1. An electrostatic precipitator is normally used for separating particles from gases when

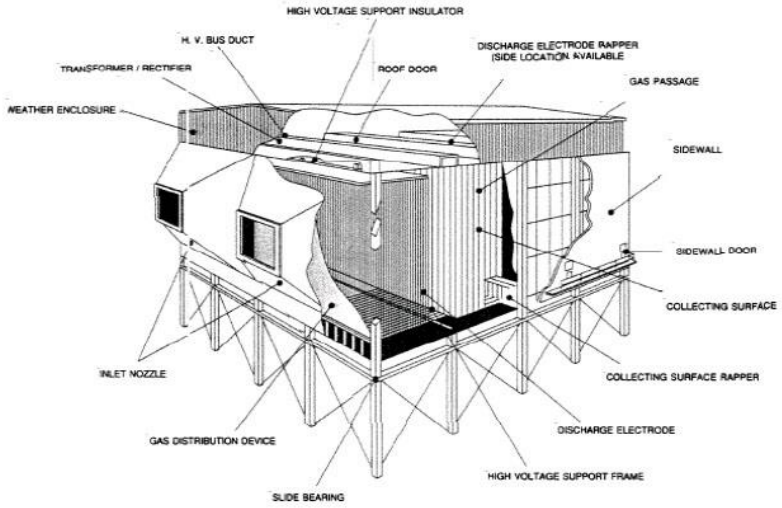
(1) particle size is greater than 1 mm
(2) particle size is less than 1 micorn
(3) gases contain high concentration of carbon monoxide
(4) gases contain high concentration of solids

Ans: 2

Note: Electrostatic precipitators are important tools in the process of filtering flue gases in a coal based thermal power plant. They are highly effective at reducing particle pollution, including those particles whose sizes approximate **1 micron (0.00004 inch) in diameter**, and some precipitators can remove particles of 0.01 micron in diameter.

An electrostatic precipitator (ESP) removes particles from a gas stream by using electrical energy to charge particles either positively or negatively. The charged particles are then attracted to collector plates carrying the opposite charge. The collected particles may be removed from the collector plates as dry material (dry ESPs), or they may be washed from the plates with water (wet ESPs). ESPs are capable of collection efficiencies greater than 99 percent.

An ESP is primarily made up of the following four components: gas distribution plates, discharge electrodes, collection surfaces (either plates or pipes) and rappers.



https://www.epa.gov/sites/default/files/2016-05/esp.jpg
https://www.epa.gov/air-emissions-monitoring-knowledge-base/monitoring-control-technique-electrostatic-precipitators#:~:text=An%20electrostatic%20precipitator%20(E

SP)%20removes,plates%20carrying%20the%20opposite%20charge.

2. The Weber number can be used to estimate

(1) ratio of inertial and surface tension forces
(2) ratio of inertial and compressibility forces
(3) ratio of inertial and centrifugal forces
(4) ration of pressure and surface tension forces

Ans: 1 (Application of Weber number in fluid mechanics:

i. Flow in Capillary tubes

ii. thin sheet flow

iii. Liquid atomization)

The dimensionless ***Weber number*** represents the ratio of disruptive hydrodynamic forces to the stabilizing surface tension force. Hence, the ***Weber number*** indicates whether the kinetic or the surface tension energy is dominant. For a spherical droplet the ***Weber number*** can be derived using the kinetic energy compared to the surface energy.

The higher the ***Weber number*** the more dominant is the kinetic energy. This means that most of the inserted energy converts into kinetic energy, i. e. an ejected droplet is faster with higher ***Weber number***. The lower the ***Weber number***the more dominant is the surface tension energy

(2008) Weber Number. In: Li D. (eds) Encyclopedia of Microfluidics and Nanofluidics. Springer, Boston, MA. https://doi.org/10.1007/978-0-387-48998-8_1689

The Weber Number is a dimensionless value useful for analyzing fluid flows where there is an interface between two different fluids.

The Weber Number is the ratio between the inertial force and the surface tension force and the Weber number indicates whether the kinetic or the surface tension energy is dominant. It can be expressed as

$$N_W = \rho\, v^2\, l / \sigma \qquad (1)$$

where

N_W = ***Weber number (dimensionless)***

ρ = *density of fluid* ***(kg/m^3, lb/ft^3)***

v = velocity of fluid (m/s, ft/s)

l = characteristic length (m, ft)

σ = *surface tension* ***(N/m)***

Since the Weber Number represents an index of the ***inertial force*** to the ***surface tension force*** acting on a fluid element, it can be useful analyzing thin films flows and the formation of droplets and bubbles.

Engineering ToolBox, (2004). *Weber Number*. [online] Available at: https://www.engineeringtoolbox.com/weber-number-d_583.html.

3. A particle *A* of diameter 10 micron settle in an oil of specific gravity 0.9 and viscosity 10 poise under Stokes Law. *Another* particle *B* with diameter 20 micron settling in the same oil will have a settling velocity

(1) same as that of *A* (2) one-fourth as that of *A*
(3) twice as that of *A* (4)four times as that of *A*

Ans: 4 (Note: Terminal or settling velocity, $v \propto R^2$)

4. Indirect contact heat exchangers are preferred over direct heat exchangers because

(1) Heat transfer co-efficient are high (2) There is no risk of contamination
(3) There is no mist formation (4) Cost of equipment is lower

Ans: 2

5. Which of the following fuels has the lowest calorific value per unit mass?

(1) Coal (2) Kerosene (3) Natural gas (4) Furnace oil

Ans: 4

6. Which of the following fuels has the highest calorific value per unit mass?

(2) Coal (2) Kerosene (3) Natural gas (4) Furnace oil

Ans: 3

The most widely used coagulant for removing suspended impurities from water is

(1) Bleaching power (2) Chlorine
(3) Calcium sulphate (4) Alum

Ans: 4

7. Ideal gas law is applicable at

(1) low temperature, low pressure (2) high temperature, high pressure
(3) low temperature, high pressure (4) high temperature, and low pressure

Ans: 4

8. For an ideal fluid flow, the Reynolds number is

(1) 2100 (2) 100 (3) 0 (4) infinity

Ans: 4

9. A solid is transformed into vapour without going through the liquid phase at

(1) triple point (2) boiling point
(3) below triple point (4) always

Ans: 1

10. The kinetic energy of gas molecule is zero at

(1) 0°C (2) 279°C (3) 100°C (4) -273°C

Ans: 4 (i.e., at absolute temperature 0 K)

11. Styrene-Butadiene rubber is commercially manufactured by

(1) Bulk polymerization (2) Suspension polymerization
(3) Solution polymerization (4) Emulsion polymerization

Ans: 2

12. According to the kinetic theory, the thermal conductivity of a monoatomic gas is proportional to

(1) T (2) $T^{0.5}$ (3) $T^{1.5}$ (4) T^2

Ans: 2

13. The equilibrium constant, *K*, for a chemical reaction depends on

(1) temperature only
(2) pressure only
(3) temperature and pressure
(4) ratio of reactants

Ans: 3 (**Equilibrium constant (K_{eq}) :** The ratio of the mathematical product of the concentrations of the products of a reaction to the mathematical product of the concentrations of the reactants of the reaction. Each concentration is raised to the power of its coefficient in the balanced chemical equation.)

> At equilibrium the ratio of products to reactants, called the equilibrium constant, is a fixed value that is independent of the rate at which the reaction occurs. The rate of a chemical reaction can be increased by a catalyst, a substance that brings reactants together and accelerates their interactions but is not permanently changed during a reaction. The equilibrium constant (K_{eq}) depends on the nature of the reactants and products, the temperature, and the pressure (particularly in reactions involving gases). Under standard physical conditions (25 °C and 1 atm pressure, for biological systems), the K_{eq} is always the same for a given reaction,
>
> https://www.ncbi.nlm.nih.gov/books/NBK21503/

14. A Carnot cycle consists of the following steps

(1) two isothermals and two isentropics
(2) two isobarics and two isothermals
(3) two isochorics and two isobarics
(4) tow isothermals and two isochorics

Ans: 1

Fig…

15. Gibbs phase rule finds application when the heat transfer occurs by

(1) Conduction (2) Convection (3) Ratiation (4) Condensation

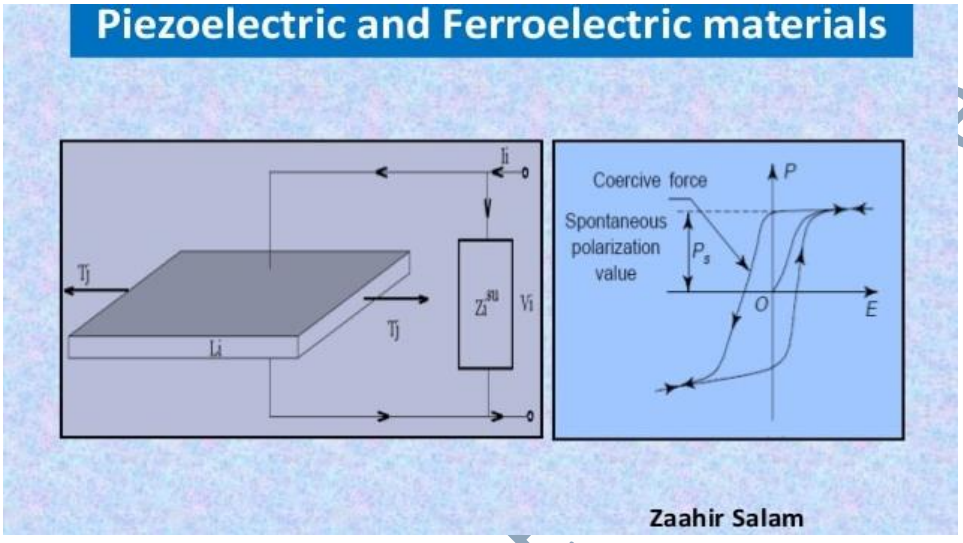
Ans: 4

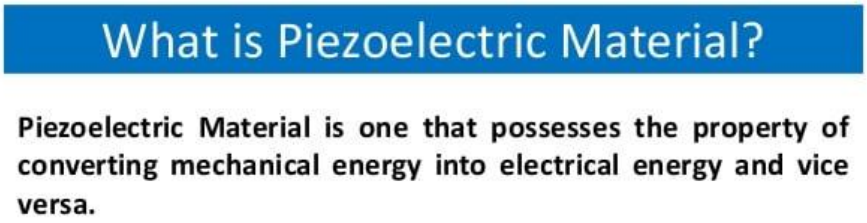
16. Which one of the following statements is correct?

(1) All ferroelectric solids are piezoelectric too

(2) All piezoelectric solids are ferroelectric too
(3) Bohr magnetron is the unit of dipole moment
(4) Glass is an alloy

Ans: 1 (All ferroelectrics are piezoelectric, but all piezoelectrics are not ferroelectric. For example: tourmaline is piezoelectric, but not ferroelectric. Quartz, the most widely used single-crystal piezoelectric, occurs naturally.)





QUARTZ-BASED PIEZOELECTRIC MATERIALS

Y. Saigusa, in Advanced Piezoelectric Materials, 2010

DIFFERENCES AMONG OTHER PIEZOELECTRIC MATERIALS

There are many materials that have piezoelectricity aside from quartz crystal. These are classified as single crystals and polycrystals. Generally, single crystals like SiO_2, $LiNbO_3$, $LiTaO_3$ and $La_3ga5SiO_{14}$, etc., have a steady construction of elements so that their characteristics are stable. On the other hand, polycrystals such as $Pb(Zr.Ti)O_3$, $BaTiO_3$, and $PbTiO_3$, etc., have many rates of the elements so they have many characteristics.

All these piezoelectric materials have a relationship between their geometrical element arrangements and characteristics. The designer has to choose suitable material(s) when considering their process and purpose.

Piezoelectric materials are used when electric energy is changed to mechanical energy or in reverse of the energy change. It is very important for a device designer to choose the material with characteristic(s) that suit their purpose such as

1. excellent frequency stability
2. negligible deviation of equivalent circuit constants for aging
3. stable oscillator.

https://www.sciencedirect.com/topics/materials-science/piezoelectric-material

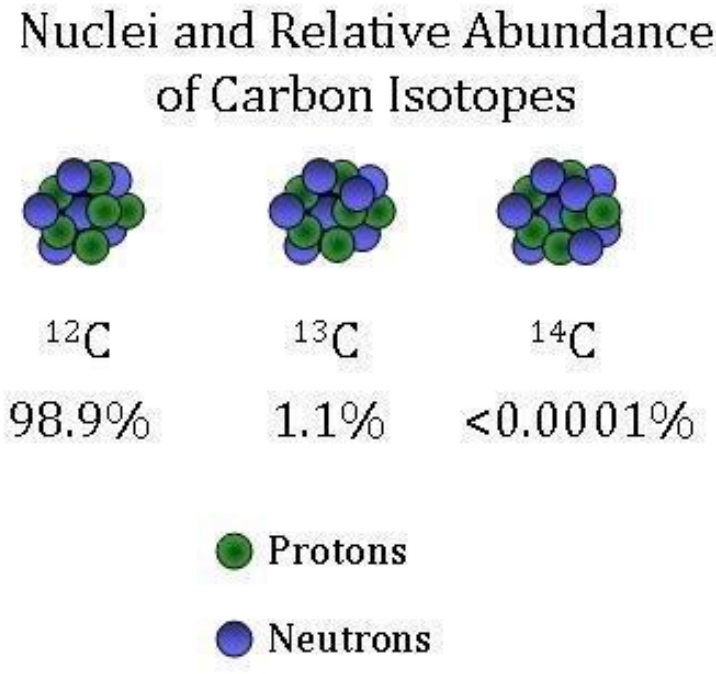
17. Naturally occurring carbon consists of

(1) 2 stable isotopes and radioactive isotope
(2) one stable isolate and two radioactive
(3) one stable isotope and one radioactive isotope
(4) two stable isotopes and two radioactive isotopes

Ans: 1

ISOTOPES OF CARBON

Carbon isotopes come in three forms. By far the most common isotope of carbon is carbon-12 (^{12}C), which contains six neutrons in addition to its six protons. The next heaviest carbon isotope, carbon-13 (^{13}C), has seven neutrons. Both ^{12}C and ^{13}C are called stable isotopes since they do not decay into other forms or elements over time. The rare carbon-14 (^{14}C) isotope contains eight neutrons in its nucleus. Unlike ^{12}C and ^{13}C, this isotope is unstable, or radioactive. Over time, a ^{14}C atom will decay into a stable product.



The vast majority of all carbon found on Earth is ^{12}C. Almost 99% of all carbon on Earth is of this form. While only approximately 1% of all carbon on Earth is of the ^{13}C isotopic form, ^{14}C is still much rarer. Only one out of every trillion carbon atoms is ^{14}C.

https://gml.noaa.gov/ccgg/isotopes/chemistry.html

18. When pure water is kept exposed to the atmosphere for a few days, what happens to its pH?

(1) Increases to a level atleast 2 or 3 units above 7
(2) Decreases slightly from 7
(3) Remains unchanged
(4) Decreases from 7 and becomes negative

Ans: 2

19. In a DNA structure, how many hydrogen bonds are formed between Adenine and Thymine?

(1) 4 (2) 3 (3) 2 (4) 1

Ans: 3

20. The alpha particles cause luminescence on striking a

(1) Sodium sulphide screen
(2) Potassium sulphide screen
(3) Zinc sulphide screen
(4) Copper sulphide screen

Ans: 3

21. The metal which does not give H_2 on reaction with dil. HCl is

(1) Iron (2) Zinc (3) Calcium (4) Silver

Ans: 4

22. Brown ring is used for the detection of

(1) Nitrite (2) Nitrate (3) Sulphate (4) Sulphide

Ans: 2

23. Which of the following is diamagnetic?

(1) Cu (2) O_2 (3) N_2 (4) Both (1) and (2)

Ans: 4

DIAMAGNETISM

A diamagnetic substance is one whose atoms have no permanent magnetic dipole moment. When an external magnetic field is applied to a diamagnetic substance such as bismuth or silver a weak magnetic dipole moment is induced in the direction opposite the applied field. Some of the most common examples of diamagnetic substances are Copper, Zinc, Bismuth, Silver, Gold, lead, carbon, Antimony, Marble, Water, Glass,etc.

FERROMAGNETIC ELEMENTS

SOME FERROMAGNETIC ELEMENTS

In addition to iron, the elements cobalt, nickel and gadolinium are ferromagnetic.

- Iron
- Nickel
- Cobalt
- Gadolinium
- Dysprosium

Paramagnetism is a form of magnetism whereby some materials are weakly attracted by an externally applied magnetic field, and form internal, induced magnetic fields in the direction of the applied magnetic field. In contrast with this behavior, diamagnetic materials are repelled by magnetic fields and form induced magnetic fields in the direction opposite to that of the applied magnetic field.

Paramagnetism is due to the presence of unpaired electrons in the material, so most atoms with incompletely filled atomic orbitals are paramagnetic, although exceptions such as copper exist. Due to their spin, unpaired electrons have a magnetic dipole moment and act like tiny magnets. An external magnetic field causes the electrons' spins to align parallel to the field, causing a net attraction.

Paramagnetic materials include most chemical elements and some compounds; they have a relative magnetic permeability slightly greater than 1 (i.e., a small positive magnetic susceptibility) and hence are attracted to magnetic fields.

Paramagnetic materials include aluminium, oxygen, titanium, and iron oxide (FeO). Therefore, a simple rule of thumb is used in chemistry to determine whether a particle (atom, ion, or molecule) is paramagnetic or diamagnetic: if all electrons in the particle are paired, then the substance made of this particle is diamagnetic; if it has unpaired

electrons, then the substance is paramagnetic.

Unlike ferromagnets, paramagnets do not retain any magnetization in the absence of an externally applied magnetic field because thermal motion randomizes the spin orientations. Thus the total magnetization drops to zero when the applied field is removed. Even in the presence of the field there is only a small induced magnetization because only a small fraction of the spins will be oriented by the field. This fraction is proportional to the field strength and this explains the linear dependency. The attraction experienced by ferromagnetic materials is non-linear and much stronger, so that it is easily observed,

https://en.wikipedia.org/wiki/Paramagnetism

Characteristics of Paramagnetic Compounds and Atoms

Paramagnetic elements and paramagnetic molecules share one main trait and that is having **unpaired electrons**. The more of these there are, the more likely the atom or molecule is to show paramagnetism. This is because these electrons align themselves in a fixed way with the orientation of an applied magnetic field, creating something called magnetic dipole moments around each atom or molecule.

https://sciencing.com/list-paramagnetic-atoms-7375978.html

SOME PARAMAGNETIC ELEMENTS

- Uranium
- Platinum
- Aluminum
- Sodium
- Oxygen

https://www.magcraft.com/diamagnetism

Ferrimagnetism and **antiferromagnetism** are less commonly encountered types of magnetism. Ferrimagnetic materials behave much like ferromagnetic materials, and include jacobsite and magnetite. Hematite and troilite are two compounds that demonstrate antiferromagnetism, where no magnetic moment is generated.

24. Silica in any form is

(1) Reactive
(2) Unreactive
(3) Highly reactive
(4) Inert

Ans: 1

Silica, or silicon dioxide (SiO_2), is a group IV metal oxide, which naturally occurs in both crystalline and amorphous forms

Silica or silicon dioxide is a crystalline compound that is common in most rocks, mineral, and sand. This substance forms when silicon and oxygen react with each other and another metal or mineral. Typically, silica in water supply exists in two forms: reactive silica and colloidal silica.

https://www.differencebetween.com/difference-between-colloidal-silica-and-reactive-silica/

.....

USE. PHYSICAL AND CHEMICAL PROPERTIES OF SILICA MAKE IT SUITABLE FOR MANY USES. MOST SILICA IN COMMERCIAL USE IS OBTAINED FROM NATURALLY OCCURRING SOURCES, AND IS CATEGORIZED BY END-USE OR INDUSTRY. THE THREE PREDOMINANT COMMERCIAL SILICA PRODUCT CATEGORIES ARE: SAND AND GRAVEL, QUARTZ CRYSTALS, AND DIATOMITES.

https://www.ncbi.nlm.nih.gov/books/NBK304370/

25. The total number of quantum numbers needed to describe an electron in an atom is

(1) 4 (2) 3 (3) 2 (4) 1

Ans: 1

To completely describe an electron in an atom, **four quantum** numbers are needed: energy (n), angular momentum (ℓ), magnetic moment (m_ℓ), and spin (m_s).

26. The compounds having same molecular formula but possessing different properties that result from a difference in structure are termed as

(1) Hydrocarbons (2) Isomers
(3) Carbon chain compounds (4) None of the three are correct

Ans: 2

27. What is the major component of permanent type of antifreeze for automobile cooling system?

(1) Ethyl alcohol
(2) Ethylene glycol
(3) Methanol
(4) Ether

Ans: 2

28. A process is said to be _____ if the pressure remains unchanged during the process

(1) Cyclic
(2) Isothermal
(3) Isobaric
(4) Isochoric

Ans: 3

29.1 A Process is said to be _____ if the temperature remains unchanged during the process

(2) Cyclic
(2) Isothermal
3. Isobaric
(4) Isochoric

Ans: 2

29.2 A process is said to be _____ if the volume remains unchanged during the process

1. Cyclic
2.Isothermal
3. Isobaric
4.Isochoric

Ans: 4

29. Atoms with nearly filled shells of electrons will tend to have higher

(1) Electro positivity
(2) Electro negativity
(3) Electron affinity
(4) Resonance energy

Ans: 2

STRUCTURE OF ORGANIC COMPOUNDS

Robert J. Ouellette, J. David Rawn, in Principles of Organic Chemistry, 2015

ELECTRONEGATIVITY

Electronegativity is a measure of the attraction of an atom for bonding electrons in molecules compared to that of other atoms. The electronegativity values devised by Linus Pauling, an American chemist, are dimensionless quantities that range from slightly less than one for the alkali metals to a maximum of four for fluorine. Large electronegativity values indicate a stronger attraction for electrons than small electronegativity values.

Electronegativities increase from left to right across the periodic table. Elements on the left of the periodic table have low electronegativities and are often called electropositive elements. The order of electronegativities F > O > N > C is an important property that we will use to explain the chemical properties of organic compounds. Electronegativities decrease from top to bottom within a group of elements. The order of decreasing electronegativities F > Cl > Br > I is another sequence that we will use to interpret the chemical and physical properties of organic compounds.

https://www.sciencedirect.com/topics/chemistry/electronegativity

It is a dimensionless property because it is only a tendency. It basically indicates the net result of the tendencies of atoms in different elements to attract the bond-forming electron pairs. It is measured, i.e., electronegativity on several scales. The most commonly used scale was designed by Linus Pauling. According to this scale, fluorine is the most electronegative element with a value of 4.0 and cesium is the least electronegative element with a value of 0.7.

30. A mixture of carbon dioxide and hydrogen derived from a process is called

(1) Solid gas
(2) Carbon gas
(3) Hydrogen gas
(4) Water gas

Ans: 4 (a fuel gas consisting mainly of carbon monoxide and hydrogen, made by passing steam over incandescent coke.)

31. Which type of bond is present in hydrogen molecule?

(1) Ionic
(2) Covalent
(3) Hydrogen
(4) Metallic

Ans: 2

32. Marsh test is used for the detection of

(1) Cadmium
(2) Bismuth
(3) Arsenic
(4) Copper

Ans: 3

33. For a gas, absolute zero may be defined as the temperature at which

(1) Molecular motion in a gas would cease
(2) all substances freeze
(3) water freezes
(4) a liquid is converted into solid

Ans: 1

34. A X-ray beam

(1) is an electromagnetic wave/ radiation
(2) is emitted from the atomic nucleus
(3) can penetrate through bones
(4) is made of electrons

Ans: 1

35. A mixture of ethanol and phenol can be separated by

(1) Fractional distillation
(2) Paper chromatography
(3) Ion exchange
(4) Sublimation

Ans: 1

36. Esters are usually

(1) Non-volatile
(2) Volatile
(3) pleasant smelling
(4) (2) and (3)

Ans: 4

37. Isotonic solutions must have the same

(1) Normality
(2) Molar concentration

(3) Density (4) Critical temperature

Ans: 2

38. Cathode rays are a stream of

(1) Protons (2) Electrons
(3) Neutrons (4) Positrons

Ans: 2

39. Parts of circular cross section which are symmetrical about the axis of rotation are made by

(1) Hot spinning (2) Hot forging
(3) Hot extrusion (4) Hot piercing

Ans: 1

40. Process used for making seamless tube is

(1) extrusion (2) piercing
(3) forging (4) casting

Ans: 2

41. Process used for making nuts and bolts is

(1) extrusion (2) cold peening
(3) hot piercing (4) upsetting

Ans: 4

42. Process used to improve fatigue resistance of the metal by setting up compressive stresses in its surface, is known as

(1) extrusion (2) piercing
(3) cold peening (4) swaging

Ans: 3

43. Mechanical properties of the metal improve in hot working due to

(1) recovery of grains
(2) recrystallization
(3) grain growth
(4) refinement of grain size

Ans: 4

44. Production of contours in flat blank is termed as

(1) blanking (2) piercing (3) perforating (4) punching

Ans: 1

45. Laser is produced by

(1) graphite (2) ruby (3) diamond (4) emerald

Ans: 2

46. Compression moulding is the ideal method of processing

(1) plastics
(2) thermo-setting plastic
(3) thermoplastics
(4) nonferrous materials

Ans: 3

47. Advantage of cold forming is
(1) grain refinement takes place
(2) strength and increase in hardness
(3) no consequent heat treatment is needed
(4) force required is relatively small

Ans: 2

48. Energy equation/Bernoulli's equation deals with the conservation of

(1) Mass
(2) Force
(3) Momentum
(4) Energy

Ans:4

49. Continuity equation deals with the conservation of

(1) Mass (2) Force

(3) Momentum (4) energy

Ans:1

Ans:3 (when acting in opposite direction)

50. Two forces of 12 N and 8 N are acting on a body. The resultant force on the body has a maximum value of :

(1) 20N (2) 8N (3) 4N (4) Zero

Ans:1 (when the 2 forces are superimposed and act in the same direction.)