RRB JE
MECHANICAL
&
ALLIED ENGINEERING
CHAPTERWISE
SOLVED PAPERS

Chief Editor

A.K. Mahajan

Writers

Er. Brijesh Maurya

Computer Graphics By

Balkrishna Tripathi & Ashish Giri

Editorial Office

12, Church Lane Prayagraj-211002

🟢 **9415650134**

Email : yctap12@gmail.com

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Government of India, Ministry of Railways, Railway Recruitment Boards

Recruitment of Junior Engineer (JE), Junior Engineer (Information Technology) [JE(IT)], Depot Material Superintendent (DMS)

2nd Stage CBT : Short listing of Candidates for the 2nd Stage CBT exam shall be based on the normalized marks obtained by them in the 1st Stage CBT Exam. Total number of candidates to be shortlisted for 2nd Stage shall be 15 times the community wise total vacancy of Posts notified against the RRB as per their merit in 1st Stage CBT. However, Railways reserve the right to increase/decrease this limit in total or for any specific category(s) as required to ensure availability of adequate candidates for all the notified posts.

Duration   :   120 minutes *(160 Minutes for eligible PwBD candidates accompanied with Scribe)*

No of Questions :   150

Syllabus : The Questions will be of objective type with multiple choices and are likely to include questions pertaining to General Awareness, Physics and Chemistry, Basics of Computers and Applications, Basics of Environment and Pollution Control and Technical abilities for the post. The syllabus for General Awareness, Physics and Chemistry, Basics of Computers and Applications, Basics of Environment and Pollution Control is common for all notified posts under this CEN as detailed below:-

a) **General Awareness :** Knowledge of Current affairs, Indian geography, culture and history of India including freedom struggle, Indian Polity and constitution, Indian Economy, Environmental issues concerning India and the World, Sports, General scientific and technological developments etc.

b) **Physics and Chemistry:** Up to 10th standard CBSE syllabus.

c) **Basics of Computers and Applications:** Architecture of Computers; input and Output devices; Storage devices, Networking, Operating System like Windows, Unix, Linux; MS Office; Various data representation; Internet and Email; Websites & Web Browsers; Computer Virus.

d) **Basics of Environment and Pollution Control:** Basics of Environment; Adverse effect of environmental pollution and control strategies; Air, water and Noise pollution, their effect and control; Waste Management, Global warming; Acid rain; Ozone depletion.

e) **Technical Abilities:** The educational qualifications mentioned against each post shown in Annexure-A, have been grouped into different exam groups as below. Questions on the Technical abilities will be framed in the syllabus defined for various Exam Groups given at Annexure-VII-A, B, C, D, E, F & G.

The section wise Number of questions and marks are as below :

Subjects	No. of Questions	Marks for each Section
	Stage-II	Stage-II
General Awareness	15	15
Physics & Chemistry	15	15
Basics of Computers and Applications	10	10
Basics of Environment and Pollution Control	10	10
Technical Abilities	100	100
Total	150	150
Time in Minutes	120	

The section wise distribution given in the above table is only indicative and there may be some variations in the actual question papers.

Minimum percentage of marks for eligibility in various categories: UR -40%, OBC-30%, SC-30%, ST -25%. This percentage of marks for eligibility may be relaxed by 2% for PwBD candidates, in case of shortage of PwBD candidates against vacancies reserved for them.

Virtual calculator will be made available on the Computer Monitor during 2nd Stage CBT.

2nd Stage Syllabus for Mechanical & Allied Engineering Exam Group – JE

1. **Engineering Mechanics :** Resolution of forces, Equilibrium and Equilibrant, parallelogram law of forces, triangle law of forces, polygon law of forces and Lami's theorem, couple and moment of a couple, condition for equilibrium of rigid body subjected to number of coplanar non-concurrent forces, definition of static friction, dynamic friction, derivation of limiting angle of friction and angle of repose, resolution of forces considering friction when a body moves on horizontal plane and inclined plane, calculation of moment of inertia and radius of gyration of : (a) I-Section (b) channel section (c) T-Section (d) L-Section (Equal & unequal lengths) (e) Z-Section (f) Built up sections (simple cases only), Newton's laws of motion (without derivation), motion of projectile, D'Alembert's principle, definition law of conservation of energy, law of conservation of momentum.

2. **Material Science :** Mechanical properties of engineering materials – tensile strength, compressive strength, ductility, malleability, hardness, toughness, brittleness, impact strength, fatigue, creep resistance. Classification of steels, mild steel and alloy steels. Importance of heat treatment. Heat treatment processes – annealing, normalizing, hardening, tempering, carburizing, nitriding and cyaniding.

3. **Strength of Materials :** Stress, strain, stress strain diagram, factor of safety, thermal stresses, strain energy, proof resilience and modules of resilience. Shear force and bending moment diagram – cant leaver beam, simply supported beam, continuous beam, fixed beam. Torsion in shafts and springs, thin cylinder shells.

4. **Machining :** Working principle of lathe. Types of lathes – Engine lathe – construction details and specifications. Nomenclature of single point cutting tool, geometry, tool signature, functions of tool angles. General and special operations – (Turning, facing, taper turning thread cutting, knurling, forming, drilling, boring, reaming, key way cutting), cutting fluids, coolants and lubricants. Introduction to shaper, slotter, plainer, broaching, milling and manufacture of gears, heat treatment process applied to gears.

5. **Welding :** Welding – Introduction, classification of welding processes, advantages and limitations of welding, principles of arc welding, arc welding equipment, choice of electrodes for different metals, principle of gas (oxy-acetylene) welding, equipment of gas welding, welding procedures (arc & gas), soldering and brazing techniques, types and applications of solders and fluxes, various flame cutting processes, advantages and limitations of flame cutting, defects in welding, testing and inspection modern welding methods, (submerged, CO_2, atomic – hydrogen, ultrasonic welding), brief description of MIG & TIG welding.

6. **Grinding & Finishing Process :** Principles of metal removal by grinding, abrasives, natural and artificial, bonds and binding processes, vitrified, silicate, shellac rubber, grinding machines, classification: cylindrical, surface, tool & cutter grinding machine, construction details, relative merits, principles of centreless grinding, advantages & limitations of centreless grinding work, holding devices, wheel maintenance, balancing of wheels, coolants used, finishing by grinding, honing, lapping, super finishing, electroplating, basic principles – plating metals, applications, hot dipping, galvanizing tin coating, parkerising, anodizing, metal spraying, wire process, powder process and applications, organic coatings, oil base paint, lacquer base enamels, bituminous paints, rubber base coating.

7. **Metrology :** Linear measurement – Slip gauges and dial indicators, angle measurements, bevel protractor, sine bar, angle slip gauges, comparators (a) mechanical (b) electrical (c) optical (d) pneumatic. Measurement of surface roughness; methods of measurements by comparison, tracer instruments and by interferometry, collimators, measuring microscope, interferometer, inspection of machine parts using the concepts of shadow projection and profile projection.

8. **Fluid Mechanics & Hydraulic Machinery :** Properties of fluid, density, specific weight, specific gravity, viscosity, surface tension, compressibility capillarity, Pascal's law, measurement of pressures, concept of buoyancy. Concept of Reynold's number, pressure, potential and kinetic energy of liquids, total energy, laws of conservation, mass, energy and momentum, velocity of liquids and discharge, Bernoulli's equation and assumptions, venturimeters, pitottube, current meters. Working principle & constructional details of centrifugal pump, efficiencies – manometric efficiency, volumetric efficiency, mechanical efficiency and overall efficiency, cavitation and its effect, working principle of jet & submersible pumps with line diagrams.

9. **Industrial Management :** Job analysis, motivation, different theories, satisfaction, performance reward systems, production, planning and control, relation with other departments, routing, scheduling, dispatching, PERT and CPM, simple problems. Materials in industry, inventory control model, ABC Analysis, Safety stock, re-order, level, economic ordering quantity, break even analysis, stores layout, stores equipment, stores records, purchasing procedures, purchase records, Bin card, Cardex, Material handling, Manual lifting, hoist, cranes, conveyors, trucks, fork trucks.

10. **Thermal Engineering :** Laws of thermo dynamics, conversion of heat into work vice versa , laws of perfect gases, thermo dynamic processes – isochoric, isobaric, isothermal hyperbolic, isentropic, polytrophic and throttling, modes of heat transfer, thermal conductivity, convective heat transfer coefficient, Stefan Boltzman law by radiation and overall heat transfer coefficient. Air standards cycles – Carnot cycle, Otto cycle, Diesel cycle, construction and working of internal combustion engines, comparison of diesel engine and petrol engine. Systems of internal combustion engine, performance of internal combustion engines. Air compressors their cycles refrigeration cycles, principle of a refrigeration plant.

RRB JE Previous Exam Papers Analysis Chart

Sr. No.	Exam	Year	Question
RRB JE 2025			
1.	RRB JE CBT-II	04.06.2025	100
2.	RRB JE CBT-II	22.04.2025	100
3.	RRB JE CBT-II	22.04.2025	100
RRB JE 2019			
4	RRB JE CBT-II	29.08.2019	100
5.	RRB JE CBT-II	30.08.2019	100
6.	RRB JE CBT-II	31.08.2019	100
RRB JE 2015			
6.	RRB JE 2015	26.08.2015 Shift-I	21
8.	RRB JE 2015	26.08.2015 Shift-II	24
9.	RRB JE 2015	26.08.2015 Shift-III	22
10.	RRB JE 2015	27.08.2015 Shift-I	25
11.	RRB JE 2015	27.08.2015 Shift-II	26
12.	RRB JE 2015	27.08.2015 Shift-III	21
13.	RRB JE 2015	28.08.2015 Shift-I	18
14.	RRB JE 2015	28.08.2015 Shift-II	20
15.	RRB JE 2015	28.08.2015 Shift-III	22
16.	RRB JE 2015	29.08.2015 Shift-I	24
17.	RRB JE 2015	29.08.2015 Shift-I	19
18.	RRB JE 2015	29.08.2015 Shift-I	23
19.	RRB JE 2015	30.08.2015 Shift-III	22
20.	RRB JE 2015	01.09.2015 Shift-I	20
21.	RRB JE 2015	01.09.2015 Shift-II	21
22.	RRB JE 2015	01.09.2015 Shift-III	19
23.	RRB JE 2015	02.09.2015 Shift-I	18
24.	RRB JE 2015	02.09.2015 Shift-II	17
25.	RRB JE 2015	02.09.2015 Shift-III	18
26.	RRB JE 2015	03.09.2015 Shift-I	15
27.	RRB JE 2015	03.09.2015 Shift-II	19
28.	RRB JE 2015	03.09.2015 Shift-III	20
29.	RRB JE 2015	04.09.2015 Shift-II	18

30.	RRB JE 2015	16.09.2015 Shift-I	21
31.	RRB Ranchi JE 2015	04.01.2015 Yellow Paper	20
32.	RRB Ranchi JE 2015	04.01.2015 Red Paper	25
RRB JE/Sr. SE Exam 2014		
33.	RRB JE (Bilaspur/Kolkata/Mumbai/Guwahati) 2014	14.12.2014 SET : 01 Red Paper	20
34.	RRB JE (CHENNAI) 2014	14.12.2014 SET : 02 Red Paper	26
35.	RRB JE (Bilaspur/Guwahati/Patna) 2014	14.12.2014 SET : 03 Green Paper	25
36.	RRB JE (Muzaffarpur) 2014	14.12.2014 SET : 04 Green Paper	28
37.	RRB JE (Bilaspur/Guwahati) 2014	14.12.2014 SET : 05 Yellow Paper	31
38.	RRB JE (Patna/Muzaffarpur/Chennai/Ahmedabad/ Bangalore) 2014	14.12.2014 SET : 06 Yellow Paper	21
39.	RRB Sr. SE (Bilaspur/Secunderabad) 2014	21.12.2014 SET : 07 Red Paper	18
40.	RRB Sr. SE (Bilaspur/Secunderabad) 2014	21.12.2014 SET : 08 Green Paper	25
41.	RRB Sr. SE (Bilaspur/Secunderabad) 2014	21.12.2014 SET : 09 Yellow Paper	21
42.	RRB Sr. SE (BHOPAL) 2014	21.12.2014	15
DMRC/LMRC/JMRC/NMRC/BMRCL JE Exam		
43.	DMRC JE 2017	18.02.2017	75
44.	DMRC JE 2016	06.03.2016	75
45.	DMRC JE 2015	15.03.2015	75
46.	DMRC JE 2014	07.09.2014	75
47.	DMRC JE 2013	21.07.2013	75
48.	DMRC JE 2017	22.09.2017	75
49.	DMRC JE 2018	20.04.2018	75
50.	LMRC JE 2016	17.03.2016	75
51.	LMRC JE 2015	26.06.2015	75
52.	JMRC JE 2012	23.12.2012	50
53.	NMRC JE 2017	05.03.2017	75
54.	JMRC JE 2017	10.06.2017	50
55.	BMRCL JE 2019	24 Feb. 2019	75
OTHER RAILWAY JE & SSE Exams.		
56.	RRB Bhubneshwar JE-II 2010	19.12.2010	19
57.	RRB Allahabad JE 2010	19.12.2010	25
58.	RRB Allabahad SSE 2010	19.12.2010	23

59.	RRB Mumbai JE 2008	05.10.2008	28
56.	RRB Mumbai SSE 2008	05.10.2008	31
61.	RRB Mumbai JE 2010	19.12.2010	22
62.	RRB Mumbai SSE 2010	19.12.2010	26
63.	RRB Bhubneshwar JE-II 2010	19.12.2010	20
64.	Konkan Railway STA 2017	2017	24
65.	Konkan Railway TA 2017	2017	18
66.	Konkan Railway SSE 2015	2015	31
67.	RRB Kolkata Diesel JE 2009	25.10.2009	23
68.	RRB Chandigarh SSE 2009	25.10.2009	26
69.	RRB Mumbai C&G JE 2009	25.10.2009	24
70.	RRB Gorakhpur RDSO SSE 2009	25.10.2009	25
71.	RRB Jammu JE 2009	25.10.2009	23
72.	RRB Malda SSE 2009	25.10.2009	27
73.	RRB Allahabad JE 2009	25.10.2009	21
74.	RRB Mumbai C&G SSE 2009	25.10.2009	26
75.	RRB Patna JE	25.10.2009	23
76.	RRB Bhopal TM SSE 2009	25.10.2009	24
77.	RRB Allahabad SSE 2012	09.09.2012	25
78.	RRB Banglore SSE 2012	09.09.2012	29
79.	RRB Kolkala SSE 2012	09.09.2012	18
80.	RRB Gorakhpur Design SSE 2012	09.09.2012	23
81.	RRB Bhopal SSE 2012	09.09.2012	25
82.	RRB Chandigarh SSE 2012	09.09.2012	28
83.	RRB Jammu SSE 2012	09.09.2012	23
84.	RRB Allahabad JE 2012	09.09.2012	21
85.	RRB Bhubneshwar JE II 2008	29.11.2008	25
86.	Konkan Railway STA 2017	2017	23
87.	Konkan Railway TA 2017	2017	24
88.	Konkan Railway SSE 2015	2015	20
89.	RRB Kolkata Diesel JE 2009	25.10.2009	22
90.	RRB Bhopal Section Engineer,	24.11.2002	24
91.	RRB Bhopal & Mumbai Apprentice Section Engg.	23.03.2003	28

92.	RRB Secunderabad Section Engineer (Mech.)	29.06.2008	22
93.	RRB Bangalore Section Engineer (Mech.)	01.02.2009	23
94.	RRB Chandigarh Section Engineer,	15.03.2009	25
95.	RRB Chennai Section Engineer,	12.02.2012	27
96.	RRB Chandigarh Section Engineer (Mech.),	26.02.2012	24
97.	RRB Chandigarh Section Engineer,	26.02.2012	29
98.	RRB Jammu Section Engg., 2013	2013	20
99.	RRB Bhubaneswar Section Engg (Mech.) ,	19.08.2001	18
100.	RRB Kolkata Engg. (P.Way),	20.02.2000	15
101.	RRB Kolkata Apprentice Engg.,	14.10.2001	20
102.	RRB Bangalore Material Engg.	21.11.2004	23
103.	RRB Bangalore Material Engg,	21.11.2004	21
104.	RRB Kolkata Mech. Engg.,	06.02.2005	15
105.	RRB Allahabad Junior Engineer-II [Mech. DSL (C&W)],	08.01.2006	15
106.	RRB Kolkata Jr. Engineer-II Mech. DRG & Design,	11.06.2006	15
107.	RRB Kolkata Technical-Engg.,	20.08.2006	28
108.	RRB Chennai Technical (Eng.),	15.04.2007	25
109.	RRB Bangalore Technical (Eng.),	22.04.2007	27
110.	RRB Secunderabad Technical (Eng.),	20.05.2007	22
111.	RRB Patna Technical Eng.,	27.07.2008	28
112.	RRB Thiruvananthapuram Section Eng. (Mech.),	04.01.2009	19
113.	RRB Bangalore Section Eng. (Mech.),	01.02.2009	23
114.	RRB Chandigarh Section Eng. Mech.	15.03.2009	26
115.	RRB Chandigarh Section Eng. (Mech.),	26.02.2012	27
116.	RRB Chandigarh Section Eng. (Mech.),	26.02.2012	29
117.	RRB Bhopal Section Engineer,	24.11.2002	20
		Total	**4600**

Note : After due analysis of the above question papers, **4600** Questions related to **Mechanical, JE & SSC and Other Railway Exams** have been presented chapter wise. Questions of repetitive and similar nature have been included so that the technique of asking questions can benefit the competitors.

Trend Analysis of Previous Year RRB JE Papers Through Bar Graph and Pie Chart

Heat Transfer, 169 — Refrigeration System, 149 — Internal Combustion Engine, 373 — Mechanics, 354 — Material Science, 233 — Strength of Materials, 417 — Thermodynamics, 429 — Machining, 313 — Grinding and Surface Finishing Process, 172 — Industrial Management, 347 — Fluid Mechanics, 549 — Welding, 303 — Metrology, 208

Bar graph values: Mechanics 354, Material Science 233, Strength of Materials 417, Machining 313, Grinding and Surface Finishing.. 172, Metrology 208, Welding 303, Fluid Mechanics 549, Industrial Management 347, Thermodynamics 429, Heat Transfer 169, Refrigeration System 149, Internal Combustion Engine 373

01.

Mechanics

Resolution of forces, Equilibrium and Equilibrant, parallelogram law of forces, triangle law of forces, polygon law of forces and Lami's theorem, couple and moment of a couple, condition for equilibrium of rigid body subjected to number of coplanar non-concurrent forces, definition of static friction, dynamic friction, derivation of limiting angle of friction and angle of repose, resolution of forces considering friction when a body moves on horizontal plane and inclined plane, calculation of moment of inertia and radius of gyration of : (a) I-Section (b) channel section (c) T-Section (d) L-Section (Equal & unequal lengths) (e) Z-Section (f) Built up sections (simple cases only), Newton's laws of motion (without derivation), motion of projectile, D'Alembert's principle, definition law of conservation of energy, law of conservation of momentum.

1. Law of Forces and Analysis

1. **What is a coplanar force system?**
(a) A system where all forces lie in the same plane
(b) A system where forces act only in one direction
(c) A system where forces do not intersect at a point
(d) A system where all forces lie in different planes

Ans. (a) : Coplanar force system is a system where all forces lie in the same plane.
- All forces are parallel to each other and lie in a single plane is called coplanar parallel forces.
- Line of action of all the forces act along the same line is called collinear forces.
- Line of action of all forces pass through a single point and forces lie in same plane is called coplanar concurrent forces.
- All the forces do not meet at a point but lie in a single plane is called coplanar non concurrent forces.

2. **Three collinear horizontal forces of magnitudes 250 N, 150 N and 350 N are acting on a rigid body. If the 150 N force acts in the opposite direction, determine the resultant force.**
(a) 350 N
(b) 250 N
(c) 450 N
(d) 550 N

Ans. (c) : Three collinear horizontal forces are 250 N, 150 N and 350 N.
In this 150 N is acts in the opposite direction.

$$250\,N \quad 150\,N \quad 350\,N$$

$$\sum H = 250N - 150N + 350N$$

$$\boxed{\sum H = 450N}$$

3. **In the resolution of a force, along which of the following directions is a force generally resolved?**
(a) Two mutually perpendicular directions
(b) Any three random directions
(c) A single fixed direction
(d) Two parallel directions

Ans. (a) : A force is generally resolved into the two mutually perpendicular directions.
- This is because any force can be respected as the vector sum of its components along the two perpendicular axes.

4. **What is the purpose of introducing two equal and opposite forces at a different point on a rigid body?**
(a) To transfer the original force to a new location
(b) To change the direction of the applied force
(c) To balance the rotational motion of the body
(d) To increase the force acting on the body

Ans. (a) : The purpose of introducing two equal and opposite forces at a different point on a rigid body is to transfer the original force to a new location.
- When two equal and opposite forces are applied at a point on a rigid body, they are known as balanced forces.
- Balanced forces are forces that are equal in magnitude but opposite in direction. They act along the same line of action and as a result they cancel each other out.

5. **In the analytical method, how is the resultant force determined when all forces act in the same direction?**
(a) By adding all the forces together
(b) By subtracting the smallest force from the largest
(c) By dividing the total force by the number of forces
(d) By multiplying all the forces together

Ans. (a): In the analytical method, the resultant force is determined by adding all the forces act in the same direction.

$$\sum R = F_1 + F_2 + F_3$$

6. Why is the concept of transmissibility of forces valid for a rigid body?
   (a) Because a rigid body does not deform under applied forces
   (b) Because forces always act in the direction of motion
   (c) Because internal forces in a rigid body do not exist
   (d) Because a rigid body always has an infinite number of forces acting on it

Ans. (a) : The transmissibility of force states that a force acting at a point on a rigid body can be considered to act at any other point along its line of action, provided the external effect (such as motion and equilibrium) remain the same. This principal is crucial for simplifying the analysis of forces in mechanical system.
• Since a rigid body does not deform under applied forces, the internal distribution of forces and moments remain unaffected when a force is transmitted along its line of action.

7. According to the Principle of Resolution, the algebraic sum of the resolved parts of multiple forces in a given direction is equal to
   (a) the total magnitude of all forces combined
   (b) the resolved part of their resultant in the same direction
   (c) the sum of all forces acting in that direction
   (d) the difference between the largest and smallest force

Ans. (b) : Principle of Resolution in Mechanics:- According to this principle the algebraic sum of the resolved parts of multiple forces in a given direction is equal to the resolved part of their resultant force in the same direction.

8. What does the Polygon Law of Forces describe?
   (a) The equilibrium condition of multiple forces
   (b) The force required to balance a single force
   (c) The interaction between two perpendicular forces
   (d) The method to find the resultant of multiple forces

Ans. (d) : Polygon law of forces describe the method to find the resultant of multiple forces.
The polygon law states that if a number of concurrent forces acting simultaneously on a body are represented in magnitude and direction by sides of a polygon taken in order then closing side of polygon represents the resultant in opposite order.

9. If two forces act at a right angle (90º), what will be the magnitude of their resultant force?
   (a) $R = F_1 + F_2$
   (b) $R = \sqrt{F_1^2 + F_2^2}$
   (c) $R = 2F_1F_2 \cos\theta$
   (d) $R = F_1 - F_2$

Ans. (b): When two forces act at a right angle (90º) their resultant is found using vector addition based on the Pythagorean theorem. Then resultant

$$R = \sqrt{F_1^2 + F_2^2 + 2F_1F_2 \cos\theta}$$
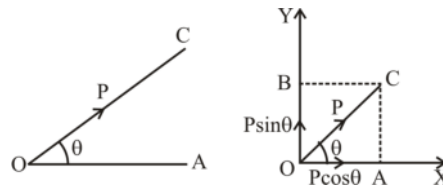
$$R = \sqrt{F_1^2 + F_2^2 + 2F_1F_2 \cos 90º}$$

$$\boxed{R = \sqrt{F_1^2 + F_2^2}}$$

10. What is meant by the resolution of a force?
   (a) Reducing the magnitude of a force in a given direction
   (b) Splitting a force into components without changing its effect
   (c) Changing the direction of a force without altering magnitude
   (d) Combining multiple forces to form a single resultant

Ans. (b) : Resolution of forces is the process of breaking down a single force into its component forces along two perpendicular directions (horizontal and vertical) without changing the overall effect of the original force.

Horizontal component $(\Sigma H) = P\cos\theta$
Vertical component $(\Sigma V) = P\sin\theta$

11. How is the resultant force calculated if two forces act along the same straight line but in opposite directions?
   (a) $R = 2F_1F_2 \cos\theta$
   (b) $R = F_1 + F_2$
   (c) $R = F_1 - F_2$
   (d) $R = \sqrt{F_1^2 + F_2^2}$

Ans. (c) : Let the two resultant force F_1 and F_2 and their resultant F then

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

If they act in opposite direction $\theta = 180º$

$$F = \sqrt{F_1^2 + F_2^2 + 2F_1F_2 \cos 180º}$$

$$F = \sqrt{F_1^2 + F_2^2 - 2F_1F_2}$$

$$F = \sqrt{(F_1 - F_2)^2}$$

$$\boxed{F = F_1 - F_2}$$

12. Which of the following options best describes non-coplanar concurrent forces?
(a) Forces that meet at one point and their lines of action lie on the same plane
(b) Forces that meet at one point but their lines of action do not lie on the same plane
(c) Forces that do not meet at one point but their lines of action lie on different planes
(d) Forces that do not meet at one point and their lines of action lie on the same plane

Ans. (b) : Non-coplanar concurrent forces are forces that meet at a single point, but their lines of action do not lie within the same plane. These forces exist in three dimensional space and are commonly encountered in engineering problems involving structures, mechanics or physics.

13. Which of the following happens when two equal and opposite forces are applied at a point on a rigid body?
(a) They cancel each other and have no effect.
(b) They produce an additional force on the body.
(c) They create rotational motion in the body.
(d) They change the magnitude of the original force.

Ans. (a) : When two equal and opposite forces are applied at a point on a rigid body. They cancel each other and have no effect this means that the body remains in its state of rest or uniform motion.

14. When two equal forces F act at an angle θ, the resultant force is given by which of the following expressions?
(a) $R = F_1 - F_2$ (b) $R = F_1 + F_2$
(c) $R = 2F\cos\left(\dfrac{\theta}{2}\right)$ (d) $R = 2F\sin\left(\dfrac{\theta}{2}\right)$

Ans. (c) : When two equal forces F act at an angle θ, the resultant force.

$$R = \sqrt{F^2 + F^2 + 2 \times F \times F \times \cos\theta}$$
$$R = \sqrt{2F^2 + 2F^2\cos\theta}$$
$$R = \sqrt{2F^2(1+\cos\theta)}$$
$$R = \sqrt{2F^2\, 2\cos^2\left(\frac{\theta}{2}\right)}$$
$$= \sqrt{4F^2\cos^2\left(\frac{\theta}{2}\right)}$$
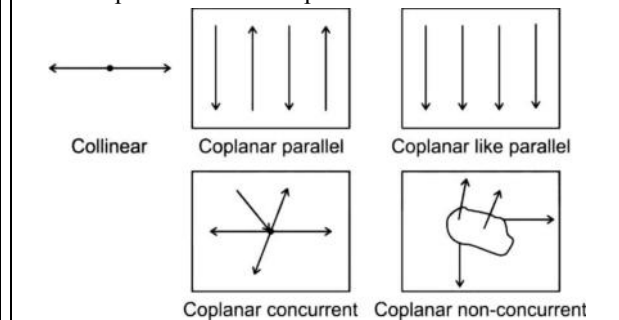$$\boxed{R = 2F\cos\left(\frac{\theta}{2}\right)}$$

15. What is a characteristic of a coplanar parallel force system?
(a) Forces act in the same plane but are not parallel.
(b) Forces act in different planes and are parallel.
(c) Forces act in the same plane and are parallel.
(d) Forces act in different planes and are not parallel.

Ans. (c) : Coplanar parallel force system in which all the force act in the same plane and are parallel to each other.

• Concurrent coplanar force system is a system of two or more forces whose line of action intersect at a common point in the same plane.

Collinear   Coplanar parallel   Coplanar like parallel

Coplanar concurrent   Coplanar non-concurrent

16. Three forces acting on a rigid body are represented in magnitude, direction and line of action by the three sides of a triangle taken in order. The forces are equivalent to a couple whose moment is equal to-
(a) Thrice the area of the triangle
(b) Twice the area of the triangle
(c) The area of the triangle
(d) Half the area of the triangle

Ans. (b) : If three forces acting on a rigid body are represented in magnitude, direction and line of action by the three sides of a triangle taken in order, then these forces are equivalent to a couple whose moment in equal to twice the area of the triangle.
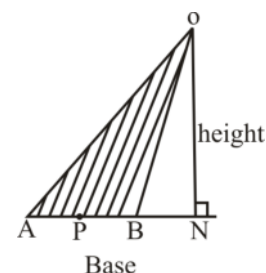
$M = P \times ON$
∵ $P = AB$,
Then, $M = AB \times ON$
$M = Base \times height$
∴ $M = 2 \times$ Area of Δ ABO

height
A   P   B   N
Base

17. The weight of an object on the Moon is W_m and its weight on the Earth is W_e. Which of the following formulas is CORRECT?
   (a) $W_m = 6 \times W_e$ (b) $W_m = 3 \times W_e$
   (c) $W_m = (1/6) \times W_e$ (d) $W_m = (1/3) \times W_e$

Ans. (c) : As we know that,

$$\frac{\text{Weight of the object on the moon}}{\text{Weight of the object on the earth}} = \frac{1}{6}$$

Thus the weight of the object on the moon

$= \dfrac{1}{6} \times$ its weight on the earth

$$\boxed{W_m = \frac{1}{6} \times W_e}$$

18. If the line of action of all the forces are along the same line, then the forces are said to be-
   (a) Collinear forces
   (b) Coplanar concurrent forces
   (c) Non-coplanar non-concurrent forces
   (d) Coplanar parallel forces

Ans. (a) : If the line of action of all the forces are along the same line, then the forces are said to be collinear forces.
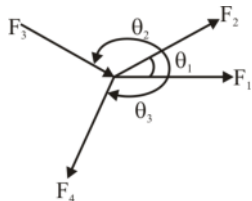* The forces, which meet at one point, are known as concurrent forces.
* The forces, whose line of action lies on the same plane are known as coplanar forces.

19. The algebraic sum of the resolved parts of a number of forces in a given direction is equal to the resolved part of their resultant in the same direction. This is known as-
   (a) Principle of resolution of forces
   (b) All of the options
   (c) Principle of transmissibility of forces
   (d) Principle of independence of forces

Ans. (a) : According to the principle of resolution of forces the algebraic sum of the resolved parts of a number of forces in a given direction is equal to the resolve part of their resultant in the same direction.

$R = \sqrt{\Sigma F_x^2 + \Sigma F_y^2}$

$\tan\theta = \dfrac{\Sigma F_y}{\Sigma F_x}$

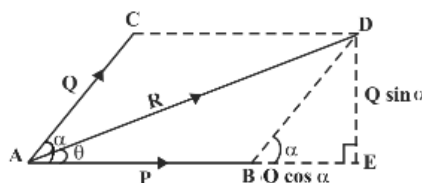$F_x = F_1 \cos 0^0 + F_2 \cos\theta_1 - F_3 \cos\theta_2 + F_4 \cos(360 - \theta_3)$

$F_y = F_1 \sin 0^0 + F_2 \sin\theta_1 - F_3 \sin\theta_2 + F_4 \sin(360 - \theta_3)$

20. If 'α' is the angle between two forces P and Q, then the angle made by the direction of the resultant 'θ' relative to the force P is given by-

   (a) $\theta = \tan^{-1}\left(\dfrac{Q\sin\alpha}{P + Q\cos\alpha}\right)$

   (b) $\theta = \cos^{-1}\left(\dfrac{P\sin\alpha}{Q + P\cos\alpha}\right)$

   (c) $\theta = \sin^{-1}\left(\dfrac{Q\sin\alpha}{Q + P\cos\alpha}\right)$

   (d) $\theta = \sin^{-1}\left(\dfrac{P\sin\alpha}{P + Q\cos\alpha}\right)$

Ans. (a) :

ΔAED

$$\tan\theta = \frac{\text{Perpendicular}}{\text{Base}} = \frac{Q\sin\alpha}{P + Q\cos\alpha}$$
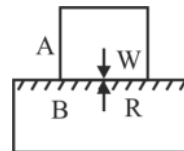
$\therefore$ $\boxed{\theta = \tan^{-1}\left(\dfrac{Q\sin\alpha}{P + Q\cos\alpha}\right)}$

21. Action and reaction act on–
   (a) Different bodies but in same direction
   (b) Same body but in opposite direction
   (c) Same body and in same direction
   (d) Different bodies but in opposite direction

Ans. (d) Action and reaction act on different bodies but in opposite direction.

Body A is subjected to its own weight (W) in the form of action and body B oppose this action in the form of reaction (R).

& $\boxed{R = W}$ (But opposite in direction)

22. What is the value of the acceleration due to gravity (g) of Earth?
   (a) 5.4 m s^{-2} (b) 9.8 m s^{-2}
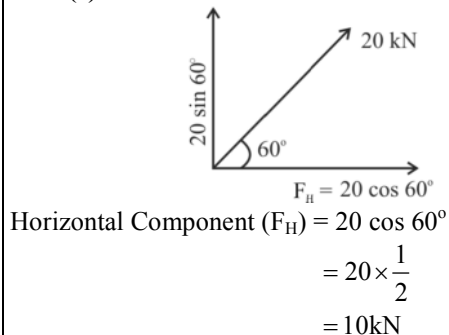   (c) 3.8 m s^{-2} (d) 6.8 m s^{-2}

Ans. (b) Acceleration due to gravity is the acceleration gained by an object due to gravitational force. Its SI unit is m/s^2. The standard value of gravity on the surface of the earth at sea level is 9.8m/s^2.

23. The horizontal component of tensile force in a wire that makes 60° with horizontal and is carrying a force of 20 kN is-
(a) 30 kN   (b) 18 kN
(c) 10 kN   (d) 25 kN
RRB JE 31-08-2019

Ans. (c)

Horizontal Component $(F_H) = 20 \cos 60^\circ$
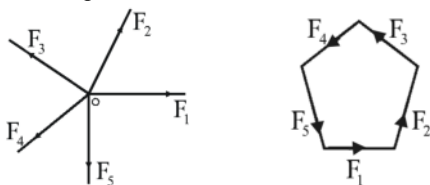$$= 20 \times \frac{1}{2}$$
$$= 10 kN$$

24. Polygon of forces is useful for computing the resultant of
(a) Concurrent spatial forces
(b) Coplanar parallel forces
(c) Coplanar Concurrent forces
(d) Coplanar Collinear forces
(RRB Bhubneshwar JE-II 19.12.2010)

Ans. (c) Polygon of forces is useful for computing the resultant of coplanar concurrent forces.
Polygon Law of forces – If a number of forces acting simultaneously on a particle, be represented in magnitude and direction by sides of a polygon taken in order, then their resultant is represented in magnitude and direction by the closing side of the polygon taken in opposite order.
- If all the concurrent force acting on a body shows as the sides of polygon in direction & magnitude then they are in equilibrium.

25. A drum weighting 60 N and holding 40 kgf of water is raised from a well by means of a wheel and axle with an effort of 120 N. Its mechanical advantage (MA) will be............
(a) 0.83   (b) 4.5
(c) 3.77   (d) 3
DMRC JE 17.04.2018, 4:30-6:45 pm

Ans : (c) Weight of drum (W) = 60 N
Weight of water to be lifted = 40 kgf = 40 × 9.81 N
Effort (P) = 120 N
Mechanical advantage (MA) $= \dfrac{W}{P}$
$$= \frac{60 + 40 \times 9.81}{120} = 3.77$$

26. The force applied on a body of mass 100 kg to produce an acceleration of 5 m/s^2 is
(a) 500 N   (b) 100 N
(c) 20 N   (d) 10 N
(RRB Bhopal SSE 09.09.2012)

Ans. (a) : m = 100 kg   a = 5 m/s^2
F = ma
= 100 × 5 = 500 N

27. The law of parallelogram of forces gives the resultant of-
(a) Parallel forces
(b) Two coplanar concurrent forces
(c) Like parallel forces
(d) Non Coplanar concurrent forces
DMRC JE 22.09.2017
RRB Bhopal Section Engineer, 24.11.2002

Ans. (b) : When the line of action of acting forces lies in same plane and meeting at a point to each other said to be coplanar concurrent forces.
Parallelogram law of forces - If two forces, acting at a point are represented in magnitude and direction by the two sides of the parallelogram drawn from one of its angular points, their resultant is represented both in magnitude and direction by the diagonal of the parallelogram passing through that angular point.

28. 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
(Konkan Railway TA 2017)

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.
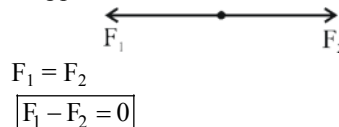
29. Which equilibrium is used for two forces?
(a) Same line of action
(b) Equal in magnitude
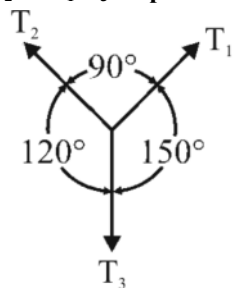(c) Opposite in direction
(d) All of the above options
DMRC JE 17.04.2018 12:15-2:30 PM
RRB Bhopal & Mumbai Apprentice Section Engg. 23.03.2003

Ans : (d) If only two forces act on a body that is in equilibrium, then they must be equal in magnitude, co-linear and opposite in sense.
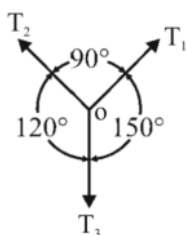

$F_1 = F_2$
$\boxed{F_1 - F_2 = 0}$

30. If three coplanar concurrent forces acting at a point 'O' are in equilibrium, then ratio of forces T_1/T_2 & T_1/T_3 respectively are

(a) $\sqrt{3}$ and $\dfrac{\sqrt{3}}{2}$ (b) $\sqrt{\dfrac{3}{2}}$ and $\sqrt{3}$

(c) 1 and $\dfrac{1}{2}$ (d) $\dfrac{1}{2}$ and 1

(RRB Allahabad SSE 19.12.2010)

Ans : (a)

According to Lami's Theorem–

$$\frac{T_1}{\sin 120°} = \frac{T_2}{\sin 150°} = \frac{T_3}{\sin 90°}$$

So,

$$\frac{T_1}{T_2} = \frac{\sin 120°}{\sin 150°} = \frac{\sqrt{3}/2}{1/2} = \sqrt{3}$$

$$\boxed{\frac{T_1}{T_2} = \sqrt{3}}$$

$$\frac{T_1}{T_3} = \frac{\sin 120°}{\sin 90°} = \frac{\sqrt{3}/2}{1} = \frac{\sqrt{3}}{2}$$
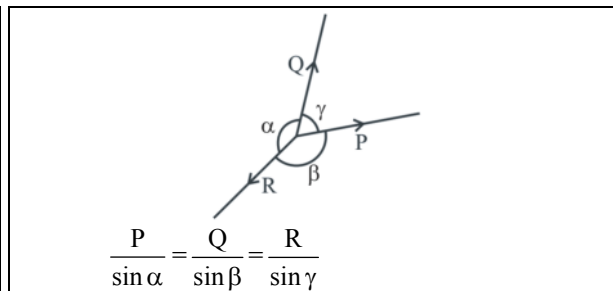
$$\boxed{\frac{T_1}{T_3} = \frac{\sqrt{3}}{2}}$$

31. According to Lami's theorem
(a) the three forces must be equal
(b) the three forces must be at 120° to each other
(c) the three forces must be in equilibrium
(d) if the three forces acting at a point are in equilibrium, then each force is proportional to the sine of the angle between the other two

(JMRC JE 10.06.2017)

Ans : (d) According to the Lami's theorem, if the three forces acting at a point are in equilibrium then each force is proportional to the sine of the angle between the other two.

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

32. Two equal forces are acting at a point with an angle of 60^0 between them the resultant is $50\sqrt{3}$ N, the magnitude of each force will be :
(a) 100 N (b) 150 N
(c) 50 N (d) $50\sqrt{3}$ N

(RRB Mumbai JE 05.10.2008)

Ans. (c) $\because R^2 = P^2 + Q^2 + 2PQ \cos\theta$
If $P = Q$ [given]
Then, $R^2 = P^2 + P^2 + 2P \times P \cos 60$

$$R = \sqrt{P^2 + P^2 + 2 \times P^2 \times \frac{1}{2}}$$

$$50\sqrt{3} = \sqrt{3P^2}$$

$$\boxed{P = 50N}$$

$\therefore$ Magnitude of each forces will be 50 N.

33. Two equal forces of magnitude 10 Newton act at an angle of 90°. Their resultant is equal to:
(a) 10 N (b) 10 √2 N
(c) 10 √3 N (d) 20 N

(RRB Mumbai SSE 19.12.2010)

Ans. (b) Given, P = Q = 10 N
$\theta = 90°$
We know that,
Resultant (R) $= \sqrt{P^2 + Q^2 + 2PQ\cos\theta}$
$= \sqrt{10^2 + 10^2 + 2 \times 10 \times 10 \times \cos 90°}$
$= \sqrt{200} = 10\sqrt{2}$
$R = 10\sqrt{2}\,N$

34. 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

(DMRC JE 2013)

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.