Name: ....

Group: ....

Materials science

Test1

1. Answer the questions and complete the sentences. (6 points)

1. Materials science is also known as
   ....

2. What is forensic engineering?
   ....
   ....
   ....

3. Materials science originally derived from
   ....

4. Modern materials science evolved directly from
   ....

5. When did the major breakthrough in the understanding of materials occur? ....

6. What is the way of classifying materials?
   ....
   ....
   ....
   ....
   ....

2. Translate the words. (10 points)

1. constitute –
2. silica –
3. various –
4. properties –
5. significant –
6. occur –
7. putative –
8. derivative –
9. emphasis on –
10. encompass –

Total: ....

Mark: ....

Name: ....

Group: ....

Materials science

Test2

1. Answer the questions and complete the sentences. (8 points)

1. Ceramics and glasses are ....in form.
2. Most glasses contain ....
3. Engineering ceramics are known for their

   ....
4. What are composite materials?...

   ....
5. What are polymers?...

   ....
6. The dividing lines between the various types of plastics are based on their...
7. The alloys of iron make up...

   ....
8. Copper alloys have been known for...

   ....

2. Translate the words. (12 points)

1. application-
2. brittle-
3. concrete-
4. fuse-
5. stiffness-
6. fundamental-
7. insulative-
8. composite-
9. modify-
10. resistance-
11. raw-
12. compression-

3. Explain the terms. (6 points)

1. Biomaterials –
   ....
   ....
2. Ceramography –
   ....
   ....
3. Crystallography -
   ....
   ....

4. Metallography - ....

5. Metallurgy - ....

6. Microtechnalogy - ....

Total: ....

Mark: ....

Materials science

Materials science, also commonly known as **materials engineering**, is an interdisciplinary field applying the properties of matter to various areas of science and engineering. This relatively new scientific field investigates the relationship between the structure of materials at atomic or molecular scales and their macroscopic properties. It incorporates elements of applied physics and chemistry. With significant media attention focused on nanoscience and nanotechnology in recent years, materials science is becoming more widely known as a specific field of science and engineering. It is an important part of forensic engineering (Forensic engineering is the investigation of materials, products, structures or components that fail or do not operate or function as intended, causing personal injury or damage to property.) and failure analysis, the latter being the key to understanding, for example, the cause of various aviation accidents. Many of the most pressing scientific problems that are currently faced today are due to the limitations of the materials that are currently available and, as a result, breakthroughs in this field are likely to have a significant impact on the future of human technology.

History

Phrases such as Stone Age, Bronze Age, Iron Age, and Steel Age are good examples. Originally deriving from the manufacture of ceramics and its putative derivative metallurgy, materials science is one of the oldest forms of engineering and applied science. Modern materials science evolved directly from metallurgy The material of choice of a given era is often a defining point., which itself evolved from mining and (likely) ceramics and the use of fire. A major breakthrough in the understanding of materials occurred in the late 19th century, when the American scientist Josiah Willard Gibbs demonstrated that the thermodynamic properties related to atomic structure in various phases are related to the physical properties of a material. Important elements of modern materials science are a product of the space race: the understanding and engineering of the metallic alloys, and silica and carbon materials, used in the construction of space vehicles enabling the exploration of space. Materials science has driven, and been driven by, the development of revolutionary technologies such as plastics, semiconductors, and biomaterials.

Before the 1960s (and in some cases decades after), many *materials science* departments were named *metallurgy* departments, from a 19th and early 20th century emphasis on metals. The field has since broadened to include every class of materials, including ceramics, polymers, semiconductors, magnetic materials, medical implant materials and biological materials (materiomics).

Classes of materials

Materials science encompasses various classes of materials, each of which may constitute a separate field. There are several ways to classify materials. For instance by the type of bonding between the atoms. The traditional groups are ceramics, metals and polymers based on atomic structure and chemical composition. New materials have resulted in more classes. One way of classifying materials is:

- Biomaterials
- Carbon
- Ceramics
- Composite materials
- Glass
- Metals
- Nanomaterials
- Polymers
- Refractory
- Semiconductors
- Thin Films
- Functionally Graded Materials

Ceramics and glasses

Another application of the material sciences is the structures of glass and ceramics, typically associated with the most brittle materials. Bonding in ceramics and glasses use covalent and ionic-covalent types with SiO_2 (silica or sand) as a fundamental building block. Ceramics are as soft as clay and as hard as stone and concrete. Usually, they are crystalline in form. Most glasses contain a metal oxide fused with silica.

Engineering ceramics are known for their stiffness and stability under high temperatures, compression and electrical stress. Alumina, silicon carbide, and tungsten carbide are made from a fine powder of their constituents in a process of sintering with a binder. Hot pressing provides higher density material. Chemical vapor deposition can place a film of a ceramic on another material. Cermets are ceramic particles containing some metals. The wear resistance of tools is derived from cemented carbides with the metal phase of cobalt and nickel typically added to modify properties.

Composite materials

Filaments are commonly used for reinforcement in composite materials

Another application of material science in industry is the making of composite materials. Composite materials are structured materials composed of two or more macroscopic phases. Applications range from structural elements such as steel-reinforced concrete, to the thermally insulative tiles which play a key and integral role in NASA's Space Shuttle thermal protection system which is used to protect the surface of the shuttle from the heat of re-entry into the Earth's atmosphere.

Polymers

Polymers are also an important part of materials science. Polymers are the raw materials (the resins) used to make what we commonly call plastics. Plastics are really the final product, created after one or more polymers or additives have been added to a resin during processing, which is then shaped into a final form. Polymers which have been around, and which are in current widespread use, include polyethylene, polypropylene, PVC, polystyrene, nylons, polyesters,acrylics, polyurethanes, and polycarbonates. Plastics are generally classified as "commodity", "specialty" and "engineering" plastics.

Metal alloys

The study of metal alloys is a significant part of materials science. Of all the metallic alloys in use today, the alloys of iron (steel, stainless steel, cast iron,tool steel, alloy steels) make up the largest proportion both by quantity and commercial value. Iron alloyed with various proportions of carbon gives low, mid and high carbon steels.

Other significant metallic alloys are those of aluminium, titanium, copper and magnesium. Copper alloys have been known for a long time (since the Bronze Age), while the alloys of the other three metals have been relatively recently developed. Due to the chemical reactivity of these metals, the electrolytic extraction processes required were only developed relatively recently. The alloys of aluminium, titanium and magnesium are also known and valued for their high strength-to-weight ratios and, in the case of magnesium, their ability to provide electromagnetic shielding. These materials are ideal for situations where high strength-to-weight ratios are more important than bulk cost, such as in the aerospace industry and certain automotive engineering applications.

Sub-disciplines of materials science

Below is a list of disciplines within or related to the materials science field. These range from biomaterials, to ceramics, to metals, to textile reinforced materials. Also note that these are linked to the respective main article.

- Biomaterials – materials that are derived from and/or used with life forms.

- Ceramography – the study of the microstructures of high-temperature materials and refractories, including structural ceramics such as RCC, polycrystalline silicon carbide and transformation toughened ceramics
- Crystallography – the study of regular arrangement of atoms and ions in a solid, the defects associated with crystal structures such as grain boundaries and dislocations, and the characterization of these structures and their relation to physical properties.
- Electronic and magnetic materials – materials such as semiconductors used to create integrated circuits, storage media, sensors, and other devices.
- Forensic engineering – the study of how products fail, and the vital role of the materials of construction
- Forensic materials engineering – the study of material failure, and the light it sheds on how engineers specify materials in their product
- Glass science – any non-crystalline material including inorganic glasses, vitreous metals and non-oxide glasses.
- Metallography - Metallography is the study of the physical structure and components of metals, typically using microscopy.
- Metallurgy – the study of metals and their alloys, including their extraction, microstructure and processing.
- Microtechnology – study of materials and processes and their interaction, allowing microfabrication of structures of micrometric dimensions, such as Microelectromechanical systems (MEMS).
- Nanotechnology – it is the creation and study of materials whose defining structural properties are anywhere from less than a nanometer to one hundred nanometers in scale, such as molecularly engineered materials.
- Rheology – Some practitioners consider rheology a sub-field of materials science, because it can cover any material that flows.
- Tribology – the study of the wear of materials due to friction and other factors.