Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.
8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

<table>
<tr><th>Q No</th><th>Sub q.no.</th><th>Answer</th><th>marks</th></tr>
<tr><td>1</td><td></td><td>Any five</td><td>10</td></tr>
<tr><td>1</td><td>a</td><td>Distinguish between Micro structure and Nano structure
<table>
<tr><th>Micro structure</th><th>Nano structure</th></tr>
<tr><td>1. Microstructures are structures that are revealed by a microscope of 25x or greater magnification.</td><td>1. Nanostructures are structures that range between 1nm and 100nm (1nm=10-9m) in at least one dimension.</td></tr>
<tr><td>2. A microstructure has very small size than other structures.</td><td>2. A nanostructure is a structure of intermediate size between microstructures and molecular structures.</td></tr>
<tr><td>3. Microstructures are one dimension in scale.</td><td>3. Nanostructures are one dimension , two dimension and three dimension in scale.</td></tr>
<tr><td>4. The microstructure of a material influences physical properties of the material such as strength , toughness , wear resistance etc.</td><td>4. The nanostructure of a material influences physical properties of the material such as size , shape , specific surface area , aspect ratio etc.</td></tr>
</table></td><td>1 mark each for any two points</td></tr>
<tr><td>1</td><td>b</td><td>Define elasticity and plasticity.
Ans. <u>Elasticity</u> – The ability of a material to deform under load and return to its original shape when the load is removed is called elasticity.
<u>Plasticity</u> – The ability of a material to deform under load and retain its new shape when the load is removed is called plasticity.</td><td>1

1</td></tr>
</table>

1	c	**Compare thermoplastic and thermosetting polymers.**	1 mark each for any 2 points

Thermoplastic	Monomer used in this polymer bi functional.
1. Polymers whose shape can be changed on application of Polymers whose shape can be changed on application of	1. Polymers which once mould /shaped do not soften when heated and thus cannot be reshaped.
2. These are soften by heating , shaped when hot, harden when cooled, reshaped when heated again.	2. It can be heated and shaped once.
3. These are soften for no. of times on heating without change in their properties.	3. It can be decamped when reheated. No plasticity.
4. e.g. polyethylene, polypropylene etc.	4. e.g. epoxy resins, urea formaldehyde etc.
5. They have long chain linear structure	5. They have 3 dimensional cross linked structure.
6. Produced by addition polymerization process.	6. Produced by condensation polymerization process.
7. Low molecular weight	7. High molecular weight.
8. These are soft, less brittle and weak.	8. High molecular weight.
9. Monomer used in this polymer is bi-functional.	9. Monomer used in this polymer is tri, tetra or poly functional.

1	d	**(a) Define corrosion with example.** Ans. **<u>Corrosion - Definition</u>** – • Corrosion is the gradual deterioration or destruction of materials (usually metals and alloys) by chemical or electrochemical reactions with its environment. • Corrosion is defined as the gradual deterioration or destruction of a metal by chemical or electrochemical reactions with its environment. • Any process of deterioration and consequent loss of a solid metallic material through undesired chemical or electrochemical attack by its environment starting at the surface. **<u>Example</u>** – 1. Rusting of iron (i.e. the formation of iron oxide $Fe_2O_3.H_2O$) when exposed to atmospheric conditions. 2. Formation of green film of basic carbonate $CuCO_3$+$Cu(OH)_2$ on the surface of copper when exposed to moist air containing CO_2.	1 1 Mark for any 1
1	e	**Give the meaning of pig iron and cast iron.** **<u>Pig Iron</u>** – It is a semi finished product produced in the form of a chunky moulded blocks known as pigs , by heating an iron ore in a blast furnace. It contains about 91-94% Fe and high amounts of carbon , typically 3.5 to 4.5% along with small amounts of P , Mn , Si and S. **<u>Cast Iron</u>** – It is primarily comprised of iron (Fe) , carbon (C) and silicon (Si).In addition it also contains traces of sulphur , manganese (Mn) and phosphorous (P).The carbon content of cast iron ranges from 2 to 4.5% and its silicon content ranges from 0.5 to 3%.	1 1
1	f	**Classify steel based on deoxidation practice.**	1/2mark

		Classification of steels based on de-oxidation process (oxygen removed from steel making process)- 1. Killed steels 2. Semi-killed steels 3. Rimmed steels 4. Capped steels	each
1	g	**List out the factors which affects on corrosion** **Factors affecting rate of corrosion** – The factors affecting rate of corrosion are : A) Nature of the material (metal dependent factors) – 1) Position of the metal in the electrochemical or galvanic series 2) Purity of the metal 3) Surface of the metal 4) Relative area of cathodic and anodic part (anode-cathode area ratio) 5) Nature of the oxide film 6) Solubility of the corrosion product 7) Physical state of the metal 8) Volatility of the corrosion product B) Nature of the environment (environment dependent factors) – 1) Temperature of the environment 2) pH of the environment 3) Humidity of the environment/presence of the moisture in the environment 4) Presence of impurities in the environment 5) Amount of oxygen in the environment 6) Nature of anions and cations present in the environment 7) Presence of suspended particles in the environment	1 mark each
2		**Any three**	**12**

2	a	**Explain thermal insulator and electrical insulator with example.** **Thermal Insulators** – • The process of insulating against transmission of heat is called heat insulation and the materials are known as thermal insulating materials. • A material of relatively low thermal conductivity is used to cover a volume against loss or entrance of heat by conduction , convection and radiation. • The insulating capacity of a material is measured in terms of thermal conductivity of the material.Low thermal capacity is equivalent to high insulating capacity. • Insulating materials conserve energy by reducing heat loss or gain , lower energy bills/reduce energy costs , control surface temperatures for personnel protection and comfort , reduce emissions of pollutants to the atmosphere/reduce greenhouse emissions , provide comfortable/acceptable living/working environment , enhance process performance and reduce noise levels. **Examples:** Commonly used thermal insulating materials are glass wool (fiber glass) , polyurethane foam , ceramic wool , cork , expanded rock wool , slag wool , polystyrene (thermocol) , extruded polystyrene foam. **Electrical Insulators** – • Electrical shocks caused by the flow of current through the human body can result in injuries , disablement or death.D.C. voltage upto 40 volts and A.C. voltage upto 60 volts are considered as safe limits to the human body.Electricity is considered as a hazard beyond these limits and to prevent it , electrical insulation is required. • An insulating material used to cover electrical wires, cables or other equipments is called electrical insulation. • A material which does not allow the electricity to pass through it is called as an insulating material. A material that is unable to conduct electricity due to its very high electrical resistivity is called as an electrical insulator/insulating material.	1 1 1

		• Electrical insulating materials are usually used as protective coatings on electrical wires and cables , electrical machines as bushings for high voltage overhead transmission lines etc. **Examples:** Materials like ceramic , mica impregnated paper , porcelain , epoxy resin , polystyrene , polyester resin , silicone , polyurethane , butyl rubber silicone rubber , polyethylene , polyvinyl chloride , cross-linked polyethylene , teflon and fiber glass are very good electrical insulators.	1
2	b	**Define chemical reactivity.Explain it with air , water and acid.** **Definition** -Chemical reactivity is the ability of a material to combine with other materials such as water , air , acids , steam etc.	1
		With Air – e.g. mild steel reacts with air to form iron oxide (Fe_2O_3) – mild steel reacts with oxygen from air in the presence of moisture or dissolved oxygen from water to produce hydrated iron oxide $Fe_2O_3.xH_2O$.	1
		With Water – stainless steel does not react with water (i.e. stainless steel resists attack by air and water) due to the presence of a passive film of chromium oxide (Cr_2O_3) on its surface. This film is protective , stable , invisible , tightly adhered to the surface. i.e. it will not flake-off and self healing.If the surface is scratched then also the film of Cr_2O_3 will quickly be formed on its surface.This chromium oxide film acts as a barrier that prevents the access of oxygen and water to the underlying metal surface and consequently prevents further reaction of the material surface with air and water.	1
		With acid – 1. Iron (mild Steel) does not react with commercial grade sulphuric acid i.e. with conc. Sulphuric acid. 2. Iron (mild Steel) reacts with dilute sulphuric acid producing ferrous	

		sulphate as corrosion product. $Fe + 2H_2SO_4 \text{ -----> } FeSO_4 + SO_2 + 2H_2O$ 3. Iron (mild Steel) reacts with hydrochloric acid producing ferric chloride and hydrogen gas. $2Fe + 6HCl \text{ -----> } 2FeCl_3 + 3H_2$	1
2	c	**List out the engineering applications of ceramics.** Ceramics are used for following engineering applications , 1. Cutting tools and dies 2. Molten metal filters 3. Bearings 4. Sealing rings 5. Bushes 6. Fuel injection components 7. Spark plug insulators 8. Disk brakes and clutches 9. Jet turbine blades 10. Fuel cells 11. Body armour 12. Tank power trains 13. Gas burner nozzles 14. Catalytic converters 15. Catalyst supports 16. Catalyst 17. Heat exchangers 18. Reformers	½ mark each for any 8

		19. Kiln linings 20. Crucibles for glass making 21. Firebricks for furnace and ovens 22. Cylinder liners 23. Capacitors 24. Resistance heating elements 25. Flow control valves 26. Light emitting diodes , laser diodes 27. Optical communication cables 28. Heat sink for electronic parts 29. Filters 30. Rotors and gears 31. Electrode materials 32. Precise instrument parts 33. Grinding media 34. Ballistic armour 35. Bullet proof vests 36. Thread processing nozzles , oiling nozzles , rollers and twister parts.	
2	d	**Explain corrosion in acidic and alkaline environments.** **Corrosion in acidic medium :** • An acidic environment refers to an environment having a pH value of less than seven. Acidic environments are more prone to cause corrosion than alkaline and neutral environments. • When an acid reacts with a metal , salt is produced with the evolution of hydrogen gas. The general chemical reaction between an acid and a metal is , Metal + Acid → Salt + Hydrogen gas	2

		e.g. $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$ • Acid contains H+ ions and tend to accept electrons. They tend to grab electrons and form hydrogen gas. Metals give up electrons and from metal ions. $Fe \rightarrow Fe^{2+} + 2e^-$ and $2H^+ + 2e^- \rightarrow H_2$ • Thus , when we put an iron nail in an acid , the H^+ ions present in the acid grab electrons from the iron. Iron gives up electrons and gets converted into soluble Fe^{2+} ions and the solid material (nail) gradually disappears. The electrochemical reaction is , $Fe + 2H^+ \rightarrow Fe^{2+} + H^2$ **Corrosion in alkaline medium:** • Cathodic reaction is : absorption of oxygen $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$ • Corrosion is less in alkaline medium • Example of alkaline medium is NaCl solution, e.g. a piece of iron is immersed in sodium chloride solution $Fe \rightarrow Fe^{2+} + 2e^-$ $NaCl \rightarrow Na^+ + Cl^-$ $\frac{1}{2} O_2 + H_2O + 2e^- \rightarrow 2OH^-$ $Na^+ + OH^- \rightarrow NaOH$ $Fe^{2+} + 2Cl^- \rightarrow FeCl^2$	2
3		**Any three**	**12**
3	a	**Effect on Iron on:** **i)Chromium:** It increases hardenability. It increases corrosion resistance and oxidation resistance. It increases resistance to scaling at high temperature.	1

		ii)Copper: it improves the resistance to atmospheric corrosion. It strengthens steel. It may be added to improve formability. It improves pains adhesion **iii)Magnesium**: Magnesium is used in alloys because it is a light metal, which improves the mechanical properties of steels. At the same time, the strength and hardness also increase, while the relative elongation and impact toughness decrease. It is also used in alloys with iron, which improves its strength and ductility. **iv)Nickel:** It increases hardenability, improves toughness , ductility and corrosion resistance.	1 1 1
3	b	**Prevention and control of corrosion:** 1.Material selection and choice of materials 2.Proper design and fabrication of components 3. Use of high purity metals: The impurities present in a metal cause heterogeneity and form tiny electrochemical cells with rest of the metal. Due to this, metal undergoes corrosion at the region where impurities are present. Pure metal does not corrode. 4.Specific heat treatment 5.Modification of corrosion environment 6. Use of alloying: Corrosion resistance of many metals can be increased by alloying them with suitable alloying elements.	List of any 4 methods 2M and explanation of any 1 method 2 M

		7. Use of inhibitors: Inhibitors are organic chemicals which are added in small amounts to a corrosive medium in order to reduce its corrosive effect. Usually they form and maintain a protective film on the metal surface and thus acts as a barrier for further corrosion. 8.Cathodic protection (electrochemical protection): In this, the metal is forced to behave like a cathode thus protecting it from corrosion. This is achieved by supplying electrons to the metal surface to be protected. Addition of electrons to the metal suppresses its dissolution into metal ions. Different types are: Sacrificial anodic method Impressed current method 9.Use of protective surface coatings: Protective coatings provide a continuous physical barrier between the surface to be protected and the environment. These are classified as: Metallic coatings Inorganic coatings Organic coatings	
3	c	**Properties of Ceramics (In General)** 1 Mechanical Properties High compressive strength. High Young's modulus. High hardness Low toughness Very brittle High wear resistance.	1mark each

		Low tensile strength 2 Electrical Properties High electrical resistivity- very low electrical conductivity High dielectric strength. High dielectric constant Very low dielectric losses Some ceramics conduct electricity well and are used as semiconductors, Le. NTC and PTC resistors Some ceramics exhibit plezoelectric properties and can transfer mechanical deformations into voltage changes 3 Chemical Properties Very good resistance to all chemicals and organic solvents-chemically inert, Le very good corrosion resistance Completely resistant to oxidation even at high temperatures. 4 Thermal Properties Very low thermal conductivity-thermal insulators Very low coefficient of thermal expansion High thermal shock resistance High heat capacities. Ability to withstand very high temperatures.	
3	d	(i) **Specific heat –** • The specific heat of a material is the amount of heat energy per unit mass required to raise the temperature of the material by one degree Celsius.	1

		(ii) Heat capacity – • Heat capacity is the quantity of heat energy needed to raise the temperature of a specific material by one degree Celsius. • Heat capacity is the ratio of the quantity of heat energy transferred to a material and the resultant temperature rise. **iii)Thermal conductivity-** Thermal conductivity of engineering material is the property of a material that determines the rate at which it can transfer heat. It is a measure of the ability of a material to transfer heat. Thermal conductivity of material is the property to conduct heat. **iv)Thermal stability:** The ability of a material to withstand long time exposure to elevated/high temperatures without getting degraded. A thermally stable material will not be destroyed/degraded/decomposed by heat under high operating temperatures of the application.	1 1 1
4		**Any three**	**12**
4	a	**Relevant Organic and Inorganic Insulations:** **i)Refrigeration system:** Extruded Polystyrene Insulation. Cellular Glass, Polytechnic isocyanurate (PIR) Polyurethane (PU) Reason: polyurethanes are used to insulate freezers is that of their low thermal conductivity. These plastic foams are structurally robust and stable (they do not shrink or become deformed), thus they can withstand the extremes of cold temperatures.	1

		ii)Steam pipeline: calcium silicate and mineral fibres, Fibre glass (or cellular glass) Reason: Both can handle high temperatures and provide a good insulation value. **iii)Thermal incinerator:** Plastics. Ceramics. Fiberglass. Foam. Reason: Ceramic insulators are widely used in high heat. Ceramic's resistance to abrasion and long life and its ability to hold its shape and size under pressure makes it the perfect insulation material for heated applications. **(iv)Storage vessel:** polyurethane foam, mineral wool . Reason: good thermal insulation and fire resistance. It is highly fire-resistant.	1 1 1
4	b	Q = m x Cp x(T2-T1) = 20g x 4.18 7 J/g C X (90-0) C = 7536.6 joules	1 2 1
4	c	**Addition polymerization:** 1)the polymerization reaction involves the joining of unsaturated monomers by breaking of bonds in a chain like manner without loss of any by products is k/as addition polymerization. 2)monomers must have at least double or triple 3)monomers add to produce polymers	2

		4)no by product is form 5)it produces thermoplastics Example: pvc(poly vinyl chloride) **Condensation polymerization:** 1)Many monomers molecules join together to form the polymer with the loss or elimination of a small by products such as water or methanol is k/as condensation polymerization 2)Monomers must have at least two dis similar of different functional groups. 3)Monomers are condensed to produce polymers 4)By product is formed such as water or methanol 5)It produces thermosetting polymers Example: formaldehyde	2
4	d	**Applications of special alloy steel:** **Heat resistant steels :** Heat resistant steels are hard wearing and offer resistance to large variation in temperatures. Other characteristics/properties of these steels include corrosion resistance, oxidation resistance, creep resistance and hydrogen brittleness under very high temperature: Heat resistant steels are available in the form of plate, sheet, bar, pipe, tubing and fitting. Heat resistant steels are used in industrial furnaces, heat exchangers, steam tubes, steam boilers, recuperators gas and fuel lines, heaters, resistors, fire boxes and incinerators/waste incineration plants. **Stainless Steels:** Ferrite Stainless Steels Martensitic Stainless Steels	2 2

		Austenitic Stainless Steels Uses: It is used for process equipments, piping, valves, fittings and flanges in milk processing (dairy), wine making brewing, fruit juice and chemical industry. In chemical industry it is used especially for process equipments for nitration plants. It is used for storage tanks tankers and containers. It is used for handling nitric acid, phosphoric acid, citric acid, dyestuffs, crude and refined oils and organic and inorganic chemicals.	
5		**Any two**	**12**
5	a	Ferrous metal e.g. Gray cast iron White cast iron Plain carbon steel Low alloy steel Stainless steel e.g. making kitchen cutlery, appliances, and cookware. hospital equipment. machinery and tools, vehicles, hulls of ships, structural elements for buildings, bridges, and aircraft. 2) Non Ferrous metals: e.g. copper and its alloys Aluminium and its alloys Nickel and its alloys Lead and its alloys e.g. copper is used in electrical equipment such as wiring and motors. Aluminium is used in cans, foils, kitchen utensils, window frames, beer kegs and aeroplane parts. Gold is use in making wedding rings, Olympic medals, money, jewellery e.t.c **Composition of Some Alloy Steels**	2 M for list & 2 M for e.g. & 2 M for chemical composition

		(1) Hadfield manganese steel: 11-14% Mn, 1-1.3% C 0.60% max Si 0.05% max P, 0.04% max 5 and the rest Fe. (2) High speed steel/High speed tool steel/Tungsten high speed steel: 18% tungsten (W), 4% chromium (Cr), 1% vanadium (V), 0.7% carbon (C), small amounts of Si, S, P and Mn and the rest Fe. (3)Molybdenum high speed steel 8-7.5% Mo, 1.6% W, 2% V. 3.4% Cr, 0.8 to 1% C, small amounts of St. S. P and Mn and the rest Fe (4) Maraging steel 300: 18-19% Ni 8-9.5% Co, 4.6-5.2% Mo, 0.5-0.8% Ti 0.05 -0.15% Al, 0.03% C+ small amounts of S, P. Si and Mn and	
5	b	**Dry corrosion :** It is also known as chemical corrosion. It occurs due to direct chemical attack of metals surface by the atmospheric gases **Wet corrosion:** It is also known as electrochemical corrosion, Such type of corrosion is due to the flow of electron from metal surface anodic area towards cathodic area through a conducting solution. DRY CORROSION: OXIDATION CORROSION LIQUID METAL CORROSION	3 Marks each

		CORROSION BY OTHER GASES WET CORROSION: GALVANIC/BIMETALLIC CORROSION DIFFERENTIAL AERATION/CONCENTRATION CELL CORROSION **Characteristics of Chemical Corrosion(Dry corrosion)** It occurs in dry condition. It is due to the direct chemical attack of the metal by the environment. Even a homogeneous metal surface gets corroded. Corrosion product accumulate at the place of corrosion. It is self-controlled process. It adopt adsorption Mechanism **Characteristics of Electrochemical corrosion (Wet corrosion):** It occurs in the presence of moisture or electrolyte It is due to the formation of a large number of anodic and cathodic areas. Heterogeneous (bimetallic) surface alone gets corroded Corrosion occurs at the anode while the products are formed elsewhere . It is a self continuous process. Corrosion occurs at the anode while the products are formed elsewhere It follows electrochemical reaction.	
5	c	**Properties and Applications of:** **Silicon carbide:** Properties: Density = 3.2 g/cu.cm M.P = 2800 deg C Hardness = 9 Mohs Modulus of elasticity = 6.5 High wear resistance Excellent corrosion resistance	3

		Very hard materials High thermal conductivity Uses: It is used in car brakes and clutches. Ceramic plates in bulletproof vests Bearings Semiconductors wafer processing equipment Light emitting diode Cutting tools and burner nozzles. **Aluminium Carbide:** Properties: Density = 2.36 g/cu.cm M.P = 2200 deg C B.P.= 1400 deg.C Colourless hexagonal crystal High wear Resistance Excellent dielectric properties Good chemical resistance Uses: Use for bearing liners and seals Cutting tools Turbine parts Engine parts Refractories Insulators	3
6		**Any two**	**12**
6	a	**Hardness** It is the resistance of a material to plastic deformation-penetration, scratching,	1

		abrasion . The greater the hardness of the metal the greater the resistance it has for deformation.	
		Malleability Malleability Properties of Engineering Materials It is the ability of a material to deform plastically without fracture under compressive load Because of this property, metals are hammered and rolled into thin sheets.	1
		Ductility Ductility is the ability of a material to be deformed plastically without fracture under tensile load Because of this property, materials can be drawn out into fine wire without fracture	1
		Brittleness It is the property of sudden fracture without any visible permanent deformation Brittleness is the opposite of ductility (eg, cast iron and glass products). Brittleness is the tendency/ability of a material to break into pieces upon application of tensile force without any elongation or plastic deformation. Brittleness is the opposite of plasticity.	1
		Tensile Strength The tensile strength is defined as the maximum tensile load a material abject can withstand before fracture/failure divided by its cross-sectional area. The tensile strength is defined as the ability of a material to resist stretching (tensile/pulling load without fracture.	1
		Yield Strength The yield strength or yield stress is defined as the stress at which a material begins to deform plastically. Stress is the amount of force/energy that is being exerted on a material object	1

		divided by its cross-sectional area	
6	b	**Resistivity** The resistivity of a material is a measure of its resisting power to the flow of an electric current The resistivity of a material is the resistance of a wire of that material of unit length and unit cross-sectional area of the flow of electric current Resistivity is the reciprocal of conductivity. Thus, a material that has a high resistivity will have a low (electrica conductivity and vice versa. The resistivity (also known as specific resistance) depends on the nature and temperature of a material. A good conductor has a low resistivity, while a bad conductor has a high resistivity. The SI unit of resistivity a ohm meter (ohm.m) (Resistivity) = (V/I) *(A/L) V=Voltage I= Current A= c/s Area L= length Unit is = Ohm.cm **Conductivity (Electrical Conductivity)** Is a measure of the ability of a material to conduct an electric current (or to conduct electricity). Electrical conductivity is also known as specific conductance and has SI units of siemen per meter (S /m). Electrical Conductivity can flow easily through a material having a high conductivity. For example, copper, As per order of conductivity, we have conductors-copper, alumiinium, semiconductors-silicon and insulators	3 3

		Conductivity = 1/ (Resistivity) Unit is = Siemens per meter	
6	c	**Metals and Non Metals:** **Classification of metals:** Metals: 1. Ferrous. example: cast iron, stainless steel 2. Non ferrous. example: Al and its alloys, Cu and its alloys **Classification of non metals:** 1. Plastic 2. Rubber 3. Glass 4. Ceramics e.g. wood, asbestoses etc. **Uses of metals:** metals are used for MOC in steam boiler and steam pipeline it is used in storage and transporting it used for distillation column, storage tank, pump, pipe etc. **Uses of non metals:** non-metals are used for gaskets. It is used for seals, bushes , glands etc. Used for vessel and reaction kettle lining. Etc. **Physical properties of Metals:** Metals are ductile. Metals are malleable. Metals have high to moderate density. It has electricity conductivity	3 marks for metals and 3 marks for non metals

		These have metallic lusters. Metals are opaque **Chemical properties:** Metals form oxides that are acidic. Metals have one to three electrons in their outer shell Metals tend to loose their electrons. Metals are very good reducing agents. Metals are more prone to corrosion. Examples: Steel, aluminium, copper, cast iron, stainless steel. **Non-metals** Non-metals are poor conductors (or nonconductors) of heat and electricity These have no lusters. Non-metals are transparent. Non-metals have four to eight electrons. Non-metals gain or share electrons. Non-metals are very good reducing agents (plastics and rubbers). Non-metals Non-metals are not ductile. Non-metals are brittle. Non-metals have low to moderate density. Non-metals form oxides that are basic. Non-metals are less prone to corrosion. Examples: Ceramics, glass, polymers	