Chemist and Metallurgist

1. The Coriolis component of acceleration is present in

(1) 4-bar mechanisms with 4 turning pairs
(2) shaper mechanism
(3) slider-crank mechanism
(4) Scotch Yoke mechanism

Ans:2

2. The total area under the stress-strain curve of a mild steel specimen tested up to failure under tension is a measure of

(1) ductility
(2) ultimate strength
(3) stiffness
(4) toughness

Ans:4

3. A lead-screw with half nuts in a lathe, free to rotate in both directions has

(1) V-threads
(2) Whitworth threads
(3) Buttress threads
(4) Acme threads

Ans:

4. The primary purpose of sprue in a casting mould is to

(1) feed the casting at a rate consistent with the rate of solidification
(2) act as a reservoir for molten metal
(3) feed molten metal from the pouring basin to the gate
(4) help feed the casting until all solidification take place

Ans:3

5. Hot rolling of mild steel is carried out

(1) at recrystallization temperature
(2) below recrystallization temperature
(3) above recrystallization temperature
(4) None

Ans:3

6. Which of the following arc welding processes does **not** use consumable electrodes

(1) GMAW
(2) GTAW
(3) Submerged Arc Welding
(4) none of these

Ans:2 (other methods which donot use consumable electrode include PAW and Carbon arc welding)

7. Which of the following welding method does **not** use electrode?

(2) GMAW
(2) GTAW
(4) Submerged Arc Welding
(4) Laser welding

Ans:4.

8. Trepanning is performed for

(1) finishing a drilled hole
(2) Producing a large hole without drilling
(3) truing a hole for alignment
(4) enlarging a drilled hole

Ans:2

9. The hardness of a grinding wheel is determined by the

(1) hardness of abrasive grains

(2) ability of the bond to retain abrasives

(3) hardness of the bond

(4) ability of the grinding wheel to penetrate the work piece

Ans:2

10. A positive value of Joule-Thomson coefficient of a fluid means

(1) temperature drops during throttling
(2) temperature remains constant during throttling
(3) temperature rises during throttling
(4) none of these

Ans:1

11. If there are m physical quantities and n fundamental dimensions in a particular process, the number of non-dimensional parameters is

(1) $m+n$ (2) $m \times n$ (3) $m-n$ (4) m/n

Ans:3

12. If x is the distance measured from the leading edge of a flat plate, the laminar boundary layer thickness varies as

(1) 1/x (2) $x^{4/5}$ (3) x^2 (4) $x^{1/2}$

Ans:4

13. Flow separation in flow past a solid object is caused by

(1) a reduction of pressure to vapour pressure
(2) a negative pressure gradient
(3) a positive pressure gradient
(4) the boundary layer thickness reducing to zero

Ans:2

14. A correctly designed convergent-divergent nozzle working at a designed load is

(1) always isentropic (2) always choked
(3) never choked (4) never isentropic

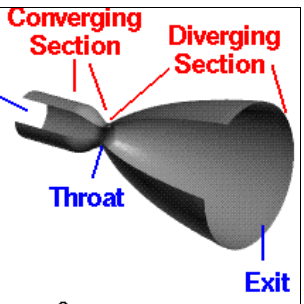
Ans:2

Nozzles are actually used to modify the flow of a fluid (i.e. by increasing kinetic energy of the flow in expense of its pressure). Convergent-divergent type of nozzles are mostly used for supersonic flows because it is impossible to create supersonic flows (mach number more than one) in convergent type of nozzle and therefore it restricts us to a limited amount of mass flow through a particular nozzle. In convergent-divergent type of nozzles we can increase the flow velocity much higher than sonic velocity that is why these type of nozzles have a wide applications such as propelling nozzles in jet engines or in air intake for engines working at high rpm.

https://en.wikibooks.org/wiki/Fluid_Mechanics_Applications/B25:Supersonic_Flow_In_Convergent-Divergent_Type_of_Nozzles

Cconvergent-Divergent nozzle

$\dot{m}$ = mass flow rate
V = velocity
ρ = density
γ = specific heat ratio
A = area
p = pressure
M = Mach
a = speed of sound



Conservation of Mass: $\dot{m} = \rho V A = \text{constant}$

$$\frac{d\rho}{\rho} + \frac{dV}{V} + \frac{dA}{A} = 0$$

Conservation of Momentum: $\rho V\, dV = -dp$

Isentropic Flow: $\frac{dp}{p} = \gamma \frac{d\rho}{\rho}$ $\qquad dp = a^2\, d\rho$

Combine with Momentum: $-M^2 \frac{dV}{V} = \frac{d\rho}{\rho}$

Combine with Mass: $(1 - M^2)\frac{dV}{V} = -\frac{dA}{A}$

For subsonic flow ($M < 1$), increase in area ($dA > 0$) causes flow velocity to decrease ($dV < 0$)

For supersonic flow ($M > 1$), increase in area ($dA > 0$) causes flow velocity to increase ($dV > 0$)

https://www.grc.nasa.gov/www/k-12/airplane/nozzled.html

15. The value of Biot number is very small (less than 0.01) when

(1) the convective resistance of the fluid is negligible
(2) the conductive resistance of the fluid is negligible
(3) the conductive resistance of the solid is negligible
(4) none of these

Ans:3

16. For the same inlet and oulet temperatures of hot and cold fluids, the Log Mean Temperature Difference (LMTD) is

(1) greater for parallel flow heat exchanger than for counter flow heat exchanger
(2) greater for counterflow heat exchanger than for parallel flow heat exchanger
(3) same for both parallel and counter flow heat exchangers
(4) dependent on the properties of the fluids

Ans:2

17. The coupling used to connect two shafts with offset

(1) a Flange coupling
(2) an Oldham's coupling
(3) a Flexible bush coupling
(4) a Hooke's joint

Ans:2

18. The coupling used to connect two shafts with large angular misalignment is

(2) a Flange coupling
(2) an Oldham's coupling
(4) a Flexible bush coupling
(4) a Hooke's joint
Ans:4

19. A static load is mounted at the centre of a shaft rotating at uniform angular velocity. This shaft will be designed for

(1) the maximum compressive stress (static)
(2) the maximum tensile stress (static)
(3) the maximum bonding moment (static)
(4) fatigue loading
Ans:4 (dynamic condition)

20. Large speed reductions (greater than 20) in one stage of a gear train are possible through

(1) Spur gearing
(2) Worm gearing
(3) Bevel gearing
(4) Helical gearing
Ans:2

21. If the wire diameter of a closed coil helical spring subjected to compressive load is increased from 1 cm to 2 cm, other parameters remaining same, the deflection will decrease by a factor of

(1) 16 (2) 8 (3) 4 (4) 2
Ans:1

Deflection is given by:

$$\delta = \frac{8PD^3N}{G.d^4}$$

22. The relationship between Young's modulus (E), Bulk modulus (K) and Poisson's ratio (μ) is given by

(1) $E=3K(1-2\mu)$
(2) $K=3E(1-2\mu)$
(3) $E=3K(1-\mu)$

(4) K=3 E (1-μ)

Ans:1

23. The ratio of Euler's buckling loads of columns with the same parameters having both ends fixed, and both ends hinged is

(1) 2 (2) 4 (3) 6 (4) 8

Ans:2

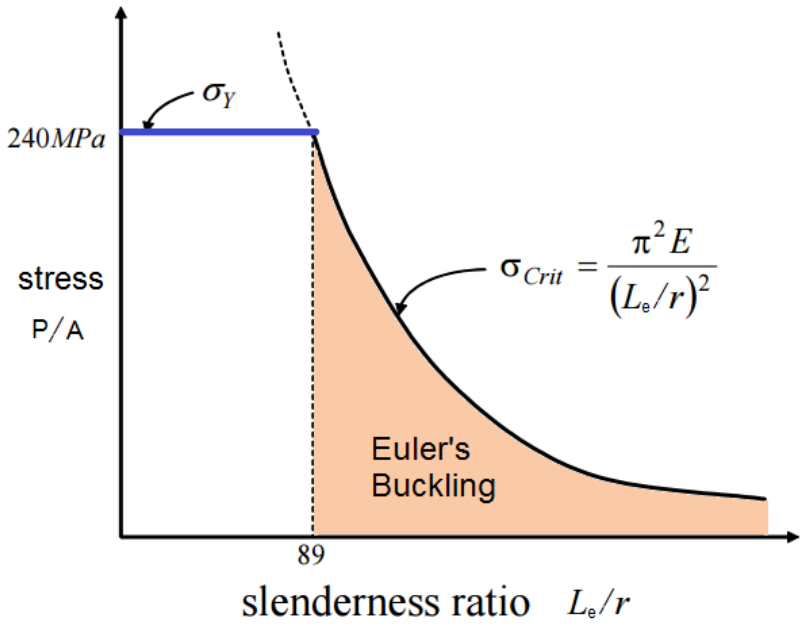
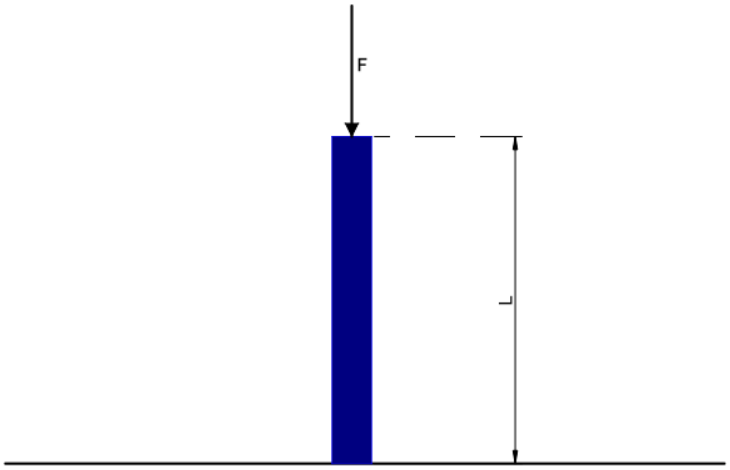


Fig. 1: Critical stress vs slenderness ratio for steel, for E = 200 GPa, yield strength = 240 MPa.



Columns fail by buckling when their critical load is reached. Long columns can be analysed with the Euler column formula

$$F = n \pi^2 E I / L^2 \qquad (1)$$

where

F = allowable load (lb, N)

n = factor accounting for the end conditions

E = modulus of elastisity (lb/in^2, Pa (N/m^2))

L = length of column (in, m)

I = Moment of inertia (in^4, m^4)

n = factor accounting for the end conditions

- column pivoted in both ends : ***n = 1***
- ***both ends fixed : n = 4***
- one end fixed, the other end rounded : ***n = 2***
- one end fixed, the other end free : ***n = 0.25***

Surce: Engineering ToolBox, (2012). *Euler's Column Formula*. [online] Available at: https://www.engineeringtoolbox.com/euler-column-formula-d_1813.html [Accessed on 25th October 2021

].

24. In centrifugal casting, the impurities are

(1) uniformly distributed
(2) forced towards the outer surface
(3) trapped near the mean radius of the casting
(4) collected at the centre of the casting

Ans:2

25. The ductility of a material with work hardening

(1) increases
(2) decreases
(3) remains unaffected
(4) unpredictable

Ans:2

26. The temperature of a carburizing flame in gas welding is ---------- that of a neutral or an oxidizing flame.

(1) lower than
(2) higher than
(3) equal to
(4) unrelated to

Ans:1

FLAME TYPES

THE NEUTRAL FLAME

Neutral welding flames are commonly used to weld:

- Mild steel
- Stainless steel
- Cast Iron
- Copper
- Aluminum

The neutral or balanced flame is obtained when the mixed torch gas consists of approximately one volume of oxygen and one volume of acetylene. It is obtained by gradually opening the oxygen valve to shorten the acetylene flame until a clearly defined inner cone is visible.

In the neutral flame, the temperature at the inner cone tip is approximately 5850ºF (3232ºC), while at the end of the outer sheath or envelope the temperature drops to approximately 2300ºF (1260ºC). This variation within the flame permits some temperature control when making a weld. The position of the flame to the molten puddle can be changed, and the heat controlled in this manner.

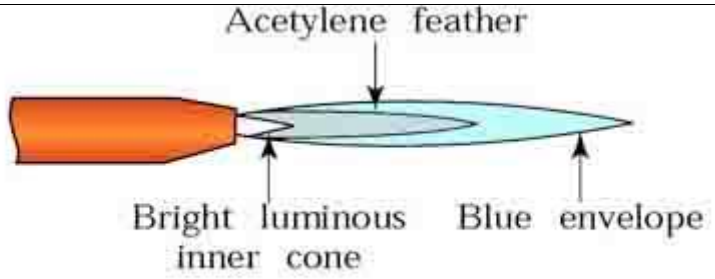


Figure 2: Carburizing Flame

Components of a Carburizing Welding Flame

The reducing or carburizing flame can always be recognized by the presence of three distinct flame zones. There is a clearly defined bluish-white inner cone, white intermediate cone indicating the amount of excess acetylene, and a light blue outer flare envelope. This type of flare burns with a coarse rushing sound. It has a temperature of approximately 5700ºF (3149ºC) at the inner cone tips.

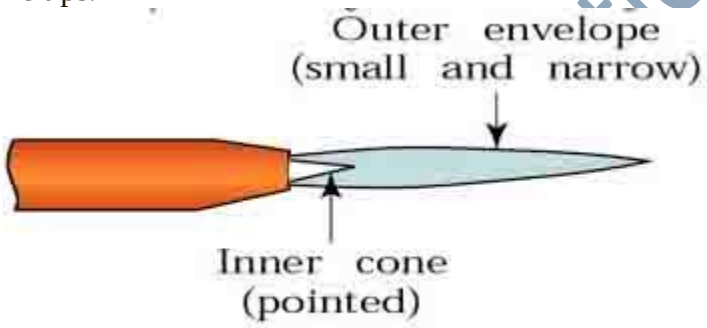


Figure3: Oxidizing Flame

An oxidizing flame can also be recognized by its distinct hissing sound. The temperature of this flame is approximately 6300ºF (3482ºC) at the inner cone tip.

Oxidizing welding flames are commonly used to weld these metals:

- zinc
- copper
- manganese steel
- cast iron

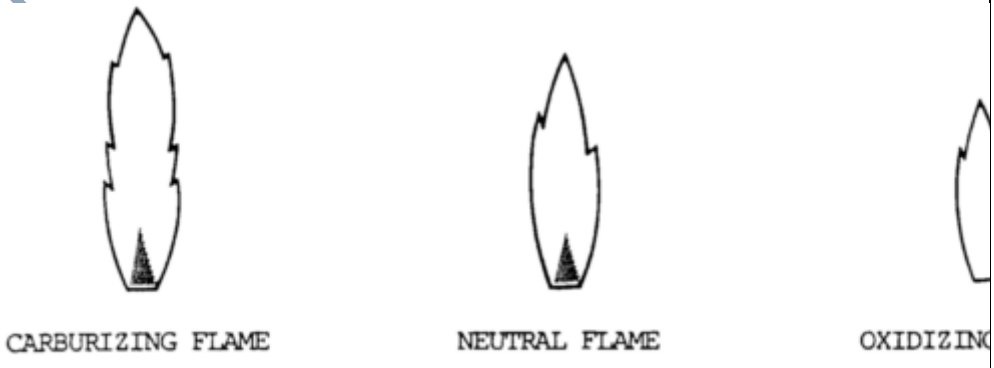


Figure 11-3. What MAPP gas flames should look like.

https://weldguru.com/welding-flames/

.....

TYPES OF FLAME

There are three basic welding flames. These are as follow.

NATURAL FLAME:

As the name implies, this flame has equal amount of oxygen and gases fuel by the volume. This flame burns fuel completely and does not produce any chemical effect on metal to be welded. It is mostly used for welding mild steal, stainless steel, cast iron etc. It produces little smoke. This flame has two zones. The inner zone has white in color and has temperature about 3100^{o}C degree centigrade and outer zone has blue color and have temperature about 1275 ^{o}C.

CARBURIZING FLAME:

This flame has excess of fuel gas. This flame chemically reacts with metal and form metal carbide. Due to this reason, this flame does not used with metal which absorb carbon. It is smoky and quiet flame. This flame has three regions. The inner zone has white color, the intermediate zone which is red in color and outer cone has blue color. The inner cone temperature is about 2900^{o}C. This flame is used to weld medium carbon steel, nickel etc.

OXIDIZING FLAME:

When the amount of acetylene reduces from natural flame or amount of oxygen increases, the inner cone tend to disappear and the flame obtain is known as oxidizing flame. It is hotter than natural flame and has clearly defined two zones. The inner zone has very bright white color and has temperature of about 3300 ^{o}C. The outer flame has blue in color. This flame is used to weld oxygen free copper alloy like brass, bronze etc.

27. In a blanking operation, the clearance is provided on

(1) the die
(2) both the die and the punch equally
(3) the punch
(4) neither the punch or the die

Ans:3

28. In a piercing operation, the clearance is provided on

1.the die
(2) both the die and the punch equally
3. the punch
(4) neither the punch or the die

Ans:3

29. A built-up-edge is formed while machining

(1) ductile materials at high speed (2) ductile materials at low speed
(3) brittle materials at high speed (4) brittle materials at low speed

Ans:2

https://www.harveyperformance.com/in-the-loupe/causes-effects-of-built-up-edge-bue-in-turning-applications/

The term built-up edge means that the material that is being machined is pressure welded to the cutting tool. evidence of a BUE problem is material on the rake face or flank face of the cutting tool.

CAUSES OF BUILT-UP EDGE IN TURNING APPLICATIONS

IMPROPER TOOLING CHOICE

Built-Up Edge is oftentimes caused by using a turning tool that does not have the correct geometry for the material being machined. Most notably, when machining a gummy material such as aluminum or titanium, your best bet is to use tooling with extremely sharp cutting edges, free cutting geometry, and a polished flank and rake face. This will not only help you to cut the material swiftly but also to keep it from sticking to the cutting tool.

USING AGED MACHINE TOOL

INSUFFICIENT HEAT GENERATION

Built-up edge can be caused from running a tool at incorrect cutting parameters. Usually, when BUE is an issue, it's due to the speed or feed rates being too low. Heat generation is key during any machining application – while too much heat can impact a part material, too little can cause the tool to be less effective at efficiently removing chips.

30. The time taken to drill a hole through a 25 mm thick plate with the drill rotating at 300 r.p.m. and moving at a feed rate of 0.25 mm/revolution is

(1) 10 sec (2) 20 sec
(3) 60 sec (4) 100 sec

Ans:

31. The properties of mercury at 300 K are: density = 13529 kg/m^2, specific heat at constant pressure = 0.1393 kJ/kg-K, dynamic viscosity = 0.1523 x 10^{-2} N.s/m^2 and thermal conductivity = 8.540 W/m-K. the Prandtl number of the mercury at 300K is

(1) 0.0248 (2) 2.48 (3) 24.8 (4) 248
Ans:

32. What is the value of the view factor for two inclined flat plates having common edge of equal width, and with an angle of 20°?

(1) 0.83 (2) 1.17 (3) 0.66 (4) 1.34
Ans:1

33. An ideal air standard Otto cycle has a compression ration 8.5. If the ratio of the specific heats of air (γ) is 1.4,what is the thermal efficiency (in percentage) of the Otto cycle?

(1) 57.5 (2) 45.7 (3) 52.5 (4) 95
Ans:1

$$\text{Efficiency of otto cycle} = 1 - \frac{1}{r^{\gamma-1}}$$

$$= 1 - \frac{1}{8.5^{1.4-1}} = 57.5\%.$$

where r is the compression ratio and is the specific heat ratio for air.

34. 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
Neon is a monotomic gas for which n =4/3.

For n = 5/3,
C = $\sqrt{nRT}$ =592

Diatomic elements
oxygen (O), fluorine (F), chlorine (Cl), bromine (Br), and iodine (I).

Monatomic gases

The noble gases are the examples of monatomic gases, and they are:

Helium.
Radon.
Neon.
Xenon.
Argon.
Krypton.

35. The efficiency of superheat Rankine cycle is higher than that of simple Rankine cycle because

(1) the enthalpy of main steam is higher in a superheated cycle
(2) the main temperature of heat addition is higher of superheat cycle
(3) the temperature of steam in the condenser is high
(4) the quality of steam in the condenser is low

Ans:1

39. Which of the following tools has the highest cutting speed ?

(1) Diamond tool (2) High speed steel tool
(3) Cemented carbide (4) Cemented oxide (Ceramic)

Ans: 1

A diamond tool is conventionally used to cut brittle materials, since it provides a high cutting quality and productivity.

A cutting tool must have the following characteristics in order to produce good quality and economical parts:

Hardness — harness and strength of the cutting tool must be maintained at elevated temperatures, also called hot hardness (Figure 1.1)

Toughness — toughness of cutting tools is needed so that tools don't chip or fracture, especially during interrupted cutting operations.

Wear Resistance — wear resistance means the attainment of acceptable tool life before tools need to be replaced.

https://www.americanmachinist.com/cutting-tools/media-gallery/21893840/cutting-tool-applications-chapter-1-cutting-tool-materials

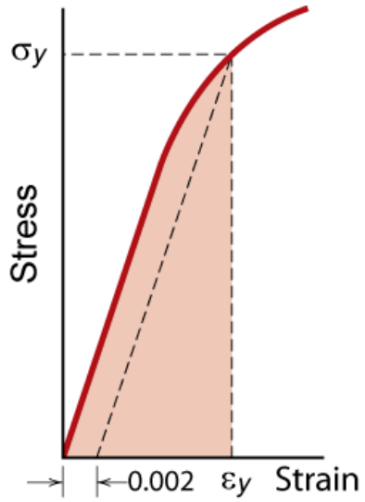
40. Ability of a material to store elastic energy without permanent deformation is known as-

(1) Elasticity
(2) Plasticity
(3) Resilience
(4) Toughness

Ans: 4

Resiliency and Toughness

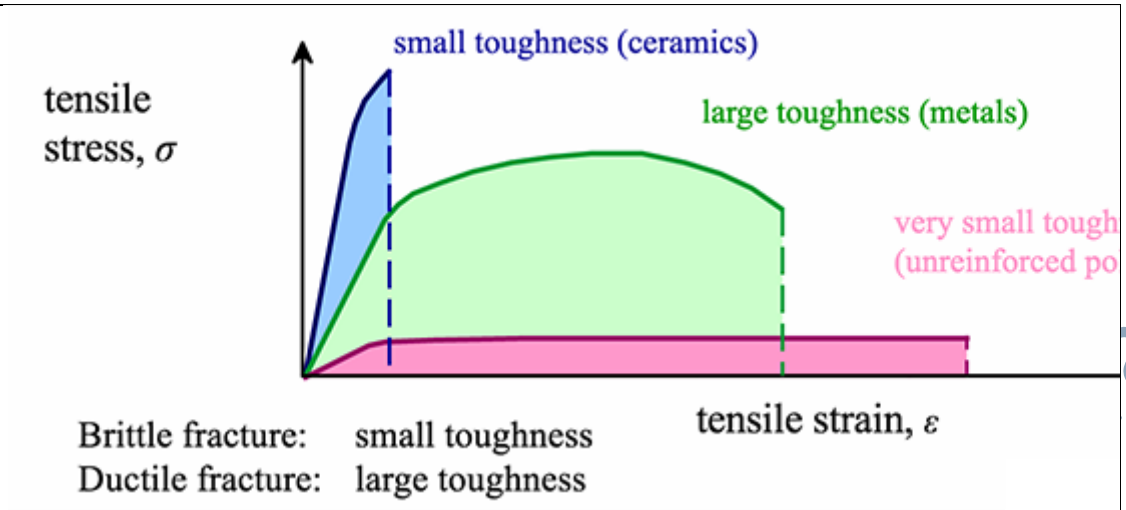
When a person is resilient, we mean that they bounce back from change to their original personality. **Resiliency** in the material sense is similar. We can define resilience of the material to be the amount of energy the material can absorb and still return to its original state. If we are talking about stressing the material and having it return to its original state, we are talking about the material remaining in the elastic region of the stress-strain curve. It turns out that we can get the energy of elasticity by taking the area under the curve of the stress-strain curve. That area has been highlighted in the figure below, which is the area under the curve from the origin to the yield strength.



Energy of elasticity shown under the curve of the stress-strain curve.
Credit: Callister

Toughness, in contrast to resilience, is how much energy can be absorbed and still keep going. One analogy that can be used when describing toughness is that of a car in a demolition derby. The car is allowed to continue the competition as long as it is capable of moving. It does not matter how many hits and how much destruction has been done to the car, but rather as long as the car can move it can stay in the competition. The toughness of the car is based on how many hits and how much damage the car can sustain and continue in the competition. In the case of materials, the amount of energy that the material can absorb plastically before fracturing is the toughness.

In the figure below, we can see that a material can have a high tensile strength (ceramics) and yet have a small toughness. In addition, materials can be extremely ductile (unreinforced polymers) and also have a small toughness. So, a large toughness (metals) is obtained by having a high tensile strength and a high ductility.



Stress-strain curve for a material with a high tensile strength (ceramics) and a small toughness.

https://www.e-education.psu.edu/matse81/node/2105

Resilience

The ability of a material to absorb energy when deformed elastically and to return it when unloaded is called resilience. This is usually measured by the modulus of resilience, which is the strain energy per unit volume required to stress the material from, zero stress to the yield stress. The toughness of a material is its ability to absorb energy in the plastic range. The ability to withstand occasional, stresses above the yield stress without fracturing is particularly desirable in parts such as freight-car couplings, gears, chains, and crane hooks. Toughness is a commonly used concept, which is difficult to pin down and define.

The ability of a material to absorb energy when deformed elastically and to return it when unloaded is called **resilience**. This is usually measured by the **modulus of resilience**, which is the strain energy per unit volume required to stress the material from, zero stress to the yield stress □. The strain energy per unit volume for uniaxial tension is

$$U_0 = \frac{1}{2}\sigma_x e_x \qquad (1)$$

From the above definition the modulus of resilience is

$$U_R = \frac{1}{2}s_0 e_0 = \frac{1}{2}s_0\frac{s_0}{E} = \frac{s_0^2}{2E} \qquad (2)$$

This equation indicates that the ideal material for resisting energy load

https://www.totalmateria.com/page.aspx?ID=CheckArticle&site=kts&NM=41

41. Instrument for measuring angles relative to the horizontal plane is-

(1) Clinometer (2) Sinebar

(3) Anemometer (4) Theodilite

Ans: 4

A theodolite is a precision optical instrument for measuring angles between designated visible points in the horizontal and vertical planes.

Clinometer or inclinimeter

A clinometer is a tool that is used to measure the angle of elevation, or angle from the ground, in a right - angled triangle. You can use a clinometer to measure the height of tall things that you can't possibly reach to the top of, flag poles, buildings, trees. Follow the directions below to create your own clinometer.

Sine bar

Sine Bar is a precise angle measuring instrument. It is used to measure angles very accurately or to align the workpiece at a given angle. Sine Bar is the most accurate instrument for measuring angles.

Sine bar is made up of high carbon high chromium corrosion resistance steel. Sine bar is made with this material so that it can avoid wear and tear of sine bar when handling. As the tear and wear are avoided, the errors are eliminated and the accuracy of the sine bar is maintained.

WORKING PRINCIPLE OF SINE BAR:
The principle of operation of the sine bar is based on the law of trigonometry. If one roller of sine bar is placed on the surface plate and the other roller is placed on the height of slip gauges, then the structure formed by the sine bar, surface plate, and slip gauges forms a triangle. The **hypotenuse** of this triangle is the sine bar, **perpendicular** is formed by combination of slip gauges and the surface plate is the **base**

http://www.mechanicalwalkins.com/sine-bar-working-principle-construction-working-errors-and-types-of-sine-bar/

42. Milling operation done with two or more milling cutters fitted on the door with spacing collars between them is called-

(1) Gang milling (2) End milling
(3) Straddle milling (4) Face milling

Ans: 1

43. Air fuel mixture supplied to a SI engine during idling is called –

(1) Lean mixture (2) Very lean mixture
(3) Rich mixture (4) Stochiometric mixture

Ans: 3

44. Temperature at which all molecular motion ceases, according to kinetic theory of gases, is called-

(1) Critical temperature (2) Absolute zero temperature
(3) Freezing point (4) Adiabatic temperature

Ans: 1

45. The kickstart device in two wheelers incorporates-

(1) Rack and pinion mechanism
(2) Drive shaft with universal joints
(3) Ratchet and pinion mechanism
(4) Chain drive

Ans: 1

46. An alloy used in bearings of machine parts is-

(1) Babbit metal (2) Bell metal
(3) Phospur bronze (4) Monel

Ans: 1

47. Tool used for accurate setting out angles by arranging to convert angular measurements to linear ones is called-

(1) Sine bar (2) Protractor
(3) Clinometer (4) Try square

Ans: 1

48. The value used in design in place of the yield point for those metals that do not exhibit a yield point on their stress strain curve is called-

(1) Residual stress (2) Proof stress
(3) Ultimate stress (4) Shear stress

Ans: 2

49. The main cause for diesel knock is-

(1) Higher compression ratio
(2) Injection of fuel before TDC
(3) Greater delay period
(4) Using fuel with Higher viscosity

Ans: 2

50. Sling psychrometer measures-

(1) Vapour pressue in the atmosphere

(2) Air velocity in the atmosphere

(3) Relative Humidity and dew point in the atmosphere

(4) Direction of air movement in the atmosphere

Ans: 1

A sling psychrometer is an instrument that measures the relative humidity and dew point in an area. A sling psychrometer has two thermometers: a wet bulb and a dry bulb. The wet bulb has a cotton wick over the bulb of the thermometer, which is moistened with room temperature water. The dry bulb is simply a thermometer. Both are attached to a dowel with a screw so that they may be spun through the air. A sling psychrometer works on the premise that evaporation is a cooling process. The drier the air, the more evaporation takes place off of the wet bulb, dropping the temperature on the thermometer.
https://sciencing.com/read-sling-psychrometer-5333022.html

SLING PSYCHROMETERS

Hygrometers measure the relative humidity of an environment. Psychrometers are battery-free hygrometers that offer a straightforward way of obtaining humidity measurements

Sling Psychrometer is used to measure both the dry bulb and wet bulb temperatures at time. These temperatures are a measure of humidity content in air.

APPLICATION OF SLING PSYCHROMETER

1. It is used for checking humidity level in air-conditioned rooms and installations.
2. It is used to set and check **hair hygrometer.**
3. It is used in the measurement range of 0 to 100% RH.
4. It is used for measuring wet bulb temperature between 0'C to 180'C.

https://automationforum.co/what-is-a-sling-psychrometer-limitations-application-working/