Youth Competition Times

MECHANICAL ENGINEERING

[English Medium]

SSC JE

Chapterwise and Sub-topicwise

SOLVED PAPERS

Chief Editor
Anand Kumar Mahajan

Compiled, Writer & Edited by
Er. Brijesh Maurya

Computer Graphics by
Balkrishna, Charan Singh, Pankaj Kushwaha

Editorial Office
Youth Competition Times
12, Church Lane Prayagraj-211002
Mob. : 9415650134
Email : yctap12@gmail.com
website : www.yctbooks.com

Publisher Declaration
Edited and Published by A.K. Mahajan for YCT Publications Pvt. Ltd.
and printed by Om Sai Offset, Prayagraj.
In order to publish the book, full care has been taken by the editor and the publisher, still your suggestions and queries are welcomed.
In the event of any dispute, the Judicial area will be Prayagraj.

Rs. : 395/-

CONTENTS

Note : Thermodynamics, Power Plant Engineering, Refrigeration and Air-Conditioning, Internal Combustion Engine, Automobile Engineering, Fluid Mechanics, Fluid Machinery, Heat and Mass Transfer Study Vol.-II.

SSC Junior Engineer Paper Syllabus

MECHANICAL ENGINEERING

The Examination will be conducted in two stages:

A. Paper-I (Pre) (200 marks)
B. Paper-II (Mains) (300 marks)
Total Written Test (500 marks)

Written Test :

Paper	Subject	Max. Mark	Duration & Timing
Paper-I Objective type	(i) General Intelligence & Reasoning (ii) General Awareness (iii) General Engineering (Mechanical)	50 50 100	2 Hours
Paper-II Conventional	General Engineering (Mechanical)	300	2 Hours

There will be negative marking **of 0.25 marks** for each wrong answer in Paper-I. Candidates are, therefore advised to keep this in mind while answering the questions. Paper-II will be Descriptive Type.

Syllabus of Examination

- The standard of the questions in Engineering subjects will be approximately of the level of Diploma in Mechanical Engineering from a recognized Institute, Board or University recognized by All India Board of Technical Education. All the questions will be set in SI units. The details of the syllabus are given below.

Paper-I

- ***General Intelligence & Reasoning:*** The Syllabus for General Intelligence would include questions of both verbal and non-verbal type. The test may include questions on analogies, similarities, differences, space visualization, problem solving, analysis, judgment, decision making, visual memory, discrimination, observation, relationship concepts, arithmetical reasoning, verbal and figure classification, arithmetical number series etc. The test will also include questions designed to test the candidate's abilities to deal with abstract ideas and symbols and their relationships, arithmetical computations and other analytical functions.
- ***General Awareness:*** Questions will be aimed at testing the candidate's general awareness of the environment around him/her and its application to society. Questions will also be designed to test knowledge of current events and of such matters of everyday observations and experience in their scientific aspect as may be expected of any educated person. The test will also include questions relating to India and its neighbouring countries especially pertaining to History, Culture, Geography, Economic Scene, General Polity and Scientific Research, etc. These questions will be such that they do not require a special study of any discipline.
- **General Engineering : Civil and Structural, Electrical & Mechanical**

Mechanical Engineering

- Theory of Machines and Machine Design, Engineering Mechanics and Strength of Materials, Properties of Pure Substances, 1st Law of Thermodynamics, 2nd Law of Thermodynamics, Air standard Cycles for IC Engine Performance, IC Engines Combustion, IC Engine Cooling & Lubrication, Rankine cycle of System, Boilers, Classification, Specification, Fitting & Accessories, Air Compressors & their cycles, Refrigeration cycles, Principle of Refrigeration Plant, Nozzles & Steam Turbines. Properties & Classification of Fluids, Fluid Statics, Measurement of Fluid Pressure, Fluid kinematics, Dynamics of Ideal fluids, Measurement of Flow rate, basic principles, Hydraulic Turbines, Centrifugal Pumps, Classification of steels.

Detailed Syllabus JE Mechanical Engineering

Theory of Machines and Machine Design

- Concept of simple machine, Four bar linkage and link motion, Flywheels and fluctuation of energy, Power transmission by belts – V-belts and Flat belts, Clutches – Plate and Conical clutch, Gears – Type of gears, gear profile and gear ratio calculation, Governors – Principles and classification, Riveted joint, Cams, Bearings, Friction in collars and pivots.

Engineering Mechanics and Strength of Material

- Equilibrium of Forces, Law of motion, Friction, Concepts of stress and strain, Elastic limit and elastic constants, Bending moments and shear force diagram, Stress in composite bars, Torsion of circular shafts, Bucking of columns – Euler's and Rankin's theories, Thin walled pressure vessels.

Thermal Engineering

Properties of Pure Substances:

- P-V & P-T diagrams of pure substance like H_2O, Introduction of steam table with respect to steam generation process; definition of saturation, wet & superheated status. Definition of dryness fraction of steam, degree of superheat of steam. H-S chart of steam (Mollier's Chart).

1st Law of Thermodynamics :

- Definition of stored energy & internal energy, 1st law of Thermodynamics of cyclic process, Non-Flow Energy Equation, Flow Energy & Definition of Enthalpy, Conditions for Steady State and Steady Flow; Steady State Steady Flow Energy Equation.

2nd Law of Thermodynamics :

- Definition of Sink, Source Reservoir of Heat, Heat Engine, Heat Pump & Refrigerator; Thermal Efficiency of Heat Engines & co-efficient of performance of Refrigerators, Kelvin – Planck & Clausius Statements of 2nd Law of Thermodynamics, Absolute or Thermodynamic Scale of temperature, Clausius Integral, Entropy change calculation of ideal gas processes. Carnot Cycle & Carnot Efficiency, PMM-2; definition & its impossibility.

Air standard Cycles for IC engines :

- Otto cycle; plot on P-V, T-S Planes; Thermal Efficiency, Diesel Cycle; Plot on P-V, T-S planes; Thermal efficiency.
  IC Engine Performance, IC Engine Combustion, IC Engine Cooling & Lubrication.

Rankine cycle of steam :

- Simple Rankine cycle plot on P-V, T-S, H-S planes, Rankine cycle efficiency with & without pump work. Boilers; Classification; Specification; Fittings & Accessories : Fire Tube & Water Tube Boilers. Air Compressors & their cycles; Refrigeration cycles; Principle of a Refrigeration Plant; Nozzles & Steam Turbines

Fluid Mechanics & Machinery

Properties & Classification of Fluid :

- Ideal & real fluids, Newton's law of viscosity, Newtonian and Non-Newtonian fluids, compressible and incompressible fluids.

Fluid Statics : Pressure at a point.

Measurement of Fluid Pressure : Manometers; U-tube, Inclined tube.

Fluid Kinematics : Stream line, laminar & turbulent flow, external & internal flow, continuity equation.

Dynamics of ideal fluids : Bernoulli's equation, Total head; Velocity head: Pressure head; Application of Bernoulli's equation.

Measurement of Flow rate Basic Principles : Venturimeter, Pilot tube, Orifice meter

Hydraulic Turbines : Classifications, principles

Centrifugal Pumps : Classifications, Principles, Performance.

Production Engineering

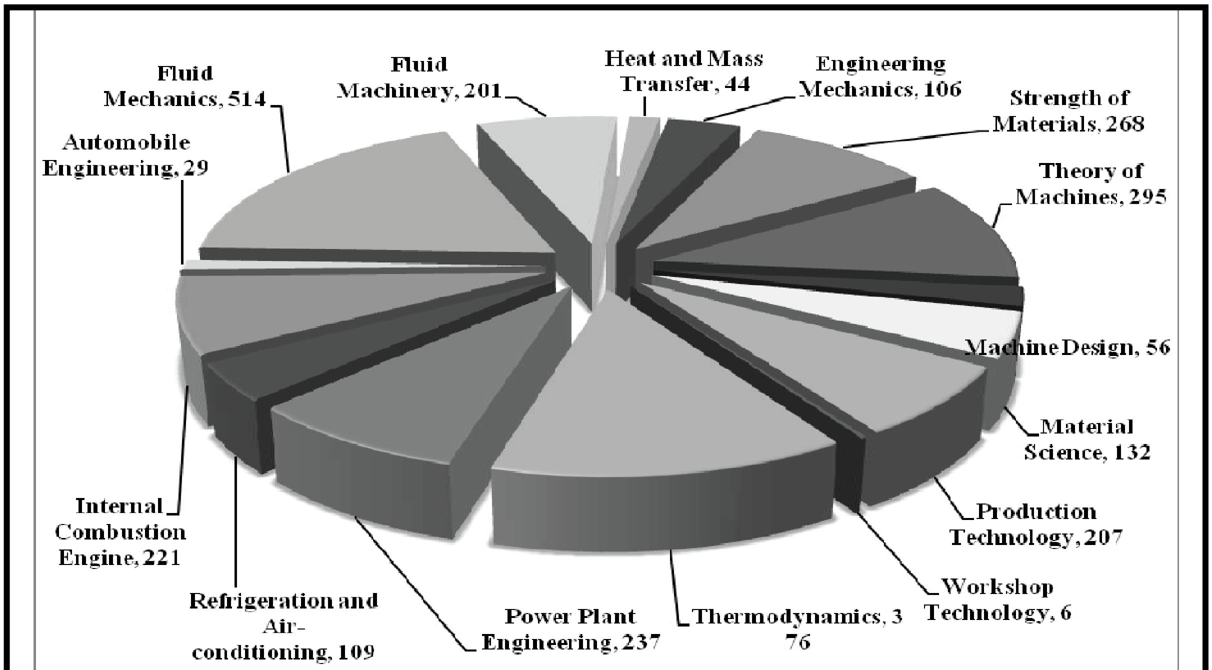
Classification of Steels :

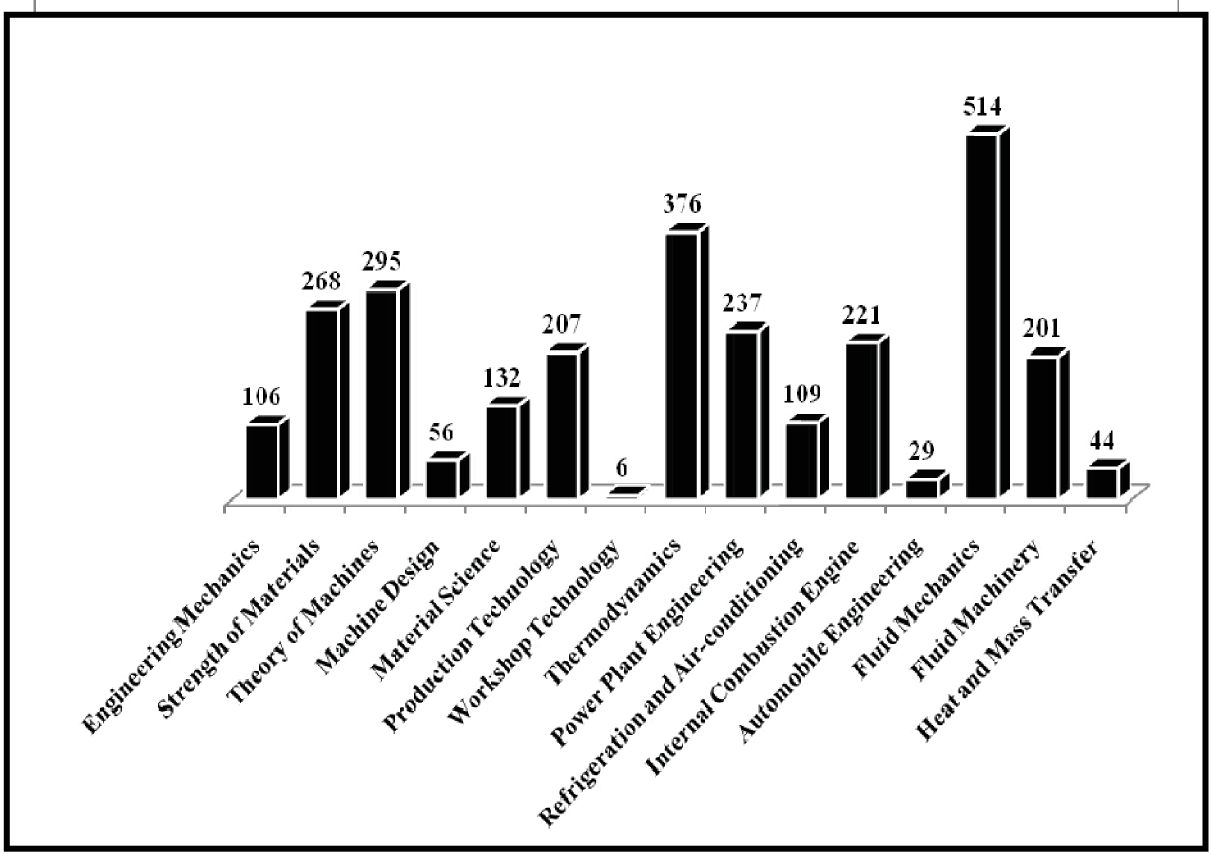
- Mild steal & alloy steel, Heat treatment of steel, Welding – Arc Welding, Gas Welding, Resistance Welding, Special Welding Techniques i.e. TIG, MIG, etc. (Brazing & Soldering), Welding Defects & Testing; Foundry & Casting – methods, defects, different casting processes, Forging, Extrusion, etc, Metal cutting principles, cutting tools, Basic Principles of machining with (i) Lathe (ii) Milling (iii) Drilling (iv) Shaping (v) Grinding, Machines, tools & manufacturing processes.

Mechanical Engineering JE Previous Years Exam Papers Analysis Chart

Sl No	Exam	Proposed Year	Question Paper	Total Question
Staff Selection Commission (SSC)				
1.	SSC (JE) Shift-I	22.03.2021		100
2.	SSC (JE) Shift-II	22.03.2021		100
3.	SSC (JE) Shift-I	27.10.2020		100
4.	SSC (JE) Shift-II	27.10.2020		100
5.	SSC (JE)	28.10.2020		100
6.	SSC (JE)	11.12.2020		100
7.	SSC (JE)	25.09.2019		100
8.	SSC (JE) Shift-I	27.09.2019		100
9.	SSC (JE) Shift-II	27.09.2019		100
10.	SSC (JE) Shift-I	22.01.2018		100
11.	SSC (JE) Shift-II	22.01.2018		100
12.	SSC (JE) Shift-I	23.01.2018		100
13.	SSC (JE) Shift-II	23.01.2018		100
14.	SSC (JE) Shift-I	24.01.2018		100
15.	SSC (JE) Shift-II	24.01.2018		100
16.	SSC (JE) Shift-I	25.01.2018		100
17.	SSC (JE) Shift-II	25.01.2018		100
18.	SSC (JE) Shift-I	27.01.2018		100
19.	SSC (JE) Shift-II	27.01.2018		100
20.	SSC (JE) Shift-I	29.01.2018		100
21.	SSC (JE) Shift-II	29.01.2018		100
22.	SSC (JE) Shift-I	01.03.2017		100
23.	SSC (JE) Shift-II	01.03.2017		100
24.	SSC (JE) Shift-I	02.03.2017		100
25.	SSC (JE) Shift-II	02.03.2017		100
26.	SSC (JE) Shift-I	03.03.2017		100
27.	SSC (JE) Shift-II	03.03.2017		100
28.	SSC (JE) Shift-I	04.03.2017		100
29.	SSC (JE) Shift-II	04.03.2017		100
30.	SSC (JE)	2015		100
31.	SSC (JE) Shift-I	2014		100
32.	SSC (JE) Shift-II	2014		100
33.	SSC (JE)	2013		100
34.	SSC (JE)	2012		100
35.	SSC (JE)	2011		100
36.	SSC (JE)	2010		50
37.	SSC (JE)	2009		50
38.	SSC (JE)	2008		50
39.	SSC (JE)	2007		50

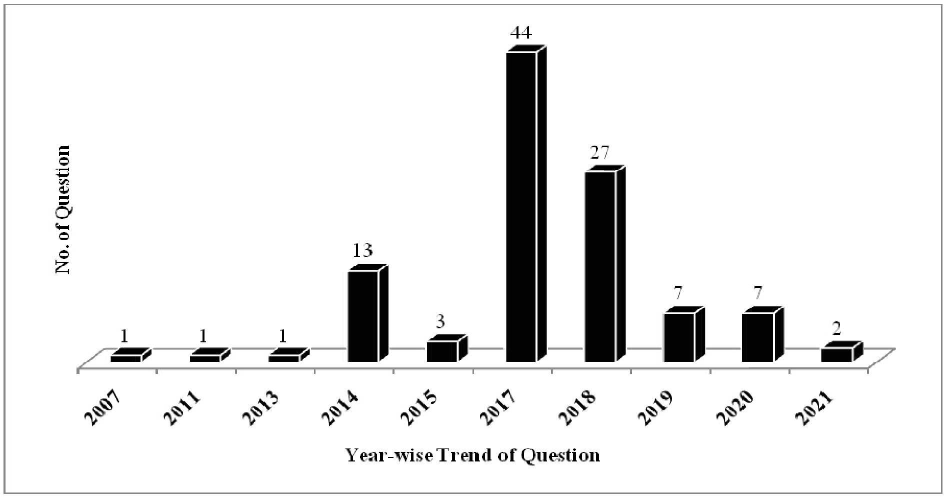
Trend Analysis of Previous Years Questions of Mechanical Engineering Through Pie Chart & Bar Graph

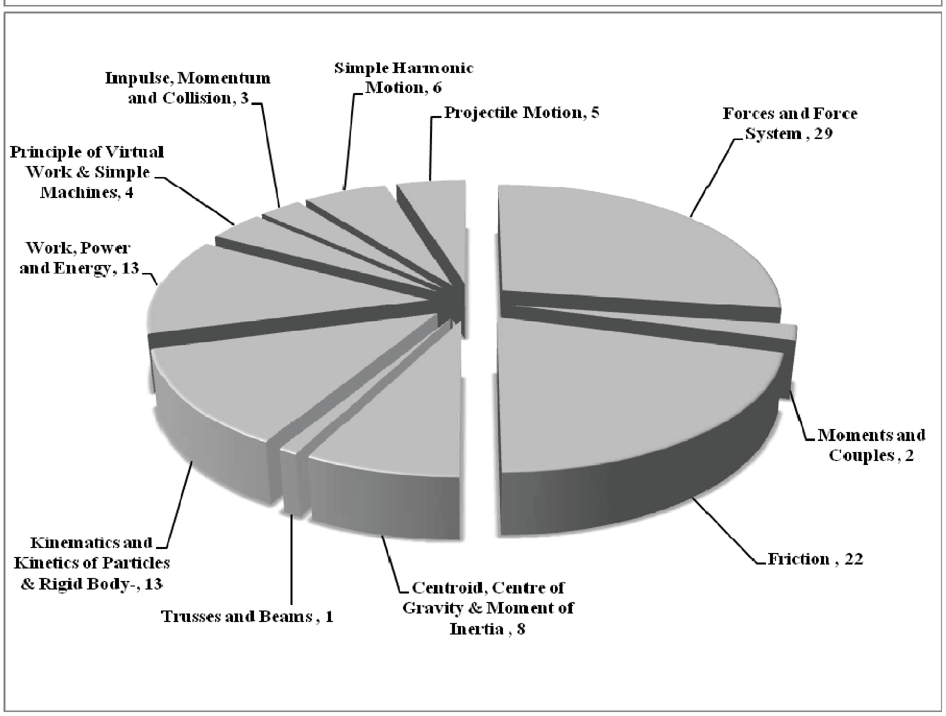




Engineering Mechanics

Yearwise & Topicwise Analysis Chart





01.

Engineering Mechanics

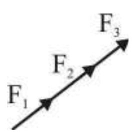
1. Forces and Force Systems

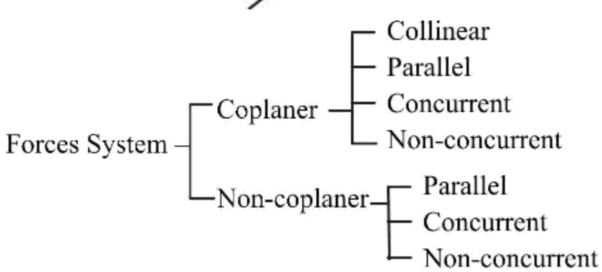
1. The forces whose line of action lie along the same line are known as:

(a) collinear forces
(b) coplanar parallel forces
(c) coplanar non-concurrent forces
(d) coplanar concurrent forces

SSC JE 27-09-2019 (Shift-2)

Ans. (a) : The forces whose line of action lie along the same line are known as collinear forces.
Forces F_1, F_2, F_3 and F_4 are collinear because they lie on the same line of action.





2. The dimensional formula of the force is———

(a) MLT^2
(b) MLT^{-2}
(c) MLT^{-1}
(d) $ML^{-1}T^{-1}$

SSC JE 27. 1. 2018 (10.15 pm)

Ans. (b) : Force = mass × acceleration
Mass (m) = kg
Acceleration (a) = m/s^2
Now, dimensional formula of force
$F = [M] \times [LT^{-2}]$
$= [MLT^{-2}]$

3. D'Alembert's principle is used for :-

(a) Reducing the problem of kinetics to equivalent statics problem
(b) Determining stresses in the truss
(c) Stability of floating bodies
(d) Designing safe structures

SSC JE 29. 1. 2018 (3.15 pm)

Ans. (a) D'Alembert's Principle states that the resultant force acting on the body together with against effective force or inertia force are in equilibrium.
$P - ma = 0$ or $P = ma$
D' Alembert's Principle is used for reducing the problem of kinetics to equivalent statics problem.

4. A satellite is kept on moving in its orbit around the earth due to ......

(a) centrifugal force
(b) centripetal force
(c) gravitational force
(d) resultant forces acting on statellite

SSC JE 2 March 2017 Shift-I

Ans. (b) Centripetal force→ It is a force that makes a body follow a curved path. Its direction is always orthogonal to the motion of the body and towards the fixed point centre of the instantaneous center of curvature of the path

$$F_c = \frac{mv^2}{r}$$

F_c= Centripetal force
m= Mass of object
v= Velocity
r = Radius

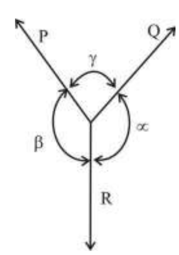
5. Which of the following theorem is used for the equilibrium of the body applied with three concurrent coplanar forces-

(a) Varignon's theorem
(b) Hamilton theorem
(c) Lami's theorem
(d) Pythagoras theorem

SSC JE 2015

Ans. : (c) Lami's theorem–An equation relating magnitudes of three coplanar concurrent forces to keep body in static equilibrium.

$$\frac{P}{\sin\alpha} = \frac{Q}{\sin\beta} = \frac{R}{\sin\gamma}$$



- It states that if three coplanar forces acting at a point be in equilibrium, then each force is proportional to the sine of the angle between the other two forces.

Pythagoras theorem–It is used to measure angle and side of triangle.

Varignon's principle−Moment of a force about any point is equal to the sum of the moments of the components of that force about the same point.

6. What are the equlibrium conditions to be satisfied for a particle applied with a system of non-coplanar, concurrent forces?

(a) $\Sigma F_x=0$ & $\Sigma F_y=0$

(b) $\Sigma F_x=0$, $\Sigma F_y=0$] $\Sigma F_z=0$, $\Sigma M_x=0$m $\Sigma M_y=0$ & $\Sigma M_z=0$

(c) $\Sigma F_x=0$, $\Sigma F_y=0$ & $\Sigma M_{z\text{-axis}}=0$

(d) $\Sigma F_x=0$, $\Sigma F_y=0$ & $\Sigma F_z=0$

SSC JE 2015

Ans. : (d) Equilibrium conditions, for non-coplanor concurrent forces:-

$\Sigma F_x=0$, $\Sigma F_y=0$ & $\Sigma F_z=0$

- For Non coplaner , non- concurrent forces:-

$\Sigma F_x=0$, $\Sigma F_y=0$, $\Sigma F_z=0$

$\Sigma M_x=0$, $\Sigma M_y=0$, $\Sigma M_z=0$

7. Parallel forces have their lines of action:

(a) tangential to each other

(b) transverse to each other

(c) parallel to each other

(d) perpendicular to each other

SSC JE 27-10-2020 (Shift-1)

Ans. (c) Parallel forces have their lines of action parallel to each other.

⇒ If the parallel forces act in the same direction then these are known as like parallel forces.

⇒ When the parallel forces act in opposite directions, then these are known as unlike parallel forces.

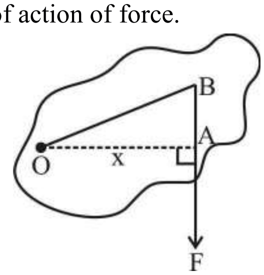
8. The moment of a force about any point is the ______ of force and perpendicular distance between the point and line of action of force.

(a) Product (b) Division

(c) Sum (d) Subtraction

SSC JE 27-10-2020 (Shift-1)

Ans. (a) : The moment of a force about any point is the product of force and perpendicular distance between the point and line of action of force.



Hence, moment about point $\boxed{(M)_O = F\times x}$

9. When a body is subjected to two forces, the body will be in equilibrium if the two forces are:

(a) collinear, unequal and opposite

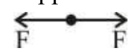
(b) collinear, equal and act in the same direction

(c) collinear, equal and opposite

(d) non collinear, equal and opposite

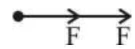
SSC JE 27-10-2020 (Shift-1)

Ans. (c) : The body will be in equilibrium if two forces are collinear, equal and opposite.



Resultant (R) = F – F = 0

Note-If forces are collinear, equal and act in the same direction then,



∴ resultant $\boxed{R = F + F = 2F}$

10. 'The moment of a force about any point is equal to the algebraic sum of moments of its components about that point' is stated by:

(a) Avogadro's principle

(b) Henry's principle

(c) Lufkin's principle

(d) Varignon's principle

SSC JE 27-10-2020 (Shift-1)

Ans. (d) : Varignon's Principle of Moments (or Law of Moments)–It states that if a number of coplanar forces acting on a particle are in equilibrium then the algebraic sum of their moments about any point is equal to the moment of their resultant force about the same point.

11. 'The rate of change of momentum is equal to the applied force and it takes place in the direction of the force' is a statement of:

(a) Pascal's equation

(b) Continuity equation

(c) Impulse-Momentum of equation

(d) Darcy's equation

SSC JE 11-12-2020

Ans. (c) : 'The rate of change of momentum is equal to the applied force and it takes place in the direction of the force is a statement of impulse-momentum of equation.

According to second law of Newton–

$$F \propto \frac{dP}{dt}$$

$$F \propto \frac{mdv}{dt}$$

$$F = k\frac{mdv}{dt} \qquad \text{(Constant value of k = 1)}$$

$$F = \frac{m(v_2 - v_1)}{dt}$$

$$F = \frac{mv_2 - mv_1}{dt}$$

$$F \times dt = mv_2 - mv_1$$

↓ ↓

Impulse force Equation of change in momentum

12. A body is in equilibrium when:

(a) the vector sum of external forces and moments is zero
(b) the vector sum of external forces is zero
(c) no force or moment acts on the body
(d) the body is accelerating

SSC JE 27-09-2019 (Shift-1)

Ans. (a) : A body is in equilibrium when the vector sum of external forces and moments is zero

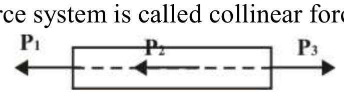
$$\sum F_x = 0, \sum M = 0$$
$$\sum F_y = 0$$
$$\sum F_z = 0$$

13. In collinear force system the forces whose line of action lie on:

(a) Meet at one point
(b) Does not meet at one point
(c) On the same plain
(d) Same line

SSC JE 27-09-2019 (Shift-1)

Ans. (d) : Collinear force system—When the lines of action of all the forces of a system act along the same line, this force system is called collinear force system.



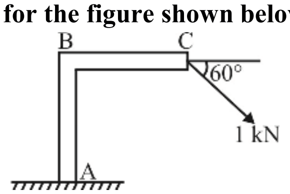
14. What term is used for the combined effect of all the forces on a body?

(a) Load (b) Stress
(c) Strain (d) None of the above

SSC JE 22 1. 2018 (10.15 am)

Ans. (a) The combined effect of all the forces on a body is load.
The overall force to which a structure is subjected in supporting a weight or mass in resisting external applied forces.
e.g. weight of vehicle on bridge, weight lifted by crane, air and water pressure at wall etc.

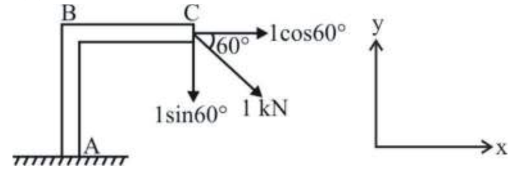
15. Calculate the value of thrust (in kN) at the point A for the figure shown below.



(a) 0.866 (b) 0.5
(c) 2 (d) 3

SSC JE 27. 1. 2018 (3.15 pm)

Ans. (a) :



Component of 1 kN on C along y–direction
$= 1 \sin 60^o$

$= \frac{\sqrt{3}}{2} kN$

$= 0.866 \, kN$

Hence transferring this vertical component force 0.866 kN on point B, one couple and thrust force on B will be induced.

16. Choose the CORRECT option regarding the effect of forces acting on the body?

(a) Introduces internal stress.
(b) Balance the other forces acting on it.
(c) Retard its motion
(d) All option are correct

SSC JE 27. 1. 2018 (10.15 pm)

Ans. (d) : A force can produce the following effects on the body–

(i) It introduces internal stresses.
(ii) It balances all the forces acting on the body so that body will remain in equilibrium.
(iii) It can move a stationary body
(iv) It can stop a moving body.
(v) It can change the direction, shape and size of a body.

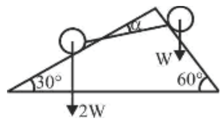
17. What is the CORRECT option for a rigid body to be in the equilibrium when the body is under the action of three forces?

(a) The forces acting on the body are equal.
(b) The line of action of these forces are parallel to each other
(c) The line of action of these forces meet in a point
(d) The line of action of these forces are parallel to each other and the line of action of these forces meet in a point both

SSC JE 25. 1. 2018 (10.15 am)

Ans. (d) For a rigid body to be in equilibrium, when the body is under the action of forces.
The net force acting on the body should be zero (ΣF_{net}= 0) and net moment (ΣM_{net}= 0) about any point should be zero.
For this, the line of action of these forces are parallel to each other and the line of action of these forces meet in a point both.

18. The weights of 2W and W are connected by an inextensible string and rest on two inclined planes, inclined at 30° and 60° respectively as shown in the figure below. Angle 'α' will be equal to

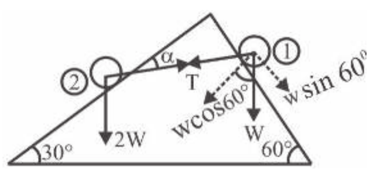


(a) 30° (b) $\cos^{-1}\left(\frac{1}{2}\right)$

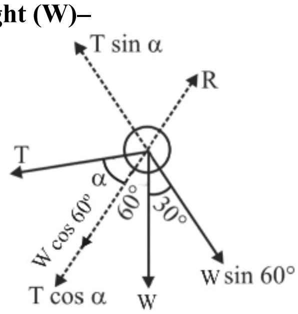
(c) 45° (d) $\tan^{-1}\left[\left(\frac{\sqrt{3}}{2}\right)\right]$

SSC JE 2 March 2017 Shift-II

Ans. (d)

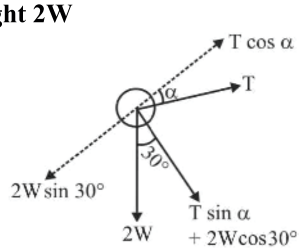


FBD for weight (W)–



T sin α = W sin 60° …… (i)

FBD for weight 2W



T cos α = 2 W sin 30°------(ii)

Dividing equation (ii) by equation (i), we get–

$$\frac{T\sin\alpha}{T\cos\alpha} = \frac{W\sin 60^0}{2W\sin 30^0}$$

$$\tan\alpha = \frac{W\times\frac{\sqrt{3}}{2}}{2W\times\frac{1}{2}}$$

$$\tan\alpha = \frac{\sqrt{3}}{2}$$

$$\therefore \boxed{\alpha = \tan^{-1}\left(\frac{\sqrt{3}}{2}\right)}$$

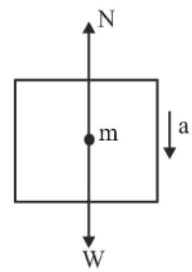
19. When a body falls freely under gravitational force, it possesses ____.

(a) maximum weight (b) minimum weight

(c) no weight (d) No effect on its weight

SSC JE 2 March 2017 Shift-II

Ans. (c)



Applying Newton's law of motion

N = W–ma

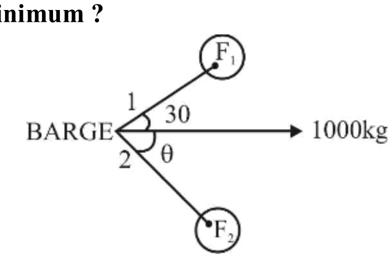
N = m(g-a)

For a free falling body, a = g

Thus, W = m (g-g) = 0

though, its apparent weight will be zero.

20. A barge is pulled by two tugboats as shown in the figure below. The resultant of forces exerted by the tugboats is 1000 kg force. What will be the value of θ so that tension in rope 2 is minimum ?

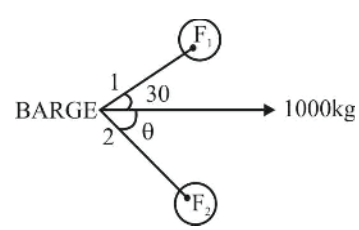


(a) 30^0 (b) 45^0

(c) 60^0 (d) 0^0

SSC JE 4 March 2017 Shift-I

Ans. (c)



$\sum H = 0$

$$F_1\cos 30 + F_2\cos\theta = 1000 \;......(i)$$

$$\sum V = 0$$

$$F_1\sin 30 = F_2\sin\theta \;.........(ii)$$

$$F_1 = \frac{F_2\sin\theta}{\sin 30}$$

From equation (I) & (II)

$$F_2 \frac{\sin\theta}{\sin 30} \times \cos 30 + F_2 \cos\theta = 1000$$

$$F_2 \sin\theta . \cos 30 + F_2 \cos\theta \sin 30 = 1000 \times \sin 30$$

$$F_2 (\sin\theta . \cos 30 + \cos\theta . \sin 30) = 500$$

$$F_2 \sin(30+\theta) = 500 \qquad F_2 = \frac{500}{\sin(30+\theta)}$$

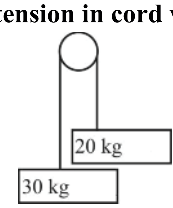
for, minimum value of F_2, when value of sin (30 + θ) will be maximum.

sin (30+θ) = sin 90

$30 + \theta = 90^0$

$\theta = 60^0$

21. In the figure given below a weight of 20 kg is suspended at one end of cord and a weight of 30 kg is suspended at other end of cord passing over a pulley. Neglecting the weight of rope and pulley, tension in cord will be :



(a) 30N (b) 20N
(c) 10N (d) None of these

SSC JE 4 March 2017 Shift-II

Ans. (d) For mass 20 kg

T– mg = ma

T – 20×10 = 20a ……(i)

For mass 30 kg

mg–T = ma

30×10–T = 30a ………(ii)

adding (i) and (ii)

100 = 50a

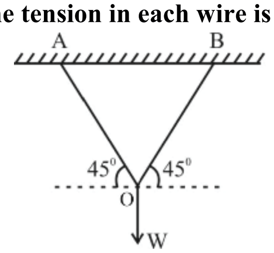
$a = 2 \text{ m/s}^2$

from equation ….(i)

T –200 = 20×2

$\boxed{T = 240 \text{ N}}$

22. Two wires AO and BO support a vertical load W at O as shown in the figure below. The wires are of equal length and equal cross sectional area. The tension in each wire is equal to :

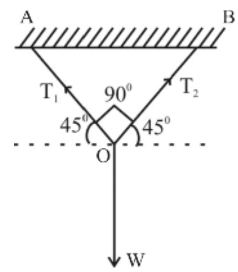


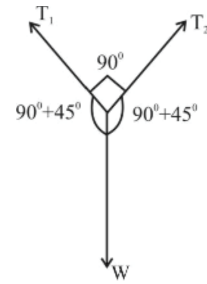
(a) W/2 (b) W
(c) $\sqrt{2}$ W (d) W/$\sqrt{2}$

SSC JE 2 March 2017 Shift-I

Ans. (d) In equilibrium condition according to Lami's theorem

$$\frac{T_1}{\sin(90+45^0)} = \frac{T_2}{\sin(90+45^0)} = \frac{w}{\sin 90^0}$$





$$\frac{T_1}{\sin(90+45^0)} = \frac{W}{\sin 90^0}$$

$$\frac{T_1}{\cos 45} = W$$

$$T_1 = W\cos 45^0 = W \times \frac{1}{\sqrt{2}}$$

$$\therefore \boxed{T_1 = \frac{W}{\sqrt{2}}}$$

$$\frac{T_2}{\sin(90+45^0)} = \frac{W}{\sin 90^0}$$

$$\frac{T_2}{\cos 45^0} = W$$

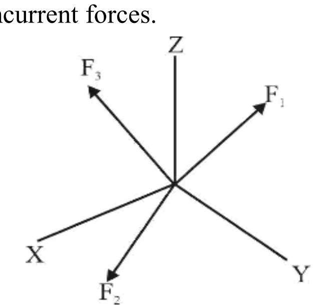
$$\boxed{T_2 = \frac{W}{\sqrt{2}}}$$

23. The forces which meet at one point and have their lines of action in different planes are called ....

(a) coplanar non–concurrent forces
(b) non–coplanar concurrent forces
(c) non–coplanar non–concurrent forces
(d) intersecting forces

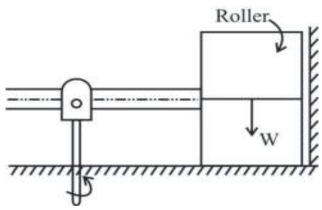
SSC JE 4 March 2017 Shift-I

Ans. (b) The force which meet at one point and have their line of action in different planes are called non coplanar concurrent forces.



Non coplanar concurrent force

24. The figure given below shown a crusher having several cylindrical rollers of weight W. The crushing force due to each roller will be :



(a) W (b) less than W
(c) more than W (d) unprfedictable

SSC JE 2 March 2017 Shift-I

Ans. (c) In the above given figure, crushing force of every roller will be greater than W,

• Crushing force
= Weight of the roller + weight of the gyroscope action.

$$\boxed{F = W + \frac{I\omega^2}{r}}$$

25. Two Tensile forces, each of magnitude F are acting at a point perpendicular to each other, then their resultant force will be :

(a) $\sqrt{F}$ (b) $\sqrt{2F}$
(c) $\sqrt{2}\,F$ (d) Zero

SSC JE 2014 (Evening)

Ans. (c) Given that : -
Tensile force = $F_1 = F_2 = F$
$\theta = 90^0$
R = ?
where, we know that :

$$R = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos\theta}$$

$$R = \sqrt{F^2 + F^2 + 2\times F\times F\cos 90^0}$$

$$R = \sqrt{2F^2}$$

$$\therefore \boxed{R = F\sqrt{2}}$$

26. The quantity, which is equal to rate of change of momentum is known as :

(a) acceleration (b) force
(c) impulse (d) displacement

SSC JE 2014 (Evening)

Ans. : (b) The quantity, is equal to rate of change of momentum is know as force. This is also known as Newton's second law of motion.

because, F = ma

$$F = m\frac{\Delta V}{t} \quad \left(\therefore a = \frac{\Delta V}{t}\right)$$

Hence, $\boxed{F = \frac{\Delta P}{t}}$

27. Which law of motion (of Newton) gives the measure of force?

(a) Newton's first law (b) Newton's second law
(c) Newton's third law (d) None of these

SSC JE 2014 (MORNING)

Ans. : (b) Newton's second law of motion gives the measure of force.

Newton's Second law of motion→ rate of change of momentum of any body is directly proportional to the applied force & direction of momentum is in the direction of applied force.

ie

$$F \propto \frac{\Delta P}{\Delta t}$$

$$F \propto \frac{mdv}{dt}$$

$$F = k\frac{mdv}{dt} \qquad \left(k = 1, \frac{dv}{dt} = a\right)$$

$$\boxed{F = ma}$$

Newton's third Law of motion → whenever one object exerts a force on a second object, the second object exerts an equal and opposite direction on the first object. It is also known as law of action and reaction.

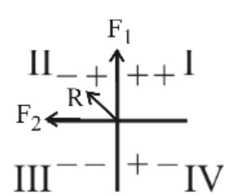
Example → Motion of rocket, motion of boat in backward when we jump, thrust generate in gun when it fired.

28. If the x-component of a force is negative and the y-component is positive, the direction of that force must lie in the:

(a) Second quadrant (b) Third quadrant
(c) Fourth quadrant (d) First quadrant

SSC JE 2014 (Evening)

Ans. : (a)



29. The unit of luminous flux is-

(a) Watt (b) Watt/m^2
(c) lumen (d) lumen/m^2

SSC JE 2007

Ans. : (c) The unit of luminous flux is lumen (in SI System). It is the received power light. It differs from radiant flux, the measure of the total power of electromagnetic radiations (including infrared, Ultraviolet and visible light) in that luminous flux is adjusted to reflect the varying sensitivity of the human eye to different wavelengths of light.

2. Moments and Couples

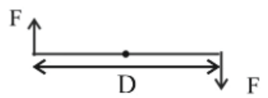
30. Two parallel forces equal in magnitude, opposite in direction and separated by a definite distance are said to form a/an:

(a) shear force (b) resultant
(c) equilibrant (d) couple

SSC JE 27-09-2019 (Shift-2)

Ans. (d) : A couple consists of two parallel forces that are equal in magnitude, opposite in direction and do not share a line of action. It produces only rotation.

$\boxed{M = F \times D}$ N-m



31. The rate of change of moment of momentum represents the :

(a) Torque applied by the fluid
(b) Work done by the fluid
(c) Power developed by the fluid
(d) Force exerted by fluid

SSC JE 2014 (Evening)

Ans. : (a) Torque can be defined as the rate of change of moment of momentum.

- The rate of change of momentum is called force.
- The rate of change of velocity is called acceleration.

3. Friction

32. The maximum frictional force which comes into play when a body just begins to slide over another surface is called :

(a) limiting friction (b) sliding fiction
(c) rolling friction (d) kinematic friction

SSC JE 3 March 2017 Shift-II

Ans. (a) :

- The maximum frictional force which comes into play when a body just begins to side over an other surface is called limiting friction.
- **Rolling friction –** The friction experienced by a body, when balls or rollers are interposed between the two surfaces, is known as rolling friction.
- **Sliding friction –** The friction, experienced by a body, when it slide over another body is known as sliding friction.
- The friction, experienced by a body, when at rest is known as static friction.

33. Limiting force of friction is the :

(a) tangent of angle between normal-reaction and the resultant of normal reaction and limiting friction
(b) ratio of limiting friction and normal reaction
(c) the friction force acting when the body is just about to move
(d) the friction force acting when the body is in motion

SSC JE 25. 1. 2018 (10.15 am)

Ans. (c) :

- The maximum valve of frictional force, which comes into play, when a body just begins to slide over the surface of the other body, is known as limiting force of friction.
- The friction, experienced by a body, when in motion, is called dynamic friction. It is also called kinetic friction. It is of the following two types.

a - Sliding friction
b- Rolling friction

34. The angle of friction is :

(a) The ratio of friction and normal reaction
(b) The force of friction when the body is in motion
(c) The angle between the normal reaction and the resultant of normal reaction and limiting friction
(d) The force of friction at which the body is just about to move

SSC JE 29. 1. 2018 (10.15 am)

Ans. (c) : Angle of friction- It is the angle which the resultant of the limiting friction and the normal reaction makes with the normal reaction.

Coefficient of frication (μ) = It is the ratio of the magnitude of limiting force of friction to the normal reaction b/w surface in contact.

$$\mu = \frac{F}{R} \Rightarrow \frac{\mu R}{R} = \mu$$

$$\boxed{\phi = \tan^{-1}\mu}$$

35. When the friction comes into action between the two running parts of a machine, it results in the production of ....

(a) light (b) oil
(c) energy (d) heat

SSC JE 24. 1. 2018 (10.15 am)

Ans. (d) Friction comes into action between the two running parts of a machine. Surface of any part has a number of valley of roughness which behave like as teeth. When two surface brought into the contact and moved over past then teeth are break due to relative motion so heat energy developed.

To reduce friction–

(i) Apply any lubricant material (ii) Grease (iii) Oil

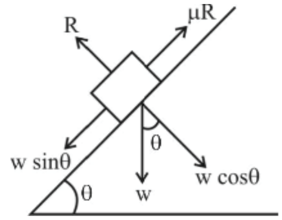
36. A body is resting on a plane inclined at angle 30^0 to horizontal. What force would be required to slide it down, if the coefficient of friction between body and plane is 0.3 ?

(a) Zero (b) 1 kg
(c) 5 kg (d) None of these

SSC JE 2 March 2017 Shift-I

Ans. (a) Plane inclined angle $\theta = 30^0$

Coefficient of friction $\mu = 0.3$



If an object is placed on a flat plane, the inclination of the ground plane is less than friction angle, external force is required to slip the object.

- If the inclination of the flat plane is greater than the frictional angle, the object will start sliding without external force.

We know that $\mu = \tan\lambda \Rightarrow \lambda = \tan^{-1}(0.3) = 16.7^0$

if $\lambda \le \theta$ (In this case, sliding of object start)

$\lambda = 16.7^0$ and $\theta = 30^0$

Friction angle is less than the inclined angle the object (16.7 < 30º). So object will start downward by its own weight without any external force sliding. $\boxed{P = 0}$

37. Using lubricants on engine parts is an example of reducing :

(a) Acceleration (b) Motion
(c) Friction (d) Force

SSC JE 2014 (Evening)

Ans. : (c) Using lubricants on engine parts is an example of reducing friction.

Lubricant– A lubricant is a substance, usually organic, introduced to reduce friction between surfaces in mutual contact, which ultimately reduces the heat generated when the surface move. It may also have the function of transmitting forces, transporting foreign particles, or heating or cooling the surfaces.

38. The direction of frictional force acting on a body which can slide on a fixed surface is:

(a) In the direction of motion
(b) Normal to the direction of motion
(c) Unpredictable
(d) Opposite to the direction of motion

SSC JE 2014 (morning shift)

Ans. (d) : The direction of frictional force is always opposite to the direction of motion. Friction always tends to oppose the applied force.

The frictional force which resists the real relative sliding motion between two contact surfaces is known as sliding or kinetic friction.

$\boxed{F_{sliding} = \mu_k.N}$

Where $\mu_k \rightarrow$ Sliding friction coefficient

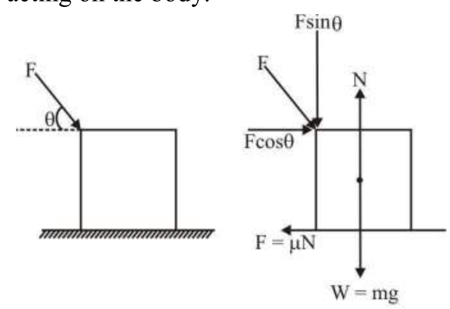
$N \rightarrow$ Normal reaction

39. Define free-body diagram

(a) A figure that represents external forces acting on a body
(b) A diagram that represents internal forces acting on a body
(c) A free-hand sketch representing a body
(d) A diagram that only represents moments acting on a body

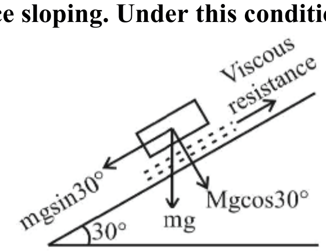
SSC JE 22-03-2021 Shift-II

Ans. (a) : Free-body diagrams are used to represent relative magnitude and direction of external forces (load) acting on the body.



Free body diagram

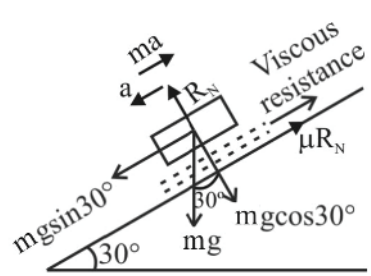
40. A rectangular plate of mass m slide down, on a film of oil, at a uniform velocity on an inclined surface sloping. Under this condition:



(a) the coefficient of friction = 0.5
(b) there is no resistance to motion as it slides down
(c) the viscous resistance to motion = m.sin30º
(d) the resistance due to viscosity of oil = m

SSC JE 25-09-2019 (Shift-2)

Ans. (c) :



$\Sigma F_{net} = W\sin\theta - \mu R_N$

$ma = W\sin\theta - \mu R_N = 0$ $[\because a = 0]$

$W\sin\theta = \mu R_N$

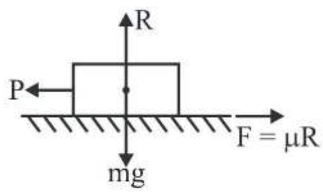
$f = W\sin 30^0$

41. Which is the CORRECT option for the movement of the body?

(a) Force of friction = Applied force
(b) Force of friction < Applied force
(c) Force of friction > Applied force
(d) All option are correct

SSC JE 27. 1. 2018 (10.15 pm)

Ans. (b) :



For just sliding – P = F
For movement P > F

$P > \mu R$

$\boxed{P > \mu mg}$

42. Choose the option which is INCORRECT about the term friction.

(a) Friction produces heat
(b) It leads to the decrease in the velocity of object
(c) It leads to the increase in the velocity of object
(d) It can stop the moving object

SSC JE 23. 1. 2018 (10.15 am)

Ans. (c) Consider the following points regarding friction

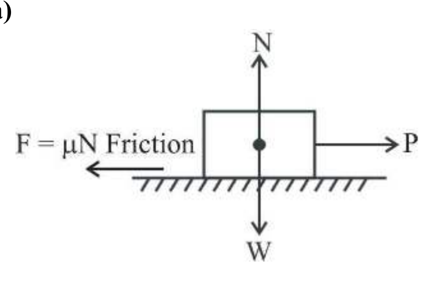
(i) Friction produces heat.
(ii) Friction leads to the decrease in the velocity of object.
(iii) Friction can stop the moving object
(iv) Friction opposes the motion.

43. Which of the given formula is CORRECT for calculating the angle of static friction ϕ_s?

(a) $\tan^{-1}\mu_s$ (b) $\sin^{-1}\mu_s$
(c) $\cos^{-1}\mu_s$ (d) None of these

SSC JE 23. 1. 2018 (10.15 am)

Ans. (a)

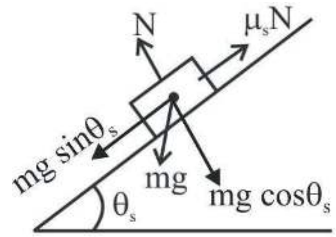


It is observed that the block does not move until the applied force P reaches a maximum value P_{max}. Thus from P = 0 up to $P = P_{max}$, the frictional force adjust itself so that it is just sufficient to stop the motion. It was observed by coulomb that P_{max} is proportional to the normal reaction of the surface of the object.

$P_{max} \propto N$

$F_{max} = \mu_s N$

Where μ_s is known as the co-efficient of static friction.



A quick way of estimating the value of static friction is to look at the motion of object on an inclined plane.

$mg \cos\theta_s = N$ .....(i)

$mg \sin\theta_s = \mu_s N$ .....(ii)

From equation (i) and (ii)

$\tan\theta_s = \mu_s$

$\therefore \boxed{\theta_s = \tan^{-1}\mu_s}$

44. Which of the following terms best describes the frictional force?

(a) None contact force (b) Contact force
(c) Static force (d) None of these

SSC JE 29. 1. 2018 (3.15 pm)

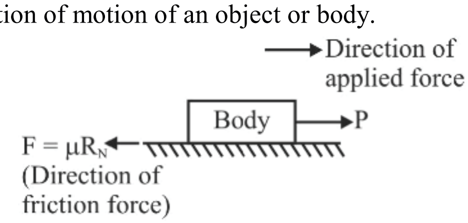
Ans. (b) A frictional force is defined as a force which resists the relative motion between the contacting surfaces hence it is also known as contact force.

45. What is the direction of application of friction force with respect to the direction of motion of an object?

(a) Same (b) Perpendicular
(c) Opposite (d) Downward

SSC JE 23. 1. 2018 (3.15 pm)

Ans. (c) Frictional force is always opposite to the direction of motion of an object or body.



46. Choose the CORRECT statement about the kinetic friction and the static friction.

(a) Kinetic friction is lesser than the static friction
(b) Kinetic friction is greater than static friction
(c) Kinetic friction is equal to static friction
(d) Kinetic friction is equal to contact force

SSC JE 27. 1. 2018 (3.15 pm)

Ans. (a) The force necessary to induce motion is always bigger than the one necessary to continue the motion.
So the kinetic friction is smaller than the static one. It will say that $\boxed{f_{st} > f_{dy}}$

47. The value of the coefficient of friction between the box and the surface is 0.20 which prevents the box from sliding. If the box decelerates with 'a' (m/s²), then calculate the deceleration, if the force applied is 'ma'.

(a) 2 (b) 2.5
(c) 3 (d) 3.5

SSC JE 25. 1. 2018 (3.15 pm)

Ans. (a) We know that $F = ma$

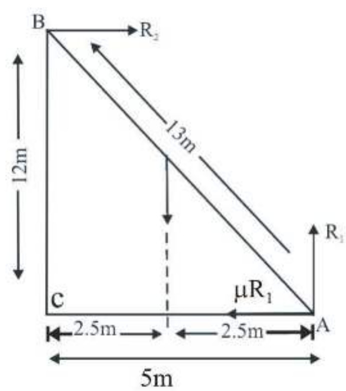
$\mu = 0.20, a = ?$
$F = \mu.R$
$F = ma = \mu R$
$R = mg$
$ma = 0.2 \times mg$
$a = 0.2 \times 10 \quad (g = 10)$
Hence $a = 2 \text{ m/s}^2$

48. A 13 m ladder is placed against a smooth vertical wall with its lower end 5 m from the wall. What should be the coefficient of friction between the ladder and floor so that it remains in equilibrium ?

(a) 0.1 (b) 0.15
(c) 0.28 (d) None of these

SSC JE 4 March 2017 Shift-I

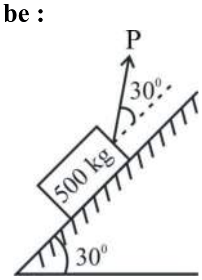
Ans. (d)



$$BC = \sqrt{AB^2 - AC^2}$$
$$= \sqrt{13^2 - 5^2}$$
$$BC = \sqrt{144} = 12$$
$$\sum v = 0$$
$$R_1 = W$$
$$\sum H = 0$$
$$\mu R_1 = R_2$$
$$R_2 = \mu W \quad ....(i)$$

$\sum M$ at the point A
$$W \times 2.5 = R_2 \times 12$$
$$R_2 = \frac{2.5}{12} \times W \quad ....(ii)$$
From equation (i) & (ii)
$$\mu = \frac{2.5}{12}$$
$$\boxed{\mu = 0.208}$$

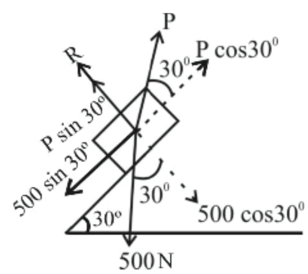
49. A weight of 500 N is held on a smooth plane, inclined at 30⁰ to the horizontal by a force P acting 30⁰ above the plane as shown in the figure below. The reaction of plane on the weight will be :



(a) 500 N (b) 250 N
(c) 476 N (d) 288 N

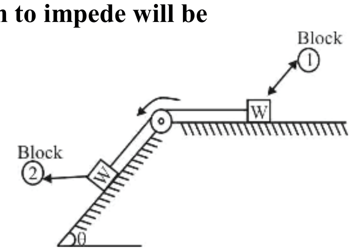
SSC JE 2 March 2017 Shift-I

Ans. (d)



Plane is smooth then $\mu = 0$
$\sum H = 500 \sin 30^0 - P \cos 30^0 = 0$
$P = 500 \tan 30^0 = 288.675$ N
$\Sigma V = 500 \cos 30° - P \sin 30° - R = 0$
$R = 288.68 \approx 288$ N
$\boxed{R = 288 \text{ N}}$

50. Two rectangular blocks of weight 'W' each are connected by a flexible cord and rest upon a horizontal and an inclined plane with the cord passing over a pulley as shown in the figure below. If μ is the coefficient of friction for all continuous surfaces, angle 'θ' for motion of system to impede will be

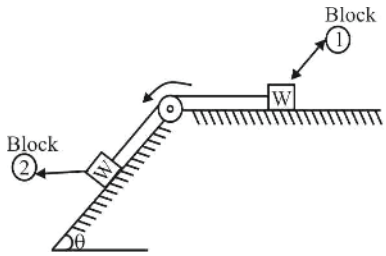


(a) $\tan\theta = \mu$ (b) $\tan\left(\frac{\theta}{2}\right) = \mu$

(c) $\tan(2\theta) = \mu$ (d) $\tan\theta = 2\mu$

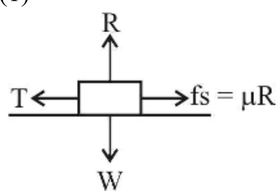
SSC JE 2 March 2017 Shift-II

Ans. (b)



Friction coefficient between block & surface=μ

FBD of Block (1)



Since Block is in equilibrium condition

Then $\Sigma F_v = 0$

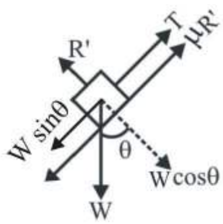
R=W

& $\Sigma F_H = 0$

$\boxed{T = f_s = \mu R}$

$\boxed{T = \mu W}$ ....(i)

FBD of Block (2)



Since block is in equilibrium condition

$\therefore \Sigma F_v = 0$

$R' = W\cos\theta$

$\therefore \Sigma F_H = 0$

$T + \mu R' = W\sin\theta$ .... (ii)

from equation (1) & (2)

$$\mu W + \mu W\cos\theta = W\sin\theta$$

$$\mu(1+\cos\theta) = \sin\theta$$

$$\mu\left(1+2\cos^2 \theta/_2 - 1\right) = 2\sin \theta/_2 \cos \theta/_2$$

$$\mu = \frac{\sin \theta/_2}{\cos \theta/_2}$$

$$\therefore \mu = \tan \theta/_2$$

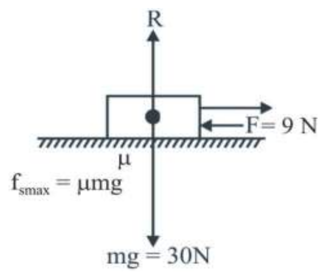
51. A body of weight 30 N rests on a horizontal floor. A gradually increasing horizontal force is applied to the body which just starts moving when the force is 9 N. The coefficient of friction between the body and the floor will be

(a) 10/3 (b) 3/10

(c) 1/3 (d) 1/9

SSC JE 2014 (MORNING)

Ans. : (b)



$\therefore \Sigma V = 0$

R = 30 N

R = W = mg

$\therefore f_{max} = \mu.R$

$f_{max} = 30\mu$

In just starts moving condition

Applied force = max friction force

$9 = 30\ \mu$

$$\mu = \frac{9}{30} = \frac{3}{10} = 0.3$$

$$\boxed{\mu = \frac{3}{10}}$$

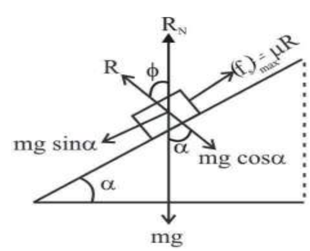
52. A body of weight W is placed on a rough inclined plane. The inclination of the plane with the horizontal is less than the angle of friction. The body will

(a) be in equilibrium (b) move downwards

(c) move upwards (d) None of the above

SSC JE 2014 (MORNING)

Ans. : (a)



Let the body is in just in slide condition the

$f_{max} = mg\sin\alpha$

$\mu mg\cos\alpha = mg\sin\alpha$

$\tan\phi = \tan\alpha$ ($\because \mu = \tan\phi$)

$\because \phi > \alpha$

Then $\boxed{\tan\phi > \tan\alpha}$

ie body will be in equilibrium condition

53. **The friction between objects that are stationary is called**
(a) Static friction (b) Rolling friction
(c) Kinetic friction (d) Dynamic friction
SSC JE 2014 (MORNING)

Ans. : (a) The friction between objects that are stationary is called static friction.
- The friction experienced by a body, when at rest, is known as static friction.
- The friction experienced by a body, when body in motion, is known as dynamic (kinetic) friction

$$\boxed{f_{st} > f_{dy}}$$

4. Centroid, Centre of Gravity & Moment of Inertia

54. **The ratio of moment of inertia of a circle and that of a square having same area about their centroidal axis is**
(a) $\frac{3}{\pi}$ (b) $\frac{3}{4}\pi$
(c) $\frac{4}{\pi}$ (d) $\frac{5}{4}\pi$
SSC JE 2013

Ans. (a) : Moment of inertia of a circle–

$$I_{circle} = \frac{\pi d^4}{64}$$

Moment of inertia of a square–

$$I_{square} = \frac{a^4}{12}$$

[given, same area, $A_{circle} = A_{square}$]

$$\frac{\pi}{4}d^2 = a^2$$

$$\because \text{ Ratio} = \frac{I_{circle}}{I_{square}} = \frac{\frac{\pi d^4}{64}}{\frac{a^4}{12}} = \frac{\pi d^4}{64} \times \frac{12}{\left(a^2\right)^2}$$

$$= \frac{\pi d^4}{64} \times \frac{12}{\left(\frac{\pi}{4}d^2\right)^2}$$

$$= \frac{\pi d^4}{64} \times \frac{12 \times 16}{\pi^2 d^4}$$

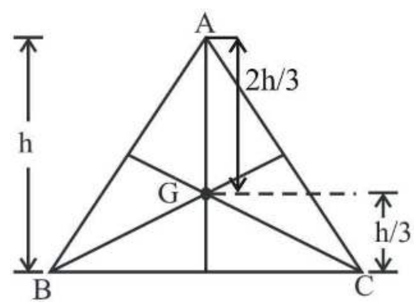
$$= \frac{3}{\pi}$$

55. **The rim of a bicycle wheel with mass M at a radius R rotates with angular acceleration α. Which statement give parameter correctly?**
(a) Mass moment of inertia is MR^2
(b) Its angular momentum is αMR^2
(c) It experiences a torque of $\alpha M(R/2)^{0.5}$
(d) Its radius of gyration is R^2
SSC JE 25-09-2019 (Shift-2)

Ans. (a) : Mass moment of Inertia of Rim of mass M and radius R with angular acceleration rotation.
- $I_{rim} = MR^2$
- $I_{soild\,cylinder} = \frac{MR^2}{2}$
- $I_{thin\ rod} = \frac{Ml^2}{12}$

56. **The centre of gravity of a triangle is located at the point of ....**
(a) intersection of its altitudes
(b) intersection of bisector of angles
(c) intersection of diagonals
(d) concurrence of the medians
SSC JE 29. 1. 2018 (10.15 am)

Ans. (d) Center of gravity of triangle is a point where all the three medians of triangle interest. C.G. is located h/3 distance from bottom & $\frac{2h}{3}$ distance from top.



57. **Which is the CORRECT option for the polar moment of inertia of the solid shaft?**
(a) $J = \frac{\pi}{64}d^4$ (b) $J = \frac{\pi}{32}d^4$
(c) $J = \frac{\pi}{16}d^2$ (d) $J = \frac{\pi}{16}d^4$
SSC JE 22 1. 2018 (10.15 am)

Ans. (b) Polar moment of inertia I = $I_{zz} = I_{xx} + I_{yy}$
I_{xx} = moment of inertia about x-axis
I_{yy} = moment of inertia about y-axis

$$I_{zz} = I_{xx} + I_{yy}$$

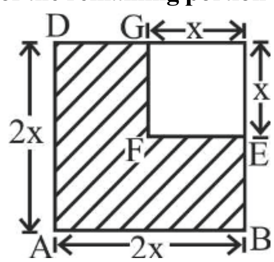
$$= \frac{\pi d^4}{64} + \frac{\pi d^4}{64}$$

$$J = I_{zz} = \frac{\pi d^4}{32} = \text{Polar moment of inertia}$$

58. **The point of application of the resultant of all the forces which tends to cause rotation in the body about a certain axis is known as.....**
(a) center of gravity
(b) the point of meta centre
(c) point of suspension
(d) centre of percussion
SSC JE 29. 1. 2018 (10.15 am)

Ans. (d) The point of application of the resultant of all the forces which tends to cause rotation in the body about a certain axis is known as centre of percussion.
Sometimes, the centre of oscillation is termed as centre of percussion. it is defined on suspended body so that the reaction at the support is zero.

59. **A Square sheet of metal has a square of one quarter of the original area cut from one corner as shown in the figure. Which of the following statements is true about the position of the centre of gravity of the remaining portion of the sheet?**



(a) Centre of gravity lies at a distance of $\frac{5}{12}$ of the side of the original square from each uncut side
(b) Centre of gravity lies at a distance of $\frac{7}{12}$ of the side of the original square from each uncut side
(c) Centre of gravity lies at a distance of $\frac{3}{4}$ of the side of the original square from each uncut side
(d) None of these
SSC JE 3 March 2017 Shift-II

Ans. (a) Let point A is origin

$$\overline{x} = \frac{A_1x_1 - A_2x_2}{A_1 + A_2}$$

$$\overline{x} = \frac{4x^2 \times x - (x)^2 \times 1.5x}{4x^2 - x^2}$$

$$\overline{x} = \frac{4x^3 - 1.5x^3}{3x^2}$$

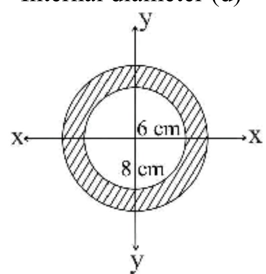
$$= \frac{2.5x^3}{3x^2} = \frac{2.5}{3}x$$

$$\overline{x} = \frac{5}{6}x$$

$x = \frac{5}{12}(2x)$, it means Centre of gravity lies at a distance of $\frac{5}{12}$ of the side of the original square from each uncut side

60. **The moment of inertia of a hollow circular section whose external diameter is 8 cm and internal diameter is 6 cm about centroidal axis is _____ cm^4.**
(a) 437.5 (b) 337.5
(c) 237.5 (d) 137.5
SSC JE 3 March 2017 Shift-II

Ans. (d) Given:- External diameter (D) = 8 cm
Internal diameter (d) = 6 cm



∴ Moment of inertia about centroidal axis

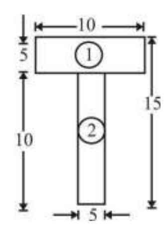
$$I_{xx} = \frac{\pi}{64}(D^4 - d^4)$$

$$I_{xx} = \frac{\pi}{64}(8^4 - 6^4) = 137.44467 \text{ cm}^4$$

$$\boxed{I_{xx} = 137.5} \text{cm}^4$$

61. **The center of gravity of a (10 × 15 × 5) cm T-section will be**
(a) 7.5 cm (b) 5.0 cm
(c) 8.75 cm (d) 7.85 cm
SSC JE 2 March 2017 Shift-II

Ans. (c)



∴ Centre of gravity of T-section

$$\overline{y} = \frac{A_1y_1 + A_2y_2}{A_1 + A_2}$$

∵ $A_1 = 10 \times 5 cm^2$

$$y_1 = \frac{5}{2} + 10 = 12.5cm$$

$A_2 = 10 \times 5 cm^2$

$$y_2 = \frac{10}{2} = 5cm$$

$$\bar{y} = \frac{(10\times5)\times12.5+(10\times5)\times5}{(10\times5)+(10\times5)}$$

$$= \frac{625+250}{100} = 8.75\text{cm}$$

5. Trusses and Beams

62. A structure made up of several bars, riveted or welded together, is known as

(a) Strut (b) Column
(c) Frame (d) Tie

SSC JE 2011

Ans. : (c)

- A structure made up of several bars, riveted or welded together, is known as frame.
- These are made up of angle irons or channel sections and are called members of the frame or framed structure.
- The frames may be classified into following two groups-

1. Perfect frame (n = 2J – 3)
2. Imperfect frame (n ≠ 2 J–3)

- Strut subjected to an axial compressive force but it may be vertical, horizontal or inclined. When strut is vertical it is called column.
- The part of structure that has a tensile force acting on it is called a Tie.

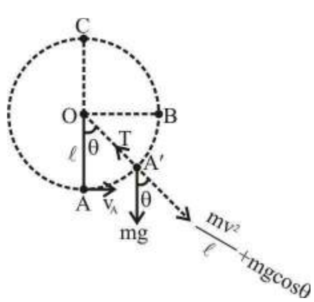
6. Kinematics and Kinetics of Particles & Rigid Body

63. A stone of mass 'm' at the end of a string of length 'ℓ' is whirled in a vertical circle at a constant speed. What position of the stone shall result in the maximum tension in the string?

(a) Quarter-way down from the top
(b) Half-way down from the top
(c) At the top-way of the circle
(d) At the bottom of the circle

SSC JE 27-10-2020 (Shift-3)

Ans. (d) :



At point A′ –

$$T = \frac{mv^2}{\ell} + mg\cos\theta$$

(i) If θ = 90°

$$T_B = \frac{mv^2}{\ell} + mg\times0 = \frac{mv^2}{\ell}$$

(ii) If θ = 180°,

Then, $T_C = \frac{mv^2}{\ell} + mg\cos180° = \frac{mv^2}{\ell} - mg$

(iii) If θ = 0°,

Then, $T_A = \frac{mv^2}{\ell} + mg\times1 = \frac{mv^2}{\ell} + mg$

∵ $\boxed{T_A > T_B > T_C}$

So that, maximum tension in string is at the bottom of the circle.

64. Choose the CORRECT equation for the, velocity in terms of distance (s).

(a) $v = \frac{ds}{dt}$ (b) $v = \frac{d^2s}{dt^2}$

(c) $v = \frac{ds}{dt^2}$ (d) $v = \frac{d^2s}{dt^2}$ and $v = \frac{ds}{dt^2}$ both

SSC JE 29. 1. 2018 (3.15 pm)

Ans. (a) Velocity is defined as the rate of change of displacement with respect to time.

$$\boxed{v = \frac{ds}{dt}}$$

65. Choose the CORRECT equation for the acceleration in terms of distance (s) and velocity (v).

(a) $a = \frac{dS}{dt}$

(b) $a = \frac{d^2S}{dt^2}$

(c) $a = \frac{dV}{dt}$

(d) both $a = \frac{d^2S}{dt^2}$ and $a = \frac{dV}{dt}$

SSC JE 25. 1. 2018 (3.15 pm)

Ans. (d) Acceleration

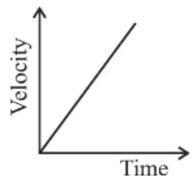
$$a = \frac{dV}{dt}$$

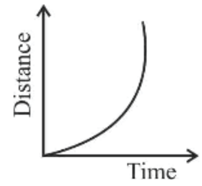
Velocity $(V) = \frac{dS}{dt}$ $\boxed{a = v\frac{dv}{ds}}$

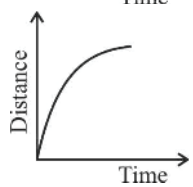
$$a = \frac{dV}{dt} = \frac{d}{dt}\left(\frac{dS}{dt}\right) = \frac{d^2S}{dt^2}$$

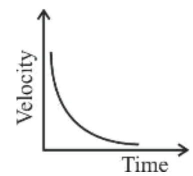
Hence, $\boxed{a = \frac{d^2S}{dt^2}}$

66. Choose the CORRECT graph for the motion of an object moving with the linearly increasing acceleration with respect to time.

(a) 

(b) 

(c) 

(d) 

SSC JE 25. 1. 2018 (3.15 pm)

Ans. (b)

a = f (t)

acceleration is linear function of time (a = t)

$$a = \frac{dv}{dt}$$

$$t = \frac{dv}{dt}$$

$$\int dv = \int t dt$$

$$v = \frac{t^2}{2} + c_1$$

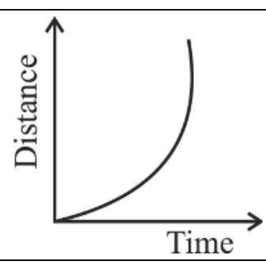
$$\frac{dx}{dt} = \left(\frac{t^2}{2} + c_1\right)$$

$$\int dx = \int \left(\frac{t^2}{2} + c_1\right) dt$$

$$x = \frac{t^3}{6} + c_1 t + c_2$$

Above equation indicate cubic relation between time and distance.

So, correct graph for linearly increasing acceleration with respect to time–



67. Which of the following term can also be used to state the dynamic equilibrium?

(a) Translatory equilibrium
(b) Static equilibrium
(c) Kinetic equilibrium
(d) Rotational equilibrium

SSC JE 23. 1. 2018 (3.15 pm)

Ans. (c) Kinetics is the branch of classical mechanics that concerns the effect of forces and torques on the motion of bodies having mass.

- Kinetic equilibrium can also be used to state the dynamic equilibrium.

68. When a body is said to be in dynamic equilibrium?

(a) When the body is moving with non uniform accelerations
(b) When the body is in uniform motion along a circular path
(c) When the body is in uniform motion along a straight line
(d) When the body is moving with instantaneous velocity

SSC JE 23. 1. 2018 (3.15 pm)

Ans. (c) Equilibrium may be divided into two categories

(i) Static equilibrium– If the combined effect of all the forces acting on a body is zero and the body is in the state of rest then its equilibrium is termed as static equilibrium.

(ii) Dynamic equilibrium– When a body is in state of uniform motion and the resultant of all the forces acting upon it is zero then it is said to be in dynamic equilibrium.

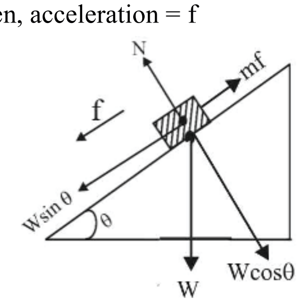
- A body is said to be in dynamic equilibrium when the body is in uniform motion along a straight line.

69. When a body slides down an inclined surface, the acceleration (f) of the body is given by :

(a) f = g
(b) f = g sin θ
(c) f = g cos θ
(d) f = g tan θ

SSC JE 4 March 2017 Shift-II

Ans. (b) Given, acceleration = f



When body slides downward-

Then, Wsinθ = mf

mg sinθ = mf

So, f = gsinθ (No friction is considered)

70. The vehicle moving on a level circular path will exert pressure such that ___.

(a) the reaction on the outer wheels will be more
(b) the reaction on the inner wheels will be more

(c) the reaction on the inner wheels as well as on the outer wheels will be equal
(d) it depends on the speed

SSC JE 1 March 2017 Shift-II

Ans. (a) The vehicle moving on a level circular path will exert pressure such that the reaction on the outer wheels will be more.

71. A particle while sliding down a smooth plane of 19.86 $\sqrt{2}$ m length acquires a velocity of 19.86 m/sec. The inclination of plane is :

(a) 30^0 (b) 45^0
(c) 60^0 (d) 75^0

SSC JE 4 March 2017 Shift-I

Ans. (b) Given that-

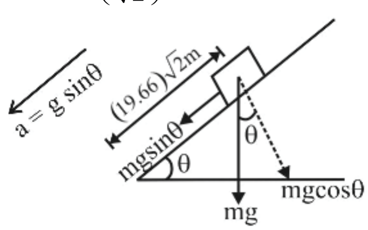
u =0
v= 19.86m/s
F= mgsinθ
m×a= m×gsinθ
a= gsinθ
$v^2 = u^2 + 2as$

So, $(19.86)^2 = (0)^2 + 2\times g\times \sin\theta\times 19.86\sqrt{2}$

$$\sin\theta = \frac{(19.86)^2}{2\times g\times(19.86)\sqrt{2}}$$

$$\sin\theta = \frac{(19.86)}{2\times 9.81\times\sqrt{2}} \approx \frac{1}{\sqrt{2}}$$

$$\theta = \sin\theta^{-1}\left(\frac{1}{\sqrt{2}}\right) = 45^o$$



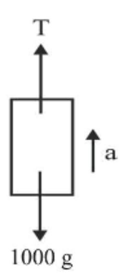
72. An elevator weighing 1000kg attains an upward velocity of 4 m/sec in two seconds with uniform acceleration. The tension in the supporting cables will be :

(a) 1000 N (b) 800 N
(c) 1200 N (d) None of these

SSC JE 4 March 2017 Shift-I

Ans. (d) Given that -

V = 4 m/s



u = 0
t = 2 s
m = 1000 kg
g = 10 m/s^2
We know that -
V = u+at
V = 0+at
V = at ⇒ V = a×2
a = 2m/s^2

Tension in supporting cable while the elevator moving upward is given by -

T – mg = ma ⇒ T = mg + ma
T = m(g+a)
T = 1000 (10+2)
T = 12000 N

73. The escape velocity of a body on earth ___.

(a) increases with the increase of its mass
(b) decreases with the increase of its mass
(c) remains unchanged with variation of mass
(d) varies as the square of the change in mass

SSC JE 1 March 2017 Shift-II

Ans. (c) The escape velocity of a body on earth remains unchanged with variation of the body mass.

$$V_e = \sqrt{\frac{2GM_e}{R_e}}$$

So, escape velocity depends on mass and radius of the earth and does not depends on mass of body. Hence it's value is same for any object of rest on the earth's surface.

as $GM_e = gR_e^2$

$$V_e = \sqrt{\frac{2\times gR_e^2}{R_e}}$$

$$V_e = \sqrt{2gR_e}$$

- The escape velocity from earth surface is about 11.2 k.m/sec.

74. A body of mass 5 kg accelerates at a constant rate of 2m/s^2 on a smooth horizonal surface due to an external force acting at 30^0 with horizontal. The magnitude of the force is :

(a) $\frac{10}{\sin 30^0}$ N (b) $\frac{10}{\cos 30^0}$ N
(c) 10cos 30^0 N (d) 10 sin 30^0 N

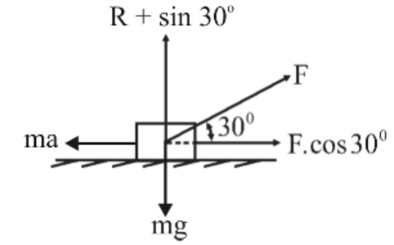
SSC JE 2015

Ans. : (b) Given data-, a = 2m/s^2 (m) = 5 kg.

F_H= F.cos30^0

m.a = F.cos30^0 ⇒5 × 2 = F.cos30^0

$$\therefore F = \frac{10}{\cos 30^0} N$$



75. The angle turned by a wheel while it starts from rest and accelerates at constant rate of 3 rad/s² for an interval of 20 sec is

(a) 900 rad (b) 600 rad
(c) 1200 rad (d) 300 rad

SSC JE 2014 (MORNING)

Ans. : (b) Given that –
$\alpha = 3\ rad/s^2$
t = 20 sec.
$\omega_0 = 0$

$$\because \quad \theta = \omega_0 t + \frac{1}{2}\alpha t^2$$

$$\theta = 0 + \frac{1}{2} \times 3 \times 20^2$$

$$\boxed{\theta = 600\ rad.}$$

7. Work, Power and Energy

76. If a light and a heavy body have equal kinetic energy of translation then

(a) lighter body will have smaller momentum
(b) heavy body will have smaller momentum
(c) both will have same momentum
(d) unpredictable

SSC JE 3 March 2017 Shift-I

Ans. (a) : According to the question,

$$(K.E.)_{heavy} = (K.E.)_{light}$$

$$\frac{1}{2}MV^2 = \frac{1}{2}mv^2$$

or, $$\frac{(MV)^2}{M} = \frac{(mv)^2}{m}$$

$$\frac{[P]^2_{heavy}}{M} = \frac{[P]^2_{light}}{m}$$

$$\frac{[P]^2_{heavy}}{[P]^2_{light}} = \frac{M}{m}$$

$$\frac{(P)_{heavy}}{(P)_{light}} = \sqrt{\frac{M}{m}} \qquad \because \left(\frac{M}{m} > 1\right)$$

$$\frac{(P)_{heavy}}{(P)_{light}} > 1$$

So, $(P)_{heavy} > (P)_{light}$

77. Choose the principle which is NOT used in the solution making of the problem related to friction.

(a) Principle of conservation of energy
(b) Principle of work and energy
(c) Principle of conservation of momentum
(d) D' Alembert's principle

SSC JE 25. 1. 2018 (3.15 pm)

Ans. (a) There are following principle related to the solution making of the problem related to friction.
(i) Principle of conservation of momentum
(ii) Principle of work and energy
(iii) D' Alembert's principle.
In actual due to friction energy loss during relative motion, no energy is conserved.

78. What is the S.I. unit of work or energy?

(a) $kg.\ m/s^2$ (b) $kg.m^2/s^2$
(c) $kg.m/s^3$ (d) $kg.m^3/s^2$

SSC JE 27. 1. 2018 (10.15 pm)

Ans. (b) : Work– Work is defined as a force acting upon an object to cause a displacement.
It is expressed as the product of force and displacement in the direction of force.

$W = F \times S$ $\boxed{F = ma}$

$= m \times a \times s$

$$= kg \times \frac{m}{s^2} \times m$$

$$= kg.\frac{m^2}{s^2}$$

• The SI unit of work is $kg.\frac{m^2}{s^2}$

or Newton meter (N–m) or Joule (J)
Energy– The capacity of a body to do work is called the energy of the body.
SI unit of energy and work are same.

79. Which of the following is the unit of energy ?

(a) Joule (b) N–m
(c) Electron volt (d) All of these

SSC JE 4 March 2017 Shift-II

Ans. (d) Energy– Capacity of doing work in any body is called energy.
Energy = Force × Displacement in direction of force = N.m.
Energy is the quantitative property that must be transferred to an abject in order to perform work on, or to heat the object. Energy is a conserved quantity. The Law of Conservation of energy states that energy can be converted in many forms, but not created or destroyed.
Example- Energy in blowing hammer, pulling of an object, electric cell kinetic energy, potential energy etc.
• Its unit are Joule, N-m, electron-volt etc.
Dimension = $[ML^2T^{-2}]$

80. The work done by a body in moving down a smooth inclined plane in comparison to being dropped vertically downwards from same height will be

(a) more (b) less

(c) equal (d) zero in both cases

SSC JE 2 March 2017 Shift-II

Ans. (c) Let, the body drop vertically from a height 'h' then energy stored (workdone) in the body is mgh (m is the mass of body). Since no friction force is act on the body hence total energy change into workdone.

- Now if body is droped on a inclined frictionless surface with same height then no energy losses and total stored energy will be mgh. Hence workdone will be same in both condition.

81. Which of the following have same units?

A. momentum and impulse

B. stress and pressure

C. work and kinetic energy

(a) A alone (b) B alone

(c) C alone (d) A, B and C

SSC JE 2 March 2017 Shift-II

Ans. (d) Momentum (p) = m.v

Unit of (p) = $kg\frac{m}{s}$ or N-s

- Impulse (j) = F × t

Unit of (j)= N-s

Hence unit of momentum & impulse are same

- Stress $= \frac{F}{A}$, unit = N/m^2
- Pressure $= \frac{F}{A}$, Unit = N/m^2

Hence unit of stress & pressure are same

- Work = F× s , unit = N-m
- Energy $= \frac{1}{2}mv^2$ or mgh, Unit = N-m

Hence unit of work & energy are same

82. A ball is thrown up. The sum of kinetic and potential energies will be maximum at

(a) ground

(b) highest point

(c) in the centre while going up

(d) at all points

SSC JE 2 March 2017 Shift-II

Ans. (d) When the body is thrown upward, the kinetic energy $\left(\frac{1}{2}mv^2\right)$ is decreased ($\because$ v=decreased) & potential energy (mgh) is increased ($\because$ h= increased). But according to the law of energy conservation total sum of energy (kinetic energy+ potential energy) is remains constant (no losses, no friction considered) at each point.

- At the maximum height, kinetic energy is changed into potential energy & at minimum height (nearest of earth surface) potential energy is changed into kinetic energy.

83. When the spring of a watch is wound it possess ____.

(a) heat energy (b) kinetic energy

(c) potential energy (d) wound energy

SSC JE 2 March 2017 Shift-II

Ans. (c) When the spring of watch is wound it possess potential energy.

Potential energy– It is the energy possessed by a body for doing work due to change of its position & size

i.e. $\boxed{PE = mgh}$

Example:- Stored energy in the key of watch.

84. A circular disc rolls down an inclined plane, the fraction of its total energy associated with its rotation is ___.

(a) $\frac{1}{2}$ (b) $\frac{1}{3}$

(c) $\frac{1}{4}$ (d) $\frac{2}{3}$

SSC JE 1 March 2017 Shift-II

Ans. (b) (i) Kinetic energy $= \frac{1}{2}mv^2$ $\boxed{v = R \times \omega}$

$$= \frac{1}{2}m(R\omega)^2 = \frac{1}{2}mR^2\omega^2$$

(ii) Rotational energy

$$= \frac{1}{2}I\omega^2 = \frac{1}{2}\times m.(R_e)^2.\omega^2$$

$$= \frac{1}{2}m\left(\frac{R}{\sqrt{2}}\right)^2 \times \omega^2 = \frac{1}{4}mR^2\omega^2$$

(for disc $R_e = \frac{R}{\sqrt{2}}$)

$$\frac{\text{Rotational energy}}{\text{Total energy}} = \frac{\frac{1}{4}mR^2\omega^2}{\frac{1}{4}mR^2\omega^2 + \frac{1}{2}mR^2\omega^2}$$

$$= \frac{\frac{1}{4}mR^2\omega^2}{mR^2\omega^2\left[\frac{1}{4}+\frac{1}{2}\right]} = \frac{1}{4}\times\frac{4}{3} = \frac{1}{3}$$

85. If two bodies, one light and other heavy, have equal kinetic energy, which one has a greater momentum?

(a) the heavy body

(b) the light body

(c) both have equal momentum

(d) unpredictable

SSC JE 1 March 2017 Shift-II

Ans. (a) $KE = \frac{1}{2}mv^2$ [$\because$ P = mv]

$P^2 = K.E \times 2m$

$P = \sqrt{2 \times KE \times m}$

$P \propto \sqrt{m}$

So, the body whose mass (m) is higher (heavy body) will have greater momentum.

86. A bucket of water weighing 10 kg is pulled up from a 20 m deep well by a rope weighing 1 kg/m length, then the work done is ___.

(a) 200 kg-m (b) 400 kg-m
(c) 500 kg-m (d) 600 kg-m

SSC JE 1 March 2017 Shift-II

Ans. (b) Let at a distance of x, weight to be pulled is 10 kg of bucket and x kg of rope weight.
So, total weight (F) = 10 + x

Workdone, $W = \int_0^{20} F dx = \int_0^{20} (10 + x) dx$

$\boxed{W = 400 \text{ kg-m}}$

87. The sum of kinetic and potential energy of a falling body ____.

(a) is constant at all points
(b) varies from point to point
(c) is maximum at starting and goes on increasing
(d) is maximum at starting and goes on decreasing

SSC JE 1 March 2017 Shift-II

Ans. (a) The sum of kinetic and potential energy of a falling body is constant at all points. The sum of kinetic and potential energy is called mechanical energy. When a body falls, its potential energy decreases, while its kinetic energy is increased. The decrease in potential energy is exactly equal to the increase in kinetic energy.

- It is possible due to law of conservation of energy principle.

88. A body of mass 5 kg is pushed up to 2 m on a smooth 30^0 inclined plane by a force of 60 N acting parallel to the plane. The work done on the body is :

(a) 141.9 J (b) 35.47 J
(c) Zero (d) 70.95 J

SSC JE 2014 (Evening)

Ans. : (d) Given that : d = 2m
mass of body = 5 kg.
applied force = 60 N

$mg \sin\theta = 5 \times 10 \times \sin 30$

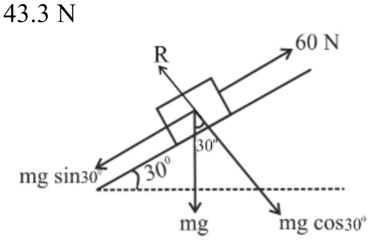
$= 5 \times 10 \times \frac{1}{2}$

= 25 N

$mg \cos 30^o = 5 \times 10 \times \cos 30$

$= 5 \times 10 \times 0.866$

= 43.3 N



Work done against gravity -

$W = mg \sin 30^o \times d$

$= 25 \times 2$

$= 50$ J

Applied load – gravity load = effective load on body.

60 – 25 = 35 N

work done for 2m displacement,

$W = F_{eff} \times$ distance

$W = 35 \times 2$

$\therefore \boxed{W = 70J}$ (approx)

8. Principle of Virtual Work & Simple Machines

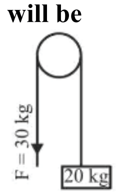
89. Choose the option which does NOT belong to the category of simple machine?

(a) Spring (b) Screw
(c) Wedge (d) Pulley

SSC JE 23. 1. 2018 (10.15 am)

Ans. (a) Spring is not belongs to the category of simple m/c because simple machine are of several devices with few or no moving parts that are used to modify motion and force in order to perform work. The simple machines are the inclined plane, lever, wedge, wheel, axle, pulley and screw.

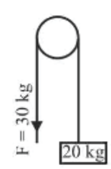
90. The figure below shows a weight of 20 kg suspended at one end of cord and a force of 30 kg applied at other end of cord passing over a pulley. Neglecting weight of rope and pulley, tension in cord will be



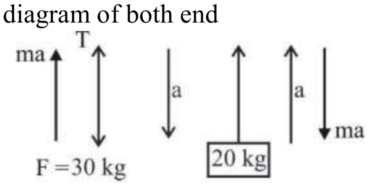
(a) 30 kg (b) 20 kg
(c) 10 kg (d) 50 kg

SSC JE 2 March 2017 Shift-II

Ans. (a)



Free body diagram of both end



ma = F – T

There is no mass, m = 0

0 = 30 – T

T = 30 kg

91. **The apparent weight of a man in moving lift is less than his real weight when it is going down with ____.**
(a) uniform speed
(b) an acceleration
(c) some linear momentum
(d) retardation

SSC JE 2 March 2017 Shift-II

Ans. (b)
Consider the man of mass m inside the lift –
(i) When the lift is moving downwards, then apparent weight of man is less than the real weight of man
Apparent weight, $\boxed{W = mg - ma}$
(ii) When the lift is moving upwards then apparent weight of man is more than the real weight of man
Apparent weight, $\boxed{W = mg + ma}$
(iii) If the lift is freely fall a=g
Apparent weight, $\boxed{W = 0}$
(iv) If the lift moves upwards or downwards with constant velocity i.e. acceleration (a)=0, then Apparent weight $\boxed{(W) = mg}$ (real weight).

92. **Which of the following is an example of a body undergoing translational equilibrium?**
(a) a body at rest on a table
(b) a boy travelling in a circular path at a constant speed
(c) a body rotating with constant angular speed about an axis
(d) a body sliding down a frictionless inclined plane

SSC JE 1 March 2017 Shift-II

Ans. (a) A body at rest on a table is an example of a body undergoing translational equilibrium.
Translational equilibrium–An object is in translational equilibrium if he velocity of its translational motion (motion that change its motion) is constant.

9. Impulse, Momentum and Collision

93. **Rate of change of momentum takes place in the direction ___.**
(a) of motion
(b) of applied force
(c) opposite to the direction of applied force
(d) perpendicular to the direction of motion

SSC JE 2 March 2017 Shift-II

Ans. (b) Rate of change of momentum is called force & the direction of rate of change of momentum is the direction of applied force.
Change of momentum (p) = m × v

$$\frac{dp}{dt} = \frac{d}{dt}(m \cdot v)$$

$$= v\frac{dm}{dt} + m\frac{dv}{dt}$$

$$\frac{dp}{dt} = m\frac{dv}{dt} \qquad (m = \text{constant})$$

$$= ma = F \qquad \left(\therefore \frac{dv}{dt} = a\right)$$

$$\therefore \boxed{\vec{F} = \frac{d\vec{p}}{dt}}$$

94. **The rate of change of linear momentum is equals to ____.**
(a) Active force (b) Reactive force
(c) Torque (d) Work done

SSC JE 3 March 2017 Shift-II

Ans. (a) The rate of change of linear momentum is equals to the active force.

$$\because \boxed{p = mv} \quad \text{where, } (m) = \text{mass}, \ v = \text{velocity}$$

The rate of change of linear momentum

$$= \frac{d}{dt}(mv)$$

$$= m\frac{dv}{dt} \qquad (\because m = c)$$

$$\therefore \boxed{F = ma} \qquad \left(\because \frac{dv}{dt} = a\right)$$

95. **A ball is dropped vertically downwards, it hits the floor with a velocity of 9 m/s and bounces to a distance of 1.2 m. Coefficient of restitution between the floor and the ball is**
(a) 0.54 (b) zero
(c) 1 (d) 0.27

SSC JE 2014 (MORNING)

Ans. : (a) Given, v = 9 m/s, x = 1.2 m/s

$$h = \frac{v^2}{2g} = \frac{9^2}{2 \times 9.81}$$

$$\because \quad x = e^2 h$$

$$e^2 = \frac{x}{h} = \frac{1.2 \times 2 \times 9.81}{9^2} = 0.29067$$

$$\therefore \quad e = 0.5391 \simeq 0.54$$

10. Simple Harmonic Motion

96. **If the period of oscillation is doubled**
(a) the length of simple pendulum should be doubled
(b) the length of simple pendulum should be quadrupled
(c) the mass of the pendulum should be doubled
(d) the length and mass should be doubled

SSC JE 1 March 2017 Shift-II

Ans. (b) If the period of oscillation is doubled then the length of simple pendulum should be quadrupled

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

$$\left(\begin{array}{c}\text{where, } T = \text{Time period} \\ \ell = \text{Length}\end{array}\right)$$

or $T \propto \sqrt{\ell}$

or $\frac{T_1}{T_2} = \sqrt{\frac{\ell_1}{\ell_2}}$

If time period becomes double, i.e. $T_2 = 2T_1$

$$\frac{T_1}{2T_1} = \sqrt{\frac{\ell_1}{\ell_2}}$$

or $\frac{1}{2} = \sqrt{\frac{\ell_1}{\ell_2}}$

$$\frac{1}{4} = \frac{\ell_1}{\ell_2}$$

$$\ell_2 = 4\ell_1$$

97. In Simple Harmonic Motion, acceleration of a particle is proportional to

(a) rate of change of velocity
(b) displacement
(c) velocity
(d) direction

SSC JE 2 March 2017 Shift-II

Ans. (b) In Simple Harmonic Motion (SHM)–

i) Acceleration is always directed towards the center is known as point of reference or mean position and

ii) Acceleration is proportional to the displacement from that point

In SHM, If displacement of any particle is y then,

$y = a \sin\omega t$

Where, a = amplitude

ω = angular velocity

Velocity of particle, $\boxed{v = a\omega\cos\omega t} \Rightarrow \boxed{v = \omega\sqrt{a^2 - y^2}}$

Acceleration of particle $\boxed{A = -\omega^2 a \sin\omega t}$

or $\boxed{A = -\omega^2 y}$

Hence acceleration $\boxed{A \propto y}$

98. A boy is swinging on a swing. If another boy sits along with him without disturbing his motion, then the time period of swing will ___.

(a) increase
(b) decrease
(c) be doubled
(d) remain the same

SSC JE 1 March 2017 Shift-II

Ans. (d) A boy is swinging on a swing. If another boy sits along with him without disturbing his motion, then the time period of swing will remain the same because time period is independent upon mass. Time period depends upon only length of the string& acceleration due to gravity.

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

$$T \propto \sqrt{\ell}$$

$$T \propto \frac{1}{\sqrt{g}}$$

99. Which one of the following laws is not applicable for a simple pendulum?

(a) the time period does not depend on its magnitude
(b) the time period is proportional to its length
(c) the time period is proportional to square root of its length
(d) the time period is inversely proportional to square root of its acceleration due to gravity

SSC JE 1 March 2017 Shift-II

Ans. (b) A simple pendulum is one which can be considered to be a point mass suspended form a string or rod of negligible mass.

Time period $T = 2\pi\sqrt{\frac{l}{g}}$

So, the statement the time period is proportional to its length is wrong.

100. The type of motion when the acceleration is proportional to displacement is called ___.

(a) translation
(b) rotational
(c) gyroscopic
(d) simple harmonic

SSC JE 1 March 2017 Shift-II

Ans. (d) The type of motion when the acceleration is proportional to displacement is called simple harmonic motion

- Simple harmonic motion is a special type of periodic motion where the restoring force on the moving object is directly proportional to the object's displacement magnitude and acts towards the objects equilibrium position.

101. A body is vibrating at 10 vibrations/second in Simple Harmonic Motion of 10 cm amplitude. The maximum velocity in cm/sec can be ____.

(a) 100π
(b) 50π
(c) 200π
(d) 100

SSC JE 1 March 2017 Shift-II

Ans. (c) Amplitude (a) = 10 cm

n = 10 Vibration/ second

v_{max} = ?

In case of S.H.M.–

$$v = \omega\sqrt{a^2 - y^2}$$

v will be maximum when, y = 0

then, $v_{max} = a\omega$

$= 10 \times 2\pi \times 10$

$\therefore \boxed{v_{max} = 200\pi}$ cm/sec

11. Projectile Motion

102. Which of the following is NOT a projectile motion ?

(a) A stone thrown in any direction
(b) A stone thrown horizontally from a building
(c) A car moving in a straight line
(d) A bullet fired from a gun

SSC JE 2021

Ans. (c) : When a object follow a straight path then its motion is rectilinear. For example a car moving in a straight line.

103. A rubber ball is thrown vertically upward with v velocity from the top of a building. It strikes the ground with a velocity 3v. The time taken by the ball to reach the ground is given by:

(a) 3v/g (b) 4v/g
(c) 2v/g (d) v/g

SSC JE 11-12-2020

Ans. (b) : Time taken by ball to move vertically upward from the top of building to maximum height–

Given that

$v_1 = u_1 - gt_1$

$0 = v - gt_1 \qquad (v_1 = 0, u_1 = v)$

$t_1 = \frac{v}{g}$

If the time taken by ball to hit the ground from the maximum height is t_2 then–

$v_2 = u_2 + gt_2$

$3v = 0 + gt_2 \qquad (\because v_2 = 3v, u_2 = 0)$

$t_2 = \frac{3v}{g}$

Total time taken by ball to hit the ground–

$= t_1 + t_2$

$= \frac{v}{g} + \frac{3v}{g} = \frac{4v}{g}$

$\boxed{T = \frac{4v}{g}}$

104. The motion of a body in x-y plane is represented by x = 4-9t and y = t^2 where x, y are in metre. Find the magnitude its absolute velocity at t = 6 sec.

(a) 5.4 km/hr (b) 10.77 m/s
(c) 15.0 m/s (d) 2.68 m/s

SSC JE 25-09-2019 (Shift-2)

Ans. (c) : Given that, x = 4 - 9t

$y = t^2$

$v_x = \frac{dx}{dt} = -9 \Rightarrow (v_x)_{t=6} = -9$

$v_y = \frac{dy}{dt} = 2t \Rightarrow (v_y)_{t=6} = 12$

$v = v_x\hat{i} + v_y\hat{j}$

$= -9\hat{i} + 12\hat{j}$

The magnitude of (v) = $\sqrt{v_x^2 + v_y^2}$

$= \sqrt{(-9)^2 + (12)^2}$

= 15 m/s

105. A body is thrown vertically upwards with a velocity of 980 cm/sec, then the time the body will take to reach the ground will be

(a) 1 second (b) 2 seconds
(c) 2.5 seconds (d) 4 seconds

SSC JE 2 March 2017 Shift-II

Ans. (b) Given,

u = 980 cm/sec = 9.8 m/sec

θ = 90º

Time taken by the body to reach the ground = $\frac{2u\sin\theta}{g}$

$= \frac{2 \times 9.8 \times 1}{9.8} = 2\sec$

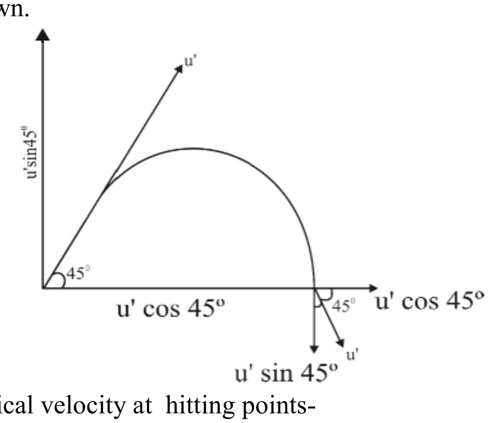
106. A body is thrown up at an angle of 45° with a velocity of 100 m/sec so as to describe a parabola. Its vertical velocity on point of return down will be

(a) Zero (b) 130 m/sec
(c) 50 m/sec (d) 70.7 m/sec

SSC JE 2 March 2017 Shift-II

Ans. (d) Given, velocity of ball, u = 100 m/sec

Velocity of body hits the earth with same velocity as its thrown.



Vertical velocity at hitting points-

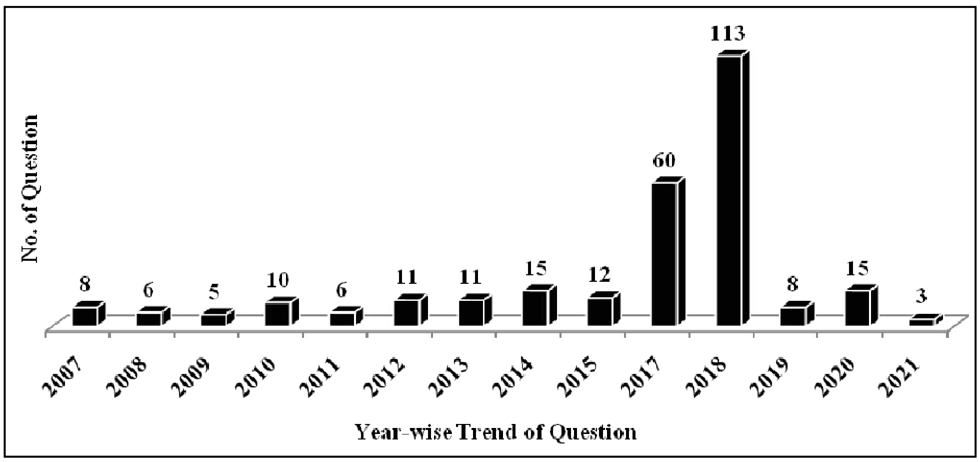
$u'' = u'\sin 45^\circ$

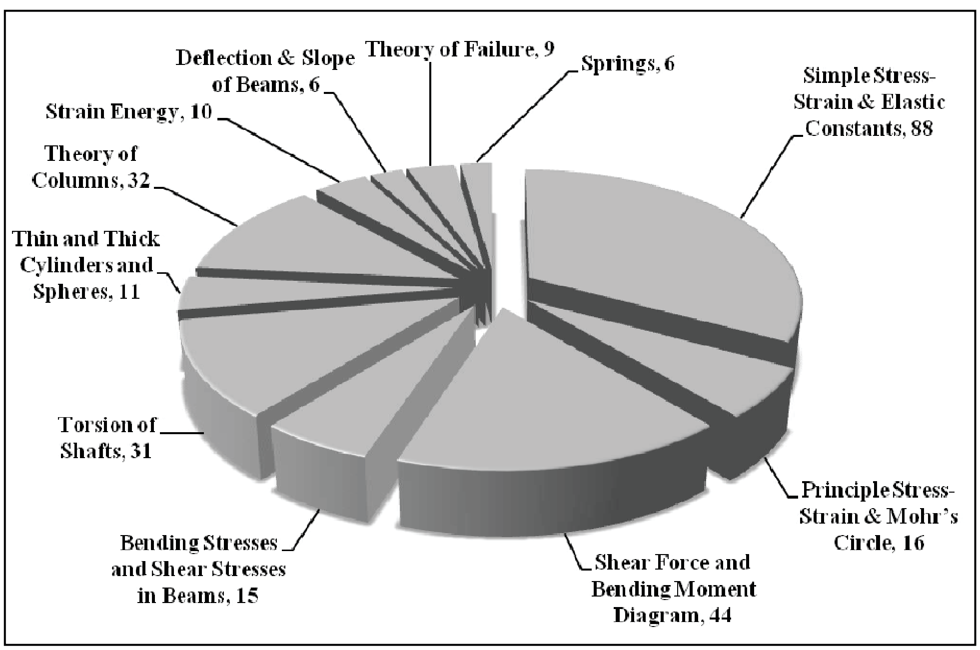
$= 100 \times \frac{1}{\sqrt{2}}$

$\therefore \boxed{u'' = 70.7}$ m/sec

Strength of Materials

Yearwise & Topicwise Analysis Chart





02.

Strength of Materials

1. Simple Stress-Strain & Elastic Constants

1. Young's Modulus, Bulk Modulus (K) and Shear Modulus (G) are related by

(a) $E = \frac{K+G}{GK}$ (b) $E = \frac{9KG}{3K+G}$

(c) $E = \frac{9K+G}{GK}$ (d) $F = \frac{K+6G}{6K}$

SSC JE 24. 1. 2018 (3.15 pm)
SSC JE 2015, 2010

Ans. (b) : We know that,

$E = 2G(1+\mu)$ — (i)

$E = 3K(1-2\mu)$ — (ii)

For equation (i)

$1+\mu = \frac{E}{2G}$

$\mu = \frac{E}{2G} - 1$ — (iii)

Value of equation (iii) put in equation (ii)–

$$E = 3K\left[1-2\left(\frac{E}{2G}-1\right)\right] = 3K\left[1-\frac{E}{G}+2\right]$$

$$= 3K\left[3-\frac{E}{G}\right] = 9K - \frac{3KE}{G}$$

$$E + \frac{3KE}{G} = 9K$$

$$E\left[\frac{G+3K}{G}\right] = 9K \quad \therefore \quad \boxed{E = \frac{9KG}{3K+G}}$$

2. Modulus of rigidity is defined as the ratio of :

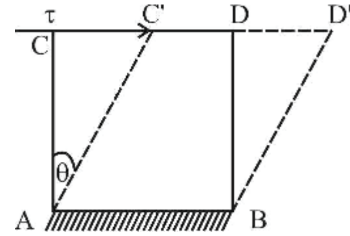
(a) Longitudinal stress to strain
(b) Shear stress to shear strain
(c) Stress to strain
(d) Stress to volumetric strain

SSC JE 2 March 2017 Shift-I
SSC JE 3 March 2017 Shift-I
SSC JE 2010

Ans : (b) The ratio of shear stress (τ) to shear strain (θ) is known as modulus of rigidity.

$$\boxed{G = \frac{\tau}{\theta}}$$

• Its unit is N/m^2.



3. Hooke's law holds good up to

(a) yield point
(b) limit of proportionality
(c) breaking point
(d) elastic limit

SSC JE 4 March 2017 Shift-I
SSC JE 2009

Ans. (b) : Hooke's law holds good upto limit of proportionality.

⇒ Hooke's law states that when a material is loaded within elastic limit, the stress is directly proportional to strain upto proportional limit.

⇒ $\sigma \propto \varepsilon \Rightarrow \boxed{\sigma = E\varepsilon}$

Where E is a constant of proportionality and it is known as modulus of elasticity.

4. The ratio of stress produced by suddenly applied load to that produced by the same load when gradually applied is :

(a) 4 (b) 2
(c) 1 (d) 1/2

SSC JE 24. 1. 2018 (3.15 pm)
SSC JE 2 March 2017 Shift-I
SSC JE 3 March 2017 Shift-II

Ans. (b) : Gradually applied load (GAL)

$$\sigma_{GAL} = \frac{P}{A}$$

While,

Impact loading,

$$\boxed{\sigma_{Impact} = I \cdot F \times \sigma_{GAL}}$$

Where,

Impact factor (I.F) $= 1 + \sqrt{1 + \frac{2h}{\delta_{static}}}$

Note-In suddenly applied load h = 0

Then, I.F = 2

Hence, $\boxed{\sigma_{SAL} = 2\sigma_{GAL}}$

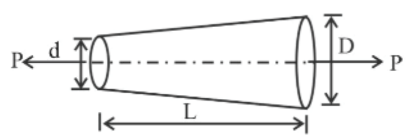
5. A rod of length L tapers uniformly from a diameter D at one end to a diameter d at the other. The Young's modulus of the material is E. The extension caused by an axial load P is.

(a) $\frac{4PL}{\pi(D^2 - d^2)E}$ (b) $\frac{4PL}{\pi(D^2 + d^2)E}$

(c) $\frac{4PL}{\pi DdE}$ (d) $\frac{2PL}{\pi DdE}$

SSC JE 25. 1. 2018 (3.15 pm)
SSC JE 24. 1. 2018 (3.15 pm)
SSC JE 2007

Ans. (c) Formula for uniformly tapered rod– Let us assume that length of the tapered bar is L and dia on the ends of bar are D and d subjected to an axial load of magnitude of P.



So, deformation in the bar (δl)

$$\delta l = \frac{4PL}{\pi EDd}$$

So $$\delta l = \frac{4PL}{\pi EdD}$$

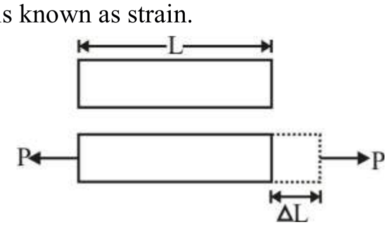
Where, E = Young's modulus of elasticity.

6. Deformation per unit length in the direction of force is known as

(a) Linear strain (b) Stress
(c) Lateral strain (d) Modulus of elasticity

SSC JE 4 March 2017 Shift-I
SSC JE 2011

Ans. (a) : Deformation per unit length in the direction of force is known as strain.



$$\boxed{\text{Strain} = \frac{\Delta L}{L}}$$

⇒ It is a dimensionless quantity.

Note - Stress is the resistance offered by the body to deformation.

$$\text{Nominal stress (Engineering stress)} = \frac{\text{Load}}{\text{Original Area}}$$

7. The unit of stress in S.I. unit is -

(a) N/mm^2 (b) kN/mm^2
(c) N/m^2 (d) All of these

SSC JE 22 1. 2018 (10.15 am)

Ans. (c) : When some force or load act on a body, the internal resisting forces are set up at various section of the body which resist the external forces, so stress is defined as internal resisting force per unit area at any section of the body.

$$\text{Stress} = \frac{\text{Force}}{\text{Area}} = \frac{F}{A} = \frac{N}{m^2}$$

Hence, unit of stress in SI unit is N/m^2.

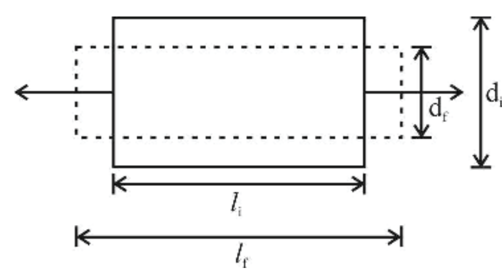
8. Poisson's ratio is defined as the ratio of :

(a) Lateral strain to longitudinal strain
(b) Axial stress to axial strain
(c) Shear stress to shear strain
(d) Longitudinal strain to lateral strain

SSC JE 29. 1. 2018 (10.15 am)
SSC JE 4 March 2017 Shift-I
SSC JE 2014 (Evening)

Ans. : (a) Poisson's Ratio → It is defined as the ratio of Lateral strain to longitudinal strain. It is expressed as 'μ'.

$$\mu = \frac{\text{lateral strain}}{\text{Longitudinal strain}}$$



$$\boxed{\mu = \frac{\Delta d/d}{\Delta l/l}} \Rightarrow \frac{\left(\frac{d_i - d_f}{d_i}\right)}{\left(\frac{l_f - l_i}{l_i}\right)}$$

• Poisson's ratio values ranging between 0 to 0.5.

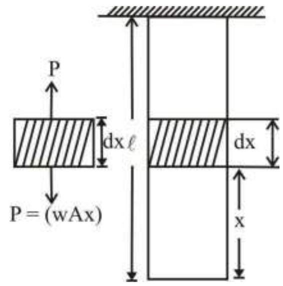
9. Which one of the following expresses the total elongation of a bar of length L with a constant cross-section of A and modulus of Elasticity E hanging vertically and subject to its own weight W ?

(a) $\frac{WL}{AE}$ (b) $\frac{WL}{2AE}$

(c) $\frac{2WL}{AE}$ (d) $\frac{WL}{4AE}$

SSC JE 2010, ESE-2007

Ans. (b) : Consider a strip dx at x distance from and of bar. The extension in strip due to load $P = \frac{Pdx}{AE}$



Total elongation of bar = $\int_0^L \frac{(wAx)dx}{AE}$

$= \frac{wL^2}{2E}$

$= \frac{(wAL)L}{2AE} = \frac{WL}{2AE}$

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

(a) E = 3K (1-2μ) (b) K = 3K (1-2μ)

(c) E = 3K (1-μ) (d) E = 3K (1- μ)

SSC JE 23. 1. 2018 (10.15 am)

Ans. (a) : Young's modulus (E), Bulk modulus (K) and Poisson ratio (μ)-

E = 2G (1 + μ)

E = 3K (1 - 2μ)

11. The value of Poisson's ratio is always less then

(a) 1 (b) 0.5

(c) 0.4 (d) 0.2

SSC JE 2013

Ans. (b) The value of Poisson ratio is always less than 0.5.

For engineering materials, it's value is–

$0 \le \mu \le 0.5$

μ = 0 for cork

μ = 0.5 for Rubber,

Material	Poisson's ratio
Aluminium alloy	0.33
Brass	0.34
Bronze	0.34
Cast iron	0.23-0.027
Rubber	0.45 - 0.50
Steel	0.27 - 0.30

12. Whenever a material is loaded within elastic limit, stress is............strain.

(a) Equal to

(b) Directly proportional to

(c) Inversely proportional to

(d) Not equal

SSC JE 27. 1. 2018 (3.15 pm)

Ans : (b) Whenever a material is loaded within elastic limit, stress is directly proportional to strain.

According to Hooke's Law–

Stress ∝ Strain

Stress = Constant × Strain

$\sigma = E \times \in$

$\boxed{E = \frac{\sigma}{\in}}$

- Hooke's law is applicable upto proportional limit
- E is called Hooke's constant (or) modulus of elasticity. For steel, E = 210 kN/mm^2
- Generally for many materials elastic limit and proportional limit are same.

13. The modulus of elasticity for a material is 200 GN/m^2 and Poisson's ratio is 0.25 what is the modulus of rigidity ?

(a) 80 GN/m^2 (b) 125 GN/m^2

(c) 250 GN/m^2 (d) 320 GN/m^2

SSC JE 24. 1. 2018 (10.15 am)

Ans. (a) : Modulus of elasticity (E) = 200 GN/m^2

(μ) = 0.25

E = 2G (1+μ)

200 = 2G (1+0.25)

$G = \frac{200}{2.50}$

$\boxed{G = 80 GN/m^2}$

14. For a material with Poisson's ratio 0.25, the ratio of modulus of rigidity to modulus of elasticity will be

(a) 0.4 (b) 1.2

(c) 2.0 (d) 3.6

SSC JE 2014 (Morning)

Ans : (a) Given,

Poisson ratio (μ) = 0.25

Modulus of elasticity = E

Modulus of rigidity = G

From equation–

E = 2G (1 + μ)

$\frac{E}{G} = 2(1+\mu)$

$\frac{E}{G} = 2(1 + 0.25)$

$\frac{E}{G} = 2.50$

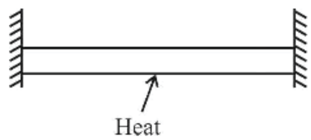
$\boxed{\frac{G}{E} = \frac{1}{2.5} = 0.4}$

15. If a beam is constrained to move and heated, it will develop .... stress.

(a) Shear stress (b) tensile stress
(c) principal stress (d) compressive stress

SSC JE 4 March 2017 Shift-I

Ans : (d)



When a beam is constrained to move and heated, it will develop compressive stress because when it heated, it will expand but due to constraints it cannot expand and a compressive stress is induced in beam.

16. The ratio of largest load in a test to the original cross-sectional area of the test piece is:

(a) elastic limit (b) yield stress
(c) ultimate stress (d) breaking stress

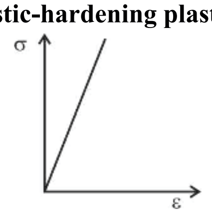
SSC JE 2012

Ans. (c) : The ratio of largest load in a test to the original cross-sectional area of the test piece is ultimate stress.

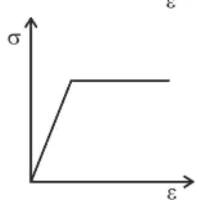
$$\text{Ultimate stress} = \frac{\text{Largest testing load}}{\text{Original cross-sectional area}}$$

17. Which of the curve is best suited for linear elastic-hardening plastic material?

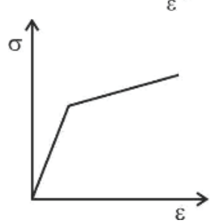
(a)



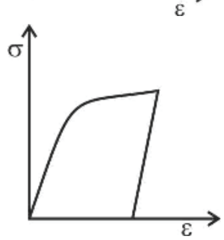
(b)



(c)

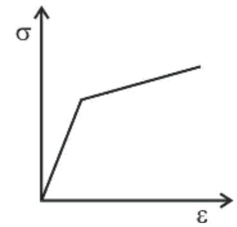


(d)



SSC JE 22 1. 2018 (3.15 pm)
SSC JE 25. 1. 2018 (10.15 am)

Ans. (c) Elastic -hardening plastic material stress- strain diagram.



18. The temperature stress is a function of

1. Coefficient of linear expansion
2. Temperature rise
3. Modulus of elasticity

(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

SSC JE 24. 1. 2018 (10.15 am)

Ans. (d) : Stress due to temperature = $E\alpha\,(\Delta T)$

where, E = Young's modulus,
α = Co-efficient of linear expansion,
ΔT = Change in temperature

- Thus, temperature stress is a function of all three variables mentioned above.

19. If a material shows different properties in different directions, then it is called as

(a) Isotropic (b) Homogeneous
(c) Anisotropic (d) Heterogeneous

SSC JE 29.1.2018 (3.15 pm)

Ans : (c)

- If a material shows different properties in different direction (direction dependent properties), then it is called anisotropic materials and this property is called anisotropy.

20. Which of the following is a dimensionless quantity?

(a) Shear stress (b) Poisson's ratio
(c) Torque (d) None of these

SSC JE 22.1.2018 (3.15 pm)
SSC JE 2007

Ans. : (b) Poisson's ratio is a dimensionless quantity. Poisson's ratio is the ratio of lateral strain to longitudinal strain.

$$\mu = \frac{\text{Lateral strain}}{\text{Longitudinal strain}}$$

Material	Poisson Ratio
1. Rubber	0.40–0.5
2. Copper	0.355
3. Steel	0.27 – 0.33
4. Cast Iron	0.23–0.27
5. Concrete	0.1–0.2
6. Glass	0.18–0.30
7. Aluminium	0.33

21. **For which material the Poisson's ratio is more than unity ?**

A. Steel **B. Copper**
C. Aluminium **D. Cast iron**

(a) only A (b) only B
(c) only C (d) None of these

SSC JE 2 March 2017 Shift-I

Ans. (d) Poisson's ratio→ The ratio of lateral strain to linear strain is called Poisson's ratio. Most of the material, Poisson ratio varies between $\frac{1}{4}$ to $\frac{1}{3}$.

• Poisson's ratio of cork = 0
• For rubber = 0.5

22. **A load of 20,000 kg applied to a brass cylinder 40 cm long & 10 cm in diameter caused the length to increase 0.8 cm & diameter to decrease 0.005 cm. Poisson's ratio of brass is :**

(a) 0.025 (b) 0.925
(c) 0.25 (d) 2.5

SSC JE 3 March 2017 Shift-I

Ans. (a) : Given data –
d = 10 cm
δd = 0.005 cm
l = 40 cm
δl = 0.8 cm

$$\text{Poisson Ratio } = \frac{\delta d/d}{\delta\ell/\ell} = \frac{0.005/10}{0.8/40} = 0.025$$

23. **True stress represents the ratio of–**

(a) Average load and average area
(b) Average load and maximum area
(c) Maximum load and maximum area
(d) Instantaneous load and the instantaneous area

SSC JE 1 March 2017 Shift-I
SSC JE 2010

Ans. : (d) True stress represents the ratio of instantaneous load and the instantaneous area.

$$\text{True stress } \sigma_T = \frac{F}{A_i} = \sigma(1+\varepsilon)$$

$$\text{True strain } \ell n\left(\frac{\ell_i}{\ell_o}\right) = \ell n(1+\varepsilon)$$

24. **............has the highest value of Poisson's ratio**

(a) Concrete (b) Wood
(c) Steel (d) Rubber

SSC JE 2011

Ans. (d) : Poisson's Ratio–It is the ratio of lateral strain to longitudinal strain.

$$\text{Poisson's Ratio } (\mu) = \frac{\text{Lateral strain}}{\text{Longitudinal strain}}$$

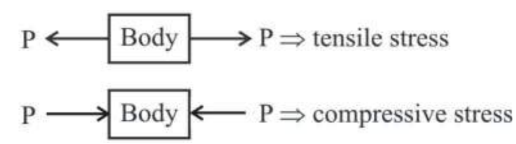
The value of Poisson's ratio for perfectly plastic material is maximum.
• Rubber has the highest value of Poisson's ratio.
• For cork, its value is zero.

25. **If equal and opposite forces applied to a body tend to elongate it, the stress so produced is called :**

(a) Internal resistance
(b) Tensile stress
(c) Transverse stress
(d) Compressive stress

SSC JE 2014 (Morning)
SSC JE 2010

Ans. : (b) It equal and opposite forces applied to a body tend to elongate it, the stress so produced is called tensile stress.



26. **A member of length 200 mm and diameter 25 mm is subjected to a tensile load of 20 kN. The final length of the member is found to be 220 mm. The percentage increase in the length of the member is :**

(a) 2% (b) 1%
(c) 5% (d) 10%

SSC JE 2021

Ans. (d) : Given,
Original length (l_0) = 200 mm
Final length (l_f) = 220 mm

$$\%\text{ increase in length } = \frac{\Delta\ell}{\ell_0} = \frac{\ell_f - \ell_0}{\ell_0} \times 100\%$$

$$= \frac{220-200}{200} \times 100\%$$

= 10%

27. **Impact load is an example of :**

(a) uniform load (b) static load
(c) dynamic load (d) fatigue load

SSC JE 22-03-2021 Shift-II

Ans. (c) : Type of Loads w.r.t. time
(i) Static loads
(a) Dead load
(b) Gradually applied loads
(ii) Dynamics loads
(a) Impact loads or shock loads or suddenly applied loads
(b) Fatigue load or cyclic loads or variable loads

28. If Poisson's ratio of an elastic material is 0.4, then what will be the ratio of modulus of rigidity to Young's modulus?

(a) 0.36 (b) 0.16
(c) 0.06 (d) 0.86

SSC JE 27-10-2020 (Shift-3)

Ans. (a) : Given, $\mu = 0.4$, $\frac{G}{E} = ?$

As we know, $E = 2G(1 + \mu)$

$$\frac{G}{E} = \frac{1}{2(1+\mu)} = \frac{1}{2(1+0.4)} = \frac{1}{2.8}$$

$= 0.357$

$\therefore \quad \boxed{\frac{G}{E} \approx 0.36}$

29. A cylindrical metal bar of 12 mm diameter is loaded by an axial force of 20 kN results in change in diameter by 0.003 mm. Poisson's ratio is given by: (Assume modulus of rigidity = 80 GPa)

(a) 0.56 (b) 0.056
(c) 0.2923 (d) 0.025

SSC JE 11-12-2020

Ans. (c) : Given,

$d = 12$ mm

$\Delta d = 0.003$ mm

$\mu = ?$

$G = 80\text{ GPa} = 80 \times 10^3\text{ N/mm}^2$

Axial force $(F) = 20\text{ kN} = 20 \times 10^3$ N

$$\mu = \frac{\frac{\Delta d}{d}}{\frac{\Delta \ell}{\ell}} = \frac{\frac{\Delta d}{d}}{\frac{F}{A/E}}$$

$$= \frac{\frac{0.003}{12}}{\frac{20\times10^3}{\pi/4\times12^2\times E}}$$

$$= \frac{25\times10^{-5}\times E}{176.83}$$

$$= \frac{25\times10^{-5}}{176.83}\times 2G(1+\mu)$$

$= 2.827 \times 10^{-6} \times G(1 + \mu)$

$= 2.827 \times 10^{-6} \times 80 \times 10^3 (1 + \mu)$

$\mu = 0.226(1 + \mu) = 0.226 + 0.226\,\mu$

$$\mu = \frac{0.226}{1-0.226} = 0.2919$$

30. If stress measuring device shows reading as 1 MPa. It is equivalent to:

(a) 1 N/mm^2 (b) 10 N/mm^2
(c) 1 MN/mm^2 (d) 1 kN/mm^2

SSC JE 11-12-2020

Ans. (a) : $1\text{ MPa} = 1 \times 10^6 \frac{N}{m^2}$

$$= 1\times10^6 \frac{N}{10^6\,mm^2}$$

$$\boxed{1\,MPa = 1\frac{N}{mm^2}}$$

31. Strain has dimension as:

(a) $M^1L^0T^0$ (b) $M^0L^1T^0$
(c) $M^0L^0T^0$ (d) $M^0L^0T^1$

SSC JE 11-12-2020

Ans. (c) : $\text{Strain } (\in) = \frac{\text{Change in length } (\delta L)}{\text{Initial length } (L)}$

$$\text{Dimension } = \frac{m}{m} = \frac{[L]}{[L]} = [M^0L^0T^0]$$

32. Mathematically, strain is defined as deformation per unit ....

(a) load (b) area
(c) length (d) volume

SSC JE 27-09-2019 (Shift-2)

Ans. (c) :

$$\boxed{\text{strain}(\in) = \frac{\delta l}{l}}$$

strain is unitless quntity

33. A steel rod is subjected to a stress of 200 MPa and has Young's modulus of 200 GPa. Calculate strain.

(a) 10^{-4} (b) 10^{-1}
(c) 10^{-3} (d) 10^{-2}

SSC JE 25-09-2019 (Shift-2)

Ans. (c) : Stress $(\sigma) = 200$ MPa

Young's modulus $(E) = 200\text{ GPa} = 200 \times 10^3$ MPa

From stress-strain relation

$$\sigma = \in E$$

$$\text{Strain } (\in) = \frac{\sigma}{E} = \frac{200}{200\times10^3} = 10^{-3}$$

$$\boxed{\varepsilon = 10^{-3}}$$

34. A rod of dimension 20 mm × 20 mm is carrying an axial tensile load of 10 kN. The tensile stress developed is______

(a) 0.025 MPa (b) 0.25 MPa
(c) 25 MPa (d) 250 MPa

SSC JE 22 1. 2018 (10.15 am)

Ans. (c) given– Tensile load $(F) = 10\text{ kN} \Rightarrow 10\times10^3$ N

Area $(A) = 20\text{mm} \times 20\text{mm} = 400 \times 10^{-6}\text{ m}^2$

$$\text{Stress } (\sigma) = \frac{F}{A} = \frac{10\times10^3}{400\times10^{-6}}$$

$\sigma = 25\times10^6\text{ N/m}^2$

$\boxed{\sigma = 25\,MPa}$

35. **If a load of 40 kN is applied in a compressive manner of a rod whose cross section is 10 mm × 20 mm. Then what will be the compressive stress (MPa) on the rod?**

(a) 0.2 (b) 2
(c) 20 (d) 200

SSC JE 22 1. 2018 (3.15 pm)

Ans. (d) Given : F = 40 kN = 40×10^3 N

$A = 10 \times 20\ mm^2 = 200\ mm^2 = 200 \times 10^{-6}\ m^2$

$$\text{Stress }(\sigma) = \frac{\text{Force(F)}}{\text{Area(A)}}$$

$$\sigma = \frac{40\times10^3}{200\times10^{-6}}$$

$\sigma = 2 \times 10^8\ N/m^2$

$\sigma = 2 \times 10^8$ Pa

$\sigma = 200 \times 10^6$ Pa

$\sigma = 200$ MPa

36. **What will be the thermal stress developed in a rod having a diameter of 4 cm and length of 2 m. It experiences heating from temperature 50^0C to 200^0C. The coefficient of thermal expansion is $\alpha = 10\times10^{-6}/^0C$ and young's modulus is 250 GPa?**

(a) 300 (b) 325
(c) 350 (d) 375

SSC JE 22 1. 2018 (3.15 pm)

Ans. (d) Given : E = 250 GPa = 250×10^9 Pa

$\alpha = 10 \times 10^{-6}$ /°C

$t_1 = 50°C = 323$ K

$t_2 = 200°C = 473$ K

$\Delta t = (t_2 - t_1) = (473 - 323) = 150$ K

$d = 4$ cm $= 4 \times 10^{-2}$ m

⇒ Thermal stress $(\sigma_{th}) = E\cdot\alpha\cdot\Delta t$

$= 250 \times 10^9 \times 10 \times 10^{-6} \times 150$

$= 375 \times 10^6\ N/m^2$

= 375 MPa

37. **Which formula CORRECTLY depicts the elongation in a composite body?**

(a) $\delta = \frac{P}{E}\left[\frac{\ell_1}{A_1}+\frac{\ell_2}{A_2}+\frac{\ell_3}{A_3}+\frac{\ell_4}{A_4}+......\right]$

(b) $\delta = \frac{P}{AE}[\ell_1+\ell_2+\ell_3+\ell_4+.......]$

(c) $\delta = \frac{P}{AE}[\ell_1+\ell_2+\ell_3-\ell_4+.......]$

(d) $\delta = \frac{PI}{AE}\left[\frac{\ell}{A_1}+\frac{\ell}{A_1}+\frac{\ell}{A_1}+\frac{\ell}{A_1}+.........\right]$

SSC JE 22.01.2018 (3.15 pm)

Ans. (a) Elongation in a composite body due to load P– Total change in length of the body

$$\delta\ell = \delta\ell_1+\delta\ell_2+\delta\ell_3+\delta\ell_4 \text{ ....(i)}$$

$$\because \quad \delta\ell_1 = \frac{P\ell_1}{E_1A_1}, \delta\ell_2 = \frac{P\ell_2}{E_2A_2}, \delta\ell_3 = \frac{P\ell_3}{E_3A_3} ......$$

$$\therefore \quad \delta\ell = \frac{P}{E}\left[\frac{\ell_1}{A_1}+\frac{\ell_2}{A_2}+\frac{\ell_3}{A_3}+........\right]$$

[$\because E = E_1 = E_2 = E_3$ ......] for same material

38. **What is the formula for elongation of a conical bar (with length L and self weight W) due to its self weight?**

(a) $\frac{WL}{2A_{min}E}$ (b) $\frac{WL^2}{2A_{min}E}$

(c) $\frac{WL}{2A_{max}E}$ (d) $\frac{WL^2}{2A_{max}E}$

SSC JE 22.01.2018 (3.15 pm)

Ans. (c) Elongation of a conical bar due to its self weight

$$\Delta = \frac{\gamma\cdot L^2}{6E} \quad .....(i)$$

Self weight of conical bar working as a axial load which acting along the axis of the conical bar.

$$W = \frac{\gamma\cdot A_{max}\cdot L}{3}$$

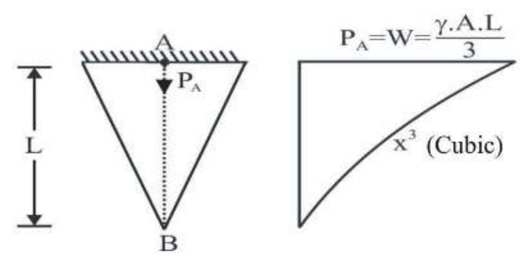
So $\gamma = \frac{3W}{A_{max}\cdot L}$

Where γ = specific weight

Value of γ putting in equation (i)

$$\Delta = \left(\frac{3W}{A\cdot L}\right)\times\left[\frac{L^2}{6\cdot E}\right]$$

$$\boxed{\Delta = \frac{WL}{2A_{max}E}}$$



39. **What will be the value of Poisson's ratio, if the elasticity and rigidity of the material is 200 GPa and 66.67 GPa?**

(a) 0 (b) 0.25
(c) 0.5 (d) 1

SSC JE 22.01.2018 (3.15 pm)

Ans. (c) Given : E = 200 GPa, G = 66.67 GPa, μ = ?

$$\boxed{E = 2G(1+\mu)}$$

$\Rightarrow$ $200 = 2 \times 66.67 (1 + \mu)$

$\Rightarrow$ $\mu = 0.49 \simeq 0.5$

40. Which of the following is NOT considered as a basic type of strain?

(a) Compressive strain
(b) Shear strain
(c) Area strain
(d) Volume strain

SSC JE 22.01.2018 (3.15 pm)

Ans. (c) There are only two basic type of strain.
(a) normal strain (tensile, compressive and volumetric)
(b) Shear strain.

41. A rod with a length of 100 cm and diameter of 4 cm undergoes an axial pull of 50 kN. what is the stress (in N/mm²)?

(a) 0.04 (b) 0.4
(c) 4 (d) 40

SSC JE 22.01.2018 (3.15 pm)

Ans. (d) Given : $F = 50 \text{ kN} = 50 \times 10^3$ N

$d = 4 \text{ cm} = 40$ mm

$$\text{Stress } (\sigma) = \frac{\text{Force}}{\text{Area}} = \frac{F}{\left(\frac{\pi}{4}d^2\right)}$$

$$\Rightarrow \quad \sigma = \frac{50 \times 1000}{\frac{\pi}{4} \times 40 \times 40} = 39.80 \text{ N/mm}^2 \simeq 40 \text{ N/mm}^2$$

42. A rod of dimension 20 mm × 20 mm is carrying an axial tensile load of 10 kN. If the modulus of elasticity is 250 MPa, then the strain induced due to this load would be.......

(a) 0.1 (b) 0.25
(c) 0.2 (d) 10

SSC JE 29.01.2018 (10.15 am)

Ans. (a) Axial tensile load (P) = 10 kN
E = 250 MPa
$A = 20 \times 20 \text{ mm}^2 = 400 \times 10^{-6} \text{ m}^2$

$$E = \frac{\sigma}{\in}$$

$$\sigma = \in E$$

$$\frac{F}{A} = \in E \qquad \left(\because \sigma = \frac{F}{A}\right)$$

$$\frac{10 \times 10^3}{400 \times 10^{-6}} = \in \times 250 \times 10^6$$

$$\in = \frac{10 \times 10^3}{400 \times 250} = 0.1$$

43. Determine the change in volume (in cm³) of a block of length 15 cm, width 10 cm and height 8 cm, undergoes a volumetric strain of 1/2500

(a) 0.004 (b) 0.0004
(c) 0.48 (d) 0.048

SSC JE 29.01.2018 (10.15 am)

Ans. (c) Given that–

l = 15 cm, b = 10 cm, h = 8 cm

$V = l.b.h$

$$e_v = \frac{1}{2500}$$

$V = 15 \times 10 \times 8$

$$e_v = \frac{\Delta V}{V}$$

$$\frac{1}{2500} = \frac{\Delta V}{15 \times 10 \times 8}$$

$$\Delta V = \frac{15 \times 10 \times 8}{2500} = \frac{1200}{2500}$$

$= 0.48$

44. The value of Poisson's ratio depends on ......

(a) material of the test specimen
(b) magnitude of the load
(c) cross section
(d) None of these

SSC JE 29.01.2018 (10.15 am)

Ans. (a) The value of Poisson's ratio depends on the material of the test specimen.
Poisson's Ratio–It is the ratio of lateral strain to longitudinal strain.

(Material)	(Poisson's ratio)
Aluminium	0.33
Brass	0.34
Bronze	0.34
Cast iron	0.23
Steel	0.25–0.33

45. To which of the following is the proof stress related?

(a) Elongation (b) Necking
(c) Yielding (d) Fracture

SSC JE 24.01.2018 (10.15 am)

Ans. (c) Proof stress– that stress which up to yield point where reasonable deformation take place.
In some ductile material such as Aluminium, copper, the yield point cannot be clearly defined during tension test, therefore yield stress is unknown and that condition proof stress closed related to yield point.

46. What will be the change in length (mm) of a steel bar having a square cross section of dimension 40 mm × 40 mm, which is subjected to an axial compressive load of 250 kN. If the length of the bar is 4 m and modulus of elasticity is E = 250 GPa?

(a) 2.5 (b) 1.25
(c) 2 (d) 1.5

SSC JE 24.01.2018 (10.15 am)

Ans. (a) P = 250 kN

A = 0.040 m × 0.040 m

= 0.001600 m^2

E = 250 GPa = 250 × 10^9 Pa

$\ell = 4$ m, $\delta\ell = ?$

$$\delta\ell = \frac{P \times \ell}{A \times E} = \frac{250 \times 10^3 \times 4}{0.001600 \times 250 \times 10^9}$$

= 0.0025 m = 2.5 mm

47. A steel rod whose diameter is 2 cm and is 2 m long, experiences heating of temperature 30°C to 150°C. The coefficient of thermal expansion is $\alpha = 12 \times 10^{-6}$/°C and Young's modulus is 200 GPa. If the rod has been restricted to its original position, then the thermal stress (MPa) developed will be ....

(a) 234 (b) 256
(c) 288 (d) 300

SSC JE 24.01.2018 (10.15 am)

Ans. (c) Given,

$(\alpha) = 12 \times 10^{-6}$/°C

(E) = 200 GPa

$\Delta t = 150 - 30 \Rightarrow 120$°C

E = 200 × 10^3 MPa

$(\sigma_{th}) = \alpha . \Delta T . E$

$\sigma_{th} = 12 \times 10^{-6} \times 120 \times 200 \times 10^3$

= 288 MPa

48. If the stress acting on a point is in the three dimensions, then what is the number of components in a stress tensor required for defining that stress?

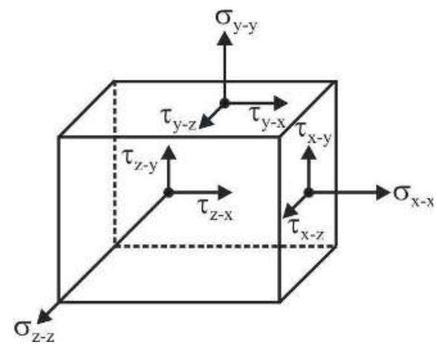
(a) 3 (b) 4
(c) 6 (d) 9

SSC JE 24.01.2018 (10.15 am)

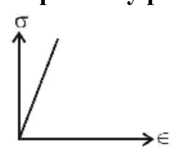
Ans. (d) Stress Tensor (or Stress Matrix)– Let the stress on a point is in the three dimensions as the resultant forces acting on these planes is the same, the stress on these planes are different because the areas and the inclinations of these plane are different. Therefore, for a complete description of stress, we have to specify not only its magnitude, direction and sense but also the surface or plane on which it acts, for this reason, the stress is called a "Tensor".

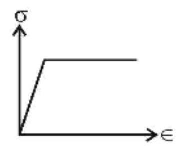
In depicts three-orthogonal co-ordinate planes representing a parallelepiped on which are 9 components of stress of these as 3 are direct stress and 6 are shear stresses.

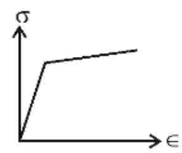
$$\sigma_{3D} = \begin{bmatrix} \sigma_{xx} & \tau_{xy} & \tau_{xz} \\ \tau_{yx} & \sigma_{yy} & \tau_{yz} \\ \tau_{zx} & \tau_{zy} & \sigma_{zz} \end{bmatrix}$$

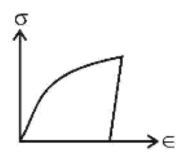


49. Which of the curve is best suited for linear elastic–perfectly plastic material?

(a) 

(b) 

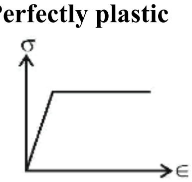
(c) 

(d) 

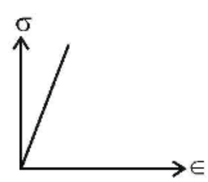
SSC JE 24.01.2018 (3.15 pm)

Ans. (b)

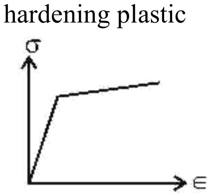
Linear Elastic– Perfectly plastic



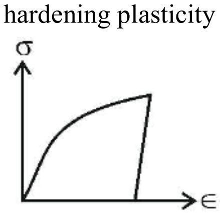
- Linear elastic



- Linear elastic– hardening plastic



- Linear elastic– hardening plasticity with unloading



50. **A steel rod whose diameter is 6 cm and is 1 m long, experiences heating from temperature 40°C to 200°C. The coefficient of thermal expansion is $\alpha = 12 \times 10^{-6}/^{o}C$ and Young's modulus is 300 GPa. If the rod has not been restricted in its original position, the thermal stress (MPa) developed is..........**

(a) 0 (b) 256
(c) 288 (d) 300

SSC JE 24.01.2018 (3.15 pm)

Ans. (a) Thermal stress developed = $\alpha\Delta TE$

Where, α = Coefficient of thermal expansion

ΔT = Temperature variation

E = Young's modulus

Since, the rod has not been restricted (i.e. free expansion), the thermal stress developed is zero.

51. **What is the tensile stress (in MPa) in a rod of cross section 20 mm × 30 mm, carrying an axial tensile load of 20 kN?**

(a) 0.03 (b) 0.33
(c) 33.33 (d) 333.33

SSC JE 24.01.2018 (3.15 pm)

Ans. (c) Given,

Cross-sectional area of Rod, A = 20 mm × 30 mm = 600 mm²

Applied axial force, F = 20 kN = 20×10^3 N.

We know that

$$\text{Tensile stress } (\sigma_t) = \frac{F}{A}$$

$$= \frac{20\times10^3}{600} N/mm^2$$

$$= \frac{200}{6} = 33.33 \text{ N/mm}^2$$

$\sigma_t = 33.33$ MPa ($\because$ 1 N/mm² = 1 MPa)

52. **There is ....for a brittle material.**

(a) no elastic zone (b) no plastic zone
(c) large elastic zone (d) large plastic zone

SSC JE 24.01.2018 (3.15 pm)

Ans. (b) In a brittle material, there are no plastic zone. It breaks without significant plastic deformation.

53. **A solid can resist which of the following stresses?**

(a) Tensile (b) compressive
(c) Shear (d) All of these

SSC JE 29.01.2018 (3.15 pm)

Ans. (d) A solid can resist tensile, compressive as well as shear stress.

54. **What is the S.I. unit of Poisson's ratio?**

(a) kN/mm² (b) N/mm²
(c) mm (d) Unitless

SSC JE 23.01.2018 (3.15 pm)

Ans. (d) The ratio of the lateral strain to longitudinal strain is known as the poison's ratio.

$$\text{Poisson's ratio } (\mu) = -\frac{\text{lateral strain}}{\text{longitudinal strain}}$$

for most engineering metals the value of μ lies between 0.25 to 0.33

55. **The elongation (mm) in a steel bar having a square cross section of 2.5 mm is subjected to an axial compressive load of 250 kN. If the length of the bar is 4 m and modulus of elasticity is E = 250 GPa. What is the dimension of the square cross section?**

(a) 25 mm × 25 mm (b) 40 mm × 40 mm
(c) 50 mm × 50 mm (d) 60 mm × 60 mm

SSC JE 27.01.2018 (3.15 pm)

Ans. (b) : Given

$\ell = 4m = 4 \times 10^3$ mm

E = 250 GPa = 250×10^3 N/mm²

P = 250 kN = 250×10^3 N

δl = 2.5 mm

$$\delta\ell = \frac{P\ell}{AE}$$

$$2.5 = \frac{250\times10^3\times4\times10^3}{A\times250\times10^3}$$

A = 40 mm × 40 mm

56. **Determine the axial strain in the cylindrical wall at the mid depth, when the Young's modulus and the Poisson's ratio of the container material is 200 GPa and 0.6 respectively. The axial and the circumferential stress are equal and its value is 20 MPa.**

(a) 2×10^{-5} (b) 6×10^{-5}
(c) 7×10^{-5} (d) 4×10^{-5}

SSC JE 27.01.2018 (3.15 pm)

Ans. (d) : Given

(E) = 200 GPa = 200×10^9 N/m².

$\sigma_c = \sigma_l = 20 \times 10^6$ N/m²

(μ) = 0.6

$$\epsilon_\ell = \frac{\sigma_\ell}{E} - \mu\frac{\sigma_c}{E} \qquad (\sigma_c = \sigma_\ell)$$

$$= \frac{\sigma_\ell}{E}(1-\mu)$$

$$= \frac{\sigma_\ell}{E}\times(1-0.6)$$

$$= \frac{20\times10^6}{200\times10^9}(1-0.6)$$

$$\epsilon_\ell = 4\times10^{-5}$$

57. A steel rod whose diameter is 2 cm and is 2 cm long experiences change in temperature due to heating. The coefficient of thermal expansion is $\alpha = 12 \times 10^{-6}$ / °C and the rod has been restricted in its original position. The young's modulus is 200 GPa and thermal stress developed is 288 MPa what is the value change in the temperature (°C)?

(a) 50 (b) 100
(c) 120 (d) 150

SSC JE 27.01.2018 (3.15 pm)

Ans. (c) : Co-efficient of thermal expansion (α) $= 12 \times 10^{-6}$/°C

Young's Modulus (E) = 200 GPa

$= 200 \times 10^9$ N/mm^2

Thermal stress developed (σ_{th}) = 288 MPa

$= 288 \times 10^6$ N/mm^2

Thermal stress (σ_{th}) = E × Δt × α

$288 \times 10^6 = 200 \times 10^9 \times 12 \times 10^{-6}\,\Delta t$

Δt = 120°C

58. The elongation (mm) in a steel bar having a square cross section of dimension 40 mm × 40 mm is 2.5 mm and is subjected to an axial compressible load of P (kN). If the length of the bar is 4 m and modulus of elasticity is E= 250 GPa. What is the value of P (kN)?

(a) 100 (b) 150
(c) 200 (d) 250

SSC JE 23.01.2018 (10.15 am)

Ans. (d) Given

δl = 2.5 mm

A = 40 × 40 mm^2

L = 4 m = 4000 mm

E = 250 GPa = 250×10^3 N/mm^2

$$\delta l = \frac{PL}{AE}$$

$$P = \frac{AE\delta l}{L}$$

$$= \frac{40 \times 40 \times 250 \times 10^3 \times 2.5}{4000}$$

P = 250 kN

59. The property of a material states that it is rigid. The value of Poisson's ratio for this particle is______

(a) 0 (b) 1
(c) 2 (d) None of these

SSC JE 23.01.2018 (10.15 am)

Ans. (a) If poison's ratio of a material is zero, then it means that material is rigid.

For engineering material, the value of Poisson's ratio range between 0 to 0.5.

60. Calculate the value of modulus of elasticity (N/mm^2), if the Poisson's ratio is 0.25 and modulus of rigidity of the material is 80 N/mm^2.

(a) 100 (b) 200
(c) 250 (d) 300

SSC JE 23.01.2018 (10.15 am)

Ans. (b) Given, Poisson's ratio (μ) = 0.25

Modulus of rigidity (G) = 80 N/mm^2

Modulus of elasticity (E) = ?

E = 2 G (1 + μ)

= 2 × 80 (1 + 0.25) = 200 N/mm^2

61. Which of the following is CORRECT option for validation of Hooke's law in simple tension test?

(a) Ultimate stress
(b) Breaking point
(c) Elastic Limit
(d) Limit of proportionality

SSC JE 23.01.2018 (10.15 am)

Ans. (d) Proportion limit is the maximum value of stress upto which stress– strain relationship is linear, hence Hooke's law is valid upto proportional limit or limit of proportionality.

- Hooke's law hold up to the proportional limit as term of stress and strain.

$$\boxed{\sigma \propto \varepsilon}$$

σ = stress, ε = strain

62. A steel rod whose diameter is 2 cm and is 2m long, experience heating from 30^{0}C to 150^{0}C. The coefficient of thermal expansion is $\alpha = 12 \times 10^{-6}/^0C$ and the rod has been restricted in its original position. The thermal stress developed in 288 MPa. What is the value of Young's modulus(GPa) ?

(a) 50 (b) 100
(c) 150 (d) 200

SSC JE 23.01.2018 (10.15 am)

Ans. (d) Given–

d = 2 cm Δt = 150°C – 30°C

ℓ = 2 m Δt = 120°C

α = 12×10^{-6}/°C

σ_{th} = 288 MPa = 288×10^6 N/m^2

Thermal stress (σ_{th}) = αEΔt

$288 \times 10^6 = 12 \times 10^{-6} \times E \times 120$

E = 200×10^9 N/m^2

E = 200 GPa

63. Choose the INCORRECT conditions for the thermal stress in a body.

(a) It is the function of coefficient of thermal expansion.
(b) It is the function of temperature rise

(c) It is the function of modulus of elasticity

(d) It is the function of modulus of rigidity.

SSC JE 23.01.2018 (10.15 am)

Ans. (d) Thermal stress in body

$\sigma_{th} = \alpha E \Delta t$

So, thermal stress is a function of co-efficient of thermal expansion, temperature rise and modulus of elasticity.

64. The Young's modulus and thermal stress developed in a steel rod of diameter 2 cm and length 2 m is 200 GPa and 288 MPa respectively, this experiences heating from temperature 30°C to 150°C and the rod has been restricted in its original position. Calculate the value of coefficient of thermal expansion.

(a) $1.2 \times 10^{-5}/^oC$ (b) $12 \times 10^{-4}/^oC$

(c) $12 \times 10^{-5}/^oC$ (d) None of these

SSC JE 25.01.2018 (3.15 pm)

Ans. (a) Given

$d = 2$ cm

$l = 2$ m

$\Delta t = 120°C$

$E = 200$ GPa

$\sigma_{th} = 288$ MPa

$\sigma_{th} = \alpha \times \Delta t \times E$

$288 \times 10^6 = \alpha \times 120 \times 200 \times 10^9$

$$\alpha = \frac{288 \times 10^6}{120 \times 200 \times 10^9}$$

$\alpha = 1.2 \times 10^{-5}/^oC$

65. Choose the CORRECT option which satisfies the Hooke's law.

(a) $\sigma \propto \frac{1}{\varepsilon}$

(b) $\sigma \propto \varepsilon$

(c) $\sigma = \varepsilon$

(d) $\sigma = \varepsilon$ and $\sigma \propto \frac{1}{\varepsilon}$

SSC JE 25.01.2018 (10.15 am)

Ans. (b) Hooke's law states that when a material is loaded upto proportionality limit, the stress is directly proportional to strain. i.e.

$$\sigma \propto \varepsilon \text{ or } \sigma = E.\varepsilon \text{ or } E = \frac{\sigma}{\varepsilon}$$

66. A steel rod of original length 200 mm and final length of 200.2 mm after application of an axial tensile load of 20 kN. What will be the strain developed in the rod?

(a) 0.01 (b) 0.1

(c) 0.001 (d) 0.0001

SSC JE 25.01.2018 (10.15 am)

Ans. (c) Given–

Original length of steel rod (L_o) = 200 mm

Final length of steel rod (L_f) = 200.2 mm

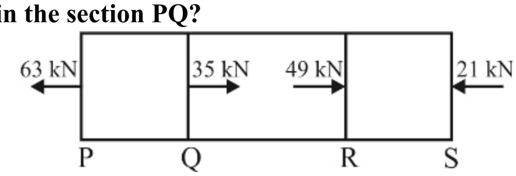
Axial tensile load (P) = 20 kN

Strain developed in the rod $(\in) = \frac{L_f - L_0}{L_0}$

$$= \frac{200.2 - 200}{200} = 0.001$$

$\boxed{\in = 0.001}$

67. A cross-sectional bar of area 700 mm² is subjected to an axial load as shown in the figure below. What is the value of stress (MPa) in the section PQ?

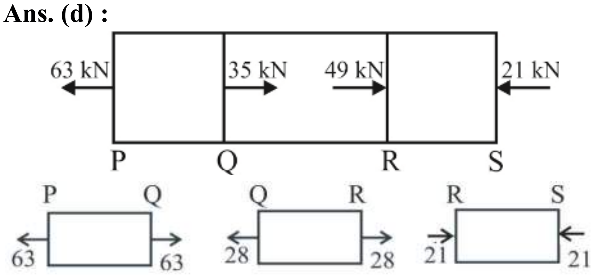


(a) 30 (b) 40

(c) 50 (d) 90

SSC JE 27.01.2018 (3.15 pm)

Ans. (d) :



PQ = 63 kN,

$$\sigma_{PQ} = \frac{P_{PQ}}{A} = \frac{63 \times 10^3}{700 \times 10^{-6}} N/m^2$$

$\sigma_{PQ} = 90$ MPa.

68. The unit of Young's modulus is ....

(a) mm/mm (b) kg/cm

(c) kg (d) kg/cm^2

SSC JE 4 March 2017 Shift-II

Ans. (d) According to Hooke's law, stress is directly proportional to strain with in proportional limit.

$\therefore$ Stress $\propto$ strain

$(\sigma) \propto (\varepsilon)$

$\therefore \sigma = E.\varepsilon$

E, is proportional constant known as Modulus of elasticity

Units of Modulus of elasticity is MPa, GPa, N/mm^2 Kg/cm^2 etc.

Dimension - $[ML^{-1}T^{-2}]$

69. In two dimensional stress–strain analysis, the shear strain component (Y_{XY}) along the XY plane is written as _____.

(a) $\gamma_{xy} = \left(\frac{\partial u}{\partial x}\right) + \left(\frac{\partial v}{\partial y}\right)$

(b) $\gamma_{xy} = \left(\frac{\partial u}{\partial x}\right) - \left(\frac{\partial v}{\partial y}\right)$

(c) $\gamma_{xy} = \left(\frac{\partial u}{\partial y}\right) + \left(\frac{\partial v}{\partial x}\right)$

(d) $\gamma_{xy} = \left(\frac{\partial u}{\partial y}\right) - \left(\frac{\partial v}{\partial x}\right)$

SSC JE 3 March 2017 Shift-I

Ans. (c) In two dimensional stress - strain analysis, shear strain component (γ_{xy}) of $\left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}\right)$ can be written along the x-y axis

70. The relation between the Young's Modulus (E), shear modulus (G) and Poisson's ratio (V) is correctly given by the expression_____.

(a) $E=\frac{G}{2(1+V)}$ (b) $G=\frac{E}{2(1+V)}$

(c) $G=\frac{E}{(1+V)}$ (d) $E=\frac{G}{(1+V)}$

SSC JE 3 March 2017 Shift-I

Ans. (b) Young modulus (E) = 2 G(1+V)

$$\boxed{G = \frac{E}{2(1+V)}}$$

$\therefore$ Where, G= shear modulus

V= Poisson ratio

Relation between E and K

$\boxed{E = 3K(1-2V)}$ $\therefore$ K = Bulk modulus

$\therefore$ Relation between E,G and K

$$\boxed{E = \frac{9KG}{(3K+G)}}$$

71. The Poisson's ratio for most of the materials is close to ....

(a) 1 : 2 (b) 1 : 3

(c) 1 : 4 (d) 1 : 5

SSC JE 1 March 2017 Shift-I

Ans. (b) The ratio of lateral strain to the longitudinal strain is called "Poisson's ratio"

$$\mu = \frac{\text{Lateral strain}}{\text{Longitudinal strain}}$$

- The Poisson's ratio for most of the materials is close to 1:3, and always less than 1:2.

Materials	Poisson's Ratio
Alluminium alloy	0.33
Brass, Broze	0.34
Steel	0.27 to 0.30
Rubber	0.5
Cork	0

72. A thin mild steel wire is loaded by adding loads in equal increments till it breaks. The extensions noted with increasing loads will behave as under :

(a) uniform throughout

(b) increase uniformly

(c) first increase and then decrease

(d) increase uniformly first and then increase rapidly

SSC JE 4 March 2017 Shift-I

Ans. (d) A thin mild steel wire is loaded by adding loads in equal increment till it breaks. The extensions noted with increasing loads will behave as under increase uniformly first and then increase rapidly.

73. The Young's modulus of a wire is defined as the stress which will increase the length of wire compared to its original length :

(a) half (b) same amount

(c) double (d) one–fourth

SSC JE 4 March 2017 Shift-II

Ans. (b) The young's modulus of wire is defined as the stress which will increase the length of wire is equal to the its original length

- According to Hooke's law stress is directly proportional to strain within proportional limit.

$\therefore \sigma \propto \varepsilon$

$\therefore \sigma = E\varepsilon$

$\therefore E = \frac{\sigma}{\varepsilon}$

$\therefore E = \frac{\sigma}{\Delta\ell/\ell}$

If $\Delta\ell = \ell$ then $\boxed{E = \sigma}$

74. Which is the false statement about stress–strain method ?

(a) It does not exist

(b) It is more sensitive to changes in both metallurgical and Mechanical conditions

(c) It gives a more accurate picture of the ductility

(d) It can be correlated with stress–strain values in other tests like torsion, impact, combined stress tests etc.

SSC JE 4 March 2017 Shift-II

Ans. (a) According to Hooke's law stress is directly proportional to the strain within proportional limit

Stress $\propto$ Strain

$\therefore \sigma = E\varepsilon$

- 'E' is proportionality constant known as modulus of elasticity.
- The value of 'E' is constant for a particular material
- 'E' decreases with increase in temperature

75. The total elongation produced in a bar of uniform section hanging vertically downwards due to its own weight is equal to that produced by a weight :

(a) of same magnitude as the of bar and applied at the lower end
(b) half the weight of bar applied at the lower end
(c) half of the square of weight of bar applied at the lower end
(d) one–fourth of weight of bar applied at the lower end

SSC JE 4 March 2017 Shift-II

Ans. (b) Deformation of bar due to self weight:-

$$\delta\ell_1 = \frac{W\ell}{2AE} \quad -(I)$$

Deformation of bar due to external load Applied on it :-

$$\delta\ell_2 = \frac{W\ell}{AE} \quad -(II)$$

From equation (I) & (II)

$$\frac{\delta\ell_1}{\delta\ell_2} = \frac{W\ell}{2AE} \Big/ \frac{W\ell}{AE}$$

$$\boxed{\delta\ell_1 = \frac{1}{2} \times \delta\ell_2}$$

76. Strain is defined as the ratio of ....

(a) change in volume to original volume
(b) change in length to original length
(c) change in cross sectional area to original cross–sectional area
(d) All options are correct

SSC JE 4 March 2017 Shift-II

Ans. (d) When a body is subjected to some external load, there is change in dimension of the body the ratio of change in dimension of the body to its original dimension is known as strain

$$\therefore \text{Strain} = \frac{\text{change in dimension}}{\text{orginal dimension}}$$

Types of strain:-
i) longitudinal strain
ii) Shear strain
iii) Volumetric strain

-longitudinal strain $(\varepsilon_\ell) = \dfrac{\text{change in length}}{\text{original length}} = \dfrac{\delta\ell}{\ell}$

- volumetric strain $(\varepsilon_V) = \dfrac{\text{change in volume}}{\text{original volume}} = \dfrac{\delta V}{V}$

77. If a load W is applied instantaneously on a bar of cross section A, then the stress induced in the bar in worst case will be :

(a) W/A
(b) W/2A
(c) 2W/A
(d) (2W/A) × (a factor greater than unity)

SSC JE 4 March 2017 Shift-II

Ans. (c) If a load 'W' is applied instantaneously on a bar of cross section 'A' then the stress induced in the bar in worst case will be '2W/A'

$$\therefore \sigma_{impact} = \frac{W}{A}\left(1 + \sqrt{1 + \frac{2h_i}{\delta\ell}}\right)$$

If h_i=0 then $\sigma_{impact} = \dfrac{2W}{A}$

78. In the case of an elastic bar fixed at upper end and loaded by a falling weight at lower end, the shock load produced can be decreased by :

(a) decreasing the cross–section area of bar
(b) increasing the cross–section area of bar
(c) remain unaffected with cross–section area
(d) would depend upon other factors

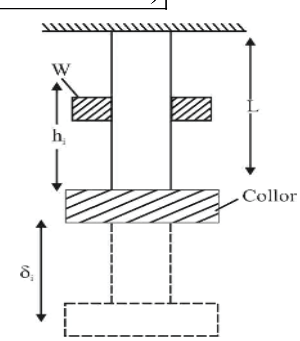
SSC JE 4 March 2017 Shift-II

Ans. (a) In the case of an elastic bar fixed at upper end and loaded by a falling weight at lower end, the shock load produced can be decreased if material elongate in the direction of applied load which is done by decreasing the cross section area of bar.

$$\therefore \sigma_i = \sigma_G\left(1 + \sqrt{1 + \frac{2h_i}{\delta_G}}\right)$$

$$\therefore \delta_G = \frac{WL}{EA}$$

$$\therefore \boxed{\sigma_i = \sigma_G\left(1 + \sqrt{1 + \frac{2h_iEA}{WL}}\right)}$$



$\therefore \sigma_i \propto A, \sigma_i \propto h_i$

$A \uparrow \Rightarrow \sigma_i \uparrow$

$A \downarrow \Rightarrow \sigma_i \downarrow$

Where, h_i = Impact height
A= Area of bar
L= Length of bar
E= Modulus of elasticity

79. The intensity of stress which causes unit strain is called ....
(a) unit stress
(b) bulk modulus
(c) modulus of rigidity
(d) modulus of elasticity

SSC JE 2 March 2017 Shift-I

Ans. (d) The intensity of stress which caused unit strain is called modulus of elasticity.

$$\text{Modulus of elasticity (E)} = \frac{\text{intensity of stress } (\sigma)}{\text{Unit Strain } (\varepsilon)}$$

80. If the value of poison's ratio is zero then it means that
(a) The material is rigid
(b) There is no longitudinal strain in the material
(c) The material is perfectly plastic
(d) none of the above

SSC JE 3 March 2017 Shift-II

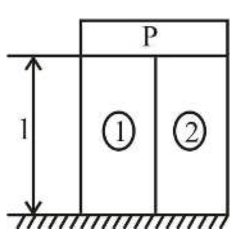
Ans. (d) :

$$\boxed{\text{Poisson's ratio} = -\frac{\text{Lateral strain}}{\text{Longitudinal strain}}}$$

81. In a Composite bar the resultant strain produced will be-
(a) sum of the strain produced by the individual bars
(b) same as the stress produced in each bar
(c) same as the strain produced in each bar
(d) difference of strain produced by the individual bars

SSC JE 2015

Ans. : (c)



Combination of bars with different materials

$(\delta l)_1 = (\delta l)_2$

$\varepsilon_1 \times l = \varepsilon_2 \times l$

$\boxed{\varepsilon_1 = \varepsilon_2}$

strain will be same.

$\sigma_1 = E_1 \times \varepsilon_1$, $\sigma_2 = E_2 \times \varepsilon_2$

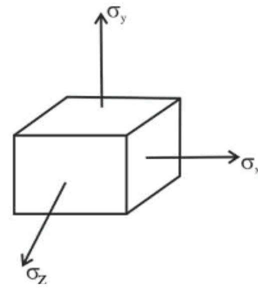
$$\frac{\sigma_1}{\sigma_2} = \frac{E_1 \times \varepsilon_1}{E_2 \times \varepsilon_2} \qquad \therefore \boxed{\varepsilon_1 = \varepsilon_2}$$

$$\boxed{\frac{\sigma_1}{\sigma_2} = \frac{E_1}{E_2}}$$

82. Volumetric strain of a rectangular body subjected to an axial force, in terms of linear strain e and Poisson's ratio μ, is equal to-
(a) e(1+μ)
(b) e(1-3μ)
(c) e(1-2μ)
(d) e(1-μ)

SSC JE 2015

Ans. : (c)



$$\epsilon_v = \frac{(\sigma_x + \sigma_y + \sigma_z)}{E}(1-2\mu)$$

$\sigma_y = \sigma_z = 0$

$$\epsilon_v = \frac{\sigma_x}{E}(1-2\mu)$$

Where, $\frac{\sigma_x}{E} = \epsilon$

$\epsilon_v = \epsilon(1-2\mu)$

83. Stress due to change in temperature developed in a bar depends upon
(a) coefficient of thermal expansion
(b) thermal conductivity
(c) density
(d) Poisson's ratio

SSC JE 2014 (MORNING)

Ans. : (a) Stress generated due to change in temperature

$\boxed{(\sigma) = \alpha\, \Delta t\, E}$

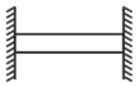
Where, α = Thermal expansion coefficient
Δt = Change in temperature
E = Elastic coefficient

- If there is no restriction in expansion or contraction of bar then no thermal stress generated.

84. A steel bar is fixed at both ends. If the bar is heated, it will develop
(a) Compressive stress
(b) Tensile stress
(c) Bending stress
(d) None of the above

SSC JE 2013

Ans. : (a) If the body is fixed at both ends and it is heated and allowed to expand or contract freely with the rise or fall of the temperature, no stresses are induced in body. But if the deformation of the body is prevented some stresses are induced in the body.



If both end fixed and heated compressive stress develop

If body is free to expand then no stress develop.

85. When a wire is stretched to double in length, the longitudinal strain produced in it is :

(a) 0.5 (b) 1.0
(c) 1.5 (d) 2.0

SSC JE 2010

Ans. : (b)

$$\text{longitudinal strain} = \frac{\text{Final length} - \text{Original length}}{\text{Original length}}$$

$$= \frac{2L - L}{L} = \frac{L}{L} = 1$$

86. Which is the correct expression?

(a) $E = 2C\left(1 + \frac{1}{m}\right)$

(b) $E = 3C\left(1 - \frac{1}{2m}\right)$

(c) $E = 3C\left(2 - \frac{1}{m}\right)$

(d) $E = 3C\left(1 - \frac{1}{3m}\right)$

SSC JE 2008

Ans. : (a) Correct expression is $E = 2C\left(1 + \frac{1}{m}\right)$

Where, E = Young modulus

C = Modulus of rigidity

$\frac{1}{m}$ = Poisson's ratio (μ)

- Relation between modulus of elasticity (E) and bulk modulus (K) is expressed as –

$$\boxed{E = 3K\left(1 - \frac{2}{m}\right)}$$

- Relation between modulus of elasticity (E) modulus of rigidity (G) and bulk modulus (K) –

$$\boxed{E = \frac{9KG}{3K + G}}$$

Where, K = Volumetric/Bulk modulus

87. Poisson's ratio is used in :

(a) one-dimensional body
(b) two dimensional body
(c) three dimensional body
(d) both two and three dimensional body

SSC JE 2008

Ans. : (d) Poisson's ratio is used in two and three dimensional body.

- Poisson's ratio of most of the materials is close to 1/3.
- $\boxed{\text{Poisson's ratio}(\mu) = -\frac{\text{lateral strain}}{\text{longitudinal strain}}}$
- For engineering materials, the value of Poisson's ratio range between 0 to 0.5.

Material	**Poisson's ratio (μ)**
Cork	0
Concrete	0.1–0.2
Aluminium	0.33
Cast iron	0.2–0.3
Steel	0.27–0.3
Perfectly elastic rubber	0.5

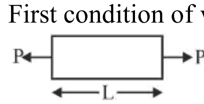
88. On the application of a given load, the length of a wire is stated to increase by 1 mm. If the same force is now applied to a wire of same material but of the length and radius twice the first, the extension produced would be

(a) 0.25 mm (b) 0. 5 mm
(c) 2. 0 mm (d) 4. 0 mm

SSC JE 2007

Ans. : (b) Given that δl = 1 mm

First condition of wire



$$\delta L_1 = \frac{PL_1}{AE} = \frac{PL_1}{\pi \times r_1^2 \times E} \quad .....(i)$$

Second condition of wire -

Length (L_2) = $2L_1$

Radius (r_2) = $2r_1$

$$\delta L_2 = \frac{PL_2}{\pi r_2^2 E} = \frac{P \times 2L_1}{\pi (2r_1)^2 E} = \frac{1}{2}\frac{PL_1}{\pi r_1^2 E}$$

$$\frac{\delta L_1}{\delta L_2} = \frac{\frac{PL_1}{\pi r_1^2 E}}{\frac{1}{2}\frac{PL_1}{\pi r_1^2 E}}$$

$$\frac{1}{\delta L_2} = 2$$

$$\delta L_2 = \frac{1}{2}$$

$$\boxed{\delta L_2 = 0.5}$$

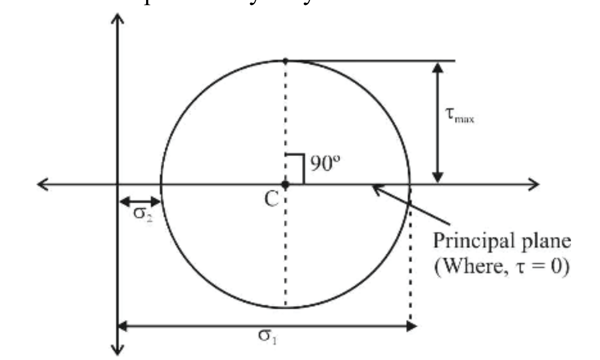
2. Principle Stress-Strain & Mohr's Circle

89. Principal planes are plane having–

(a) maximum shear stress
(b) no shear stress
(c) minimum shear stress
(d) none of the above

SSC JE 3 March 2017 Shift-I
SSC JE 2009

Ans. (b) : Principal planes are the planes of zero shear stress. These plans carry only normal stresses.



90. The value of normal stress is .... in the plane of maximum shear stress.

(a) minimum
(b) maximum
(c) zero
(d) None of these

SSC JE 25. 1. 2018 (3.15 pm)
SSC JE 1 March 2017 Shift-I

Ans. (d) The value of normal stress, in the plane of max. shear stress is neither zero nor maximum but have a some value. Normal stress on the plane of maximum shear stress is represented by co-ordinate of centre of Mohr's circle i.e. $(\sigma_n, 0)$

$$\sigma_n = \frac{\sigma_x + \sigma_y}{2}$$

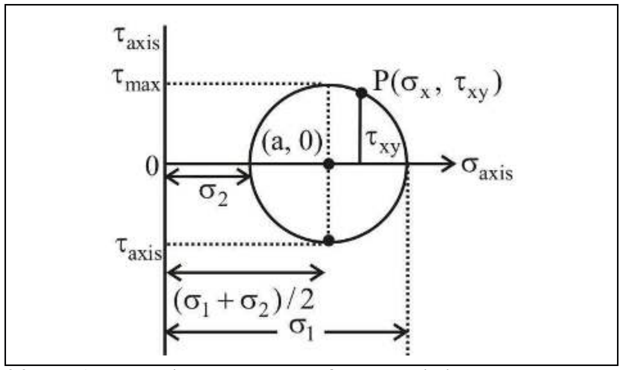
Where as at a maximum normal stress plane, the value of shear stress will be zero.

91. The shear stress along the principal plane subjected to maximum principal stress is :

(a) minimum
(b) maximum
(c) zero
(d) any value depending on loading conditions

SSC JE 3 March 2017 Shift-I

Ans. (c) : Maximum and minimum value of the normal stress occur on planes of zero shearing stress.
The maximum and minimum normal stress are called the principal stress and plane on which they act is called the principal plane.

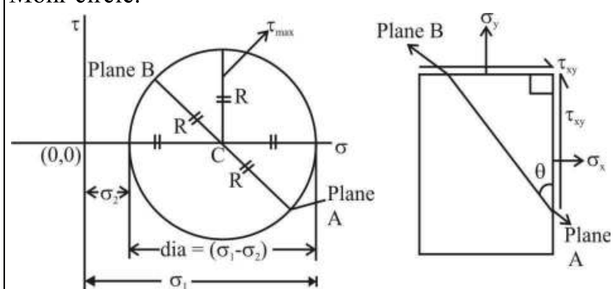


92. A graphical method of determining the normal, tangential and resultant stresses on an oblique plane is:

(a) Coulomb circle
(b) force circle
(c) stress circle
(d) Mohr circle

SSC JE 27-10-2020 (Shift-1)

Ans. (d) A graphical method of determining the normal, tangential and resultant stress on an oblique plane is Mohr circle.



Where σ_1 and σ_2 major and minor normal principal stress.

- Centre of Mohr's circle $= \left(\frac{\sigma_x + \sigma_y}{2}, 0\right)$
- Radius of Mohr's circle $= \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$

93. Which of the following statements about a principal plane is true?

(a) It has maximum shear stress
(b) No shear stress is present
(c) Shear stress can have any value
(d) It has no normal stress

SSC JE 28-10-2020 (3 to 5 pm)

Ans. (b) : Principal Plane–

- Principal plane is a plane on which normal stresses are maximum or minimum. This stresses are called principal stress.
- The plane of principal stresses carry zero shear stress.

94. What will be the magnitude of the shear stress on the principal plane?

(a) Zero
(b) Minimum
(c) Negative
(d) Maximum

SSC JE 27-10-2020 (Shift-3)

Ans. (a) : On the principal plane, the magnitude of the shear stress will be zero. On this plane, the magnitude of normal stress will be maximum or minimum.

- Principal stresses are maximum or minimum normal stress.

95. Calculate the maximum shear strain at the point where principal strains are 100 × 10^{-6} and –200×10^{-6}.

(a) 100×10^{-6} (b) 200×10^{-6}
(c) 300×10^{-6} (d) 400×10^{-6}

SSC JE 29. 1. 2018 (3.15 pm)

Ans. (c) Given,

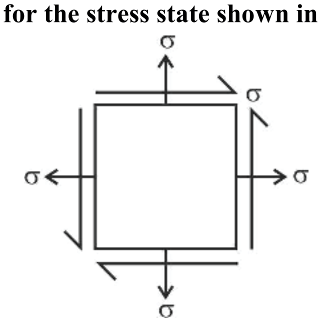
$$\in_x = 100\times10^{-6}$$

$$\in_y = -200\times10^{-6}$$

Maximum shear strain $\frac{\gamma_{xy}}{2} = \frac{\in_x - \in_y}{2}$

= [(100×10^{-6}) – (–200×10^{-6})]
= 300×10^{-6}

96. Calculate the maximum value of the principal stress for the stress state shown in the figure.



(a) σ (b) –σ
(c) 2σ (d) –2σ

SSC JE 29. 1. 2018 (3.15 pm)

Ans. (c) Given

$$\tau_{xy} = \sigma$$

$$\sigma_x = \sigma$$

$$\sigma_y = \sigma$$

Maximum principal stress (σ_{max})

$$= \frac{\sigma_x + \sigma_y}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \left(\tau_{xy}\right)^2}$$

$$= \frac{\sigma + \sigma}{2} + \sqrt{0 + \sigma^2}$$

$$= \sigma + \sigma$$

$$= 2\sigma$$

97. The value of the principal stress at a point in a plane stressed element is

$\sigma_x = \sigma_y$ = 500 MPa

Calculate the value of normal stress acting (MPa) at the angle of 45° at X axis

(a) 250 (b) 500
(c) 750 (d) 1000

SSC JE 25. 1. 2018 (3.15 pm)

Ans. (b) Given, $\sigma_x = \sigma_y = 500$ MPa, $\tau_{xy} = 0$, $\theta = 45°$

$$\sigma_n = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2}\cos 2\theta + \tau_{xy}\sin 2\theta$$

$$= \frac{500 + 500}{2} + \frac{500 - 500}{2}\cos 2\times 45^0$$

$$= \frac{1000}{2} + 0 = 500 \text{ MPa}$$

98. A body is subjected to principle stresses at a point having values as 200 MPa, 150 MPa and 100 MPa respectively. What is the value of maximum shear stress (in MPa)?

(a) 25 (b) 50
(c) 75 (d) 100

SSC JE 25. 1. 2018 (10.15 am)

Ans. (b) Given– principal stress at point–

σ_1 = 200 MPa
σ_2 = 150 MPa
σ_3 = 100 MPa

Absolute max. stress at a point

$$\tau_{max} = \text{max. value of} \left[\left|\frac{\sigma_1 - \sigma_2}{2}, \frac{\sigma_2 - \sigma_3}{2}, \frac{\sigma_3 - \sigma_1}{2}\right|\right]$$

So

Max. shear stress at a point

$$\tau_{max} = \text{max. value of} \left[\left|\frac{200 - 150}{2}, \frac{150 - 100}{2}, \frac{100 - 200}{2}\right|\right]$$

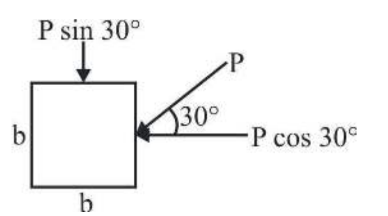
τ_{max} = 50 MPa

99. What is the normal stress on a bar of square cross–section with side 'b' on which load P is applied at an angle of 30° from the horizontal?

(a) $\frac{\sqrt{3}P}{2b^2}$ (b) $\frac{\sqrt{3}P}{4b^2}$
(c) $\frac{\sqrt{3}P}{2b^2}$ (d) $\frac{\sqrt{3}P}{4b^2}$

SSC JE 24. 1. 2018 (3.15 pm)

Ans. (c)



$$\text{Stress} = \frac{\text{Applied Load}}{\text{Cross - Sectional Area}}$$

$$= \frac{P\cos 30°}{b^2} = \frac{P\sqrt{3}}{2b^2}$$

100. For an element under the effect of biaxial state of normal stress, the normal stresses are on a 45^0 plane is equal to ......

(a) Difference of normal stresses
(b) Sum of normal stresses
(c) Half of the sum of normal stresses
(d) Half of the difference of normal stresses

SSC JE 1 March 2017 Shift-I

Ans. (c) $\sigma_n = \frac{\sigma_x + \sigma_y}{2} + \left(\frac{\sigma_x - \sigma_y}{2}\right)\cos 2\theta$

(Bi- axial loading condition)

$$= \frac{\sigma_x + \sigma_y}{2} + \left(\frac{\sigma_x - \sigma_y}{2}\right)\cos\times 90^0$$

$$\therefore \boxed{\sigma_n = \frac{\sigma_x + \sigma_y}{2}}$$

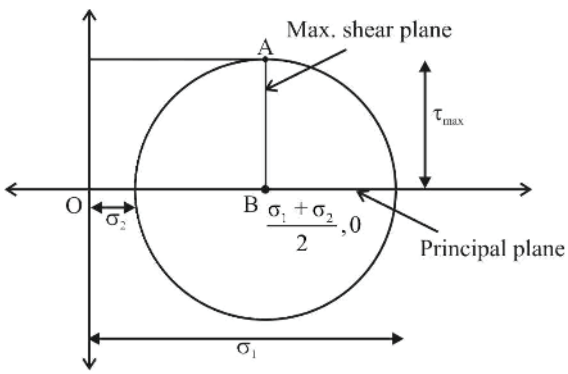
101. When two mutually perpendicular principal stresses are unequal but alike, the maximum shear stress is represented by ....

(a) The diameter of the Mohr's circle
(b) Half the diameter of the Mohr's circle
(c) One–third the diameter of the Mohr's circle
(d) One–fourth the diameter of the Mohr's circle

SSC JE 1 March 2017 Shift-I

Ans. (b) When two mutually perpendicular principal stress are unequal but alike, the maximum shear stress is represented by half the diameter of the 'Mohr's circle'

$$\tau_{max} = \frac{\sigma_1 - \sigma_2}{2}$$



102. The number of strain readings (using strain gauges) needed on a plane surface to determine the principal strains and their directions are ____.

(a) 1
(b) 2
(c) 3
(d) 4

SSC JE 3 March 2017 Shift-II

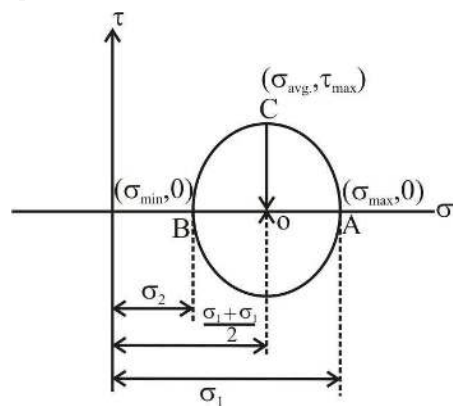
Ans. (c) Three strain gauge are needed on a plane surface to determine the principal strains and their direction.

103. Mohr's circle can be used to determine following stress on inclined surface:
A. Principal stress
B. Normal stress
C. Tangential stress
D. Maximum shear stress

(a) Only A
(b) Only B
(c) Only C
(d) A, B, C and D

SSC JE 3 March 2017 Shift-I

Ans. (d) Mohr's circle is a graphical method of finding principal, normal, tangential and resultant stresses an oblique plane.



Where, OA = maximum principal plane
OB = minimum principal plane
OC = maximum shear stress plane

104. At the principal planes ....

(a) the normal stress is maximum or minimum and the shear stress is zero
(b) the tensile and compressive stresses are zero
(c) the tensile stress is zero and the shear stress is maximum
(d) no stress acts

SSC JE 2 March 2017 Shift-I

Ans. (a) At the principal planes the normal stress is maximum or minimum and the shear stress is zero.

- Radius of Mohr circle represent the value of maximum shear stress.

3. Shear Force and Bending Moment Diagram

105. The point of contraflexure is a point where :

(a) shear force change sign
(b) bending moment changes sign
(c) shear force is maximum
(d) bending moment is maximum

SSC JE 2008

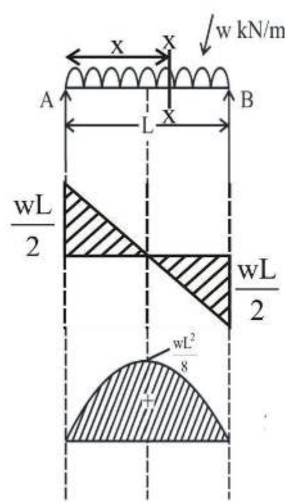
Ans. (b)
- The point of contraflexure is a point where bending moment changes sign.
- At the point of contraflexure the bending moment is zero.
- The point of contraflexure is mostly found in overhanging beam. Sometime it is referred to as point of inflection.

106. A simply supported beam of length L is loaded with a uniformly distributed load of w per unit length. The maximum bending moment will be:

(a) $\frac{wL^2}{4}$ (b) $\frac{wL^2}{8}$
(c) $\frac{wL^2}{2}$ (d) wL^2

SSC JE 27-09-2019 (Shift-1)

Ans. (b) : Given that,



Beam length = L
Uniformally distributed load = w kN/m

$R_A + R_B = wL$ .... (i)

Taking moment about B

$R_A \times L - wL \times \frac{L}{2} = 0$ .... (ii)

from equation (i) and (ii)

$R_A = \frac{wL}{2}$, $R_B = \frac{wL}{2}$

Taking moment about point, at distance of x from end A

$\Sigma M_x = 0$

$M_x = R_A \times x - wx \times \frac{x}{2}$

$M_x = \frac{wL}{2} \times x - \frac{wx^2}{2}$

For maximum moment

$\frac{dM_x}{d_x} = 0$, $\frac{wL}{2} - wx = 0$

$x = \frac{L}{2}$

Therefore, bending moment will be maximum at distance $\frac{L}{2}$ from end A

$M_{max} = \frac{wL}{2} \times \frac{L}{2} - \frac{w}{2} \times \frac{L^2}{4}$

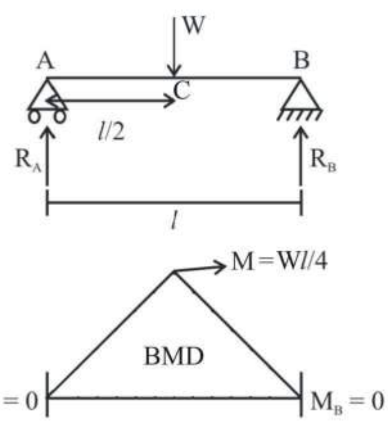
$M_{max} = \frac{wL^2}{8}$

107. For a beam of length "*l*" simply supported at the ends with a point load W at the centre, the maximum bending moment at the centre is

(a) $\frac{Wl}{8}$ (b) $\frac{Wl}{6}$
(c) $\frac{Wl}{2}$ (d) $\frac{Wl}{4}$

SSC JE 25. 1. 2018 (3.15 pm)

Ans. (d) :



$\Sigma F_y = 0 \Rightarrow R_A + R_B = W$, $\Sigma m_x = 0$

Taking moment about point A

$R_A \times 0 - W \times \frac{l}{2} + R_B . l = 0$

$R_B = \frac{W}{2}$

$R_A = \frac{W}{2}$

Taking moment about point C

$M_C = \frac{W}{2} \cdot \frac{l}{2} = \frac{Wl}{4}$

108. A beam supported on more than two supports is called

(a) Simply supported beam
(b) Continuous beam
(c) Fixed beam
(d) Overhang beam

SSC JE 2012