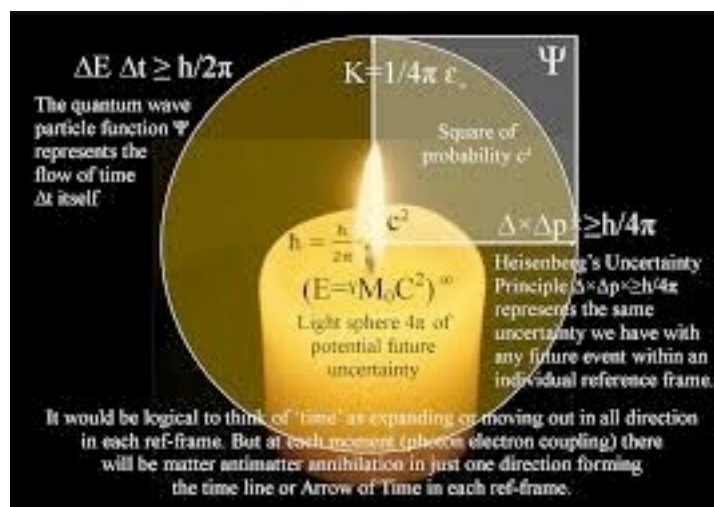


Figure 4-1. **candela**: Unit of luminous intensity

Several zones of a candle flame can be seen with the eye. At the bottom is a region that gives off blue light. This light is actually molecular emission from gaseous carbon, C₂. Further up the flame is a region that is substantially **opaque** and which gives off yellow light.

In the outer regions, where oxygen can enter from the surrounding air, the fragments combine with oxygen, eventually forming water and **carbon dioxide**.



Figure 4-2.

TEMPERATURE ZONES

What are the temperatures of the candle flame zones?

Color tells us about the temperature of a candle flame. The outer core of the candle flame is light blue -- 1400 °C. That is the hottest part of the flame. The color inside the flame becomes yellow, orange and finally red. The further you reach to the center of the flame, the lower the temperature will be. The red portion is around 1000 °C.

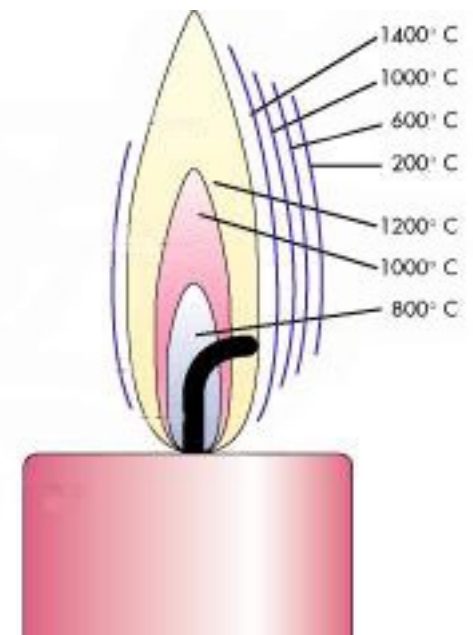


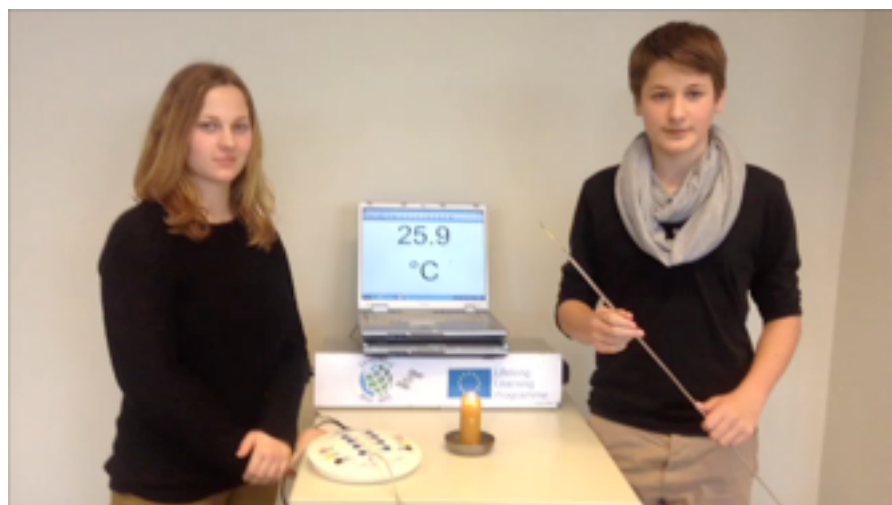
Figure 4-3.

How is it possible to measure high temperatures?

A device which is able to measure very high temperatures is called **thermocouple**. The potential difference between a “couple” of dissimilar metals in the tip of the tool, is utilized to measure the temperature.

The effect responsible for the action of thermocouples is the **Seebeck effect**.

movie 4-1. Measuring the temperature



High temperatures can be measured with a thermocouple

SEEBECK EFFECT



The Seebeck effect is used to measure temperature with great sensitivity and accuracy (see thermocouple) and to generate electric power for special applications.

The Seebeck effect is a phenomenon in which a temperature difference between two dissimilar

electrical conductors (metal **A**, metal **B**) produces a voltage difference between the two substances. The conductors are commonly metals.

The German physicist Thomas Johann Seebeck discovered (1821) the effect. The Seebeck effect is used to measure temperature with great sensitivity and accuracy (see thermocouple) and to generate electric power for special applications.

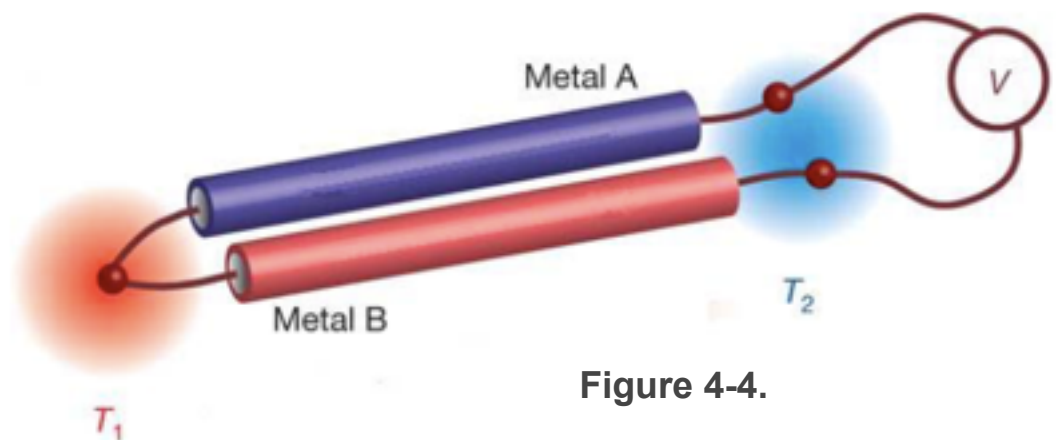


Figure 4-4.

movie 4-2. Functioning of a thermocouple



Heating at the connection point causes a potential difference



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LIST OF SOURCES

List of Sources

Introduction movie <https://www.youtube.com/watch?v=Q8ICO6P4QLE>

Page 1 (header) http://en.wikipedia.org/wiki/International_Space_Station

Figure 1-1. <http://www.betcheslovethis.com/article/olympics-2014-weird-shit-is-happening-in-sochi>

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Figure 4-1. http://quantumartandpoetry.blogspot.co.at/2012_05_01_archive.html

Figure 4-2. *Created by the author of this ibook*

Figure 4-3. <http://www.cosmiq.de/qa/show/748705/Wieviel-Grad-Temperatur-hat-eine-Kerzenflamme/>

Movie 4-1. *Movie created at BG/BRG Leibnitz*

Figure 4-4. <http://phys.org/news142847923.html>

Movie 4-2. *Movie created at BG/BRG Leibnitz*



6

REVIEW

Improve your knowledge!

OHNE TITEL

review 5.1

Question 1 of 9

In which year had been held the Olympic Winter Games in Russian Federation?

- A. 2008**
- B. 2010**
- C. 2012**
- D. 2014**

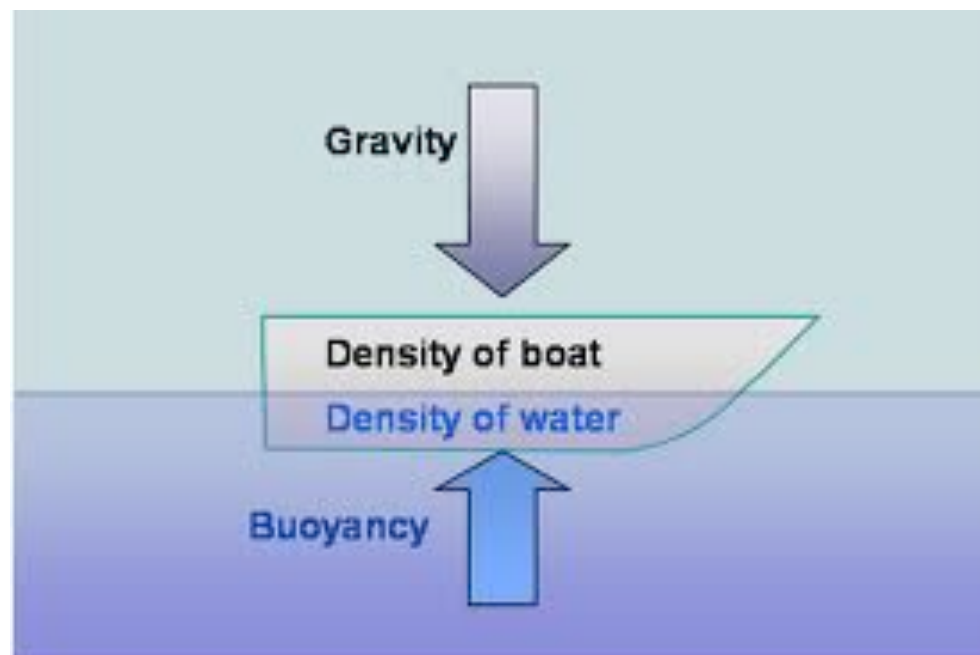


Check Answer



Buoyancy

The upward force that a fluid exerts on an object less dense than itself.



Related Glossary Terms

Drag related terms here

Index

Find Term

Chapter 3 - What is fire?

Carbon dioxide

CO₂ is a colorless, odorless, incombustible gas.

Related Glossary Terms

Drag related terms here

Convection

Heat transfer in a gas or liquid by the circulation of currents from one to another.



Related Glossary Terms

Drag related terms here

Fuels

A material such as wood, coal, gas, or oil burned to produce heat or power.

Related Glossary Terms

Drag related terms here

Microgravity

The very slight gravitational field experienced by a mass that is far removed from any other mass, as in intergalactic or interstellar space.

Related Glossary Terms

Drag related terms here

Opaque

Not reflecting light; having no luster

Related Glossary Terms

Drag related terms here

Seebeck

Thomas Seebeck (1770-1831), German physicist



Related Glossary Terms

Drag related terms here

Soot

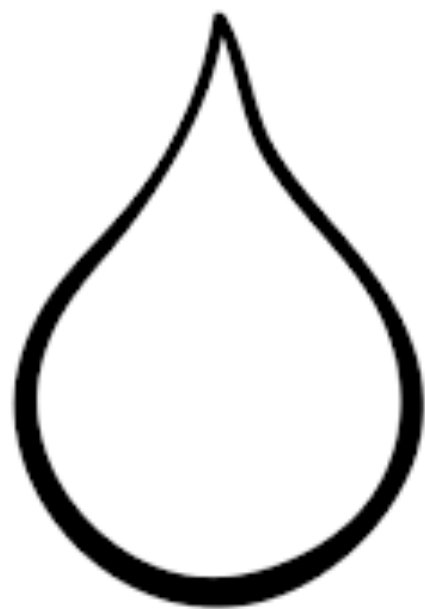
Finely divided carbon deposited from flames during the incomplete combustion of organic substances such as coal

Related Glossary Terms

Drag related terms here

Teardrop shape

Something shaped like a falling drop of a thin liquid, having a globular the bottom tapering to a point at the top.

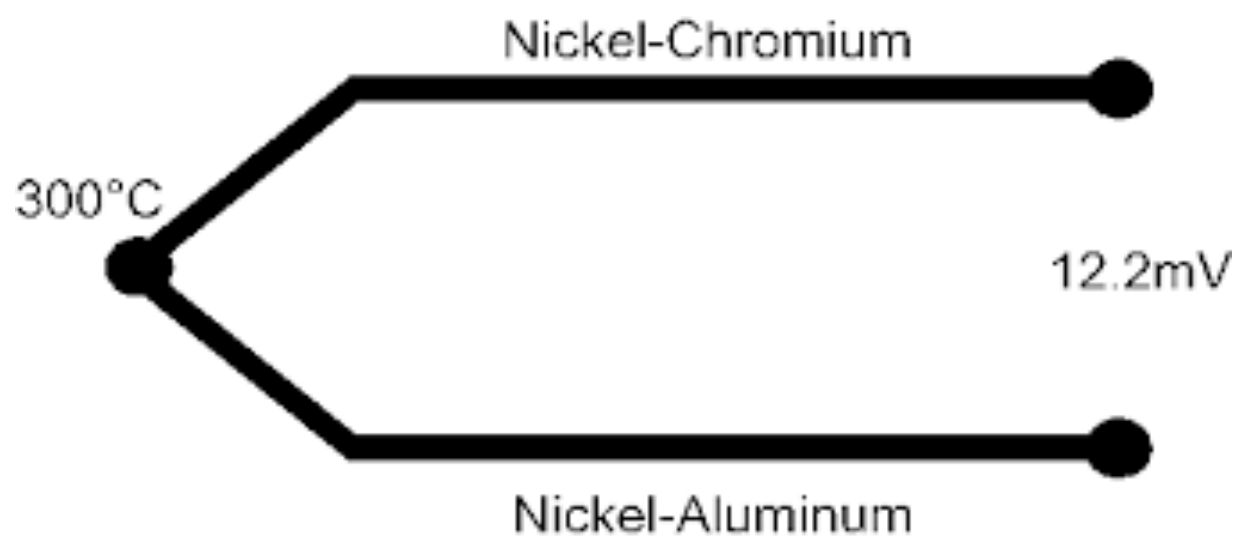


Related Glossary Terms

Drag related terms here

Thermocouple

A device for measuring temperature consisting of a pair of wires of different metals or semiconductors joined at both ends.



Related Glossary Terms

Drag related terms here

Torch

A portable light produced by the flame of a stick of resinous wood or of
le material.

Related Glossary Terms

Drag related terms here