Physical properties

Property	Metals	Non-metals
	Shiny	Dull
	High melting points	Low melting points
	Good conductors of electricity	Poor conductors of electricity
	Good conductors of heat	Poor conductors of heat
	High density	Low density
	Malleable and ductile	Brittle-Бутрамтгай

•mercury (a metal) has a low **melting point** and exists as a liquid at room temperature

•graphite, a form of carbon (a non-metal), has a high **boiling point** and is also a good **conductor** of electricity

Lesson 2. Physical properties of metal and non-metals

Some physical properties of metall and non-metall

Element	Density/g/cm^3
sodium	0.97
magnesium	1.7
aluminium	2.7
potassium	0.89
calcium	1.6
iron	7.9
copper	8.9
zinc	7.1
silver	10.5
mercury	13.5

Element	Density/g/cm^3
hydrogen	0.00009
helium	0.0001 7
carbon (graphite)	2.5
nitrogen	0.0012
oxygen	0.0013
sulfur	2.0
bromine	3.1

Some physical properties of metall and non-metall

Element	Melting point/°C
sodium	98
magnesium	650
aluminium	660
potassium	63
calcium	842
iron	1538
copper	1085
zinc	420
silver	962
mercury	-39

Element	Melting point /°C
hydrogen	-259
helium	-272
carbon (graphite)	3642
nitrogen	-210
oxygen	-219
sulfur	115
bromine	-7

Some physical properties of metall and non-metall

Element	Boiling point/°C
sodium	883
magnesium	1091
aluminium	2519
potassium	759
calcium	1484
iron	2862
copper	2562
zinc	907
silver	2162
mercury	357

Element	Boiling point/°C
hydrogen	-253
helium	-269
carbon (graphite)	sublimes
nitrogen	-196
oxygen	-183
sulfur	445
bromine	59

Some physical properties of metall and non-metall

Element	Electrical conductor
sodium	yes
magnesium	yes
aluminium	yes
potassium	yes
calcium	yes
iron	yes
copper	yes
zinc	yes
silver	yes
mercury	yes

Element	Electrical conductor
hydrogen	no
helium	no
carbon (graphite)	yes
nitrogen	no
oxygen	no
sulfur	no
bromine	no

Figure 11.3 Electricity heats the sodium until it changes into a gas called a vapour and gives out an orange-yellow glow.

Sodium / **Metal** /

Notable features

- can be easily cut up with a knife
- floats and burns on water

Uses

- orange street lamps

Figure 11.4 This magnesium flare is being used in a rescue at sea.

Magnesium / Metal /

Notable features

- Strips and powder catch fire easily

Uses

- Flares for the rescue of shipwrecked people
- Camera flashbulbs

Aluminium / Metal /

Figure 11.5 The bodies of aeroplanes are made aluminium because they are light-weight and do not corrode.

Notable features

- has a low **density** which makes it
- light-weight
- does not corrode in air

Uses

- aircraft
- power cables

Figure 11.6 This is what happens when a piece of potassium the size of a pea is dropped into water.

Potassium / Metal /

Notable features

- Can be strips easily cut up with a knife
- Explodes with water

Uses

- dyes, inks
- fertiliser
- weed killer

Calcium / Metal /

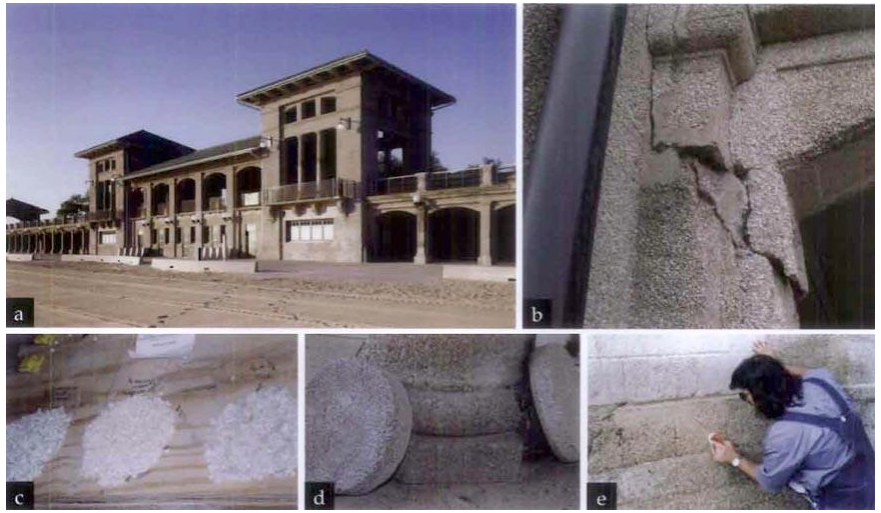


Figure 11.7 Calcium is present in the stones of the older buildings and the concrete blocks of the new buildings.

Notable features

- some effort, is needed to cut it up with a knife
- very reactive and present in many compounds

Uses

- huge number of uses including cement and concrete, cosmetics, toothpaste, insecticides, paints and cheese making

Figure 11.8 Steal car bodies at the start of a production line in a car factory

Iron / Metal /

Notable features

- a hard substance that can be shaped to make a wide variety of strong, hard objects
- can decompose into flakes of rust (see page 151)

Uses

- wrought iron was used for making swords, horseshoes and nails in the past
- cast iron used to make utility-hole covers
- combined with carbon to make steel cutlery and car bodies

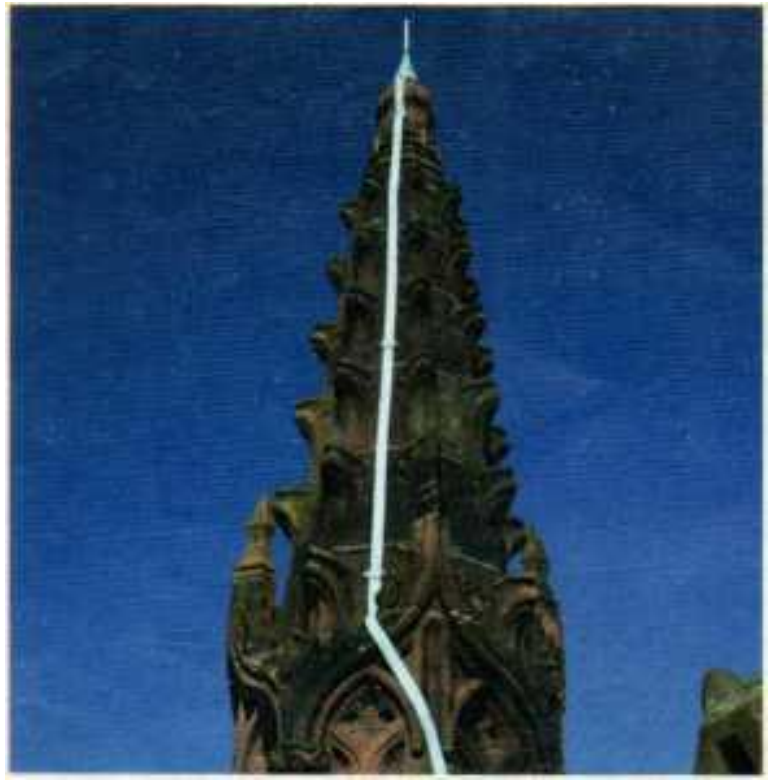


Figure 11.9 A copper lightning conductor protects a tower on a building.

Copper / Metal /

Notable features

- a red-orange metal which is soft enough to pull easily into wires or press into sheets very good conductor of heat

Uses

- wires in electrical circuits lightning conductors hot water cylinders copper-bottomed pans

Figure 11.10 Sheets of metal are coated with zinc in this iron and steel works in Russia to stop it rusting.

Zinc / Metal /

Notable features

- агаарт зэврэхгүй, хэврэг хөх цагаан металл

Uses

- rust prevention (see page 152) used in making some cells to generate electricity

Figure 11.11 Silver is used to make a range of highly decorated objects.

Silver / Metal /

Notable features

- a shiny white metal that is soft enough to be made into complicated shapes by pulling into wires and pressing into sheets

Uses

- Jewellery, coins, ornaments
- mirrors

Mercury / Metal /

Notable features

- a shiny silver liquid

Uses

- Thermometers
- liquid mirror telescopes
- fluorescent lamps
- tooth fillings

Figure 11.12 Mercury is spun in a bowl at high speed to make a thin, highly reflective layer for use in liquid mirror telescopes.

Non-metals

- Most of the non-metals that we use are not in their pure elemental form.
- We use them in compounds with metals and with other non-metals.
- Table 11.3 shows a survey of just seven non-metals to show their range of features and uses and some of their physical properties.

Hydrogen / Non-metal /

Figure 11.13 Hydrogen burning in air

Notable features

- a colourless, odourless gas
- can burn in air but a certain air/hydrogen mixture explodes

Uses

- used in making products from oil

Helium / Non-metal /

Figure 11.14 These large helium balloons can lift people high Into the air.

Notable features

- a colourless, odourless gas less dense (and therefore lighter) than air
- does not burn in air

Uses

- party balloons, airships
- provides low temperatures for super-conducting magnets in MRI scanners

Carbon / Non-metal /

Figure 11.15a This diamond-tipped drill can bore a hole in rock.

Notable features

- two main forms:
- diamond - hard, transparent crystal
- graphite - a grey, shiny, slippery solid which conducts electricity

Uses

- diamond - jewellery, saws, drills and certain types of scalpel
- graphite - used with clay to make pencil leads, lubricants for machinery and in some kinds of batteries and electric motors

Nitrogen / Non-metal /

Figure 11.16 The low temperature of liquid nitrogen has a wide range of uses from storing biological material such as cells, to providing cooling in some large computer systems.

Notable features

- a colourless, odourless gas
- does not allow things to burn in it
- slows down chemical reactions which cause decay

Uses

- food storage bags
- aircraft tyres
- to provide a low temperature for the storage of blood

Oxygen / Non-metal /

Figure 11.17 A torch burning acetylene in oxygen gas is being used to weld two metals together.

Notable features

- a colourless, odourless gas supports burning is needed for respiration

Uses

- life support systems in hospital to help breathing
- in industry for welding and cutting metals

Sulfur / Non-metal /

Figure 11.18 Sulfur burns with a blue flame.

Notable features

- yellow, brittle solid
- does not dissolve in water
- burns in air to produce sulfur dioxide gas

Uses

- to make rubber harder for use as tyres
- as a fungicide to protect crops

Bromine / Non-metal /

Figure 11.19 Fumes rise from the surface of liquid bromine

Notable features

- a red-brown liquid which is slightly transparent
- produces red-brown toxic fumes with an unpleasant smell soluble in water
- present in seawater from which it is extracted

Uses

- flame retardants
- dyes
- disinfectants

Table 11.5 Physical properties of metal and non-metals

Property	Metal	Non-metal
state at room temperature	solid (one is a liquid)	solid, liquid or gas
density	generally high	generally low
surface	shiny	dull
melting point	generally high	generally low
boiling point	generally high	generally low
effect of hammering	shaped without breaking	breaks easily
magnetic	a few examples	no examples
conduction of heat	good	very poor
conduction of electricity	good	very poor (one conductor)

Homework

1-11 асуултыг бичээд хариулах

Homework

2. What feature of magnesium makes it suitable for making flares?

Magnesium catches fire easily

Homework

3. Why do the notable features of aluminium make it suitable for making aircraft and power cables?

Aluminium has a low density which makes it light-weight so it is easier to keep aircraft in the air and to support power cables. It does not corrode in air so it is not damaged by exposure to air.

Homework

4. Why is copper particularly useful in electrical circuits?

Copper is easy to pull into wires.

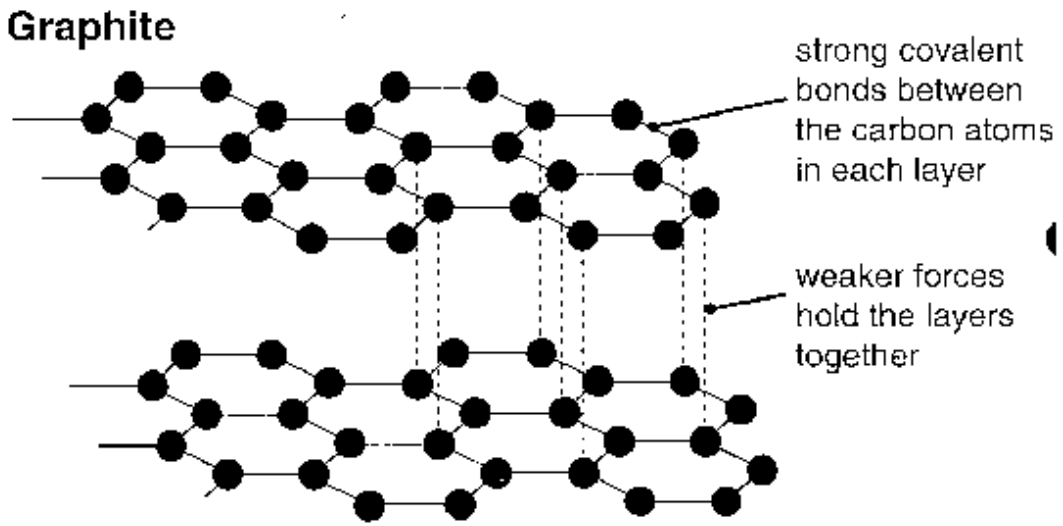
Homework

5. Why is helium used in airships?

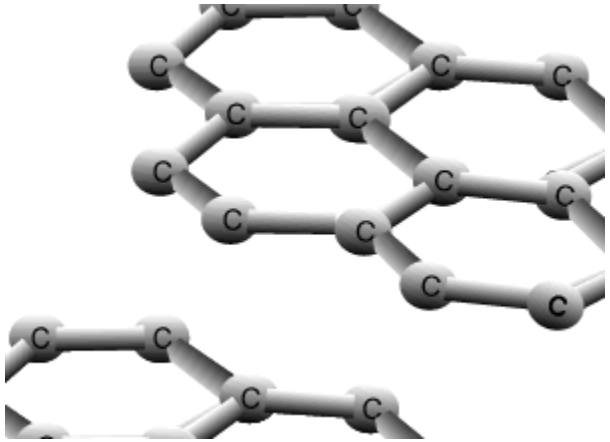
Helium is lighter than air so it causes the airships to rise.

Homework

6. Why is graphite used as a lubricant?



Graphite is a slippery solid.



Homework

7. Why is oxygen used in life support systems in hospitals?

Oxygen is needed for respiration.

Homework

8 a) Use the data on the physical properties of the metals and non-metals in Tables 11.2 and 11.4 to arrange the metals and non-metals in order of their densities, starting with the most dense.

1. mercury (13.5 g/cm^3)
2. silver (10.5g/cm^3),
3. copper (8.9g/cm^3),
4. iron (7.9g/cm^3),
5. zinc (7.1 g/cm^3),
6. bromine (3.1 g/cm^3),
7. aluminium (2.7g/cm^3),
9. carbon (2.5g/cm^3),
10. sulfur (2.0g/cm^3),
11. magnesium (1.7g/cm^3),
12. calcium (1.6g/cm^3),
13. sodium (0.97g/cm^3),
14. potassium (0.89g/cm^3),
15. oxygen (0.0013g/cm^3),
16. nitrogen (0.0012g/cm^3),
17. helium (0.00017g/cm^3),
18. hydrogen (0.00009g/cm^3)

Homework

8 b) What general conclusions can you draw from your list?

Metals are generally denser than non-metals.

Homework

8 c) What exceptions can you find to your general conclusions?

- Bromine is an exceptional non-metal in that it is denser than some metals.
- Magnesium, calcium, sodium and potassium are exceptional metals in that they are less dense than some non-metals.

1. mercury (13.5 g/cm^3)
2. silver (10.5g/cm^3),
3. copper (8.9g/cm^3),
4. iron (7.9g/cm^3),
5. zinc (7.1 g/cm^3),
6. bromine (3.1 g/cm^3),
7. aluminium (2.7g/cm^3),
9. carbon (2.5g/cm^3),
10. sulfur (2.0g/cm^3),
11. magnesium (1.7g/cm^3),
12. calcium (1.6g/cm^3),
13. sodium (0.97g/cm^3),
14. potassium (0.89g/cm^3),

Homework

8 d) Gold is a metal with a density of 19.3g/cm^3. How does this information fit with your general conclusion?

It fits well because it is much denser than any non-metal.

Homework

8 e) Iodine is a non-metal with a density 4.9g/cm^3. How does this information fit with your general conclusion?

It does not fit well because iodine is denser than bromine and therefore denser than some metals. bromine (3.1 g/cm^3),

Homework

9 a) Use the data on the physical properties of the metals and non-metals in Tables 11.2 and 11.4 to arrange the metals and non- metals in order of their melting points, starting with the element that has the highest melting point.

1. carbon (3642 °C),
2. iron (1538°C),
3. copper (1084 °C),
4. silver (962 °C),
5. calcium (842°C),
6. aluminium (660°C),
7. magnesium (650 °C
8. zinc (420 °C),
9. sulfur (115°C),
10. sodium (98 °C),
11. potassium (63 °C),
12. bromine (-7°C),
13. mercury (-39°C),
14. nitrogen (-210°C),
15. oxygen (-219°C),
16. hydrogen (-259 °C),
17. helium (-272 °C)

Homework

9 b) What general conclusions can you draw from your list?

Metals tend to have higher melting points than non-metals.

Homework

9 c) What exceptions can you find to your general conclusions?

- Carbon is an exceptional non-metal because it has a higher melting point than all the metals in the list.
- Mercury is an exceptional metal because its melting point is below those of some non-metals in the list.

1. carbon (3642 °C),
2. iron (1538°C),
3. copper (1084 °C),
4. silver (962 °C),
5. calcium (842°C),
6. aluminium (660°C),
7. magnesium (650 °C
8. zinc (420 °C),
9. sulfur (115°C),
10. sodium (98 °C),
11. potassium (63 °C),
12. bromine (-7°C),
13. mercury (-39°C),

Homework

9 d) Silicon is a non-metal with a melting point of 1414 °C. How does this information fit with your general conclusion?

It does not fit well as its melting point is higher than all but one of the metals in the list.

Homework

9 e) Lead is a metal with a melting point of 327.5 °C. How does this information fit with your general conclusion?

It just about fits as it is the eighth metal in the list with a melting point higher than sulfur, a non-metal, but lower than most of the other metals in the list.

Homework

10 Can the property of electrical conductance be used to distinguish metals from non-metals? Explain your answer.

Yes. All metals conduct electricity and all non-metals except one, carbon, do not conduct electricity.

Homework

11 How could use the particle theory to explain why metals generally have a greater density than non-metals?

The particles of metals are always packed tightly together because they are solids but many of the non-metals are gases which have large spaces between their particles.