UNIT 4
ALLOYS

Vocabulary

- **revision of the vocabulary**

Grammar and functions

- **Defining and explaining**
- **Relative clauses**
- **WHAT vs WHICH**
- **Shortened relative clauses**
- **Uses of THAT**

TRANSLATION: METALS

Read the text and decide how best to translate the expressions given below.

1- usan los ingenieros
2- tantos metales
3- Hay
4. ofrece
5.fuerza
6. su fuerza y tenacida

d

Why **DO ENGINEERS USE** (1) **SO MANY METALS** (2) today when **THERE ARE** (3) other materials, especially plastics, which are available? A material is generally used because **IT OFFERS** the required **STRENGTH** (5) and other properties at minimum cost.Appearance is also an important factor. The main advantage of metals is **THEIR STRENGTH AND TOUGHNESS** (6). **CONCRETE** (7) may be cheaper and **IS FREQUENTLY/OFTEN widely/commonly USED** (8) in building, but even concrete **DEPENDS ON** (9) its core/nucleus of steel for strength.

Plastics are **LIGHTER AND MORE/BETTER CORROSION RESISTANT/RESISTANT TO CORROSION** (10) but they are not usually as strong. Another problem with plastics is **WHAT (WE HAVE) TO DO** (11) with them after use. Metal objects **CAN BE BROKEN** (12) down and the metals recycled; plastics can only be dumped or burned. Not all metals are strong, however. Copper and aluminium are both fairly **WEAK** (13), but if **(THEY ARE) MIXED** (14) together, the result is **AN ALLOY** (15) called aluminium bronze, **WHICH IS MUCH/FAR STRONGER** (16) than either pure copper or pure aluminium. Alloying is an important method of **OBTAINING/ACHIEVING/(GETTING)** (17) whatever special properties are required: strength, toughness, resistance to wear, magnetic properties, high electrical resistance or corrosion resistance.

The properties of a metal can be further improved by use of heat treatment. Heat treatment is the term given to **A SERIES/GROUP/NUMBER/SET OF DIFFERENT** (18) procedures **IN WHICH** (19) the properties of metals and alloys are changed. It usually **CONSISTS OF/in HEATING** (20) the metal or alloy to a selected temperature **BELOW ITS MELTING POINT** (21) and then **COOLING IT (DOWN)/LETTING IT COOL** (22) at a certain rate to obtain those properties which are required. For example, hardening is used to make metals harder. Tempering **MAKES THEM SOFTER AND LESS BRITTLE/softens and embrittles them** (23)

Annealing is carried out to make a metal soft so that it can be machined **MORE EASILY** (24).

It is easier to machine
more easily machined
more easily machineable

(IN) THIS WAY/THUS (25), metallic materials can be produced to meet every kind of engineering specification and requirement. ***Meet specification/requirements=to fulfil full+fill***

Methods of extracting, producing and treating metals **ARE BEING DEVELOPED** (26) all the time to meet engineering requirements. This means that there is an enormous variety of metals and metallic materials **FROM WHICH TO CHOOSE/TO CHOOSE FROM (27)**

18. una serie de diferentes
19. en los que
20. consiste en calentar
21. por debajo de su punto de fusión
22. enfriarlo
23. los hace más blandos y menos quebradizos
24. más fácilmente
25. De esta forma
26. se están desarrollando
27. de los que elegir

Make a list of all the properties given in the text and write down the corresponding NOUN or ADJECTIVE for each of them

STRENGTH- STRONG
WEAKNESS-WEAK
BRITTLENESS-BRITTLE
LIGHTNESS-LIGHT
RESISTANCE-RESISTANT
MAGNETISM-MAGNETIC
HARDNESS-HARD

GIVING DEFINITIONS: RELATIVE CLAUSES

When defining, we normally mention a specific item which belongs to a general class and then we add the characteristics which make that item different from the other members of the class. The main structure used in definitions is the RELATIVE CLAUSE.

FUNCTION	SUBJECT	OBJECT	POSSESSIVE	PREPOSITION
DEFINING	that (which/who)	that(0)	whose + NOUN NOUN + of which	PREP + which
NON-DEFINING	which (who)	which (whom)	whose + NOUN NOUN + of which	PREP + which

The elements that/which compose steel are iron and carbon
Iron, which is a component of steel, is a common metal
Iron and carbon, of which steel is composed, have different properties
, which steel is composed of,
Steel, whose components are iron and carbon, is a metal
, the components of which are iron and carbon, is a metal

An ITEM is a GENERAL CLASS:
-Which(that)+vb-s: Stainless steel is an alloy WHICH/THAT DOES NOT CORRODE.
-Which(THAT)+IS VB-ED: Al. is a metal WHICH/THAT IS PRODUCED from bauxite.
-PREP+WHICH: Acoustics is a branch of physics IN WHICH sound is studied.

A. The structure PREP+REL is very common in Scientific English. Decide which is appropriate.

1. The nucleus is the part of the atom (***around which***/*to which/by which*) smaller particles rotate.
2. Corrosion is a process (***which***/*by which/of which*) cannot be totally avoided.
3. The magnitude of a force is equal to the number of grams constituting the mass (*at which/**on which**/about which*) it acts multiplied by the number of cm/sc.
4. Polymers are the elements (***on which***/in which/ which) plastics are based
5. Dynamics is a discipline (***in which***/*which/for which*) movement is studied in detail.
6. The coating (***with which***/*at which/in which*) the system is covered costs ten thousand pounds.
7. A thermostat is a device (*on which/around which/**with which***) temperature can be controlled.
8. A thermometer is a device ***on which*** temperature can be displayed

9. Our engineers are designing a technique (*for which/**by which**/which*) energy loss can be significantly decreased.
10. The way [(*at which/**in which**/for which*)] these components are assembled is not the ideal one.
11. The glass (*which/**from which**/by which*) retorts are made must be fire-proof
12. A container of hot water gives off heat to the objects (*which/**by which**/in which*) it is surrounded.
13. The melting point is the temperature (in which/by which/ ***at which***) metals change from solid to liquid

1. Strength is the main property **which/that** steel offers.
2. The process ~~**that/which is**~~ known as polymerization consists of joining different polymers **of/by which** plastics are composed.
3. Electrons, the electrical charge **of which**/*(whose electrical charge)* is negative, are the responsible particles for the production of electricity.
4. The high speeds **at which** the rotor in a generator turns produce large amounts of electricity.
5. An electrolytic cell is the place **in which/(where)** the electrolytic process takes place.
6. The discovery of semiconductors allowed the mass production of chips, **which** reduced the cost of computers significantly.
7. Lead, **whose** symbol is Pb, is the heaviest metal. *the symbol of which*
8. There are many different ways **in which** we may change the properties of materials.

B. Join these sentences with the appropriate relative structure

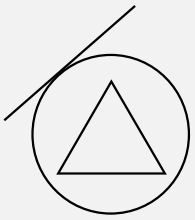
1. Atoms are the particles **by/of which** all matter is composed.
2. Strength is the main property **which/that/0** steel offers.
3. The process **which/that** is known as polymerization consists of joining different polymers **of/from which** plastics are made.
4. Electrons, the electrical charge **of which** is negative [**whose electrical charge is negative**], are the responsible particles for…electricity.
5. The high speeds **at which** the rotor in a generator turns produce large amounts of electricity.
6. An electrolytic cell is the place (**where)/in which** the electrolytic process takes place.
7. The discovery of semiconductors allowed the mass production of chips, **which** reduced the cost.
8. The temperature **at which** iron melts is 1550ºC.
9. Lead **whose** symbol is Pb, is the heaviest metal.
10. There are many different ways **in which** we may change the properties of materials.
11. The lower part of the atmosphere, (**where)/in which** weather phenomena occur, is known as..
12. Ductility is the main property **that/which/0** copper possesses

SHORTENED RELATIVE CLAUSES

SHORTENED RELATIVE CLAUSES are very common in technical texts. Relative clauses can **ONLY** be shortened when the Relative Pronoun is the **SUBJECT** of the relative clause. There are two possibilities:

When the verb in the Relative clause is in the passive voice = **VB-ED** Aluminium is a metal ***that/which is produced*** from bauxite =>
Aluminium is a metal ***PRODUCED*** from bauxite.

When the verb in the Relative clause is in the active voice = **VB-ING**:
A tangent is a straight line ***that/which touches*** *a curve*. =>
A tangent is a straight line ***TOUCHING*** a curve



Tin is a metal ***BELONGING*** to the carbon group
WHICH/THAT BELONGS
The triangle, ***WHICH IS SURROUNDED*** by a circle, represents the nucleus
SURROUNDED
The circle ***WHICH SURROUNDS*** the triangle contains electrons
The circle ***SURROUNDING*** the triangle...
Steel is an alloy ***that/which consists of*** *Fe and C*
CONSISTING OF

EXERCISES

SHORTENED RELATIVE CLAUSES

Write the verb in brackets in the -ED or -ING form

1. The test-tube ***CONTAINING*** the solution
   The solution CONTAINED in the test tube
2. The cables ***SUPPLYING*** the electricity
   The electricity SUPPLIED by the cables
3. This report contains the results ***OBTAINED*** from the test.
4. The temperatures ***SHOWN*** in the graph are.
5. The liquid ***FLOWING*** through the pipe is low grade oil.
6. The mixture ***FED*** to the machine is then processed.
7. We analyzed the samples ***TAKEN*** from polluted water.
8. A new synthetic material ***DEVELOPED*** last year
9. The metal ***SURROUNDING*** the engine must
   The engine SURROUNDED by the metal
10. The metals ***KNOWN*** as ferrous metals

NON-DEFINING RELATIVE CLAUSES

The elements that/which compose steel are iron and carbon
Iron, which is a component of steel, is a common metal
Iron and carbon, of which steel is composed, have different properties
Steel, whose components are iron and carbon, is a metal
, the components of which are iron and carbon, is a metal
The circle SURROUNDING the triangle has electrons
The triangle SURROUNDED by the circle is the nucleus

In NON-DEFINING RELATIVE CLAUSES the relative pronoun WHICH (WHO) cannot be replaced by THAT. They usually follow a comma.

Remember that when the Rel. Pronoun is replacing an entire sentence, it is ALWAYS a Non-Defining Relative Clause, and therefore the only possibility is WHICH:

E.g.: One of the most commonly used metals is steel, WHICH consists of Fe and C.
We cool the metal slowly, WHICH releases the internal stresses.

Note the difference between WHAT and WHICH. WHICH always needs a specific reference in the previous sentence whereas WHAT has no specific reference at all.

I gave her just what she needed
What I'd like is a digital watch
Do you want to hear what she said?
John got the job, which surprised everybody
Steel, which is an alloy of Fe and C

USES of THAT

THAT has 4 main uses: (+1)
(+Demonstrative adjective)

- Relative pronoun (THAT or WHICH) : e.g. *The materials (THAT /WHICH are) used in structures must be very strong*
- Conjunction: THAT (after vbs such as TO SAY, TO STATE, TO KNOW). E.g. *She said THAT it was raining*
- Pronoun (= THE ONE(S) usually with adjectives): THAT / THOSE. They are generally used in comparative constructions and are normally followed by preposition or shortened relative clause (THAT/THOSE + Rel Clause or Prepositional phrase = el(los) que // el(los)de :
  - ~~*I like the blue bag but not the RED ONE*~~
  - *The density of iron is higher than THAT OF/the one of zinc*
  - *The results are better than THOSE/the ones presented last year*
  - *The properties of alloys are better than those/the ones of their components*
  - *I have two articles. I think I'll read that/the one about materials first*

EXERCISE

The melting point of Hg is far/much lower than <u>that of</u> the rest of metals

(the melting point of the rest of metals)

The melting points of alloys are usually higher than <u>those of</u> their components

Decide the function of THAT / THOSE in the following sentences

1. The microscope showed that the membrane of TiNi was thicker than that of stainless steel
2. The result is a plethora of choices that enable today's engineers to fine-tune the selection process
3. Natural materials such as obsidian and tektites have compositions and properties similar to those of synthetic glass.
4. Plastics have a lower melting point than that of metals
5. The results obtained in the experiment are compared to those given in the specifications
6. The toughness and hardness of a steel that is not heat treated depend on the amount of carbon that is added to the mixture
7. The results that were obtained during the experiment show clearly that the elasticity of steel is higher than that found in pure iron.
8. this alloy has a high tensile strength, comparable to that of the duplex stainless steels Engineers must choose the materials that they consider best suited for a particular purpose
9. Wilm discovered that the alloy increased in hardness when left to age at room temperature
10. Polymers can never have a degree of order equivalent to that of low molecular materials like ice or common salt

. EXERCISES

A. Decide whether WHAT or WHICH should be used in the following sentences

1. The mixture of copper and tin is **WHAT** is known as bronze, **WHICH** was probably the first alloy used by man.
2. We need to benefit from solar energy, **WHICH** is difficult in some countries.
3. They were not surprised at **WHAT** this device can detect, because they knew **WHAT** to expect.
4. The maintenance engineers did **WHAT** they could, **WHICH** wasn't much.
5. Many companies don't know **WHAT** to do with their waste, **WHICH** makes for serious environmental problems.
6. He is familiar with several programming languages, **WHICH** makes him suitable for the job.
7. We don't know **WHAT** caused the accident in the power plant.
8. **WHAT** goes up must come down.
9. It doesn't matter **WHAT** you do, the system won't work properly anyway.

10. I am sure that **WHAT** the technicians say is correct, but we should look for better alternatives to provide clean energy. (TO **PROVIDE** THE CITY **WITH** CLEAN ENERGY/ TO **SUPPLY)**

EXERCISES

A. Join these pairs of sentences by means of a relative. Use shortened relative clauses whenever possible.

1. H.Oersted discovered the relationship between electricity and magnetism. He was a Danish scientist.
2. Light moves at 300.000 Km/s. (The speed..... (*a la que se mueve la luz* ...)
3. An atom has a nucleus. Electrons orbit around the nucleus.
4. The figure shows an apparatus. It is used to measure the specific heat of a metal.
5. Steel contains very little carbon. It is known as mild steel.
6. Venus is a planet. The surface of Venus is thought to be at least 200ºC
7. An axis is an imaginary line. A body rotates around this line.
8. Conductors are a kind of material. Electricity flows through them.
9. Electrons, protons and neutrons make up an atom. An atom is composed of these particles. (*Electrons, protons and neutrons are the particles ....)*
10. Steel consists of carbon and iron. Steel is an alloy.

B. Here are some of the most common mistakes made by students when using relative clauses. Correct the wrong sentences (Not all sentences have mistakes, and some sentences have more than one mistake).

1. The properties of an alloy depend on the materials that **IT** contains.
2. Electrons orbiting farther from the nucleus are (**MORE**) easily drawn away.
3. An electrolytic cell is the place in which **ELECTROLYSIS** takes place.
4. Alloying is a process in which several metals are involved.
5. Steel is an alloy **WHOSE** composition consists of carbon and iron.

   the composition of which
6. Go on with what you were doing.
7. A compiler is the name **GIVEN** to the software that translates a program into machine code.
8. Conductors are materials which electricity can flow through./**THROUGH** which electricity can flow
9. The mixture of copper and zinc is called brass, (**WHICH IS**) the most common non-ferrous alloy.
10. Metals can be heated **(UP)** to a certain temperature above which their properties change.
11. The temperature **AT WHICH** iron melts is 1,550ºC.
12. The amount of electricity generated depends on the speed in which **THE ROTOR** turns the rotor.

LISTENING: ALLOYS

An alloy is a **COMBINATION OF METALS** with each other or with nonmetals, such as **CARBON** or phosphorous, and formed by **MIXING** the molten components. The **PROPERTIES OF AN ALLOY** can be adjusted by varying the proportions of the constituents. Very few metals are used today **IN (THEIR)/(A) PURE STATE**.

The most common alloys are the different forms of **STEEL**, all **OF WHICH** contain a large proportion of **IRON** and **small amounts of CARBON** and other elements. For example, alloy steel is **CARBON STEEL** to which various elements, such as **CHROMIUM**, **COPPER**, cobalt, manganese, molybdenum, **NICKEL**, tungsten or vanadium, have been added in sufficient amounts **TO OBTAIN THE DESIRABLE PHYSICAL AND** chemical properties. **BRASS AND BRONZE**, two well-known alloys of **COPPER**, are still used in industry.

The properties of an alloy **DEPEND ON THE PROPERTIES OF THE ELEMENTS (THAT) IT CONTAINS** although the alloy behaves **in a different way**. For example, there is an alloy of **IRON THAT IS EVEN MORE MAGNETIC THAN PURE IRON**

The usual method of making an alloy is to heat the different elements **UNTIL THEY MELT** ***(up to their melting points)***, then to mix them. Thus, an alloy is a solution **RATHER THAN A SIMPLE MIXTURE**. As you know, the properties of a solution are not simply **A MIXTURE OF THE PROPERTIES OF ITS COMPONENTS**. Water for example, **FREEZES AT 0ºC** and sodium chloride **MELTS AT 801ºC**, but if sodium chloride is dissolved in water to form a strong solution of salt, **THIS SOLUTION FREEZES AT –23ºC**.

In fact/ACTUALLY, as a general rule, **A SOLUTION FREEZES AT A LOWER TEMPERATURE THAN ITS COMPONENTS (DO)**. And since alloys are **SOLID SOLUTIONS**, it should not surprise you to learn that **THEY BEHAVE IN A SIMILAR WAY**: an alloy usually has **A LOWER MELTING POINT** than the substances **OF WHICH IT IS COMPOSED**. For example, **PURE IRON MELTS AT 1,500ºC** and carbon at 3,350ºC, but cast iron, an alloy of iron and carbon, melts at **1,150ºC**.