

1. What is the speed of sound in Neon gas at a temperature of 500K (Gas constant of Neon is 0.4210 kJ/kg-K)?

(1) 492 m/s (2) 460 m/s (3) 592 m/s (4) 543 m/s

Ans:3. ($C = \sqrt{nRT}$ where $n = 1.6$ (or $5/3$) for monoatomic gas.

Note: $n = 7/5$ for diatomic gas, $n = 4/3$ for others)

Neon is monatomic, making it lighter than the molecules of diatomic nitrogen and oxygen which form the bulk of Earth's atmosphere; a balloon filled with neon will rise in air, albeit more slowly than a helium balloon.

2. A Carnot cycle is having an efficiency of 0.175. If the temperature of the high temperature reservoir is 727°C, what is the temperature of low temperature reservoir in Celsius?

(1) 23 (2) -23 (3) 0 (4) 279

Ans: 4

$$\eta = \frac{T_1 - T_2}{T_1} = \frac{727 + 273 - T_2 - 273}{727 + 273} = 0.175$$

3. Which of the following is most common varieties of coal?

(1) Anthracite (2) Bituminous
(3) Lignite (4) Peat

Ans: 2

4. Which State is having the maximum deposits of lignite in India?

(1) Rajasthan (2) Bihar (3) Tamil Nadu (4) Kerala

Ans: 3

5. Which of the following is a physical change?

(1) Rusting (2) Oxidation of metals in atmosphere
(3) Sublimation (4) Decomposition of organic matter

Ans: 3

6. Carbon tetrachloride and water can be separated by

(1) Distillation (2) Separating funnel
(3) Crystallization (4) Filtration

Ans: 2

7. Chemically water is

- (1) A hydride
- (2) an oxide
- (3) A hydroxide
- (4) a peroxide

Ans: 1

8. A catalyst is a substance which

- (1) Stops a chemical reaction
- (2) Helps to initiate a reaction
- (3) Increases the speed of chemical reaction
- (4) Decreases the speed of reaction

Ans: 3

9. In which of the following ferrous material, carbon content is maximum.

- (1) Steel
- (2) Pig iron
- (3) Cast Iron
- (4) wrought iron

Ans: 2(Carbon content in Pig iron = 3.5–4.5% and in Cast iron is a group of iron–carbon alloys with a carbon content more than 2%. (Carbon (C), ranging from 1.8 to 4 wt%,)

Most steels also contain small but definite percentages of carbon (0.04%–2.5%)

Most cast irons have a chemical composition of **2.5–4.0% carbon**, 1–3% silicon, and the remainder

Wrought iron is an iron alloy with a very low carbon content (**less than 0.08%**) in contrast that of cast iron (2.1% to 4%).

Pig iron is an intermediate product of the iron industry in the production of steel which is obtained by smelting iron ore in a blast furnace. Pig iron has a very high carbon content, typically 3.8–4.7%,^[1] along with silica and other constituents of dross, which makes it very brittle and not useful directly as a material except for limited applications.

Low-carbon steel is the most widely used form of carbon steel. These steels usually have a carbon content of less than 0.25 wt.%. They cannot be hardened by heat treatment (to form martensite) so this is usually achieved by cold work.

Carbon steels are usually relatively soft and have low strength. They do, however, have high

ductility, making them excellent for machining, welding and low cost.

High-strength, low-alloy steels (HSLA) are also often classified as low-carbon steels, however, also contain other elements such as copper, nickel, vanadium and molybdenum. Combined, these comprise up to 10 wt.% of the steel content. High-strength, low-alloy steels, as the name suggests, have higher strengths, which is achieved by heat treatment. They also retain ductility, making them easily formable and machinable. HSLA are more resistant to corrosion than plain low-carbon steels.

Medium-carbon steel

Medium-carbon steel has a carbon content of 0.25 – 0.60 wt.% and a manganese content of 0.60 – 1.65 wt.%. The mechanical properties of this steel are improved via heat treatment involving austenitising followed by quenching and tempering, giving them a martensitic microstructure.

Heat treatment can only be performed on very thin sections, however, additional alloying elements, such as chromium, molybdenum and nickel, can be added to improve the steels ability to be heat treated and, thus, hardened.

Hardened medium-carbon steels have greater strength than low-carbon steels, however, this comes at the expense of ductility and toughness.

High-carbon steel

High-carbon steel has a carbon content of 0.60– 1.25 wt.% and a manganese content of 0.30 – 0.90 wt.%. It has the highest hardness and toughness of the carbon steels and the lowest ductility. High-carbon steels are very wear-resistant as a result of the fact that they are almost always hardened and tempered.

<https://matmatch.com/learn/material/carbon-steel>

Wrought iron, one of the two forms in which iron is obtained by smelting; the other is cast iron (*q.v.*). Wrought iron is a soft, ductile, fibrous variety that is produced from a semifused mass of relatively pure iron globules partially surrounded by slag. It usually contains less than 0.1% carbon and 1 or 2% slag. It is superior for most purposes to cast iron, which is overly hard and brittle owing to its high carbon content.

Britannica, The Editors of Encyclopaedia. "Wrought iron". *Encyclopedia Britannica*, 12 Sep. 2018, <https://www.britannica.com/technology/wrought-iron>. Accessed 16 October 2021.

10. In which of the following ferrous material, the carbon content is minimum

(1) Steel

(2) Pig iron

(3) Cast Iron

(4) wrought iron

Ans: 4

11. Which is the most suitable fire retardant rubber?

(1) Nitrile

(2) Natural

(2) Viton

(4) Neoprene

Ans: 2. Viton is rated to seal up to 400°F and is not affected by most hydraulic fluids.

General Operating Temperatures for Common Materials

Natural Rubber: less than 250°F (121°C)

Urethane: less than 250°F (121°C)

Chloroprene (Neoprene): less than 300°F (149°C)

Nitrile (Buna-N): less than 300°F (149°C)

EPDM: less than 400°F (204°C)

Fluorosilicone: 400 – 500°F (204 – 260°C)

Fluorocarbon: 400 – 500°F (204 – 260°C)

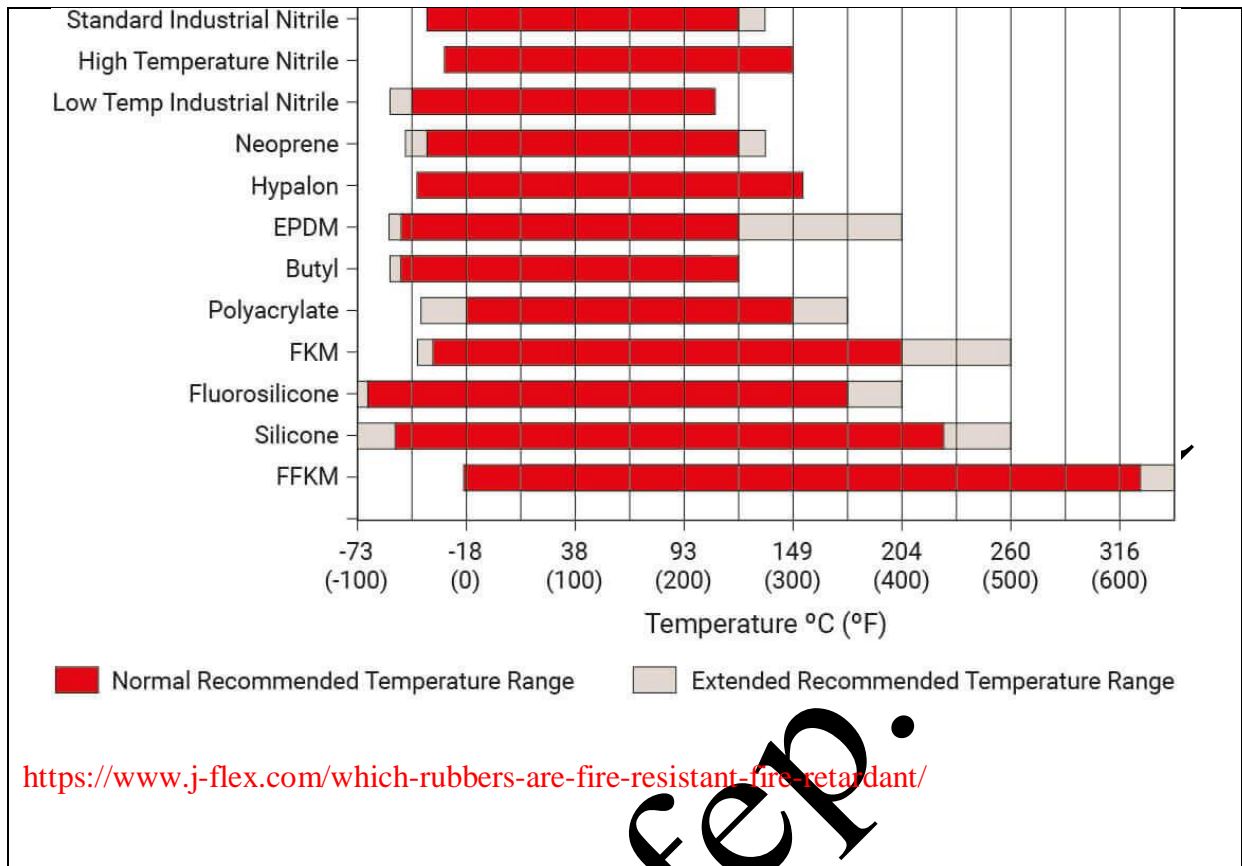
Silicone: 400 – 500°F (204 – 260°C)

<https://www.stockwell.com/blog/rubber-temperature-range/>

Fire Resistant Rubbers

Many rubber materials can be specially compounded to be fire-resistant. Silicone, EPDM, Vamac® Ethylene Acrylic Elastomer, Neoprene, Natural Rubber & Nitrile can all be compounded with special F.R. (fire retardant) additives to make them fire-resistant.

A wide variety of basic polymers (rubbers) are available, and a literally infinite array of compounds exhibiting unique physical properties as well as chemical, fluid and temperature resistances are possible. This chart, therefore, deals only with very general features of the most common basic rubber or elastomer compounds but more specific information is available upon request.



12. Bakelite is obtained from
- (1) urea and formaldehyde (2) Phenol and formaldehyde
- (3) Nitre cellulose and alcohol (4) None

Ans : 1

Bakelite was the first plastic made from synthetic components. It is a thermosetting phenol formaldehyde resin, formed from a condensation reaction of phenol with formaldehyde.

13. Which one of the following is an ionic compound?
- (1) CH₄ (2) CCL₄ (3) NaCl (4) H₂H₂

Ans: 3

14. Plaster of Paris is
- (1) CaSO₄ (2) CaSO₄2H₂O (3) CaSO₄H₂O (4) CaSO₄.½ H₂O

Ans: 4

15. The law which gives the relationship of gas between volume and temperature at constant pressure

- (1) The Gas law (2) The Charle's law
(3) The Boyle's law (4) Dalton's law

Ans: 2

16. Which of the following salts gives a green flame on test?

- (1) $ZnCl_2$ (2) $NaCl$ (3) $BaCl_2$ (4) $CaCl_2$

Ans: 3

17. The study of the internal structure of a metal and alloy is called

- (1) Radiography (2) Metallography
(3) Thermography (4) Solography

Ans: 2

18. Which of the metal is not Ferro-magnetic?

- (1) Fe (2) Cu (3) Co (4) Ni

Ans: 2

19. A mirror is coated on one side with Amalgam which is an alloy of

- (1) Gold-Silver (2) Gold – Copper
(3) Tin –Mercury (4) Gold-Nickel

Ans : 3

20. Amalgam is an alloy of

- (1) Gold-Silver (2) Gold – Copper
(3) Gold –Mercury (4) Gold-Nickel

Ans: 3

An amalgam is an alloy of mercury with one or more other metals. Most dental amalgams are called silver amalgams since silver is the principal constituent that reacts with mercury. The common constituents of amalgam are mercury, tin, silver, copper, and other trace metals.

21. Thermocouple must possess

- (1) Hot junction (2) Cold junction
 (3) Hot and cold junctions (4) None

Ans: 3

A thermocouple is a sensor that measures temperature. It consists of two different types of metals, joined together at one end. When the junction of the two metals is heated or cooled, a voltage is created that can be correlated back to the temperature. A thermocouple is a simple, robust and cost-effective temperature sensor used in a wide range of temperature measurement processes. Thermocouples are manufactured in a variety of styles, such as thermocouple probes, thermocouple probes with connectors, transition joint thermocouple probes, infrared thermocouples, bare wire thermocouple or even just thermocouple wire.

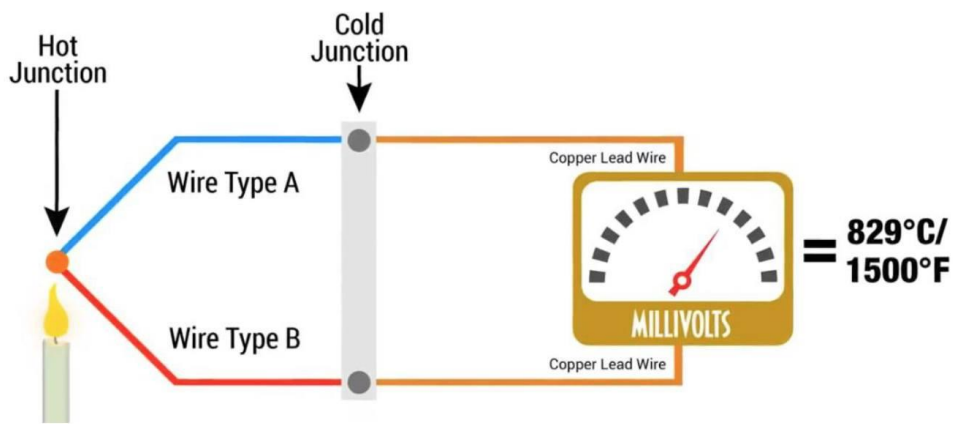


Fig: Thermocouple

<https://www.omega.com/en-us/resources/thermocouple-hub>

22. Ideal gas law is applicable at

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

Ans: 4

The term ideal gas refers to a hypothetical gas composed of molecules which follow a few rules:

1. **Ideal gas molecules do not attract or repel each other.** The only interaction between ideal gas molecules would be an elastic collision upon impact with each other or an elastic collision with the walls of the container.

2. **Ideal gas molecules themselves take up no volume.** The gas takes up volume since the molecules expand into a large region of space, but the Ideal gas molecules are approximated as point particles that have no volume in and of themselves.

<https://www.khanacademy.org/science/physics/thermodynamics/temp-kinetic-theory-ideal-gas-law/a/what-is-the-ideal-gas-law>

23. 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

24. The kinetic energy of gas molecule is zero at

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

Ans: 4

25. 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

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

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

Ans: 4

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

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

Ans: 4

Copper and mercury metal does not react with dilute hydrochloric acid as it comes after hydrogen in the activity series, i.e., they can't replace hydrogen from hydrochloric acid. Metals below hydrogen (copper, silver, gold and platinum) will not react with dilute acids. They cannot displace hydrogen from the non-metal anion.

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

- (1) Ionic (2) Covalent
 (3) Metallic (4) None

Ans: 2

31. 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

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

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

33. Cathode rays are a stream of

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

Ans: 2

34. In galvanizing, a layer of zinc is applied to the surface of steel by

- (1) Hot peening (2) Cold peening
 (3) Hot dipping or electroplating (4) Cold dipping

Ans: 3

35. In superconducting state, materials are

- (1) paramagnetic (2) ferromagnetic (3) diamagnetic (4) none

Ans: 3

36. Acetylene gas is generated from reacting with water

- (1) Calcium (2) Carbon (3) Calcium carbide (4) Calcium chloride

Ans: 3

Note: Adding water to calcium carbide will release acetylene, C_2H_2 .

37. Thermoplastic objects are produced by

- (1) die casting process (2) shell moulding process

- (3) cold forming process (4) injection moulding process

Ans: 4

38. The component which fails most frequently in an amplifier is:

- (1) Resistor (2) electrolytic capacitor
(3) Transistor (4) ceramic capacitor

Ans: 2

39. Central Leather Research Institute (CLRI) is located at:

- (1) Bangalore (2) Chennai (3) Madurai (4) Hyderabad

Ans: 2

40. If two meshing gears have 4:1 gear ratio and the smaller gear revolves at N_1 rpm. The rpm of the larger gear is

- (1) $N_1/4$ (2) $4N_1$ (3) $2N_1$ (4) $N_1/2$

41. Which of the following is most common variety of coal?

- (1) Anthracite (2) Bituminous
(3) Lignite (4) Peat

Ans: 1

42. Which State is having the maximum deposits of lignite in India?

- (1) Rajasthan (2) Bihar (3) Tamil Nadu (4) Kerala

Ans: 3

43. A reversible heat engine operates between 1600 K and T_2 K and another reversible heat engine operates between T_2 K and 400 K. If both the engines have the same output, the temperature T_2 must be equal to

- (1) 800 (2) 1000 (3) 1200 (4) 1400

Note: $\frac{T_1}{T_2} = \frac{T_2}{T_3}$

44. Laser is produced using

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

Ans: 2

(continued...)

Ruby Laser

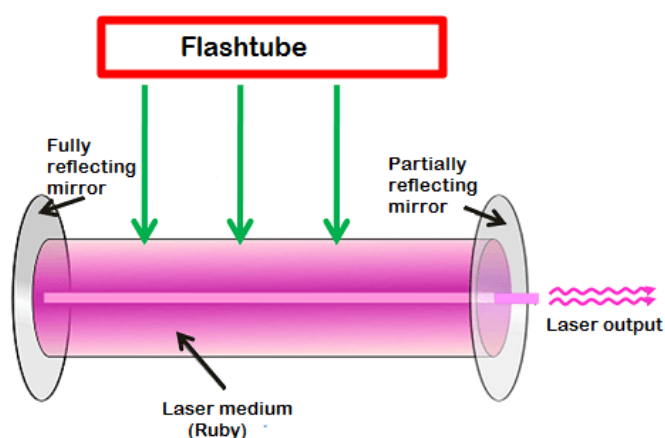
A ruby laser is a solid-state laser that uses the synthetic ruby crystal as its laser medium.

Ruby laser is one of the few solid-state lasers that produce visible light. It emits deep red light of wavelength 694.3 nm.

Construction of ruby laser

A ruby laser consists of three important elements: laser medium, the pump source, and the optical resonator.

In a ruby laser, a single crystal of ruby ($\text{Al}_2\text{O}_3 : \text{Cr}^{3+}$) in the form of cylinder acts as a laser medium or active medium. The laser medium (ruby) in the ruby laser is made of the host of sapphire (Al_2O_3) which is doped with small amounts of chromium ions (Cr^{3+}). The ruby has good thermal properties.



Pump source or energy source in ruby laser

<https://www.physics-and-radio-electronics.com/physics/laser/rubylaserdefinitionconstructionworking.html>

45. Gas prepared by burning coke is called

- | | |
|--------------------|---------------|
| (1) Producer gas | (2) Water gas |
| (3) Semi water gas | (4) Town gas |

Coal gas, gaseous mixture—mainly hydrogen, methane, and carbon monoxide—formed by the destructive distillation (*i.e.*, heating in the absence of air) of bituminous coal and used as a fuel. Sometimes steam is added to react with the hot coke, thus

increasing the yield of gas. Coal tar and coke (*qq.v.*) are obtained as by-products.

Britannica, The Editors of Encyclopaedia. "Coal gas". Encyclopedia Britannica, 18 Sep. 2007, <https://www.britannica.com/science/coal-gas>. Accessed 13 March 2021.

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Producer gas is fuel gas that is manufactured from material such as coal, as opposed to natural gas. It can be produced from various fuels by partial combustion with air, usually modified by injection of water or steam to maintain a constant temperature and obtain a higher heat content gas by enrichment of air gas with hydrogen. In this respect it is similar to other types of "manufactured" gas, such as coal gas, coke oven gas, water gas and carburetted water gas. Producer gas was used primarily as an industrial fuel for iron and steel manufacturing, such as firing coke ovens and blast furnaces, cement and ceramic kilns, or for mechanical power through gas engines. It was characteristically low in heating value but cheap to make, so that large amounts could be made and burned.

Other similar fuel gasses

Coal Gas or Illuminating gas: Produced from coal by distillation.

Water gas: Produced by injection of steam into fuel preheated by combustion with air. The reaction is endothermic so the fuel must be continually re-heated to keep the reaction going. This was usually done by alternating the steam with an air stream.

Coke Oven Gas: Coke ovens give off a gas exactly similar to illuminating gas, part of which is used to heat the coal. There may be a large excess, however, which is used for industrial purposes after it has been purified.

syngas, or synthesis gas: (from synthetic gas or synthesis gas) can be applied to any of the above gasses, but generally refers modern industrial processes, such as natural gas reforming, hydrogen production, and processes for synthetic production of methane and other hydrocarbons.

Town gas: any of the above-manufactured gases including producer gas containing sufficient hydrocarbons to produce a bright flame for illumination purposes, originally produced from coal, for sale to consumers and municipalities.

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

46. Which of the following is a physical change?

- (1) Rusting
 (2) Oxidation of metals in atmosphere
 (3) Sublimation
 (4) Decomposition of organic matter

Ans: 3

47. Carbon tetrachloride and water can be separated by

- (1) Distillation
 (2) Separating funnel
 (3) Crystallization
 (4) Filtration

Ans: 2

48. A catalyst is a substance which

- (1) Stops a chemical reaction
 (2) Helps to initiate a reaction
 (3) Increases the speed of chemical reaction
 (4) Decreases the speed of reaction

Ans: 3

49. In which of the following ferrous material, the carbon content is minimum

- (1) Steel
 (2) Pig iron
 (3) Cast Iron
 (4) wrought iron

Ans: 4

Wrought iron is a soft, ductile, fibrous variety that is produced from a semifused mass of relatively pure iron globules partially surrounded by slag. It usually contains less than 0.1% percent carbon and 1 or 2% slag.

50. A 20 mm diameter hole is to be punched in a 20 mm thick steel plate. If shear stress of steel is 30 kg/mm^2 , the force required for punching will be in the range:

1. 15-20 Tonne
 2. 20-25 Tonne
 3. 25-30 Tonne
 4. 35-40 Tonne

Ans: 4

Note: Force, $F = \pi d.t.\sigma_s$