UNIT 1

Chapter 1

Co-planar Forces

Important Concepts and Formulae

- Resultant of two coplanar concurrent forces P and Q acting at an angle θ is given by

$$\text{Magnitude } R = \sqrt{P^2 + Q^2 + 2PQ\cos\theta}$$

$$\text{Direction } \tan\alpha = \frac{Q\sin\theta}{P + Q\cos\theta}$$

Where, θ = Angle between two forces P and Q

α = Angle between P and R

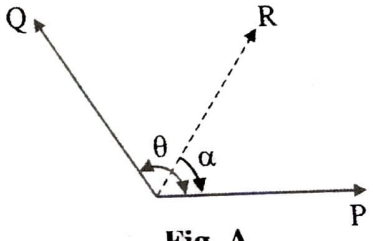


Fig. A

- If two forces P and Q are perpendicular

$$R = \sqrt{P^2 + Q^2}$$

$$\tan\alpha = \frac{Q}{P}$$

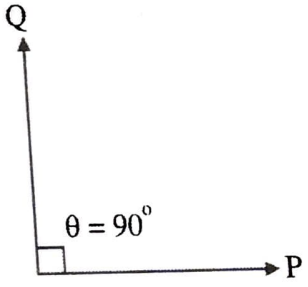


Fig. B

- For two forces, resultant is maximum when $\theta = 0$

$$\therefore R_{max} = P + Q$$

- For two forces, resultant is minimum when $\theta = 180°$

$$\therefore R_{min} = P - Q$$

- For two concurrent forces if P = Q = R then angle between two forces should be 120°.
- For two **equal forces** acting at a point, $R = 2P\cos\theta/2$
- For two equal forces, perpendicular to each other then $R = \sqrt{2}\ P$
- Law of parallelogram can be proved experimentally but not mathematically.

Resultant of more than two coplanar concurrent forces.

$$\text{Magnitude } R = \sqrt{(\Sigma F_x)^2 + (\Sigma F_y)^2}$$

$$\text{Direction } \tan\theta = \frac{\Sigma F_y}{\Sigma F_x},$$

θ = Angle of R with X – axis

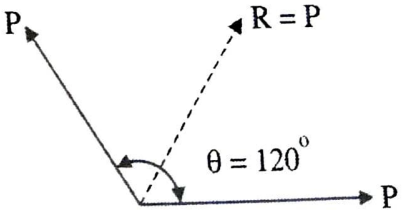


Fig. C

Note : Angle θ is always measured with the direction which is in denominator.

- **If** resultant of a system is along X – axis

$$\Sigma F_x = R \quad \text{and} \quad \Sigma F_y = 0$$

- If resultant of a system is along Y – axis

$$\Sigma F_y = R, \quad \Sigma F_x = 0$$

- It resultant of a system is inclined

$$x - \text{component of } R = \Sigma F_x$$

$$y - \text{component of } R = \Sigma F_y$$

- During resolution of a force **n-number** of components are possible.
- Resultant and equilibrant are equal in magnitudes but opposite in directions.

$$\therefore \boxed{\mathbf{R = -E}}$$

- Moment of a force = Magnitude of force × perpendicular distance
- S.I. unit of moment $\mathbf{N \cdot m}$
- If a force is passing through a point, its moment is zero about that point.
- If resultant of a system is passing through a point (say A) then available condition is

$$\Sigma M_A = 0$$

Graphically, **Moment = 2 Area of triangle**

- Varignon's theorem is used to find position of resultant or to locate the resultant.

Mathematically $\mathbf{R \cdot x = \Sigma M}$

Where x = Perpendicular distance from moment centre

- After locating resultant we can find horizontal or vertical distance of 'R' from moment centre directly by using,

$$\text{Horizontal distance} = \frac{\Sigma M}{\Sigma F_y}$$

$$\text{Vertical distance} = \frac{\Sigma M}{\Sigma F_x}$$

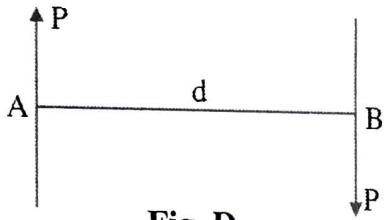


Fig. D

- **Couple :** Two unlike parallel, non collinear forces of equal magnitude from a couple.
- Resultant of a couple is zero.
- Moment of a couple.

$$\mathbf{M = P \times d}$$

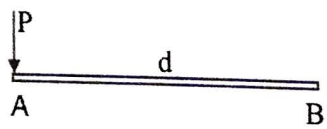


Fig. E

Force-couple system

Fig. F

- Which is independent of a point.
- A couple can be shifted, rotated or replaced by another pair of forces producing the same moment.
- If lever arm of a couple is doubled, moment is also doubled.
- If forces and lever arm both are doubled, moment increased four times.
- A force can be shifted in parallel direction only along with moment.
- Moment of a force depends upon a point so it is a **fixed vector.**
- Moment of a couple independent of a point so it is a **free vector.**
- For two **like** parallel forces 'R' lies **between** two forces.
- For two **unlike** parallel forces 'R' lies **outside** the two forces.

Multiple Choice Questions for Online Exam I

Q. 1 Varignon's Theorem can be applied to determine :

(a) Position of resultant
(b) Location of centroid
(c) Magnitude and direction of resultant
(d) None of the above.

Ans. : (a)

Explanation : We know that Varignon's theorem (mathematically) is $R \cdot x = \Sigma M$ where x is perpendicular distance of resultant from moment centre, which represents position of resultant.

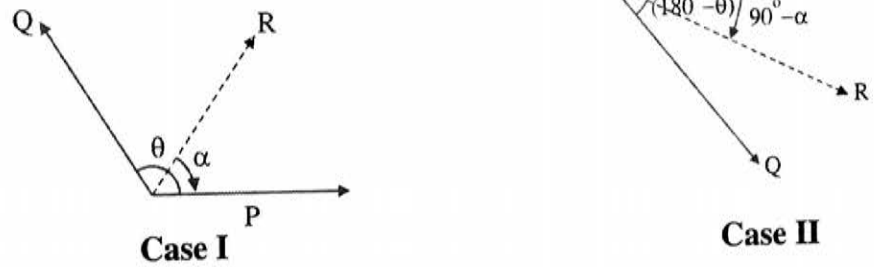
So, option (a) is correct.

Q. 2 When two forces acting at a point are such that, it the direction of one is reversed, direction of the resultant is turned through a right angle, the forces should be :

(a) Unequal in magnitude
(b) Equal in magnitude
(c) Inclined of 180°
(d) Inclined at 45°

Ans. : (b)

Explanation :



Case I **Case II**

Fig. 1

Case I : $$\tan \alpha = \frac{Q \sin \theta}{P + Q \cos \theta} \quad ...(I)$$

Case II : $$\tan (90 - \alpha) = \frac{Q \sin (180 - \theta)}{P + Q \cos (180 - \theta)} \qquad \therefore \cot \alpha = \frac{Q \sin \theta}{P - Q \cos \theta}$$

$$\therefore \tan \alpha = \frac{P - Q \cos \theta}{Q \sin \theta} \quad ...(II)$$

Equations (I) and (II) we get,

$$\frac{Q \sin \theta}{P + Q \cos \theta} = \frac{P - Q \cos \theta}{Q \sin \theta} \qquad \therefore Q^2 \sin^2 \theta = P^2 - Q^2 \cos^2 \theta$$

$$Q^2 (\sin^2 \theta + \cos^2 \theta) = P^2$$

$$\therefore P^2 = Q^2 \qquad \therefore P = Q$$

So, forces are equal in magnitudes.

So, option (b) is correct.

Q. 3 The resultant of two forces P and Q acting at an angle θ is equal to :

(a) $\sqrt{P^2 + Q^2 + 2PQ \sin \theta}$
(b) $\sqrt{P^2 + Q^2 - 2PQ \sin \theta}$
(c) $\sqrt{P^2 + Q^2 + 2PQ \cos \theta}$
(d) $\sqrt{P^2 - Q^2 - 2PQ \cos \theta}$

Ans. : (c)

Explanation :

We know that magnitude of resultant of two coplanar concurrent forces P and Q is given by ,

$$R = \sqrt{P^2 + Q^2 + 2PQ\cos\theta}$$

So, option (c) is correct.

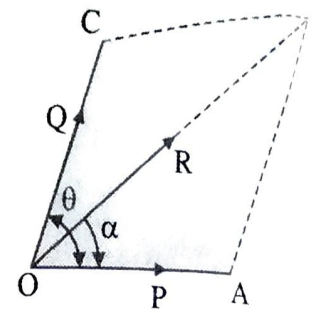


Fig. 2

Q. 4 If resultant of two concurrent forces of equal magnitudes Q is Q then angle between two forces is

(a) 30° (b) 60° (c) 90° (d) 120°

Ans. : (d)

Explanation : Using, $R^2 = P^2 + Q^2 + 2PQ\cos\theta$

$$\therefore Q^2 = Q^2 + Q^2 + 2QQ\cos\theta = 2Q^2(1 + \cos\theta)$$

$$\therefore \frac{1}{2} = 1 + \cos\theta$$

$$\therefore \cos\theta = -\frac{1}{2} \qquad \therefore \theta = 120°$$

So, option (d) is correct.

Q. 5 If magnitude of resultant of two forces of magnitudes Q and $\sqrt{2}$ Q is Q, the angle between two force is

(a) 90° (b) 45° (c) 30° (d) 135°

Ans. : (d)

Explanation :

Using $R^2 = P^2 + Q^2 + 2PQ\cos\theta$

$$\therefore Q^2 = Q^2 + (\sqrt{2}\,Q)^2 + 2Q(\sqrt{2}\,Q)\cos\theta = Q^2 + 2Q^2 + 2\sqrt{2}\,Q^2\cos\theta$$

$$\therefore 1 = 3 + 2\sqrt{2}\cos\theta \quad \therefore 2\sqrt{2}\cos\theta = -2$$

$$\therefore \cos\theta = -\frac{1}{\sqrt{2}} \qquad \therefore \theta = \mathbf{135°}$$

So, option (d) is correct.

Q. 6 Find the magnitudes of forces P and Q if they act at right angles their resultant is $\sqrt{34}$ N but if they act at 60° their resultant is 7 N.

(a) 5 N and 4 N (b) 5 N and 3 N

(c) 3 N and 4 N (d) 6 N and 5 N

Ans. : (b)

Explanation :

Case I : $R^2 = P^2 + Q^2 + 2PQ\cos\theta$

$$34 = P^2 + Q^2 + 2PQ\cos 90°$$

$$\therefore P^2 + Q^2 = 34 \qquad ...(1)$$

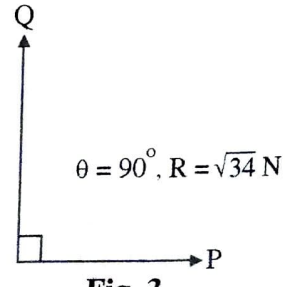


Fig. 3

Case II :

$$R^2 = P^2 + Q^2 + 2PQ \cos\theta$$

$$49 = P^2 + Q^2 + 2PQ \cos 60° = P^2 + Q^2 + PQ$$

From Equation (1), substitute value of $P^2 + Q^2$, we get

$$49 = 34 + PQ$$

$$\therefore PQ = 15 \quad ...(2)$$

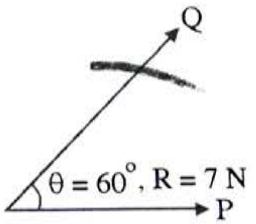


Fig. 3(a)

Solving Equations (1) and (2)

P = 5N, Q = 3N OR P = 3N, Q = 5N

So, option (b) is correct.

Q. 7 If two equal forces of magnitude P act at an angle θ, then their resultant will be

(a) $2P \sin\theta/2$ (b) $P \cos\theta/2$ (c) $2P \cos\theta/2$ (d) $P \tan\theta/2$

Ans. : (c)

Explanation : Using, $R^2 = P^2 + Q^2 + 2PQ \cos\theta$

$$\therefore R^2 = P^2 + P^2 + 2PP \cos\theta = 2P^2 (1 + \cos\theta)$$

$$\therefore R^2 = 2P^2 \times 2\cos^2 \theta/2$$

$$R = 2P \cos\theta/2$$

So, option (c) is correct.

Q. 8 Two forces act at an angle of 120°. If the greater force is 100 N and their resultant is perpendicular to the smaller force, the smaller force is

(a) 20 N (b) 25 N (c) 50 N (d) 45 N

Ans. : (c)

Explanation : Let, P be the greater force

Q be the smaller force

Given : $\theta = 120°$

$$P = 100 \text{ N}$$

$$\therefore \alpha = 120° - 90° = 30°$$

$$\text{Now, } \tan\alpha = \frac{Q \sin\theta}{P + Q \cos\theta}$$

$$\therefore \tan 30° = \frac{Q \sin(120°)}{100 + Q \cos(120°)}$$

$$0.577 (100 - 0.5\,Q) = 0.866\,Q$$

$$\therefore Q = 50 \text{ N}$$

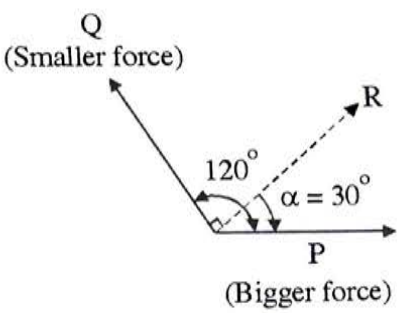


Fig. 4

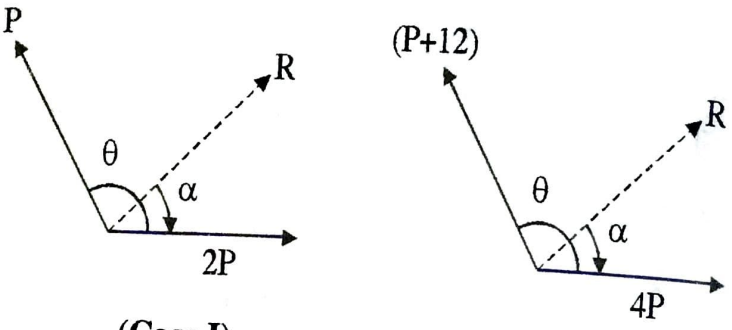
So, option (c) is correct.

Q. 9 Two forces equal to 2P and P respectively act at a point. If the first force be doubled and second be increased by 12N, the resultant is unchanged in direction, the value of P will be

(a) 10 N (b) 12 N (c) 15 N (d) 28 N.

Ans. : (b)

Explanation :



(Case I) **(Case II)**

Fig. 5

As resultant remains unchanged in direction,

$$\tan\alpha = \tan\alpha$$

(case I) (case II)

$$\frac{P\sin\theta}{2P + P\cos\theta} = \frac{(P+12)\sin\theta}{4P + (P+12)\cos\theta}$$

$$\therefore \quad 4P^2 + P(P+12)\cos\theta = (P+12)(2P + P\cos\theta)$$

$$\therefore \quad 4P^2 + P^2\cos\theta + 12P\cos\theta = 2P^2 + 24P + P^2\cos\theta + 12P\cos\theta$$

$$\therefore 2P^2 = 24P$$

$$\therefore \mathbf{P = 12\ N}$$

So, option (b) is correct.

Q. 10 The components of a force of 25N are 50N each. The angle made by 25N forces with each component will be

(a) 60.52° (b) 85.52° (c) 45° (d) 75.52°

Ans. : (d)

Explanation : Here, components are more than the original force. So this is case of non perpendicular resolution.

Using sine rule, $\frac{50}{\sin\alpha} = \frac{25}{\sin(180 - 2\alpha)}$

$$\therefore \sin\alpha = 2\sin 2\alpha$$

$$\therefore \sin\alpha = 2[2\sin\alpha\cos\alpha]$$

$$\therefore \cos\alpha = \frac{1}{4}$$

$$\therefore \alpha = 75.52°$$

So, option (d) is correct.

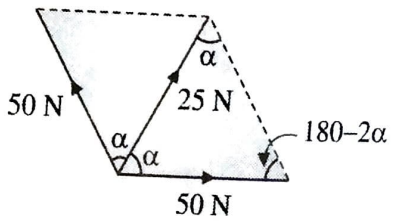


Fig. 6

Q. 11 The resultant of two perpendicular forces of magnitude p each will be

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

Ans. : (a)

Explanation : For two perpendicular forces

$$R = \sqrt{P^2 + Q^2}$$

Here, $P = Q$ given $\quad \therefore \ R = \sqrt{P^2 + Q^2} = \sqrt{2}\,P$

So, option (a) is correct.

Q. 12 Two forces of equal magnitudes P gives resultant of P/2 the angle between two forces is

(a) $\cos^{-1}\left(\frac{7}{8}\right)$ (b) $\cos^{-1}\left(\frac{-7}{8}\right)$ (c) $\cos^{-1}\left(\frac{1}{2}\right)$ (d) $\cos^{-1}\left(-\frac{1}{2}\right)$

Ans. : (b)

Explanation : Using $R^2 = P^2 + Q^2 + 2PQ\cos\theta$

$$\therefore \left(\frac{P}{2}\right)^2 = P^2 + P^2 + 2PP\cos\theta$$

$$\therefore \frac{P^2}{4} = 2P^2(1 + \cos\theta) \quad \therefore (1 + \cos\theta) = \frac{1}{8}$$

$$\therefore \cos\theta = -\frac{7}{8} \quad \therefore \theta = \cos^{-1}\left(\frac{-7}{8}\right)$$

So, option (b) is correct.

Q. 13 The resultant of two forces with magnitude ratio 3 : 5 acting at 60° with each other is 35 N. The magnitude of forces are

(a) 20 N, 15N (b) 45 N, 25N (c) 25 N, 15N (d) 35 N, 24N

Ans. : (c)

Explanation : Let two forces be P and Q

$\therefore$ P : Q = 3 : 5 given (i.e. P = 0.6 Q)

$R = 35$ N $\quad \theta = 60°$

Now $R^2 = P^2 + Q^2 + 2PQ\cos\theta$

$$(35)^2 = (0.6Q)^2 + Q^2 + 2(0.6Q)Q\cos 60°$$

$$1225 = Q^2(0.36 + 1 + 0.6)$$

$$\therefore 1.96\,Q^2 = 1225 \quad \therefore Q^2 = 625$$

$$\therefore Q = 25 \text{ N} \quad \therefore P = 0.6\,Q = 0.6 \times 25 = 15 \text{ N}$$

So two forces are 25 N and 15 N.

So, option (c) is correct.

Q. 14 State which of the following statement is true ?

(a) The parallelogram law can be proved mathematically.

(b) The parallelogram law can be proved experimentally.

(c) The parallelogram law is applicable for non concurrent forces.

(d) The parallelogram law can not be applied to spatial concurrent forces.

Ans. : (b)

Explanation : Law of parallelogram states that "Two coplanar concurrent forces acting at a point be represented in magnitude and direction by two adjacent sides of a parallelogram, the diagonal of this parallelogram, passing through intersection of two forces will represent resultant in magnitude and direction".

- It is not possible to prove above statement mathematically
- We can prove it experimentally
- It is applicable to concurrent forces.

So, option (b) is correct.

Q. 15 The minimum magnitude of resultant of two forces of magnitudes 100 N and 150 N is

(a) 0 (b) 150 N (c) 100 N (d) 50 N

Ans. : (d)

Explanation : $R_{min} = P - Q = 150 - 100 = 50N$

So, option (d) is correct.

Q. 16 Two forces acting on a particle in opposite direction have a resultant of 5 N. If they act at right angles, their resultant has magnitude of 25 N. The two forces are,

(a) 15N, 20N (b) 20N, 30N (c) 5N, 10N (d) 10N, 25N

Ans. : (a)

Explanation :

$\therefore P - Q = 5$ (From Case I) ...(1)

$P^2 + Q^2 = 625$ (From Case II) ...(2)

Solving Equations (1) and (2)

$P = 20$ N, $Q = 15$ N

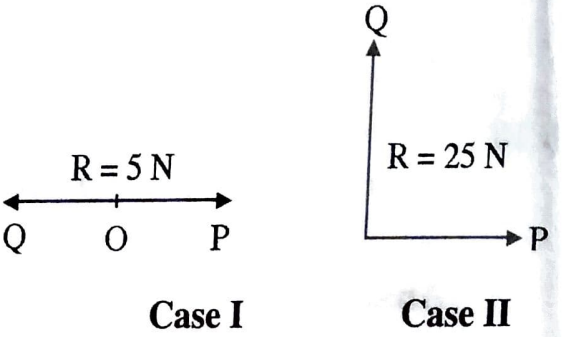


Fig. 7

So, option (a) is correct.

Q. 17 The Couple is unchanged if .....

(a) The couple is shifted to any other position

(b) The couple is rotated through any angle

(c) Couple is replaced by other pair of forces whose rotational effect is same

(d) All of the above.

Ans. : (d)

Explanation :

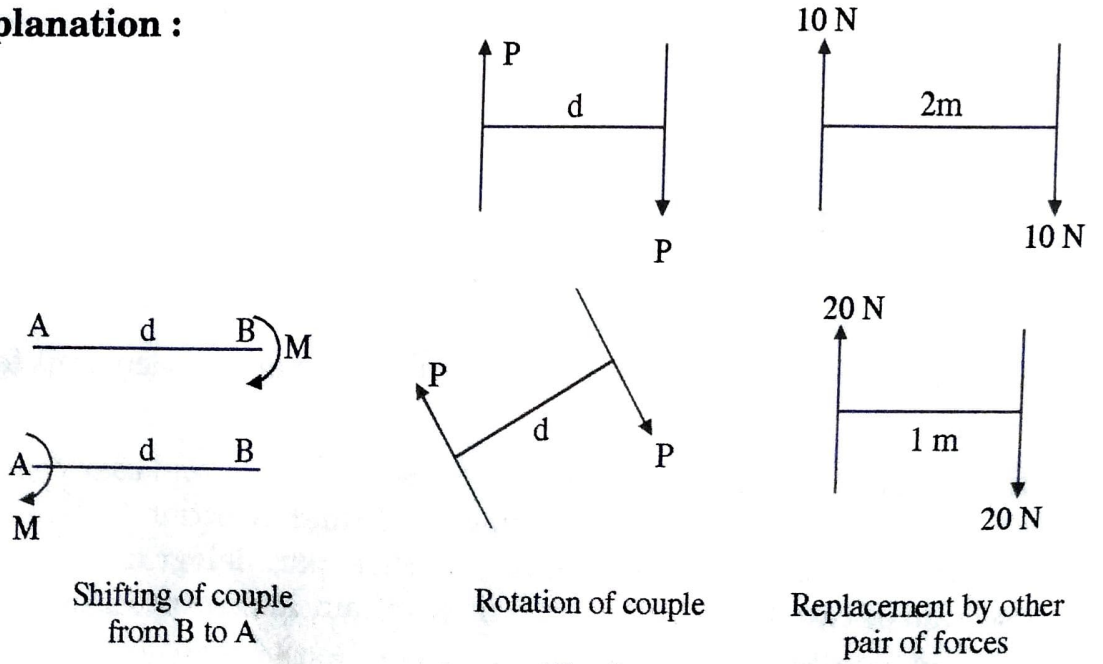


Fig. 8

So, option (d) is correct.

Q. 18 Two unlike parallel forces of 10 N each acts at points A and B making 30° with x axis. If AB = 1m. The moment of couple is

(a) 10 N m (b) 5 N.m (c) 7.86 N.m (d) None of the above

Ans. : (b)

Explanation :

$M = 10 \sin 30° \times 1 = 5 \text{ N} \cdot \text{m}$ ↷

So, option (b) is correct.

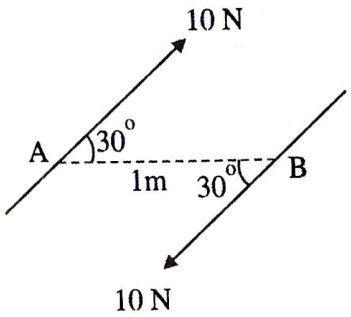


Fig. 9

Q. 19 If two like parallel forces are acting on member then their resultant will lie

(a) Outside two forces (b) Within the two forces

(c) At the centre of two forces (d) None of the above

Ans. : (b)

Explanation : When two like parallel forces are acting on a member, the resultant lies within two forces.

For example : P = 30 N, Q = 40 N, a = 3 m

$$R = P + Q \quad \ldots(i)$$

By Varignon's theorem about A

$$R \cdot x = \Sigma M_A \quad \therefore R \cdot x = Q \times a$$

$$\therefore x = \frac{Q \times a}{P + Q} = \frac{40 \times 3}{30 + 40}$$

$$x = 1.71 \text{ m from A}$$

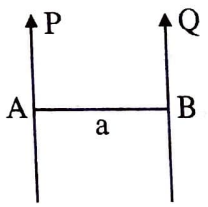


Fig. 10

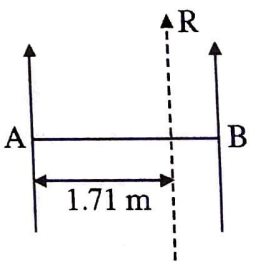


Fig. 10(a)

So, option (b) is correct.

Q. 20 Two unlike parallel forces of 20 N at 2 m apart acting on a rod. What should be the distance between two unlike parallel forces of 10 N to nullify the effect ?

(a) 2 m (b) 4 m (c) 3 m (d) 5 m

Ans. : (b)

Explanation :

for system of Fig. 11(a)

$M_1 = 20 \times 2 = 40 \text{ N.m}$ ↶

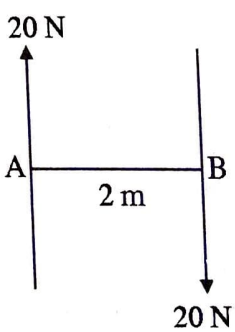
For system of Fig. 10(b)

$M_2 = 10 \times d$ ↷

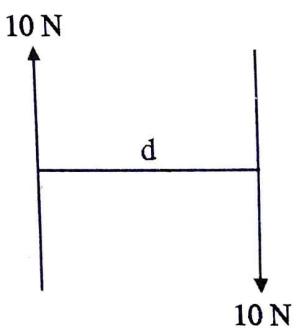
To nullify the effect we have, $M_1 = M_2$

$$40 = 10 \times d$$

$$\therefore d = 4 \text{ m}$$



(a)



(b)

Fig. 11

Conclusion : For a couple if forces are halved, the lever arm be doubled to produce the same effect.

So, option (b) is correct.

Q. 21 A 50 N force acting at one of the corner of square of side 3 m away from corner at 30° with horizontal. Its equivalent force-couple system on diagonally opposite corner is

(a) 50 N, 55 N·m (↺) (b) 50 N, 55 N·m (↻)

(c) 55 N, 50 N·m (↺) (d) 55 N, 50 N·m (↻)

Ans. : (a)

Explanation :

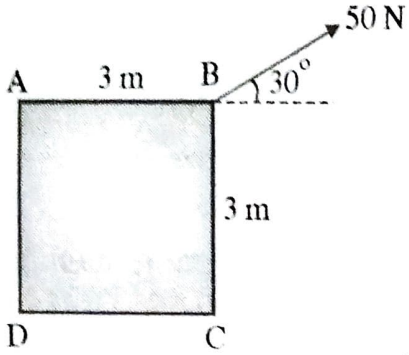
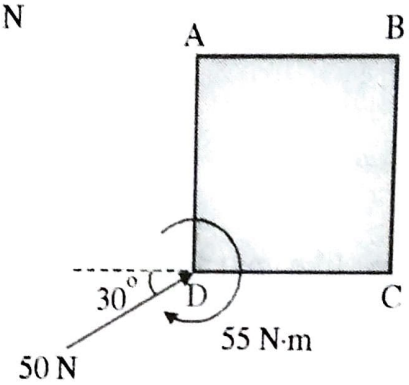


Fig. 12



(Force-couple system at D)

Fig. 13

To find force-couple system at diagonally opposite corner D we have to transfer the force from B to D but along with moment of force about D.

$$\therefore M_D = -(50 \cos 30° \times 3) + (50 \sin 30° \times 3) = -55 \text{ N} \cdot \text{m} = 55 \text{ N} \cdot \text{m} \circlearrowright$$

So, option (a) is correct.

Q. 22 Three forces P = 50 N (East), Q = 100 N (North) and S = 75 N (south) are acting on a particle. Their resultant is

(a) 55.9 N (b) 66.9 N (c) 70.9 N (d) 45.9 N

Ans. : (a)

Explanation :

$$\Sigma F_x = 50 \text{ N}(\rightarrow)$$

$$\Sigma F_y = 100 - 75 = 25 \text{ N}(\uparrow)$$

$$\therefore R = \sqrt{(50)^2 + (25)^2}$$

$$\therefore R = 55.9 \text{ N}$$

So, option (a) is correct.

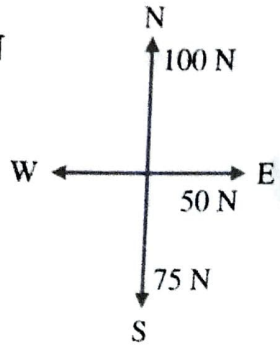


Fig. 14

Q. 23 If forces of 10 N, 20 N, 30 N, 40 N, 50 N and 60 N act in order along six sides of a regular hexagon, the resultant of system is

(a) 20 N (b) 60 N (c) Zero (d) 50 N

Ans. : (b)

Explanation :

$\Sigma F_x = 10 + 20\cos 60° - 30\cos 60° - 40 - 50\cos 60° + 60\cos 60°$

$= -30\text{ N} = 30\text{ N}(\leftarrow)$

$\Sigma F_y = 20\sin 60° + 30\sin 60° - 50\sin 60° - 60\sin 60°$

$= -51.96\text{ N} = 51.96\text{ N}(\downarrow)$

$\therefore R = \sqrt{(30)^2 + (51.96)^2}$

$R = 60\text{ N}$

So, option (b) is correct.

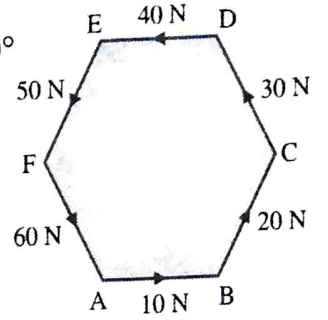


Fig. 15

Q. 24 Three like parallel forces 100 N, 150 N and 200 N act at a distance of 0.5 m each. The distance of resultant from 100 N force is

(a) 0.75 m (b) 0.61 m (c) 0.2 m (d) 0.5 m

Ans. : (b)

Explanation : $\Sigma F_x = 0$

$\Sigma F_y = 100 + 150 + 200 = 450\text{ N}(\uparrow)$

$\therefore R = 450\text{ N}\uparrow$

Now by Varignon's theorem about A,

$Rx = \Sigma M_A \therefore Rx = (150 \times 0.5) + (200 \times 1) = 275\text{ N·m}\circlearrowleft$

$\therefore x = \dfrac{275}{450} = 0.61\text{ m to right of 'A'}$

So, option (b) is correct.

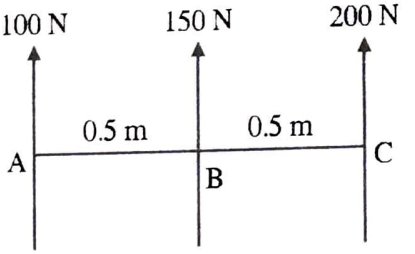


Fig. 16

Q. 25 A force of 100 N is acting through points A (1, 2) and B (2, 1). The moment of force about point O (0, 0) is

(a) 212.13 N·m (b) 210 N·m

(c) 187.5 N·m (d) 150 N·m

Ans. : (a)

Explanation :

Here angle made by force with x-axis is 45°

$\therefore M_o = (-100\cos 45° \times 2) - (100\sin 45° \times 1)$

$= 212.13\text{ N}\cdot\text{m}\circlearrowright$

So, option (a) is correct.

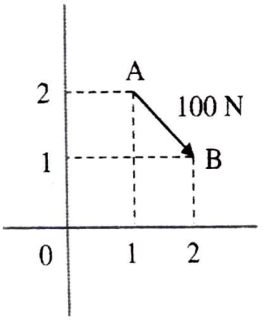


Fig. 17

Q. 26 Forces of magnitudes 1 N, 2 N, 3 N and 4 N are acting along sides AB, BC, CD and DA of a rectangle respectively. The magnitude of resultant is

(a) $\sqrt{8}$ N (b) $\sqrt{28}$ N (c) $\sqrt{34}$ N (d) $\sqrt{10}$ N

Ans. : (a)

Explanation : $\Sigma F_x = 1 - 3 = -2\text{ N} = 2\text{ N}(\leftarrow)$

$\Sigma F_y = 2 - 4 = -2\text{ N} = 2\text{ N}(\downarrow)$

$\therefore R = \sqrt{(2)^2 + (2)^2} = \sqrt{8}\text{ N}$

So, option (a) is correct.

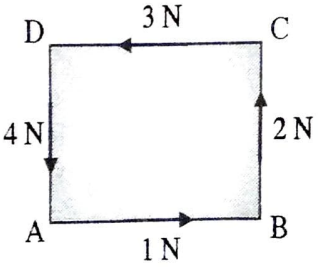


Fig. 18

Q. 27 Three forces 5 N , 10 N and 15 N act along three sides of an equilateral triangle AB, BC and CA. Side AB being horizontal. The resultant of system is

(a) 8.66 N (b) 10 N (c) 14.22 N (d) Zero

Ans. : (a)

Explanation :

$\Sigma F_x = 5 - 10 \cos 60° - 15 \cos 60° = -7.5 \text{ N} = 7.5 \text{ N}(\leftarrow)$

$\Sigma F_y = 10 \sin 60° - 15 \sin 60° = -4.33 \text{ N} = 4.33 \text{ N}(\downarrow)$

$\therefore R = \sqrt{(7.5)^2 + (4.33)^2} = 8.66 \text{ N}$

So, option (a) is correct.

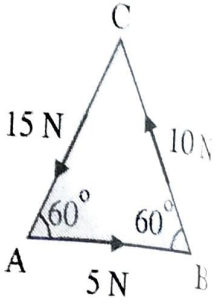


Fig. 19

Q. 28 A force of 50 N acting tangentially to a circle of radius 2 m. Its moment about diametrically opposite point will be

(a) 300 N·m (b) 200 N·m (c) 400 N·m (d) 100 N·m

Ans. : (b)

Explanation :

Moment about diametrically opposite point B is

$M_B = 50 \times 4 = 200 \text{ N} \cdot \text{m}$ (Magnitude)

So, option (b) is correct.

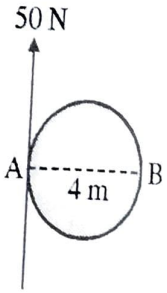


Fig. 20

Q. 29 For a given co-planer force system $\Sigma F_y = 30$ N and the angle made by resultant with X-axis is 60°. The magnitude of R is

(a) 25 N (b) 20.64 N (c) 34.64 N (d) 28.28 N

Ans. : (c)

Explanation :

We know that y component of R = ΣF_y

$\therefore R \sin 60° = 30$

$\therefore R = 34.64 \text{ N}$

So, option (c) is correct.

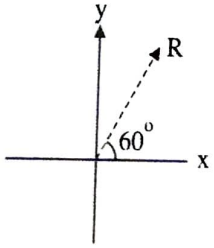


Fig. 21

Q. 30 Moment of a couple is

(a) Depends upon point (b) Independent of a point

(c) Depends upon axis (d) None of the above.

Ans. : (b)

Explanation : The moment of a force depends upon a point but moment of a couple is independent of any point.

So, option (b) is correct.

Q. 31 A number of forces acting simultaneously on a particle of a body

(a) May be replaced by a couple

(b) May be replaced by a single force

(c) May not be replaced by a single force

(d) May be replaced by a single force through c.g of body.

Ans. : (b)

Explanation : When forces are acting on a particle, the system must be a concurrent force system. A concurrent force system can be reduced to a single forces R.

So, option (b) is correct.

Q. 32 Three forces each of magnitude 10 N are acting along three sides of an equilateral triangle of side 2 m. The total moment about apex is

(a) 20 N·m (b) Zero (c) $10\sqrt{3}$ N·m (d) $\sqrt{10}$ N·m

Ans. : (c)

Explanation : Height of equilateral triangle is,

$$h = \frac{\sqrt{3}a}{2} = \frac{\sqrt{3} \times 2}{2} = \sqrt{3} \text{ m}$$

$\therefore$ Moment about apex 'C'

$$M_C = 10 \times \sqrt{3} \text{ N} \cdot \text{m}$$

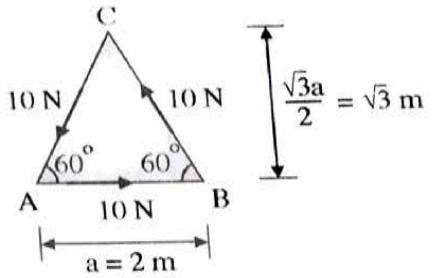


Fig. 22

So, option (c) is correct.

Q. 33 A lever OA 1 m long is inclined at 60° with horizontal. A force of 200 N is acting at A vertically down words. The moment about 'O' is

(a) 75 N·m (b) 100 N·m (c) 50 N·m (d) 200 N·m

Ans. : (b)

Explanation : Moment about point 'O'

$$M_o = -200 \times 1 \cos 60°$$

$$M_o = -100 \text{ N} \cdot \text{m}$$

$\therefore M_o = 100 \text{ N} \cdot \text{m}$ (Magnitude)

So, option (b) is correct.

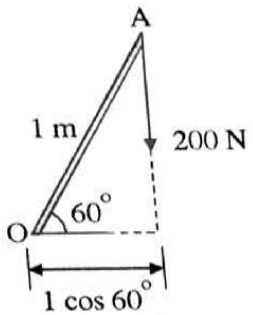


Fig. 23

Q. 34 When several forces of different magnitudes and direction act at a point upon a body in a plane, they form

(a) Concurrent force system (b) Co-planer concurrent force system

(c) Co-planer non concurrent force system (d) Co-planer force system.

Ans. : (b)

Explanation : Here forces are acting in a plane so they are coplanar. Also forces are acting at a point so they are concurrent so system is coplanar concurrent force system.

So, option (b) is correct.

Q. 35 A tripod carrying a dumpy level is example of

(a) Collinear forces

(b) Non coplanar concurrent forces

(c) Non coplanar non concurrent forces

(d) Coplanar concurrent forces.

Ans. : (b)

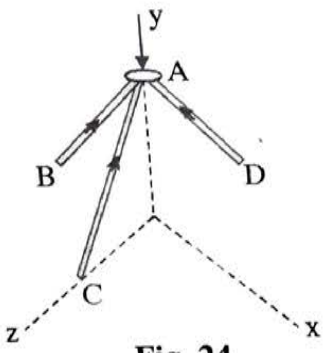


Fig. 24

Explanation : When a tripod is carrying a dumpy level, the legs are subjected to compressive forces. So point A is subjected to concurrent forces in space.

The system is 'Non coplanar concurrent' force system.

So, option (b) is correct.

Q. 36 When two forces are acting on a body, they are essentially

(a) Concurrent (b) Parallel (c) Coplanar (d) Collinear

Ans. : (c)

Q. 37 A moment is a

(a) Free vector (b) Fixed vector (c) Sliding vector (d) None of the above

Ans. : (b)

Explanation :

Fixed vector : A vector used to represent a force acting on a given particle has a well defined point of application, the vector is said to be a fixed vector. So, moment of a force about a point is a fixed vector.

So, option (b) is correct.

Q. 38 A couple is a

(a) Free vector (b) Fixed vector (c) Sliding vector (d) All the above

Ans. : (a)

Explanation :

Free vector : A vector which may be freely moved in space is called free vector. So, couple is a free vector.

So, option (a) is correct.

Q. 39 A coplanar force system is consisting an inclined force and number of couples. The resultant of system is

(a) Zero (b) Force itself (c) Horizontal or vertical (d) Can't say.

Ans. : (b)

Explanation : We know that resultant of a couple is zero. So, when a system is consisting n-number of couples but only single force then resultant would be the force itself.

So, option (b) is correct.

Q. 40 The moment of a force about any point is geometrically equal to ____ area of triangle where base represents the force and height represents the perpendicular distance.

(a) Half (b) Twice (c) Same (d) None of these.

Ans. : (b)

Explanation : Moment of force F about point 'O' is,

$$M_o = F \times d \quad \text{...(i)}$$

Now, area of triangle OAB is

$$= \frac{1}{2} \times AB \times OM = \frac{1}{2} \times F \times d = \frac{1}{2} M_o$$

$$\therefore M_o = 2[\text{Area of triangle OAB}]$$

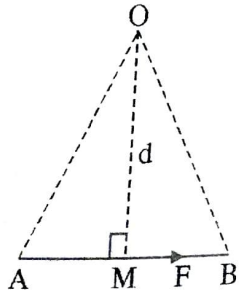


Fig. 25

So, option (b) is correct.

Q. 41 If the arm of couple is doubled, its moment will

(a) Be halved (b) Remains same (c) Be doubled (d) None of the above.

Ans. : (c)

Explanation : $M_1 = P \times d$

$$M_2 = P \times 2d = 2(Pd) = 2M_1$$

So when arm of a couple is doubled, moment is also doubled.

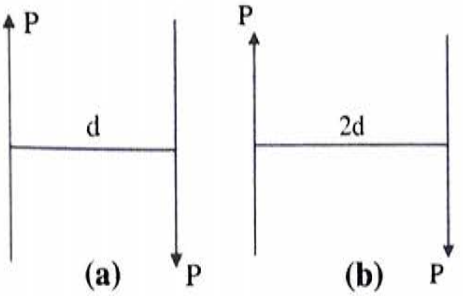


Fig. 26

So, option (c) is correct.

Q. 42 When resolving a force into components

(a) Only one component is possible

(b) Only two components are possible

(c) Only three components are possible

(d) Infinite number of components are possible.

Ans. : (d)

Explanation : Resolution of a force means splitting up a force into **number of components** without changing the effect. So due to resolution infinite number of components are possible.

So, option (d) is correct.

Q. 43 State in which of the following the applied force does not produce moment

(a) Pedaling a cycle (b) Opening a door

(c) Opening a water tap (d) Stretching a spring

Ans. : (d)

Explanation : In stretching a spring forces applied are collinear and opposite which does not produce any rotation or moment.

So, option (d) is correct.

Q. 44 Which of the following is a scalar quantity ?

(a) Moment of a force about origin

(b) Moment of a force about an axis

(c) Moment of a couple

(d) Moment of a force about a point other than origin.

Ans. : (b)

Explanation : The moment of a force F about any axis is the scalar obtained by forming the mixed triple product of DCS, r and F.

$$\therefore M_{axis} = \begin{vmatrix} l & m & n \\ r_x & r_y & r_z \\ F_x & F_y & F_z \end{vmatrix} \text{ which is scalar}$$

So, option (b) is correct.

Q. 45 Resultant and equilibrant are

(a) Equal in magnitudes (b) Opposite in direction

(c) Both (a) and (b) (d) None of these.

Ans. : (c)

Explanation :

Resultant and equilibrant are R = – E equal in magnitudes but opposite in direction.

So, option (c) is correct.

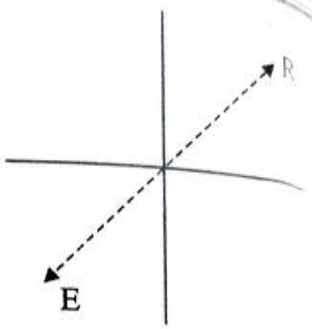


Fig. 27

Q. 46 The angles between two forces to make their resultant a minimum and a maximum respectively are

(a) 0° and 90° (b) 180° and 90° (c) 90° and 180° (d) 180° and 0°

Ans. : (d)

Explanation : For two concurrent coplanar forces, resultant is maximum when $\theta = 0$ and it is minimum when $\theta = 180°$

$$\therefore R_{max} = P + Q \text{ and } R_{min} = P - Q$$

So, option (d) is correct.

Q. 47 The resultant of two forces acting at an angle of 150° is 10 N and is perpendicular to one of the forces. The other force is :

(a) $20/\sqrt{3}$ N (b) $10/\sqrt{3}$ N (c) 20 N (d) $20/\sqrt{3}$ N

Ans. : (c)

Explanation : Here, $P \perp R$

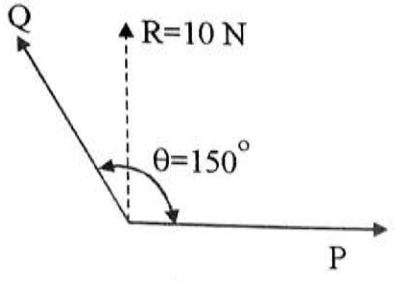


Fig. 28

$$\therefore \alpha = 90°$$

$$\therefore \tan\alpha = \frac{Q \cdot \sin\theta}{P + Q\cos\theta} \to \infty$$

$$\therefore P + Q\cos\theta = 0$$

$$\therefore Q\cos\theta = -P \quad \ldots(1)$$

$$\text{Now, } R^2 = P^2 + Q^2 + 2PQ\cos\theta$$

$$\therefore R^2 = P^2 + Q^2 + 2P(-P) = Q^2 - P^2$$

$$\therefore Q^2 - P^2 = 100$$

$$\text{From (1) } \cos\theta = -P/Q \quad \ldots(2)$$

$$\cos 150° = \frac{-P}{Q} \qquad \therefore P = \frac{\sqrt{3}}{2}Q$$

$$\text{Sub in (2) } Q^2 - \frac{3}{4}Q^2 = 100$$

$$\frac{Q^2}{4} = 100 \qquad \therefore \mathbf{Q = 20\ N}$$

So, option (c) is correct.

Q. 48 The sum of magnitudes of two forces acting at a point is 16 and magnitude of their resultant is $8\sqrt{3}$. If the resultant is at 90^0 with the force of smaller magnitude, then two forces are

(a) 3, 13 (b) 2, 14 (c) 5, 11 (d) 4, 12

Ans. : (b)

Explanation : $P + Q = 16$ and $R = 8\sqrt{3}$

We have, $\tan 90^\circ = \dfrac{Q \sin\theta}{P + Q\cos\theta}$

$\therefore \quad Q\cos\theta = -P$

So, $Q^2 - P^2 = R^2$ (see Q. 1)

$\therefore Q^2 - P^2 = 192$

$\therefore (Q - P)(Q + P) = 192$

$\therefore \quad Q - P = \dfrac{192}{16} = 12$

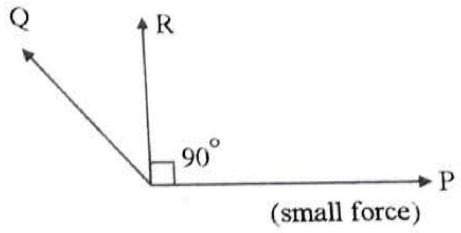


Fig. 29

Now, $P + Q = 16$ and $Q - P = 12$

$\therefore \quad P = 2N$ $\qquad Q = 14\ N$

So, option (b) is correct.

Q. 49 Two forces each of magnitude A are inclined to each other such that their resultant is equal to $\sqrt{3}$ A. Then resultant of A and – A is

(a) 2A (b) $\sqrt{3}$ A (c) $\sqrt{2}$ A (d) A

Ans. : (d)

Explanation : For two forces A and A, $R = \sqrt{3}$ A

$\therefore \quad R^2 = P^2 + Q^2 + 2PQ\cos\theta$

$3A^2 = A^2 + A^2 + 2A^2\cos\theta$

$A^2 = 2A^2\cos\theta$

$\therefore \cos\theta = 1/2 \qquad \theta = 60^\circ$

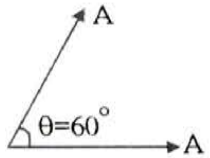


Fig. 30(a)

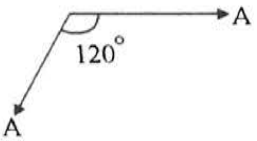


Fig. 30(b)

Now, For two forces A and – A

$R^2 = P^2 + Q^2 + 2PQ\cos\theta = A^2 + A^2 + 2A^2\cos(120^\circ) = A^2$

$\mathbf{R = A}$

So, option (d) is correct

Q. 50 Two forces, each equal to P/2, act at right angles. Their effect may be neutralized by a third force acting along their bisector in the opposite direction with a magnitude of

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

Ans. : (c)

Explanation : $R^2 = \left(\dfrac{P}{2}\right)^2 + \left(\dfrac{P}{2}\right)^2$

$R^2 = \dfrac{P^2}{2} \qquad \therefore R = \dfrac{P}{\sqrt{2}}$

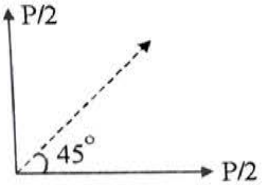


Fig. 31

So, option (c) is correct.

Q. 51 If the magnitude of the sum of the two vectors is equal to the difference of their magnitudes, then the angle between vectors is

(a) 0° (b) 120° (c) 150° (d) 180°

Ans. : (d)

Explanation :

The magnitude of sum of (i.e. resultant) of two vectors is, $\sqrt{P^2 + Q^2 + 2PQ\cos\theta}$

$\therefore \sqrt{P^2 + Q^2 + 2PQ\cos\theta} = P - Q$ (given)

Squaring both sides,

$\therefore P^2 + Q^2 + 2PQ\cos\theta = P^2 + Q^2 - 2PQ$

$\cos\theta = -1 \qquad \therefore \theta = 180^\circ$

So, option (d) is correct.

Q. 52 The simple sum of two co-initial vectors is 16 units. Their vector sum is 8 units. The resultant of the vectors is perpendicular to the smaller vector. The magnitudes of the two vectors are

(a) 2 and 14 units (b) 4 and 12 units (c) 6 and 10 units (d) 8 and 8 units

Ans. : (c)

Explanation : $P + Q = 16, \quad P^2 + Q^2 + 2PQ\cos\theta = (8)^2, \quad \alpha = 90^\circ$

$$\therefore \tan 90^\circ = \frac{Q\sin\theta}{P + Q\cos\theta} \Rightarrow Q\cos\theta = -P$$

$\therefore P^2 + Q^2 - 2P^2 = 64 \qquad \therefore Q^2 - P^2 = 64$

$\therefore (Q - P)(Q + P) = 64 \qquad \therefore Q - P = \frac{64}{16} = 4$

Now, $P + Q = 16$ and $Q - P = 4$

On solving, $P = 6$ units

$Q = 10$ units.

So, option (c) is correct.

Q. 53 The resultant of two forces at right angle is 5 N. When the angle between them is 120° , the resultant is $\sqrt{13}$ N. Then the forces are

(a) $\sqrt{12}$ N, $\sqrt{13}$ N (b) $\sqrt{20}$ N , $\sqrt{5}$ N (c) 3N , 4N (d) $\sqrt{40}$ N, $\sqrt{15}$ N

Ans. : (c)

Explanation : When $\theta = 90^\circ$, $R = 5N$

$\therefore R^2 = P^2 + Q^2 \qquad \therefore P^2 + Q^2 = 25$ ...(1)

When $\theta = 120^\circ$, $R = \sqrt{13}$ N

$\therefore R^2 = P^2 + Q^2 + 2PQ\cos\theta$

$13 = P^2 + Q^2 + 2PQ\cos 120^\circ = P^2 + Q^2 - PQ = 25 - PQ$

$\therefore PQ = 12$ ...(2)

Solving Equations (1) and (2)

$P = 3N$, $Q = 4N$ OR $P = 4N$, $Q = 3N$.

So, option (c) is correct.

Q. 54 A force is inclined at 60° to the horizontal. If its rectangular component in the horizontal direction is 50 N , then magnitude of the force in the vertical direction is

(a) 25 N (b) 75 N (c) 87 N (d) 100 N

Ans. : (c)

Explanation : x component of force $P_x = P \cos 60°$

$$50 = P \cos 60°$$

$$\therefore \quad P = 100 \text{ N}$$

y component of force $P_y = P \sin 60° = 100 \sin 60°$

$$P_y = 87 \text{ N}$$

So, option (c) is correct.

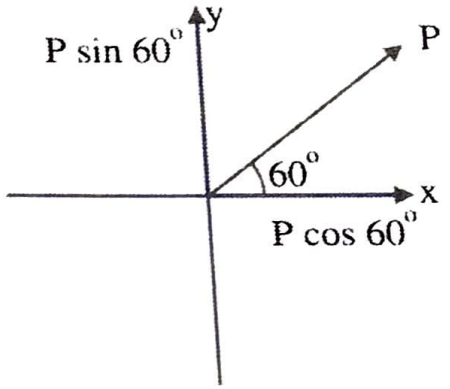


Fig. 32

Q. 55 There are two forces each of magnitude 10 units. One inclined at an angle of 30° and the other at an angle of 135° to the positive direction of x-axis. The x and y components of the resultant are respectively

(a) $1.59 \hat{i}$ and $12.07 \hat{j}$ (b) $10 \hat{i}$ and $10 \hat{j}$

(c) $1.59 \hat{i}$ (d) $15.9 \hat{i}$ and $12.07 \hat{j}$

Ans. : (a)

Explanation : x component of resultant = ΣF_x

$$= 10 \cos 30° - 10 \cos 45° = 1.59 \text{ N} \rightarrow$$

y component of resultant = ΣF_y

$$= 10 \sin 30° + 10 \sin 45° = 12.07 \text{ N} \uparrow$$

$$\therefore \quad \bar{R} = 1.59 \hat{i} + 12.07 \hat{j}$$

So, option (a) is correct.

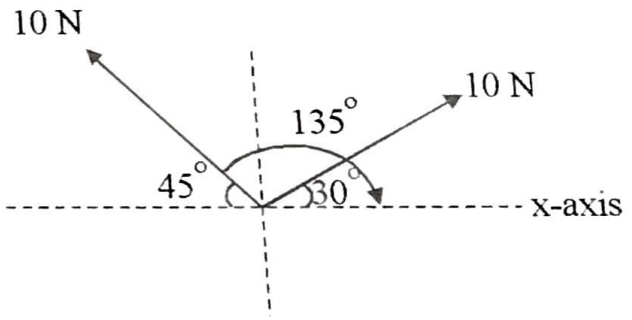


Fig. 33

So, option (a) is correct.

Fig. 33

Q. 56 A rod ABCD is subjected to four parallel forces of magnitudes 20N ↑,90N ↓, 40N ↑ and 80 N↑ acting respectively at A,B,C and D. If AB = BC=1 m and CD = 2 m, the resultant of system is :

(a) 50 N (b) 30 N (c) 120 N (d) – 35 N

Ans. : (a)

Explanation :

$\Sigma F_x = 0$

$\Sigma F_y = 20 - 90 + 40 + 80 = 50 \text{ N} \uparrow$

$\therefore \quad R = 50 \text{ N} \uparrow$

So, option (a) is correct.

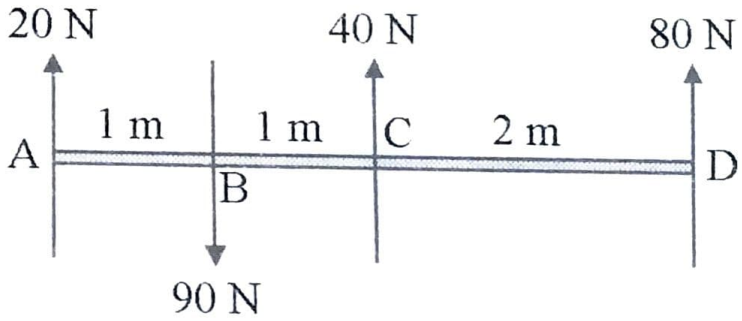


Fig. 34

Q. 57 In above question [Q 56] the resultant cuts the rod at:

(a) 8 m to right of A (b) 6.2 m to the right of A

(c) 9 m to the left of A (d) Passing through point A

Ans. : (b)

Explanation : By Varignon's theorem at A

$$R \cdot x = \Sigma M_A = (-90 \times 1) + (40 \times 2) + (80 \times 4) = 310 \text{ N.m } \circlearrowleft$$

$$\therefore \quad x = \frac{310}{50} = 6.2 \text{ m to the right of A}$$

So, option (b) is correct.

Q. 58 A square ABCD of side 1 m with side AB is horizontal at bottom and CD at top with points A,B,C and D taken in anticlockwise order is subjected to forces of 40 N ← at A, 30 N ↓ at B, 20N→ C and, 10 N↑ at D. Find resultant.

(a) 10N (b) $20\sqrt{2}$ N (c) 25 N (d) 30 N

Ans. : (b)

Explanation :

$$\Sigma F_x = 20 - 40 = -20 \text{ N} = 20 \text{ N} \leftarrow$$

$$\Sigma F_y = 10 - 30 = -20 \text{ N} = 20 \text{ N} \downarrow$$

$$\therefore R = \sqrt{(\Sigma F_x)^2 + (\Sigma F_y)^2} = \sqrt{(20)^2 + (20)^2} = 20\sqrt{2} \text{ N}$$

So, option (b) is correct.

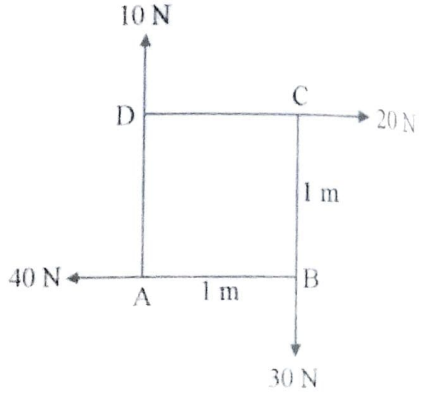


Fig. 35

Q. 59 A force of 100 N acting tangentially to a drum of radius 0.25 m, must be transferred parallel to itself to its centre 0. The moment which should accompany it for equivalent effect is

(a) 20 N · m (b) 25 N · m (c) 30 N · m (d) 35 N · m

Ans. : (b)

Explanation :

When 100 N force is transferred to centre 'O' we have to transfer moment of $100 \times 0.25 = 25$ N.m to point 'O'

So, option (b) is correct.

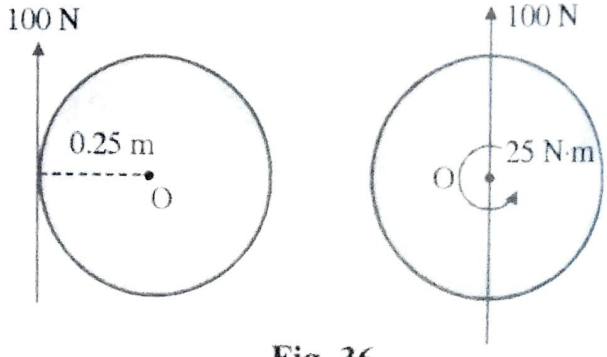


Fig. 36

Q. 60 If two forces of magnitude P each act an angle 'β'. Then resultant will be

(a) 2 P cos β (b) P cos β (c) P cos 2 β (d) $P\,[(2 + 2\cos\beta)]^{1/2}$

Ans. : (d)

Explanation :

Using, $R^2 = P^2 + Q^2 + 2PQ\cos\theta = P^2 + P^2 + 2PP\cos\beta$

$$= P^2(2 + 2\cos\beta)$$

$$\therefore R = P(2 + 2\cos\beta)^{1/2}$$

So, option (d) is correct.

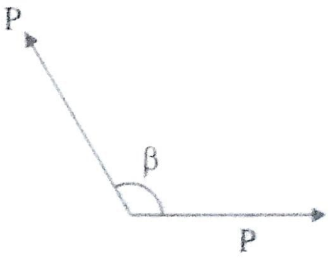


Fig. 37

Q. 61 The resultant of coplanar concurrent force system is lying in xy plane defined by positive x and negative y axes and acting away from origin. The equilibrant that brigns force system in equilibrium will be expressed as

(a) $F_x \hat{i} + F_y \hat{j}$ (b) $F_x \hat{i} + F_z \hat{k}$

(c) $F_x \hat{i} + F_y \hat{j}$ (d) $F_x \hat{k} + F_y \hat{j}$

Ans. : (c)

Explanation :

As equilibrant is in opposite direction of R i.e. in second quadrant, so it is expressed as

$-F_x \hat{i} + F_y \hat{j}$

So, option (c) is correct.

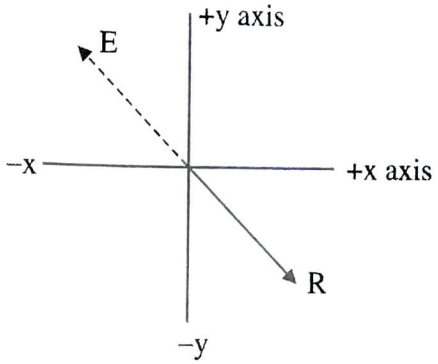


Fig. 38

Q. 62 ABC is right angled triangle having AB horizontal base of 5 m length. AC is vertical 12 m in length. Forces 50 N, 130 N and 120 N act along AB, BC and CA respectively. Find magnitude of resultant.

(a) 50 N (b) zero (c) 130 N (d) 48 N

Ans. : (b)

Explanation : $\tan\theta = \frac{12}{5} \therefore \theta = 67.38°$

$$\Sigma F_x = 50 - 130 \cos(67.38°) = 0$$

$$\Sigma F_y = 130 \sin(67.38°) - 120 = 0$$

$$\therefore R = 0$$

So, option (b) is correct.

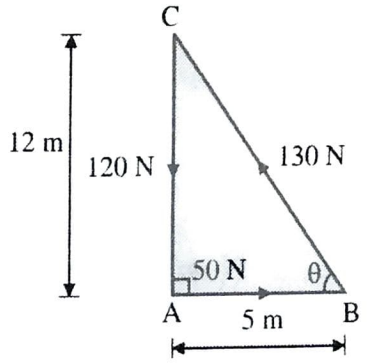


Fig. 39

Q. 63 ABC is a right angle triangle of base AB = 5 m horizontal and height AC = 9 m vertical. Three forces of 100 N, PN and 125 N are acting along sides AB, BC and CA respectively. Find P if resultant of three forces is to be vertical.

(a) 206 N (b) 106 N (c) 120 N (d) 120 N

Ans. : (a)

Explanation : $\tan\theta = \frac{9}{5}$

$$\therefore \theta = 60.95°$$

Here resultant is vertical

So, $\Sigma F_x = 0$

$$100 - P\cos\theta = 0$$

$$\therefore P = 205.94 \text{ N}$$

$$\therefore P \cong 206 \text{ N}$$

So, option (a) is correct.

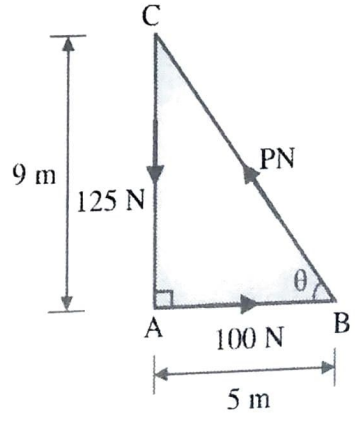


Fig. 40

Q. 64 For Q : 63 above what is value of P if resultant is to be horizontal ?

(a) 160 N (b) zero (c) 143 N (d) 168 N

Ans. : (c)

Explanation : When R is horizontal,

$\Sigma F_y = 0 \quad \therefore P \sin\theta - 125 = 0 \quad \therefore P = 143\ N$

So, option (c) is correct.

Q. 65 The resultant of two forces each of magnitude P acting at 60° is,

(a) 2P (b) 3P (c) $(3)^{1/2}P$ (d) $(2)^{1/2}\ P$

Ans. : (c)

Explanation :

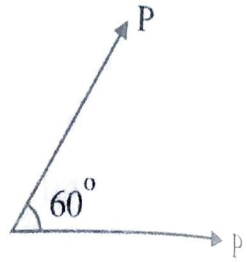


Fig. 41

Using, $R^2 = P^2 + Q^2 + 2PQ\cos\theta = P^2 + P^2 + 2PP\cos 60°$

$R^2 = 3P^2$

$R = \sqrt{3}\ P \quad \therefore R = (3)^{1/2}\,P$

So, option (c) is correct.

Q. 66 The moment of 30 N force passing through the coordinates (4, 0) and (0, 3) about origin is

(a) 60 N · m (b) 72 N · m (c) 100 N · m (d) 45 N · m

Ans. : (b)

Explanation :

$\tan\theta = \frac{3}{4}$

$\theta = 36.87°$

Now moment about origin O

$M_o = 30 \sin\theta \times 4$ (Resolving at A)

$M_o = 72\ N \cdot m$

So, option (b) is correct.

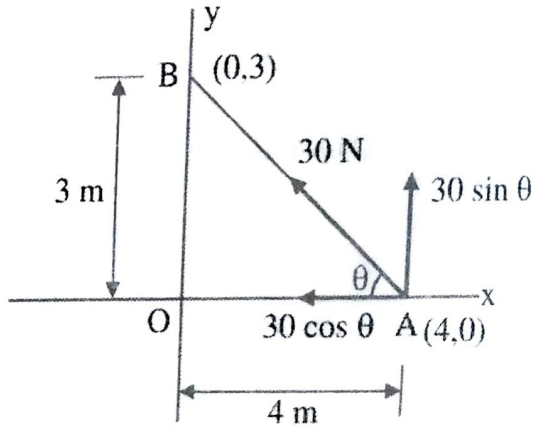


Fig. 42

Q. 67 Forces acting tangentially on a circle are

(a) 4P acting towards North (b) 3P acting towards West

(c) 2P acting towards South (d) P acting towards East

The resultant force is nearer to

(a) 1.4P (b) 2P (c) 1.8P (d) 2.83P

Ans. : (d)

Explanation : $\Sigma F_x = P - 3P = -2P = 2P(\leftarrow)$

$\Sigma F_y = 4P - 2P = 2P\ (\uparrow)$

$\therefore R = \sqrt{(2P)^2 + (2P)^2}$

$R = \sqrt{8}P = 2.83P$

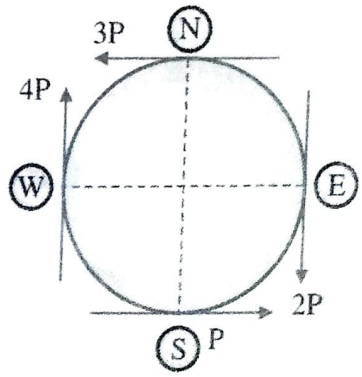


Fig. 43

So, option (d) is correct.

Q. 68 If the forces of 10 N, 20N, 30N, 40N and 50 N are acting in order along the sides of a regular pentagon and 10 N force acting horizontally towards right, then resultant is nearer to

(a) 42.5 N (b) 30 N (c) 47.5 N (d) 60 N

Ans. : (a)

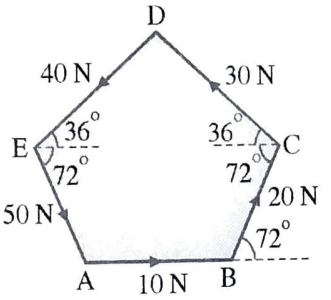


Fig. 44

Explanation :

$\Sigma F_x = 10 + 20 \cos 72° - 30 \cos 36° - 40 \cos 36° + 50 \cos 72°$

$= -25 \text{ N} = 25 \text{ N}(\leftarrow)$

$\Sigma F_y = 20 \sin 72° + 30 \sin 36° - 40 \sin 36° - 50 \sin 72°$

$= -34.41 \text{ N} = 34.41 \text{ N}(\downarrow)$

$\therefore \quad R = \sqrt{(\Sigma F_x)^2 + (\Sigma F_y)^2} = 42.5 \text{ N}$

So, option (a) is correct.

Q. 69 Two boys are pulling a box with the help of two cables. If the pull in the cables are 23 N at an angle of 40° and 35 N at 130° with positive x-axis, their resultant will be

(a) 14.88 N (b) 41.88 N

(c) 12 N (d) 58 N

Ans. : (b)

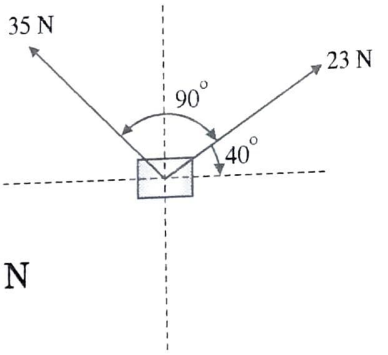


Fig. 45

Explanation : Here two forces are perpendicular

$\therefore R = \sqrt{P^2 + Q^2} = \sqrt{(23)^2 + (35)^2} = 41.88 \text{ N}$

So, option (b) is correct.

Q. 70 If the resultant is 0.6 times the magnitude of two equal forces, then the angle between the forces is,

(a) 145° (b) 100° (c) 135° (d) 120°

Ans. : (a)

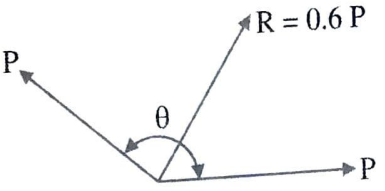


Fig. 46

Explanation : Given R = 0.6 P

Using, $R^2 = P^2 + Q^2 + 2PQ \cos \theta$

$(0.6 P)^2 = P^2 + P^2 + 2P^2 \cos \theta$

$\therefore 0.36 P^2 = 2P^2 (1 + \cos \theta) \quad \therefore 0.18 = 1 + \cos \theta$

$\therefore \cos \theta = -0.82 \quad \therefore \theta = 145°$

So, option (a) is correct.

Q. 71 Determine inclination of resultant of forces 10 N at 0° and 20 N at 90°.

(a) 20.56° (b) 63.43° (c) 126.43° (d)12°

Ans. : (b)

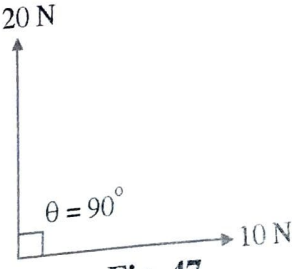


Fig. 47

Explanation : Forces are perpendicular

$$\therefore \tan\theta = \frac{20}{10}$$

$$\therefore \theta = 63.43^\circ \text{ with x axis}$$

So, option (b) is correct.

Q. 72 The magnitude of two unlike parallel forces P each acting at 1 m apart, is equivalent to, two unlike parallel forces of 300 N each acting at a distance of 100 mm. find P

(a) 240 N (b) 60 N (c) 30 N (d) 120 N

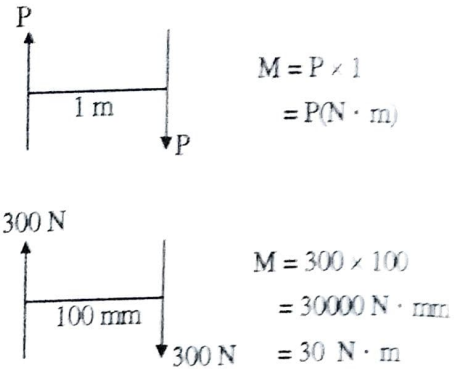


Fig. 48

Ans. : (c)

Explanation :

Equating both moments we get

$$P = 30 \text{ N}$$

So, option (c) is correct.

Q. 73 Four concurrent forces 10 kN, 20 kN, 30 kN and 40 kN acting at an angle of 20°, 63°, 95°, 150° from positive x-axis. The resultant is _____.

(a) 80.75 kN (b) 29.75 kN (c) 73.57 kN (d) 40 kN

Ans. :(c)

Explanation :

$$\Sigma F_x = 10\cos 20^\circ + 20\cos 63^\circ + 30\cos 95^\circ + 40\cos 150^\circ$$

$$= -18.78 \text{ kN} = 18.78 \text{ kN} (\leftarrow)$$

$$\Sigma F_y = 10\sin 20^\circ + 20\sin 63^\circ + 30\sin 95^\circ + 40\sin 150^\circ$$

$$= 71.13 \text{ kN} (\uparrow)$$

$$\therefore R = \sqrt{(18.78)^2 + (71.13)^2}$$

$$R = 73.57 \text{ kN}$$

So, option (c) is correct.

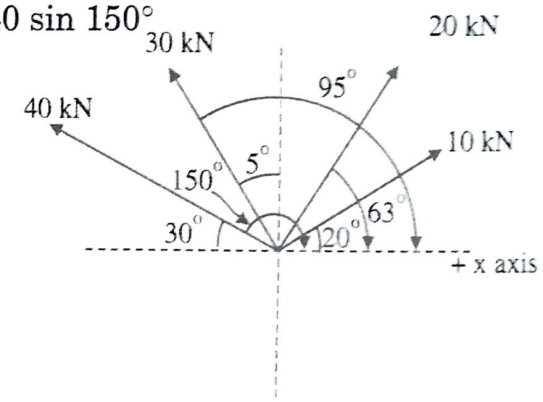


Fig. 49

Q. 74 Forces acting at points A, B, C and D tangentially on a circle taken in order anticlockwise are,

1. 100 N acting towards North
2. P N acting towards West
3. 50 N acting towards South
4. 125 N acting towards East respectively

If R = 60 N in first quadrant. Find P.

(a) 81.83 N (b) 91.83 N (c) 101.83 N (d) 11.83 N

Ans. : (b)

Explanation : Here resultant is 60 N in first quadrant at angle θ with x-axis

$\Sigma F_x = R \cos\theta$,

$125 - P = 60 \cos\theta$,

$\therefore P = 125 - 60 \cos\theta$,

$\therefore P = 125 - 60 \cos(56.44°)$

$P = 91.83$ N

So, option (b) is correct.

$\Sigma F_y = R \sin\theta$

$100 - 50 = 60 \sin\theta$

$\therefore \quad \theta = 56.44°$

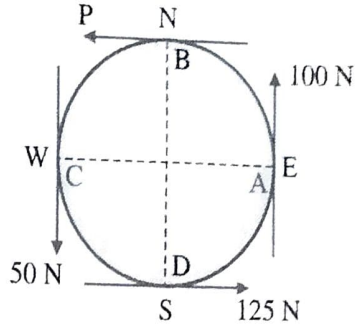


Fig. 50

Q. 75 The forces acting at a joint are 100 N along positive x direction acting away from origin, Q(N) along positive y direction acting away from origin, P(N) making 45° with x-axis acting away from origin in fourth quadrant and force F(N) making 45° with x-axis acting away from origin in third quadrant. Select the correct equation of equilibrium of forces in y direction.

(a) $100 - P \cos 45° + F \cos 45° = 0$ (b) $100 + P \cos 45° - F \cos 45° = 0$

(c) $Q - P \sin 45° - F \sin 45° = 0$ (d) $-Q + P \cos 45° + F \cos 45° = 0$

Ans. : (c)

Explanation :

Using $\Sigma F_y = 0$

$Q - P \sin 45° - F \sin 45° = \mathbf{0}$

So, option (c) is correct.

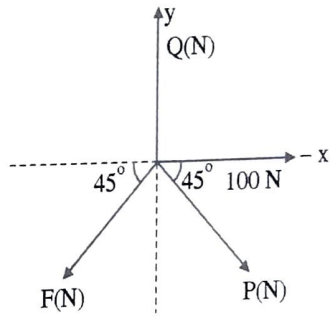


Fig. 51

Q. 76 Two forces 3 N and 7 N are acting at a point. If square of resultant is equal to three times the product of two forces. What is angle between two forces ?

(a) 22.22° (b) 46.13° (c)123.16° (d) 83.16°

Ans. : (d)

Explanation : P = 3 N, Q = 7 N and $R^2 = 3PQ = 63$ N

Using $R^2 = P^2 + Q^2 + 2PQ \cos\theta$

$63 = (3)^2 + (7)^2 + 2(3)(7) \cos\theta$

$\therefore \cos\theta = 0.119$ $\therefore \theta = 83.16°$

So, option (d) is correct.

Q. 77 Two forces P and 2P act at a point gives resultant of $\sqrt{8}$ P. What is the angle between two forces ?

(a) 62.3° (b) 41.4° (c) 32.8° (d) 121°

Ans. : (b)

Explanation : Using, $R^2 = P^2 + Q^2 + 2PQ \cos\theta$

$8P^2 = P^2 + (2P)^2 + 2P(2P) \cos\theta = 5P^2 + 4P^2 \cos\theta$

$\therefore \cos\theta = \frac{3}{4}$ $\therefore \theta = 41.4°$

So, option (b) is correct.

Q. 78 A rod ABCD is subjected to forces 20 N ↓ at A, 10 N ↓ at B, 35 N ↑ at C and 15 N ↓ at D. AB = 20 cm, BC = 10 cm, CD = 20 cm. What is the distance of R from A ?

(a) 10 cm to the left of A
(b) 10 cm to the right of A
(c) Passing through B
(d) none of the above

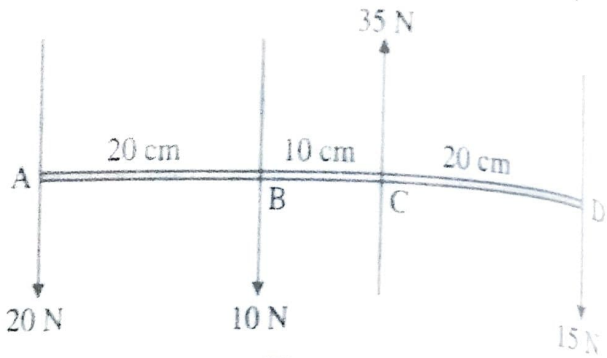


Fig. 52

Ans. : (a)

Explanation :

$\sum F_x = 0$ (All forces are vertical)

$\sum F_y = -20 - 10 + 35 - 15 = -10 \text{ N} = 10 \downarrow$

By Varignon's theorem,

$$R \cdot x = \sum M_A$$

$$Rx = (-10 \times 20) + (35 \times 30) - (15 \times 50) = 100 \text{ N·cm } \circlearrowleft$$

$$\therefore x = 10 \text{ cm from A (Left of A)}$$

So, option (a) is correct.

Q. 79 Find angle between two equal forces if resultant $R = \sqrt{3}\,P$

(a) 30° (b) 60° (c) 90° (d) 120°

Ans. : (b)

Explanation : Using, $R^2 = P^2 + Q^2 + 2PQ\cos\theta$

$$3P^2 = P^2 + P^2 + 2P^2\cos\theta$$

$$\therefore P^2 = 2P^2\cos\theta$$

$$\therefore \cos\theta = \frac{1}{2} \qquad \theta = 60°$$

So, option (b) is correct.

Q. 80 Three like horizontal forces of 10 N, 20 N, and 10 N act on a vertical rod at A, B, C. If AB = BC = 20 mm. The resultant force-couple system at A is

(a) 40 N, 800 N·mm (b) 0, 400 N·mm
(c) 20 N, 200 N·mm (d) None of the above

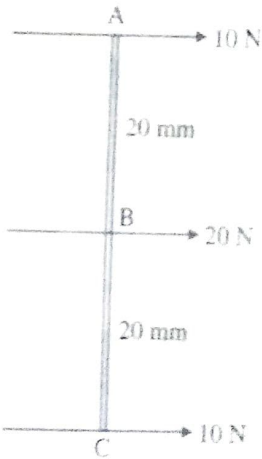


Fig. 53

Ans. : (a)

Explanation :

Here, $R = 10 + 20 + 10 = 40 \text{ N} \rightarrow$

Now, Moment about A is,

$$M_A = (20 \times 20) + (10 \times 40)$$

$$= 800 \text{ N.mm}$$

So, the resultant force-couple system at A is 40 N, 800 N.mm

So, option (a) is correct.

Q. 81 Three forces act at A(4m, 0), B (4 m, 3 m) and C (0, 5 m) of magnitudes 60 N vertically upward, 50 N along OB and 100 N horizontally towards right respectively. Find moment about origin.

(a) 250 N.m (b) 245 N.m (c) 260 N.m (d) 200 N.m

Ans. : (c)

Explanation : Moment about origin

$$M_o = -(100 \times 5) + (60 \times 4) = -260 \text{ N.m} = 260 \text{ N.m (cw)}$$

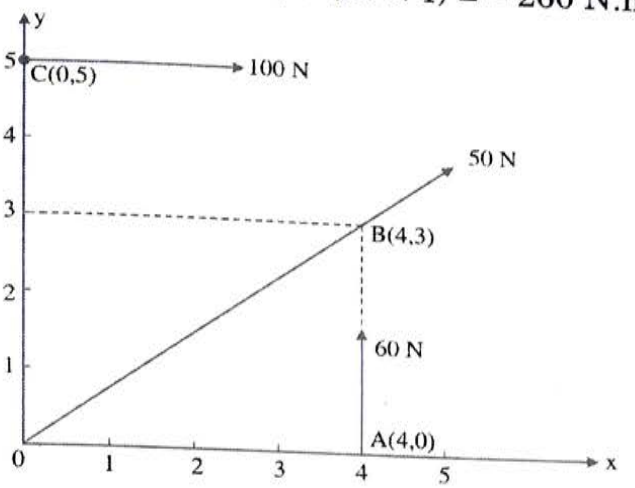


Fig. 54

So, option (c) is correct.

Q. 82 A vertical force of PN acting in first quadrant in xy plane at (2,1) m. If P = 200 N, the magnitude of moment about origin is

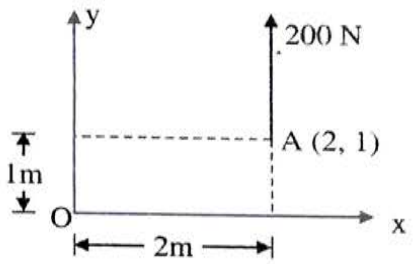
(a) 400 N·m (b) 300 N·m (c) 200 N·m (d) 100 N·m

Ans. : (a)

Explanation :

$$M_o = 200 \times 2$$

$$= 400 \text{ N} \cdot \text{m}$$



So, option (a) is correct.

Fig. 55

Q. 83 A telephone pole is supported by a wire which exerts a pull of 890 N on the top of the pole. If the angle between the wire and the pole is 50°. What are the horizontal and vertical components ?

(a) 681.8 N, 572.1 N (b) 352.3 N, 853.4 N

(c) 853.4 N,352.3 N (d) 572.1 N, 681.8 N

Ans. : (a)

Explanation :

Horizontal component = 890 sin 50° = 681.8 N (←)

Vertical component = 890 cos 50° = 572.08 N(↓)

So, option (a) is correct.

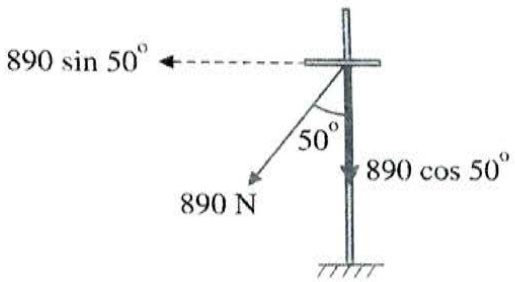


Fig. 56

Q. 84 If a block of weight W = 100 N placed on rough surface inclined at an angle θ = 60° in anticlockwise direction with positive x-axis and is at rest, then assuming up the plane forces positive, the reaction offered by the surface is

(a) 86.6 N (b) – 86.6 N (c) 50 N (d) – 50 N

Ans. : (c)

Explanation :

Reaction offered by surface

$$R = W \cos \theta = 100 \cos 60° = 50 \text{ N}$$

So, option (c) is correct.

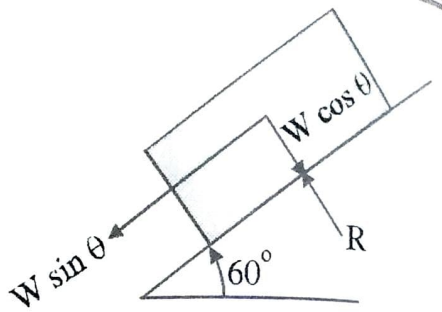


Fig. 57

Q. 85 Four forces 180 N, 100 N, 60 N and 50 N are acting along sides AB, BC, CD and DA of a square ABCD of side 2 m. Their resultant force is 130 N. Calculate position of resultant w.r.t 'A'

(a) 2.46 m (b) 3.46 m (c) 2.64 m (d) 3.64 m

Ans.: (a)

Explanation :

To find position of resultant,

Using Varignon's theorem about A

$$Rx = \Sigma M_A$$

where, $R = 130$ N(given)

$$\therefore 130\,x = (100 \times 2) + (60 \times 2)$$

$$\therefore x = 2.46 \text{ m from A}$$

So, option (a) is correct.

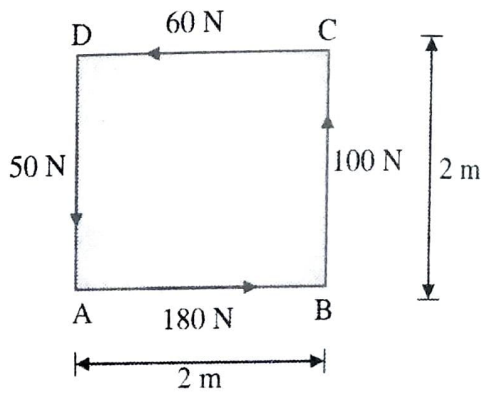


Fig. 58

Q. 86 Two like parallel forces 40 N and 70 N are acting at a distance of 40 mm. What is the distance of resultant from 40 N force ?

(a) 250 mm from 40 N force (b) 22.25 mm from 40 N force

(c) 25.45 mm from 40 N force (d) 45.25 mm from 40 N force

Ans. : (c)

Explanation :

Here $R = 40 + 70 = 110 \uparrow$

$\therefore$ By Varignon's theorem about A

$$R \cdot x = \Sigma M_A$$

$$110\,x = 70 \times 40$$

$$\therefore x = 25.45 \text{ mm from A (to the right of A)}$$

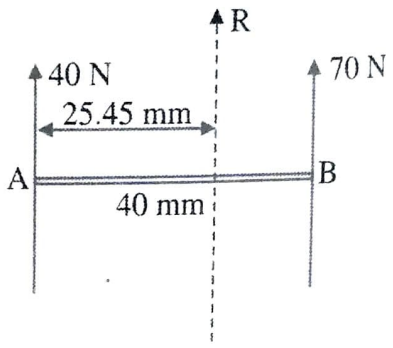


Fig. 59

So, option (c) is correct.

Q. 87 A force of magnitude 20 N makes an angle of 220° with positive x-axis. Its y component will be

(a) 15.32 N (b) – 12.86 N (c) 12.86 N (d) – 15.32 N

Ans. : (b)

Explanation :

x-component = $20 \cos (220°) = -15.32$ N

y component = $20 \sin (220°)$

= -12.86 N

OR

y component = $-20 \sin 40°$

= -12.86 N

So, option (b) is correct.

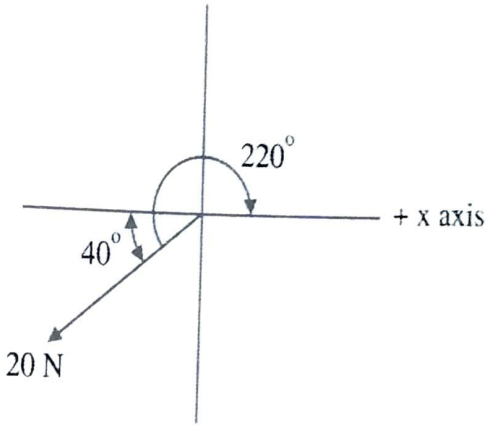


Fig. 60

Q. 88 A force of magnitude 250 N is directed from point A(1, 3) to B (4, 6). The x and y components are

(a) 130 N, 120 N (b) – 130 N, – 120 N

(c) 176.78 N, 176.78 N (d) – 176.8 N, – 176.8 N

Ans. : (c)

Explanation :

Angle made by force with x-axis is

$$\tan \theta = \frac{3}{3}$$

or $$\tan \theta = \frac{y_2 - y_1}{x_2 - x_1} = \frac{6-3}{4-1} = \frac{3}{3}$$

$$\therefore \theta = 45°$$

$\therefore$ x component = $250 \cos 45° = 176.78$ N

y component = $250 \sin 45° = 176.78$ N

So, option (c) is correct.

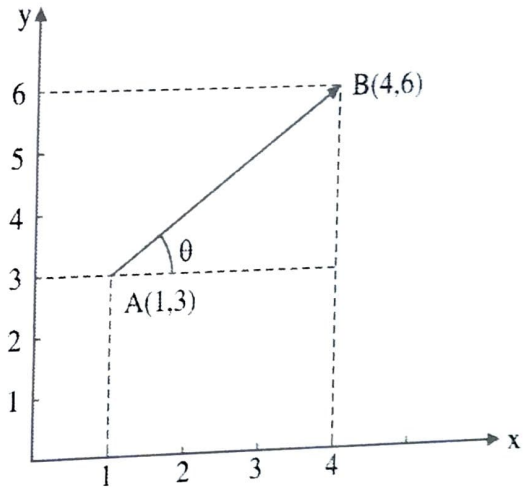


Fig. 61

Q. 89 A force of magnitude 50 N is directed form A(1, 1) to B (–3,–2). The x and y components are

(a) – 40 N, – 30 N (b) – 40N, 30 N (c) 40 N, 30 N (d) 30N, – 40 N

Ans. : (c)

Explanation : Angle made by force with x-axis

$$\tan \theta = \frac{3}{4}$$

OR use, $\tan \theta = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-2-1}{-3-1} = \frac{-3}{-4} = \frac{3}{4}$

$\theta = 36.87°$

$\therefore$ x component = $-50 \cos (36.87°)$

= -40 N

y component = $-50 \sin (36.87°)$

= -30 N

So, option (c) is correct.

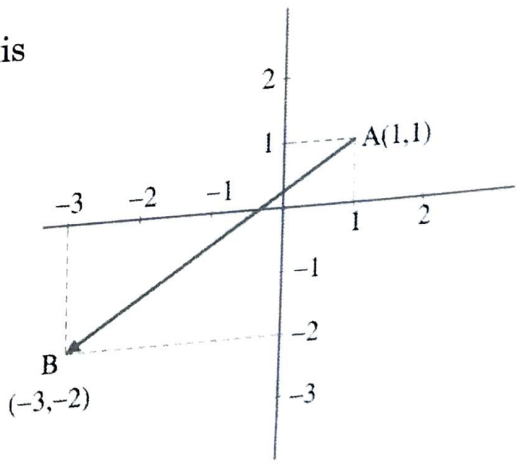


Fig. 62

Q. 90 A block of weight 100 N rests on an inclined plane making an angle of 60° with horizontal. The magnitude of component parallel to plane is,

(a) $50\sqrt{3}$ N (b) $25\sqrt{3}$ N (c) $\frac{50}{\sqrt{3}}$ N (d) 50 N

Ans. : (a)

Explanation : The magnitude of component parallel to plane $= mg \sin\theta$

$= W \sin\theta = 100 \sin 60°$

$= 100 \times \frac{\sqrt{3}}{2} = 50\sqrt{3}$ N

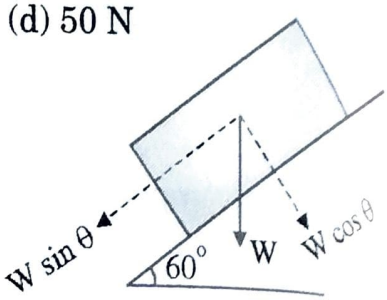


Fig. 63

So, option (a) is correct.

Q. 91 A force of 10 N is acting along a line having slope $\frac{3}{4}$. The magnitudes of x and y components are

(a) 6 N, 8 N (b) 8 N, 6 N (c) 10 N, 8 N (d) 6 N, 10 N

Ans. : (b)

Explanation : Slope $\tan\theta = \frac{3}{4}$

$\therefore \theta = 36.87°$

$\therefore$ x component $= 10 \cos(36.87°) = 8$ N

y component $= 10 \sin(36.87°) = 6$ N

So, option (b) is correct.

Q. 92 The x component of a force P(N) is $\frac{P}{2}$ (N). What is the angle made by the force with y axis ?

(a) 45° (b) 30° (c) 60° (d) None

Ans. : (b)

Explanation : x component $= P \cos\theta$

$\therefore \frac{P}{2} = P \cos\theta$

$\therefore \cos\theta = \frac{1}{2}$

$\theta = 60°$ (with x axis)

$\therefore$ Angle made by force with y-axis is 30°

$\therefore$ y component $= P \sin 60° = \frac{\sqrt{3}\,P}{2}$ (if asked)

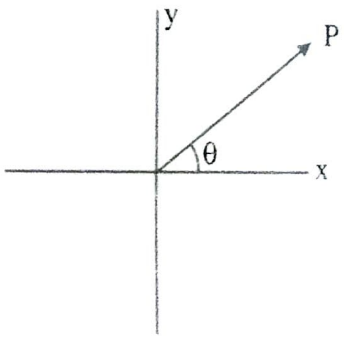


Fig. 64

So, option (b) is correct.

Q. 93 The x and y components of a force are Q(N) and – Q(N) respectively. The angle made by force with positive x axis is (measured clockwise from force)

(a) 45° (b) 135° (c) 45° (d) 315°

Ans. : (d)

Explanation :

x component = Q N (→)

y component = Q N (↓)

$$\therefore \tan\theta = \frac{\text{y component}}{\text{x component}} = \frac{Q}{Q} = 1$$

$\therefore \theta$ = 45° with x-axis in forth quadrant.

$\therefore$ Angle measured in clockwise direction from force will be 360° – 45° = 315° as shown in Fig. 65.

So, option (d) is correct.

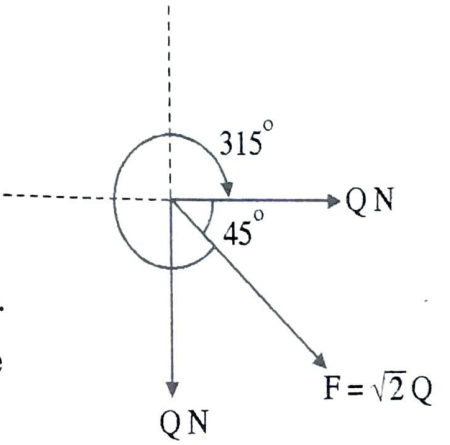


Fig. 65

Q. 94 The moment of a 100 N force acting at point A(4, 4) is zero about the point B(1, 1). The angle made by force with x-axis is

(a) 0° (b) 60° (c) 30° (d) 45°

Ans. : (d)

Explanation :

As moment of force is zero about point B, force should pass through point B.

$$\therefore \tan\theta = \frac{y_2 - y_1}{x_2 - x_1} = \frac{4-1}{4-1} = 1$$

$\therefore \theta$ = 45°

So, option (d) is correct.

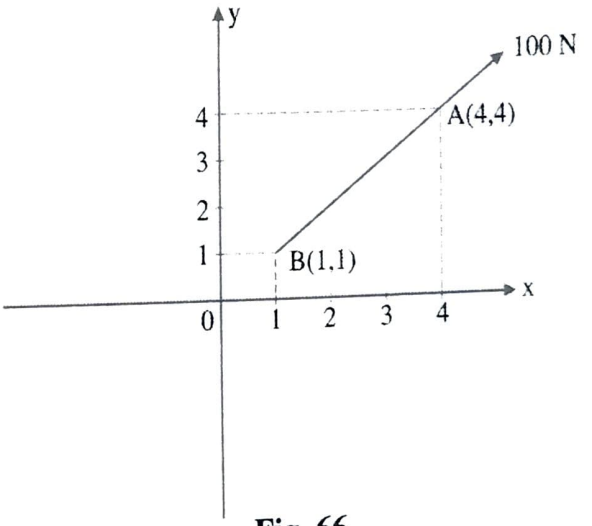


Fig. 66

Q. 95 The moment of a force P acting at point A(1, – 4) about a point B (–5, –4) is zero. The angle made by force with x-axis is

(a) 0° (b) 45° (c) 30° (d) 60°

Ans. (a)

Explanation : Here force is passing through A and B which is a horizontal force. So, angle made by force with x-axis is zero.

OR

$$\text{Slope } \tan\theta = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-4-(-4)}{-5-1} = 0$$

$\therefore \theta$ = **0°**

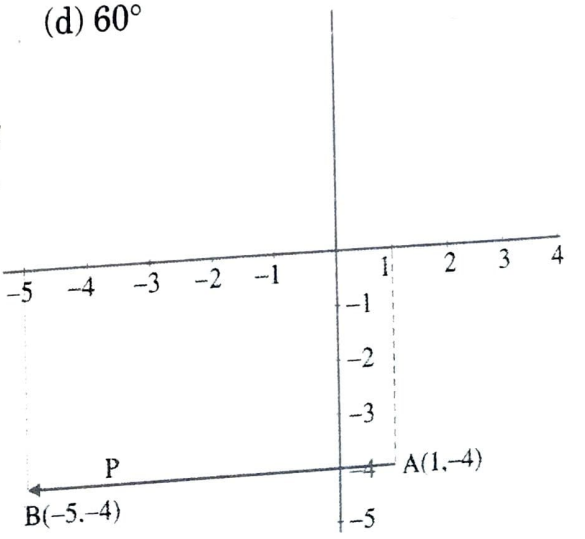


Fig. 67

So, option (a) is correct.

❑❑❑

ENGINEERING MECHANICS

MULTIPLE CHOICE QUESTIONS (MCQs):

UNIT-1: RESOLUTION AND COMPOSITION OF FORCES

1. BASIC CONCEPTS:

01. Principle of transmissibility can be applied only when the body is treated as [ ]
a) a particle b) a rigid body c) deformable d) a continuum

02. The weight of a body is a [ ]
a) body force b) surface force c) line force d) reactive force

03. Collinear forces are those which [ ]
a) are concurrent at a point b) are parallel to each other
c) lie on the same line d) act in different planes

04. The mathematical statement of the parallelogram law is called [ ]
a) sine law b) cosine law c) triangle law d) polygon law

05. The mathematical statement of the triangle law is called [ ]
a) sine law b) cosine law c) parallelogram law d) polygon law

06. State which of the following statement is true? [ ]
a) The parallelogram law can be proved mathematically
b) The parallelogram law can be proved experimentally
c) The parallelogram law is applicable for non-concurrent forces.
d) The parallelogram law cannot be applied to spatial concurrent forces.

07. An example for body force is [ ]
a) contact force b) force of gravity c) tensile force d) support reaction

08. An example for surface force is [ ]
a) contact force b) force of gravity c) tensile force d) support reaction

09. State in which of the following actions the applied force does not produce a moment. [ ]
a) pedaling a bicycle b) stretching a spring
c) Opening a water tap d) opening a door

10. The magnitude of the moment of a force about a point is equal to the product of the force and perpendicular distance between --------- and the point. [ ]
a) the magnitude of the force b) the line of action of the force
c) the sense of the force d) the point of application of the force

11. The unit of moment is [ ]
a) N/m b) N.s c) N.m d) N/m^2

12. State which of the following statement is true? [ ]
Two forces can produce the same moment about a point

a) only when the two forces are equal
b) only when the *moment* arms of the forces are equal
c) when the two forces are concurrent
d) when the product of the force and the moment arm are equal

13. Varignon.'s theorem is applicable only when the forces are [ ]
a) coplanar b) concurrent c) non-current d) Parallel

14. The magnitude of the moment is ----------when a force is applied perpendicular to a lever. [ ]
a) maximum b) minimum c) zero d) negative

15. Moment of a couple is a [ ]
a**)** free vector b) fixed vector c) sliding vector d) null vector

16. A rigid body can be idealized as a particle [ ]
a) only when its size is very minute b) only when the body is at rest
c) when there is no translational motion involved
d) when there is no rotational motion involved

17. According to Lami's theorem, the three forces [ ]
a) must be equal b) must be at 120^0 with each other
c) must be parallel d) must be concurrent

18. The Lami's theorem is applicable only for [ ]
a) coplanar forces b) concurrent forces
c) either a) or b) d) both a) and b)

19. Mechanics is that science which describes and predicts the following under the action of forces [ ]
a) condition of rest of bodies b) condition of motion of bodies
c) both of these d) none of these

20. Which of the following is an absolute rigid body? [ ]
a) Truss b) Frame c) Machine d) none of these

21. Which of the following is not an idealized concept? [ ]
a) Rigid body b) Particle c) Point of application of force d) none of these

22. Which of the following is an idealized concept? [ ]
a) 2-D body b) 3-D body c) Both of these d) none of these

23. Particle is a body whose [ ]
a) deformations are neglected b) dimensions are neglected
c) size is neglected d) both b) and c)

24. If the deformations of the body are negligible then that body is called as [ ]
a) deformable body b) rigid body c) 3-D body d) all of these

25. The purpose of mechanics is to explain and predict [ ]
a) physical phenomena b) chemical phenomena
c) both of these d) none of these

26. The basic concepts used in mechanics are [ ]
a) space b) time c) mass d) all of these

27. The concept of space is associated with [ ]
a) x-coordinate b) y-coordinate c) z-coordinate d) all of these

28. The concept of plane is associated with [ ]
a) x-coordinate b) y-coordinate c) both a) and b) d) none of these

29. Which of the following represents action of one body on the other [ ]
a) force b) mass c) time d) all of these

30. A force is characterized by its [ ]
a) point of application b) magnitude c) direction d) all of these

31. A very small amount of matter which may be assumed to occupy a single point in space is [ ]
a) particle b) smallest body c) body d) all of these

32. A rigid body is the body in which_____ under the action of applied forces. [ ]
a) distance between the particles is fixed b) there is no deformation
c) there is no change in shape and size d) all of these

33. The following law is based on experimental evidence. [ ]
a) parallelogram law of forces b) principle of transmissibility
c) Newton's laws of motion d) all of these

34. Line of action of force is the line which indicates [ ]
a) the direction of force b) the direction of displacement of the body
c) both of these d) none of these

35. Principle of transmissibility states that [ ]
a) force can be transferred to any other point along the same line of action of force
b) force can be transferred to any other point parallel to the same line of action of force c) both of these d) none of these

36. If the resultant force acting on the particle is zero, then [ ]
a) the particle will remain at rest if it is originally at rest
b) the particle will remain at rest if it is originally in motion
c) both of these d) none of these

37. If the resultant force acting on the particle is zero, then [ ]
a) the particle will remain at rest if it is in motion
b) the particle will move with constant velocity if it is in motion
c) the particle will move with constant acceleration d) all of these

38. If the resultant force acting on the particle is not zero, the particle will have an acceleration proportional to the magnitude of [ ]
a) resultant b) velocity c) displacement d) none of these

39. The study of behavior of rigid bodies under the action of forces is known as [ ]
a) Mechanics b) Engineering mechanics

c) Fluid Mechanics d) none of these

41. Statics is that branch of Engineering Mechanics which deals with the study of behavior of rigid bodies when they are [ ]
a) at rest b) in motion c) both of these d) none of these

42. The study of behavior of rigid bodies when they are in motion is [ ]
a) kinematics b) kinetics c) statics d) dynamics

43. The study of behavior of rigid bodies when they are in motion with out considering the forces causing the motion is [ ]
a) kinematics b) kinetics c) both of these d) none of these

44. The study of behavior of rigid bodies when they are in motion by considering the forces causing the motion is [ ]
a) kinematics b) kinetics c) both of these d) none of these

45. The quantities space, mass, time and force are dealt in [ ]
a) statics b) dynamics c) both of these d) none of these

46. Kinematics deals with [ ]
a) x, v, a and t b) x, v, a, t and F c) x, v, a, t, m and F d) none of these

47. Kinetics deals with [ ]
a) x, v, a and t b) x, v, a, t and g c) x, v, a, t, g and F d) none of these

48. The concept of force is not involved in [ ]
a) kinematics b) kinetics c) both of these d) none of these

49. Particle is a body that [ ]
a) possess mass b) occupy point in space
c) has negligible dimensions d) all of these

50. If the size of the body does not influence its response to the forces acting on it, then it is considered as a [ ]
a) rigid body b) particle c) deformable body d) all of these

51. Particle will have [ ]
a) only translatory motion b) only rotational motion
c) both of these d) none of these

52. When the applied forces have no tendency to rotate the body on which they act, the body may be considered as a [ ]
a) fixed body b) 1-D body c) 2-D body d) particle

53. In the computation of motion of the earth about the sun, the earth maybe accurately modeled as a [ ]
a) particle b) rigid body c) deformable body d) none of these

54. In the determination of the shape of the earth, the earth can be modeled as a [ ]
a) particle b) rigid body c) deformable body d) none of these

55. If a body is at rest, it implies that [ ]

a) the forces acting on it are always zero
b) the resultant of the forces acting on it are zero
c) the moment of the forces acting on it are zero
d) both the resultant force and moment are zero

56. Which of the following statement is correct? [ ]
a) A force is an agent which produces or tends to produce motion
b) A force is an agent which stops or tends to stop motion
c) A force may balance a given number of forces on a body
d) Both a) and b)

57. In order to determine the effects of force acting on a body, we must know [ ]
a) Its magnitude and direction of the line along which it acts
b) Its nature (whether push or pull)
c) Point through which it acts on the body d) all of the above

58. If a number of forces are acting simultaneously on a particle, then the resultant of these forces will have the same effect as produced by all the forces. This is known as [ ]
a) Principle of physical independence of forces
b) Principle of transmissibility of forces
c) Principle of resolution of forces d) None of these

59. The moment of a force about any point is geometrically equal to ____ area of the triangle whose base is the line representing the force and vertex is the point about which the moment is taken [ ]
a) Half b) Same c) twice d) None of these

60. If a number of coplanar forces are acting simultaneously on a particle, the algebraic sum of the moments of all forces about any point is equal to the moment of their resultant force about the same point. This principle is known as [ ]
a) Principle of moments b) Principle of levers
c) Principle of forces d) None of these

61. A couple consists of [ ]
a) two like parallel forces of same magnitude
b) two like parallel forces of different magnitude
c) two un like parallel forces of same magnitude
d) two un like parallel forces of same magnitude

62. If the arm of a couple is doubled, its moment will [ ]
a) be halved b) remain the same c) be doubled d) none of these

63. A couple can be balanced by a force equal to its magnitude. [ ]
a) Agree b) Disagree

64. One of the characteristics of a couple is that it can cause a body to move in the direction of the greater force [ ]
a) True b) False

65. In a couple the lines of action of forces are [ ]
a) parallel b) inclined c) concurrent d) none of these

66. A uniform bar AB weighing 100Kg is hinged at A to the vertical wall and is held in horizontal position by a vertical cord BC. The tension in the cord BC will be [ ]
a) 50Kg b) 75Kg c) 100Kg d) 150Kg

67. Forces acting on a ladder resting against a vertical wall and horizontal floor are an example of [ ]
a) concurrent forces b) coplanar non-concurrent
c) non-coplanar forces d) none of these

68. The couple is unchanged if [ ]
a) couple is rotated through any angle b) couple is shifted to any other position
c) both a) and b) d) none of these

69. The moment of a force about a point is a [ ]
a) Fixed vector b) Sliding vector c) Free vector d) Unit vector

70. The force acting on a point on the surface of a rigid body may be considered to act [ ]
a) at the centre of gravity of the body b) on the periphery of the body
c) on any point on the body on the line of action of the force
d) at any point on the surface normal to the line of action of the force

71. For which type of force system the Varignon's theorem of moment is used to locate the point of application of the resultant force. [ ]
a) concurrent force system b) concurrent space force system
c) non concurrent coplanar force system d) None of these

72. If two forces produce the same effect they are called [ ]
a) equal forces b) equivalent forces
c) same forces d) all of these

73. Which of the following quantity can be added algebraically? [ ]
a) Moment b) couple c) Torque d) all of these

74. State which of the following statement is true [ ]
a) The effect of the couple on the body is to produce translation
b) The effect of the couple on the body is to produce rotation
c) The effect of the couple on the body is to produce both, translation and rotation
d) The effect of the couple on the body is to produce equilibrium

75. The parallelogram law can [ ]
a) Be applied for non concurrent forces
b) Not be applied for non concurrent forces
c) Be proved mathematically
d) Be proved experimentally

76. Which of the following is a free vector? [ ]
a) Moment b) couple c) Torque d) none of these

77. A free body diagram is a diagram [ ]
a) drawn by free hand b) of a body suspended freely in air
c) of a body in vacuum free from any influence from the surroundings

d) drawn by detaching the the body from its attachments with the surroundings and replacing the attachments with force vectors

78. The moment of force….. [ ]
a) occurs about a point
b) measures the capacity to do useful work
c) measures only when bodies are in motion
d) measures ability to produce turning about axes

79. For a non-concurrent non-parallel coplanar force system, the closing of the force polygon insures that [ ]
a) The resultant is a couple b) The resultant is a single force
c) the resultant is not a single force d) none of these

2. RESOLUTION OF FORCES:

80. When a force vector is resolved into rectangular components, the components are -------- quantities. [ ]
a) scalar b) vector c) variable d) zero

81. When resolving a force into its components [ ]
a) only one component is possible
b) only two are components are possible
c) only three are components are possible
d) infinite number of components are possible

82. A sphere of weight 50N is suspended at centre by a rope. The sphere touches the vertical wall while the rope makes an angle of 40^0 with wall and tension in the rope is _____ [ ]
a) 70.1 N b) 65.30 N c) 77.80 N d) 101.50 N

83. A force of 100N acting away from the point at A(3,4) makes an angle 40^0 with vertical, its moment about the origin is [ ]
a) 113.58Nm(CW) b) 27.28Nm(ACW)
c) 27.28Nm(CW) d) 113.58Nm(ACW)

84. The guy wire of vertical electrical pole makes 40^0 with the pole and subjected to 40 kN force. What will be the horizontal component of the force? [ ]
a) 25.71N b) 30.64N c) 33.56N d) 25.68N

85. Two unlike parallel forces of 10N each acts at an angle of 30^0 with the horizontal. The horizontal distance between them is 1m. The couple formed by them is [ ]
a) 5Nm b) 10Nm c) 8.67Nm d) none of these

86. A force of 30N acting tangentially to a circle of radius 5m. Its moment about diametrically opposite point will be [ ]
a) 150Nm b) 300Nm c) 6Nm d) none of these

87. Resolve a force of 60 N making an angle of 60^0 with negative side of u axis, into the components acting along u and v axes which makes an angle of 40^0 with each other. [ ]

a) 55N,45N b) 31.92N, 30.83N c) 87.23N, 86.3N d) 41.58N, 69.58N

88. The flag pole is inclined at 60^0 with horizontal. A cable is attached at 30m distance from ground level to flag pole to raise it for hoisting. The cable is inclined at 30^0 with horizontal. What is the tension in cable if moment of tension about the base of pole is 72KNm. [ ]
a) 8.7 KN b) 8 KN c) 4.8 KN d) None of these

89. A 200 N force is acting tangent at circumferences of circular lamina. The force makes angle 60^0 with horizontal having x and y components positive. The radius of plate is 2m, reduce the system of forces into equivalent force system acting at centre of plate. [ ]
a) force 200 N at 60^0 and 400 Nm moment at centre of plate.
b) force 200 N at 60^0 c) 400 Nm moment at centre of plate
d)None of these

90. Four forces of magnitude of 60N, 110N, 120N, and 190N are acting along the sides AB, BC, CD and DA respectively of square ABCD. Determine the magnitude of the moment about A: if AB=2 [ ]
a) 460Nm b) 360 Nm c) 260 Nm d) None of these

91. Find the magnitude of the moment of force F about origin if F=64N, angle of F with horizontal is 140^0 and coordinates of point of application of F is (-3, 4) [ ]
a) 72.9 Nm b) 72.9 Nm c) 119Nm d) 219Nm

92. A toggle switch 24 mm long makes angle 30^0 with horizontal. It is hinged at its lower end and force 1.6 N acts verticallydown at its top end. What is moment at pivot pin? [ ]
a) 1.6 × (24 cos30) Nmm b) 1.6 × (24 sin30) Nmm
c) 16× 24 Nmm d) 1.6 × (24 tan30) Nmm

93. The resultant of two forces acting at the right angles is 5.8N and acting at 60^0 is 7N. The forces are.... [ ]
a) 1N and 4N b) 2N and 3N c) 2N and 5N d) 3N and 5N

94. A force of 30N acting tangentially to a circle of radius 5 m. Its moment about diametrically opposite point will be……. [ ]
a) 150Nm b) 300Nmm c) 300Nm d) None of the above

95. A force of 100 N acting at A (3,4) makes an angle 40° with vertical, its moment about origin is…….. [ ]
a) 499.25 Nm b) 486.92Nm c) 27.3 Nm d) 499.25 Nm

96. A sled is being pulled by a force of 25N exerted in a rope inclined at 30° with the horizontal. What is the effective component of the force pulling the sled? What is the component tending to lift the sled vertically? [ ]
a) 25N, 0 b) 12.5 N, 21.7N c) 0.25N d) 21.7N, 12.5N

97. A telephone pole is supported by a guy wire which exerts a pull of 890N on the top of the pole. The angle between the wire and the pole is 50°. What are the horizontal and vertical components of the pull on the pole. [ ]
a) 681.8N, 572.1 N b) 352.3N, 853.4N

c) 853.4N, 352.3N d) 572.1 N, 681 .8N

98. Find the moment of force F about origin if the magnitude of the force is 1 5N and the angle made by the force with horizontal is 337°. The point of application of the force is P (8, -2). [ ]
a) 19.3 Nm b) 25.6Nm c) -25.6Nm d) -19.3Nm

99. A block of mass 9kg rests on a plane making an angle of 16° with the horizontal. Determine the component of the weight normal to the plane. [ ]
a) 86.5 N b) 84.86 N c) 24.34 N d) 24.8 N

100. Find the moment of the force F about origin if [ ]
(i) the magnitude of the force = 8N
(ii) the angle made by the force with horizontal = 45°
(iii) the point of application of the force P = (6,1)
a) 56.6 Nm b) 28.3 Nm c) -56.6 Nm d) -28.3 Nm

101 The side of a regular hexagon ABCDEF is 2m. The forces of 10N, 20 N, 30 N, 40 N, 50N and 60N act along sides AB, CB, DC, DE, FE and FA respectively. Then their total moment about A is……. [ ]
a) 86.6 Nm b) 106.6 Nm c) 206.6 Nm d) 320.2 Nm

3. COMPOSITION OF FORCES:

102. If the resultant of two concurrent forces is zero then it implies that the two forces are [ ]
a) equal in magnitude b) equal in magnitude and direction
c) equal in magnitude and opposite in direction
d) equal in magnitude and perpendicular to each other

103. The vector method, for the resultant force, is also called polygon law of forces [ ]
a) Correct b) Incorrect

104. The resultant of two forces P and Q acting at an angle θ is equal to [ ]
a) $(P^2+ Q^2+2PQ\sin\theta)^{1/2}$ b) $(P^2+ Q^2+2PQ\cos\theta)^{1/2}$
c) $(P^2+ Q^2 -2PQ\sin\theta)^{1/2}$ d) $(P^2+ Q^2-2PQ\cos\theta)^{1/2}$

105. If the resultant of two forces P and Q acting at an angle (α) with P, then [ ]
a) $\tan\alpha= P\sin\theta/(P+Q\cos\theta)$ b) $\tan\alpha= P\cos\theta/(P+Q\cos\theta)$
a) $\tan\alpha= Q\sin\theta/(P+Q\cos\theta)$ b) $\tan\alpha= Q\cos\theta/(P+Q\cos\theta)$

106. Find the magnitude of two unlike parallel forces acting at a distance 1m apart, which is equivalent to a force of 300N acting at a distance of 200mm? [ ]
a) 240 N b) 60 N c) 120 N d) 300 N

107. Three forces F1=50N (East), F2= 100N (North) and F3= 75N (South) are acting at a point. Their resultant is [ ]
a) 56 N b) 66N c) 76N d) 86N

108. If forces of 1N, 2N, 3N, 4N, 5N and 6N act in order along the sides of a

regular hexagon, then the resultant is [ ]
a) 0N b) 6N c) 12N d) 21N

109. The centroid of a quadrant of a circle lies along its central radius at a distance of [ ]
a) 0.2R b) 0.3R c) 0.4R d) 0.6R

110. Find the Resultant of forces of 60 N and 150 N acting at a point, at an angle of 55^0 [ ]
a) 100N b) 150N c) 161.87N d) 190.84N

111. If two like parallel forces of 50N and 120N are acting at points A and B, which are 3.2m apart. Find the magnitude of resultant and its position with respect to point 'A'. [ ]
a) 120N & 2m b) 50N & 3.2m
c) 170N & 2.259m d) None of the above

112. 'P' and 'Q' are like parallel forces. If a couple, each of which forces is 'F' and whose arm is 'a' in the plain of P and Q is combined with them then the resultant is displaced through a distance of [ ]
a) $\frac{Fa}{P+Q}$ b) $\frac{F}{P+Q}$ c) $\frac{a}{P+Q}$ d) $\frac{1}{P+Q}$

113. Which of the following system of forces cannot be reduced to a single force? [ ]
a) non concurrent forces in a plane b) non concurrent forces in a space
c) parallel forces in space d) parallel forces in a plane

114. Four concurrent force are acting at a point such that F_1 = 70 N, 120^0 F_2 = 120 N, 24^0 and F_3 = 50 N, 310^0 The resultant of them is 100 N at 45^0, Then determine the fourth force. [ ]
a)203N,49^0 b) 103N, 49^0 c) 203N, 59^0 d)103N, 59^0

115. A horizontal beam AB of length 5 m is subjected to the two forces and a couple as given below. A force of 85 KN is acting at a distance of 1 m from left end A in downward direction and another force of 35 KN is acting at a distance of 3 m from A in upward direction. Also a moment of 60 KNm (clockwise) is acting at other end B. Find resultant in magnitude, direction and also finds its position from A. [ ]
a) 50 KN (Vertically Downward), 0.8 m
b) 50 KN (Vertically Downward), 1.8 m
c) 50 KN (Vertically upward), 1.8 m
d) 50 KN (Vertically upward), 0.8 m

116. A horizontal beam PQ of span 4m is subjected to uniformly distributed load of 10KN/m on 2m span from left end P from top and a counter clockwise moment of 5 KNm at left Q. Find its resultant in magnitude and direction. [ ]
a) 25 KN(Vertically upward) at P
b) 25KN(Vertically Downward) at 1.25 m to the left of P
c) 20KN(Vertically upward)
d) 20KN(Vertically Downward) at 1.25 m to the right of P

117. Determine the resultant of the coplanar forces 32N, 20^0 and 64N, 190^0 [ ]
a) 64N,$\theta=240^0$ b) 33N, $\theta=180^0$ c) 90N, $\theta=136^0$ d) 46.5N, $\theta=54^0$

118. Two unequal forces acting at a point at an angle of 150^0 have a resultant which is perpendicular to the smaller force. The larger force is 24 N. Find the smaller force and the resultant [ ]
a) 20.78N, 12N b) 13.6N,33N c) 43.24N,16N d) 53.44N,18N

119. Force P = 126N is acting at an angle 60 degree in II quadrant and force Q is acting at 30^0 in III quadrant . Find the magnitude of force Q if the resultant is 143.28 N [ ]
a) 70 KN b) 40 N c) 68.2 N d) 50 N

120. Four forces of magnitude of 40N, 90N, 100N, 170N are acting along the sides AB, BC, CD, DA respectively of a square ABCD the magnitude of resultant force is [ ]
a) 94.34 N b)100 N c) 90 N d) None

121. The resultant of two forces by law of parallelogram is….. [ ]
a) $R^2=P^2+Q^2-2PQ\ COS\ \theta$ b) $R^2=P^2+Q^2+2PQ\ COS\ \theta$
d) $R^2= P^2-Q^2+2PQ\ COS\ \theta$ d) $R^2=P^2-Q^2-2PQ\ COS\ \theta$

122. Two equal, opposite and parallel forces from a couple and the resultant force of the couple is….. [ ]
a) Parallel to force b) Perpendicular to forces
c) Zero d) None of above

123. The direction of the resultant of general force system with respect to y-axis is [ ]
a) $\beta= \tan^{-1} \frac{\Sigma Fx}{(\Sigma Fy)}$ b) $\beta= \tan^{-1} \frac{\Sigma Fy}{(\Sigma Fy)}$
c) Parallel to x-axis d) Parallel to y-axis

124. A square PQRS of 1 .5m side is acted by 100N, 200N and 400N along sides taken in order. The 100N force acts horizontally towards right. Their resultant is [ ]
a) 330 N b) 360 N c) 400 N d) 250 N

125. If two equal forces of magnitude P act at an angle 2θ, then their resultant will be..... [ ]
a) P cosθ/2 b) 2P sinθ/2 c) P tanθ/2 d) 2P cosθ

126. If two forces act at right angles their resultant is 5 N. While if they act at 600, their resultant is N. The magnitude of two forces is…….. [ ]
a) 4 N and 5N b) 3 N and 5 N c) 3 N and 4NS d) 4 N and 5N

127. Forces 10 N, 20 N, 30 N and 40 N act along sides of a rectangle P0, OR, RS, SP. Their resultant force will be…… [ ]
a) 28.28 N b) 44.72 N c) 100 N d) 32.32 N

128. If three forces 10 N ,20 N and 10 N act at a point and angle between the first two forces is 30°and angle between the latter two forces is 60° ‘then calculate the value of the resultant force. [ ]

a) 33.85 N b) 5.77 N c) 8.66 N d) 10 N

129. Forces 15N, 25N, 35N, 45N and 50N act along AB, AD, GB, CD and BD of a square. The resultant will be …….. [ ]
a) 54.1 N b) 63.40 N c) 70.10 N d) 60.54 N

130. A horizontal bar AB of length 8m is acted upon by a 20N vertically upward force at end A, 20N vertically downward force at C, where AC = 3m and a 80N vertically upward force at end B. Then the resultant force on bar AB is. [ ]
a) 80N (-), 0.75m, left of B b) 100N (-) 2m, left of B
c) 80N (¯), 0.75m, right of B d) 80N (¯), 0.75m, left of B

131. The resultant of two forces in a plane is 800 N at 60°. One of the forces is 160N at 30°. Determine the missing force. [ ]
a) 250N at 76° b) 320N at 76° c) 667N at 67° d) 450N at 105°

132. Find the resultant of 130N at 300W of S and 280N at 40° S of E [ ]
a) 329N at 63° S of E b) 329N at 63° N of E
c) 329N at 63° S of W d) 329N at 63° W of N

133. If the resultant of the two forces acting on a particle be at right angles to one of them, and its magnitude is 1/3rd of the other. Then the ratio of the larger force to the smaller one is…… [ ]
a) 3:1 b) 1:3 c) 3:2 d) 1:1

134. Two given forces act on a particle. Find in what direction a third force of a given magnitude must act, so that the resultant of the three may be as great as possible. [ ]
a) in the direction of the greater force b) in the direction of the smaller force
c) in the direction of the resultant of the two given forces
d) opposite to the direction of the resultant of the two given forces

ANSWERS:

01.b	02.a	03.c	04.b	05.a	06.b	07.b
08.a	09.b	10.b	11.c	12.d	13.b	14.a
15.a	16.d	17.d	18.d	19.c	20.d	21.d
22.a	23.d	24.b	25.a	26.d	27. d	28.c
29. a	30. d	31.a	32.d	33.d	34.c	35.a
36.a	37.b	38.a	39.b	40.c	41.a	42.d
43.a	44.b	45.c	46.a	47.c	48.a	49.d
50.b	51.a	52.d	53.a	54.c	55.d	56.d
57.d	58.a	59.c	60.a	61.c	62.c	63.b

64.b	65.a	66.a	67.b	68.c	69.a	70.c
71.c	72.b	73.d	74.b	75.d	76.b	77.d
78.d	79.c	80.b	81.d	82.b	83.c	84.a
85.a	86.b	87.b	88.c	89.a	90.a	91.a
92.a	93.d	94.c	95.c	96.d	97.a	98.d
99.b	100.b	101.d	102.c	103.b	104.b	105.c
106.b	107.a	108.b	109.d	110.d	111.c	112.a
113.b	114.a	115.a	116.d	117.b	118.a	119.c
120.a	121.b	122.c	123.a	124.b	125.d	126.c
127.b	128.a	129.c	130.a	131.c	132.a	133.c
134.c						