

# Chapter Eight: Statics

## Creative Essay Type

1. ► Scenery-I : Three forces P, Q, R acting at a point are in equilibrium and the angle between P and Q is double than the angle between P and R.

Scenery-II : Two unlike parallel forces P, Q ( $P > Q$ ) act at A and B respectively. If P and Q are both increased by R and distance is 'd'.

[Mirzapur Cadet College, Tangail]

- a. Write down Lamy's Theorem. 2
- b. From Scenery-I, prove that  $R^2 = Q(Q - P)$ . 4
- c. From Scenery-II, show that  $d = \frac{R}{P - Q} \cdot AB$  4

Ans: See HSC EV Higher Mathematics 2nd Paper 8th Chapter Note Ques. No. 10 of Answer Paper.

2. ► The resultant of two forces P and Q ( $P > Q$ ) acting at a point O is R and the angle between them is  $\alpha$ .

[Mymensingh Girls' Cadet College, Mymensingh]

- a. State the parallelogram law of forces. 2
- b. If  $F = R_{\max}$  and  $G = R_{\min}$ , then show that  $R = \sqrt{F^2 \cos^2 \frac{\alpha}{2} + G^2 \sin^2 \frac{\alpha}{2}}$ . 4

- c. If a transversal intersects the lines of action of the three stimulus forces P, Q and R at the points L, M and N, then show that  $\frac{P}{OL} + \frac{Q}{OM} = \frac{R}{ON}$ . 4

Ans: See HSC EV Higher Mathematics 2nd Paper 8th Chapter Note Ques. No. 11 of Answer Paper.

3. ► The concurrence and parallel forces—

The figure – 01

[Joypurhat Girl's Cadet College]

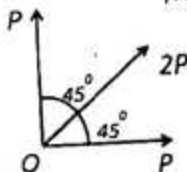
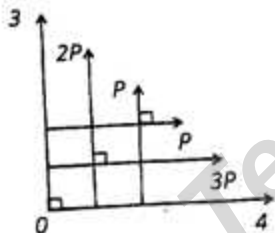


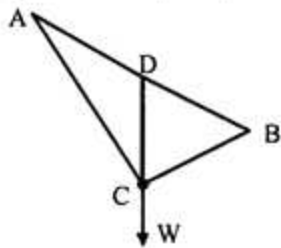
Figure-2



- a. Find the difference between the concurrence forces and parallel forces. 2
- b. From the figure-1, if the resultant is R, then prove that  $R \propto P$ . 4
- c. In the figure-2, find the magnitude, direction and position of their resultant. 4

Ans: See Page HSC EV Higher Mathematics 2nd Paper 8th Chapter Note Ques. No. 13 of Answer Paper.

4. ►



The weight W is kotted at C &  $AB = c$ ,  $AC = b$ ,  $BC = a$  where D is the middle point of AB.

[Cumilla Cadet College, Cumilla]

- a. If the greatest and least resultant of two forces are 9N and 4N, then what are the forces? 2
- b. If  $a = 16m$ ,  $b = 12m$ ,  $c = 20m$ ,  $W = 30kg\text{-wt}$ , then find the tension of AC and BC. 4

- c. If AB is horizontal and  $\Delta$  be the area of the triangle ABC, then show that the tension of the rope CA is  $\frac{Wb}{4c\Delta} (c^2 + a^2 - b^2)$ . 4

Ans: HSC EV Higher Mathematics 2nd Paper 8th Chapter Note

Ques. No. 16 of Answer Paper.

5. ► Scenario-I : Angle between forces Q and R ( $Q > R$ ) is  $\theta$ ; If two forces interchange their position, the direction of the resultant is turned into the angle  $\phi$ .

Scenario-II : O is the circum center of the triangle ABC, a force P acting along AO.

[RAJUK Uttara Model College, Dhaka]

- a. If three forces 5N, 7N and 8N acting on a body are in equilibrium then find the angle between forces 8N and 5N. 2
- b. From Scenario-I, Prove that,  $\tan \frac{\phi}{2} = \frac{Q - R}{Q + R} \tan \frac{\theta}{2}$ . 4

- c. From Scenario-II, Show that, the parallel components of P at the points B and C are in the ratio  $\sin 2B : \sin 2C$ . 4

Ans: See HSC EV Higher Mathematics 2nd Paper 8th Chapter Note

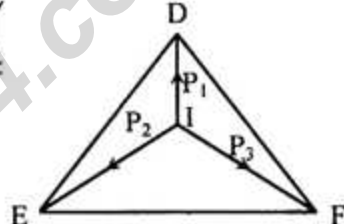
Ques. No. 21 of Answer Paper.

6. ►

Senerio-1:



Senerio-2:



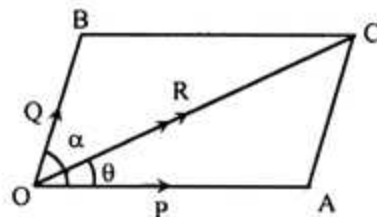
[Viqarunnisa Noon School & College, Dhaka]

- a. The resultant of forces 2N and  $2\sqrt{2}$  N trisects the angle between them. Find the angle between two forces. 2
- b. From Scenario-2, the forces  $P_1, P_2, P_3$  are in equilibrium and I is the incentre of the triangle DEF prove that  $P_1 : P_2 : P_3 = \cos \frac{D}{2} : \cos \frac{E}{2} : \cos \frac{F}{2}$ . 4
- c. From Scenario-1, If two forces increased by the same amount, show that the resultant will move further off from 20N. 4

Ans: See HSC EV Higher Mathematics 2nd Paper 8th Chapter Note

Ques. No. 24 of Answer Paper.

7. ►



In the figure : OACB is parallelogram which  $\angle AOB = \alpha$  and  $\angle AOC = \theta$

[Dhaka Residential Model College, Dhaka]

- a. Define parallelogram Law of forces. 2
- b. From the figure; find the value of R and  $\theta$ . 4

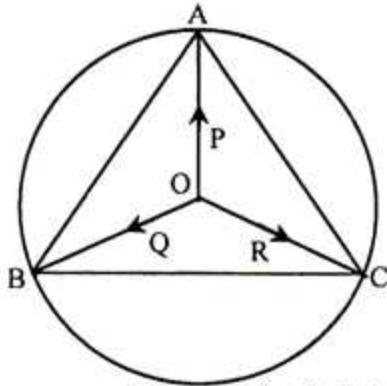
If  $p = Q$  then show that  $\theta = \frac{\alpha}{2}$

- c. In the figure: If  $P > Q$  and  $\theta = \frac{\alpha}{2}$  then show that  $\alpha = 3\cos^{-1} \left( \frac{P}{2Q} \right)$  and  $R = \frac{P^2 - Q^2}{Q}$ . 4

Ans: See HSC EV Higher Mathematics 2nd Paper 8th Chapter Note

Ques. No. 25 of Answer Paper.

8. ▶

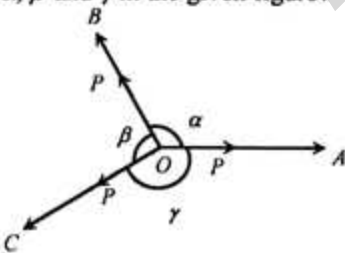


[Chattogram Cant Public College, Chattogram]

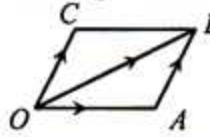
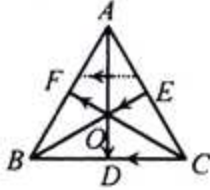
- a. Two forces  $4P$  and  $3P$  acting at a point  $O$  have a resultant  $5P$ . If any transversal cuts the line of action of the forces at the points  $R, S, T$  respectively show that  $\frac{4P}{OR} + \frac{3P}{OS} = \frac{5P}{OT}$ . 2
- b. If the forces in the stem are in equilibrium then show that,  $\frac{P}{a^2(b^2 + c^2 - a^2)} = \frac{Q}{b^2(c^2 + a^2 - b^2)} = \frac{R}{c^2(a^2 + b^2 - c^2)}$ . 4
- c. If the like parallel forces  $P, Q, R$  act at  $A, B, C$  and their resultant passes through  $O$ . Then prove that,  $P : Q : R = a \cos A : b \cos B : c \cos C$ . 4

Ans: See HSC EV Higher Mathematics 2nd Paper 8th Chapter Note Ques. No. 30 of Answer Paper.

### Creative Multiple Choice

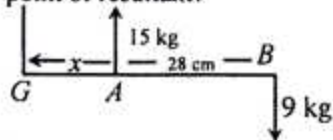
- What is the angle between  $4N$  and  $5N$  if their resultant force is  $9N$ ?  
 (a)  $0^\circ$  (b)  $30^\circ$   
 (c)  $60^\circ$  (d)  $90^\circ$  1
- What is the angle between two equal forces if the resultant force of them is equal to the square root of their product?  
 (a)  $0^\circ$  (b)  $30^\circ$   
 (c)  $60^\circ$  (d)  $120^\circ$  1
- What is called the intersecting point of three perpendicular bisectors of the arms of a triangle?  
 (a) incentre (b) circumcentre  
 (c) orthocentre (d) centroid 1
- Which of the following is the relation among the angles  $\alpha, \beta$  and  $\gamma$  in the given figure?  
  
 (a)  $\alpha = \beta = \gamma$  (b)  $\alpha = \beta = \gamma$   
 (c)  $\alpha = \beta + \gamma$  (d)  $\alpha = \beta = \gamma$  1
- Which of the following is known as the theorem of Lami?  
 [JNU: 2010-11]  
 (a)  $\frac{P}{\sin \alpha} = \frac{Q}{\sin \beta} = \frac{R}{\sin \gamma}$  (b)  $P^2 + Q^2 = R^2$   
 (c)  $S = ut + \frac{1}{2}at^2$  (d)  $\sin^2 \alpha + \sin^2 \beta = \sin^2 \gamma$  1
- Which formulae describe "If three coplanar forces acting at a point along different lines are in equilibrium, the magnitude of each is proportional to the sine of the angle between the other two"?  
 [RU: 2008-09]

- (a) triangle law of forces  
 (b) parallelogram law of forces  
 (c) Lami's theorem  
 (d) reverse theorem of Lami's theorem

- Three forces  $R_1, R_2, R_3$  are acting along the sides  $BC, CA$  and  $AB$  of triangle  $ABC$ . What will be the resultant of the forces?  
 (a)  $\sqrt{R_1^2 + R_2^2 + R_3^2}$  (b) 1  
 (c) 0 (d)  $R_1 + R_2 + R_3$  1
- Acting point of the resultant of two unlike parallel forces  $R$  and  $S$  does not change even though the forces exchange their positions of action. Which of the following is correct?  
 [KU: 2004-05]  
 (a)  $\frac{R}{S} = 1$  (b)  $\frac{R}{S} = 2$  (c)  $\frac{R}{S} = 3$  (d)  $\frac{R}{S} = 4$  1
- How much distance the resultant acts away from the largest force of two like parallel forces  $12N$  and  $8N$  those are acted on two sides of a stick of length  $10$  meter?  
 (a)  $2m$  (b)  $4m$  (c)  $8m$  (d)  $12m$  1
- The resultant of two unlike parallel forces is  $10$  dyne. The resultant acts  $3cm$  and  $5cm$  away from the forces. Which of the following are the values of forces?  
 (a)  $25, 15$  (b)  $10, 25$  (c)  $15, 20$  (d)  $10, 20$  1
- If the resultant of two equal forces  $P$  is  $R$  then what will be the angle between them?  
 (a)  $-\alpha$  (b)  $-\frac{\alpha}{2}$  (c)  $\frac{\alpha}{2}$  (d)  $\alpha$  1
- If the line of action of a system of forces lies on a plane then what is called the forces?  
 (a) System of like forces  
 (b) System of unlike forces  
 (c) System of coplanar forces  
 (d) System of perpendicular forces 1
- If we consider the parallelogram  $OACB$  then according to the parallelogram law of vector addition, which one of the following relation will be true?  
  
 (a)  $\vec{AB} + \vec{OC} = \vec{OB}$  (b)  $\vec{OA} + \vec{AB} = \vec{OB}$   
 (c)  $\vec{OB} + \vec{OA} = \vec{AB}$  (d)  $\vec{OA} + \vec{OC} = \vec{AB}$  1
- $O$  is a point on the plane of the triangle  $ABC$  and the middle point of the sides  $BC, CA, AB$  are  $D, E, F$  respectively. Which one will be the resultant of forces  $\vec{OD}, \vec{OF}$  and  $\vec{EO}$ ?  
  
 (a)  $\vec{OB}$  (b)  $\vec{OC}$   
 (c)  $\vec{OD}$  (d)  $\vec{OA}$  1
- Two parallel forces  $12kg$  and  $8kg$  weights, acting from two points at  $13cm$  apart. What will be their resultant when forces are unlike?  
 (a)  $12kg$  (b)  $8kg$   
 (c)  $20kg$  (d)  $4kg$  1



16. Two unlike parallel forces 15 kg and 9 kg acting at two points at a distance 28 cm. apart. Where will be acting point of resultant?



- (a) 42 cm (b) 32 cm  
(c) 24 cm (d) 36 cm
17. Two like parallel forces  $3W$  and  $W$  weights acts at the end points of a rod of length 8 ft. What will be the distance of the resultant acting point in ft. from the greatest force?
- (a) 8 (b) 4  
(c) 2 (d) 1

18. A man places a stick horizontally on his shoulder and a load at the end of the stick. If  $x$  is the distance of the shoulder and his hand then how pressure ( $R$ ) will vary on the shoulder?

- (a)  $R \propto x^2$  (b)  $R \propto \frac{1}{x^2}$   
(c)  $R \propto \frac{1}{x}$  (d)  $R \propto x$

19. If two equal forces of size  $\sqrt{5}$  units and having an angle between the forces  $120^\circ$  act from the same point then—

- i. the resultant is  $\sqrt{5}$  units  
ii. resultant makes an angle  $60^\circ$  with the force of  $\sqrt{5}$  units  
iii. resultant is less than the sum of the forces

Which of the following is correct?

- (a) i and ii (b) i and iii  
(c) ii and iii (d) i, ii and iii

20. A force of 12N which acts vertically has a portion of 5N acts along horizontal then —

- i. resultant force is 13N  
ii. angle between forces is  $90^\circ$   
iii. angle between forces is  $0^\circ$

Which of the following is correct?

- (a) i and ii (b) i and iii  
(c) ii and iii (d) i, ii and iii

21.  $P$  and  $Q$  are two forces. If they act on opposite and same direction, the resultant will be 3N and 5N respectively—

- i. value of force  $P$  is 4N  
ii. value of force  $Q$  is 1N  
iii.  $Q : P = 4 : 1$

Which of the following is correct?

- (a) i and ii (b) i and iii  
(c) ii and iii (d) i, ii and iii

Answer the questions 22 and 23 on the basis of following information:

Two forces, one of which two times of other, acted on the same point.

22. What is the resultant if the angle between them is  $120^\circ$ ?

- (a)  $\sqrt{3}P$  (b)  $\sqrt{7}P$   
(c)  $3P^2$  (d)  $7P^2$

23. What is the angle between the resultant and the smaller force if the angle between the forces is  $120^\circ$ ?

- (a)  $30^\circ$  (b)  $45^\circ$   
(c)  $90^\circ$  (d)  $120^\circ$

Answer the questions 24 and 25 on the basis of following information:

$S, T$  ( $S > T$ ) are two forces. Maximum and minimum resultants of them are 8N and 2N respectively.

24. What is the value of  $S$  ?

- (a) 2 N (b) 5 N  
(c) 6 N (d) 8 N

25. What is the value of resultant if the angle between the forces is  $60^\circ$  ?

- (a) 3 N (b)  $\sqrt{13}$  N  
(c) 5 N (d) 7 N

Answer the questions 26 and 27 on the basis of following information:

If two forces  $S$  and  $T$  ( $S > T$ ) acts perpendicularly then their resultant is  $2\sqrt{13}$  N. The greatest resultant of the forces is 10 N.

26. What will be the lowest resultant of the forces?

- (a) 2 N (b) 4 N  
(c) 6 N (d) 10 N

27. Which is the ratio of forces  $S$  and  $T$  ?

- (a) 2 : 3 (b) 5 : 1  
(c) 1 : 5 (d) 3 : 2

28. What will be the resultant force if 3 forces 6, 10, 14 units are acting along parallel to three sides of an equilateral triangle in same order? [DU 16-17]

- (a)  $4\sqrt{3}$  Units (b)  $7\sqrt{3}$  Units  
(c)  $10\sqrt{3}$  Units (d)  $15\sqrt{3}$  Units

29. Two forces 8N and 3N are acting at a point with an angle of  $60^\circ$ . The value of resultant force — [DU 15-16; JU 09-10]

- (a)  $\sqrt{73}$  N (b)  $\sqrt{97}$  N  
(c)  $\sqrt{55}$  N (d)  $\sqrt{11}$  N

30. If the resultant of the forces  $P$  and  $P$  is  $P$  then the included angle of the forces — [KUET 14-15]

- (a)  $30^\circ$  (b)  $60^\circ$   
(c)  $90^\circ$  (d)  $120^\circ$

31. Two forces  $P$  and  $\sqrt{2}N$  are acting at an angle  $45^\circ$  and their resultant force is  $\sqrt{10}N$ . What is the value of  $P$ ? [KUET 14-15]

- (a) 3N (b) 2N  
(c) 5N (d) 7N

32. Two forces acting at a point makes an angle of  $120^\circ$  whose largest force is 10N and the resultant force is perpendicular to smallest force. What is the value of resultant force? [CUET 14-15]

- (a)  $3\sqrt{3}N$  (b)  $5\sqrt{3}N$   
(c)  $5\sqrt{2}$  (d) None of those

33. Two forces of magnitude  $P$  and  $2P$  act on a particle. If the first is doubled and the second is increased by 8 units, the resultant is unaltered in direction. What is the value of  $P$ ? [CUET 14-15]

- (a) 4 unit (b) 8 unit  
(c) 12 unit (d) None of those

34. The resultant force of two forces  $P$  and  $10\sqrt{2}$  unit is perpendicular to  $P$  and the value of resultant force is one third of  $P$ . What is the value of  $P$ ? [KUET 14-15]

- (a)  $5\sqrt{2}$  unit (b)  $6\sqrt{5}$  unit  
(c) 10 unit (d)  $15\sqrt{2}$  unit

35. The forces of magnitude 4, 2 and 1 unit are acting along the sides AB, AC and BC respectively of an equilateral triangle ABC. What is the value of resultant force? [KUET : 09-10]

- (a)  $3\sqrt{3}$  (b)  $2\sqrt{3}$   
(c)  $\sqrt{3}$  (d) None of those



36. The resultant force of two forces PN and 12N is  $3\sqrt{7}$ N and it makes an angle of  $90^\circ$  with P. The value of P— [DU 08-09]
- (a) 9N (b) 12N  
(c)  $2\sqrt{7}$ N (d) 11N
37. Two equal forces are acting at a point at  $60^\circ$  which are in equilibrium by another force of 9N at the point. The value of each equal forces — [DU 08-09]
- (a) 3N (b)  $3\sqrt{3}$ N  
(c)  $\sqrt{3}$  (d) 7N
38. The largest force of two forces which are acting at  $120^\circ$  is 10N. The resultant force makes right angle with smallest force. The smallest force is — [DU 06, 07]
- (a) 4N (b) 5N  
(c) 6N (d) 8N
39. The greatest resultant of two forces is 17N. If they act at right angles, their resultant is 13N; the least resultant of the forces— [DU 04-05]
- (a) 6N (b) 7N (c) 5N (d) 8N
40. Three forces of magnitude 5N, 7N and 8N acting on a particle are in equilibrium. What is the angle between forces 5N and 8N? [BUET 05-06]
- (a)  $30^\circ$  (b)  $60^\circ$  (c)  $90^\circ$  (d)  $120^\circ$
41. The force  $F_1$  is acting horizontally and the force  $F_2$  is acting at an angle  $30^\circ$  with horizontal plane. Those forces make a body stable with 5 kg weight. What are the values of  $F_1, F_2$ ? [BUET 06-07]
- (a)  $\frac{5}{\sqrt{3}}, 10$  (b)  $5\sqrt{3}, 10$   
(c) 5, 10 (d) 5,  $10\sqrt{3}$
42. Two unlike parallel forces 45N and 15N are acting at points A and B of a rod. If the resultant force is acting at point C and  $AC = 5$ m then  $AB = ?$  [CUET 09-10]
- (a) 6m (b) 10m  
(c) 12m (d) None of those
43. Three like parallel forces 2, 2, P act at the vertices of the triangle ABC. If the line of action of their resultant passes through the centroid, the value of P — [CUET 13-14]
- (a) 2 (b) 3 (c) 4 (d) 5
44. The weight of 9kg is attached to the one side of a uniform rod of weight W and length 12m. If the rod is in stable vertically on a stake which is set 5.25m apart from that side then W = what? [BUET 12-13]
- (a) 65 kg (b) 60 kg (c) 63 kg (d) 45 kg
45. Two unlike parallel forces of 8 and 3 dyne are acting on two points of a rod in 12 cm apart. If only one force can keep the rod in equilibrium then what is the minimum length of the rod? [CUET 05-06]
- (a) 19.5 cm (b) 19.2 cm  
(c) 15 cm (d) 18 cm
46. Two forces of magnitudes 3P, 2P have a resultant R. If the first force is doubled, the magnitude of the resultant is also doubled. What is the angle between the forces? [DU 12-13]
- (a)  $30^\circ$  (b)  $60^\circ$  (c)  $120^\circ$  (d)  $150^\circ$
47. A body P placed on a uniform plane which is inclined at an angle  $\theta$  with the horizon. If a small body of mass m acts a horizontal force F on P and keep it in equilibrium then what is the value of F? [RUET 10-11]
- (a)  $m \cot \theta$  (b)  $m \tan \theta$   
(c)  $mg \cot \theta$  (d)  $mg \tan \theta$
48. A man places a stick of 6 feet length horizontally on his shoulder and a load of W weight at end of the stick. If the pressure on the shoulder is three times of the load then what is the distance of his hand from shoulder? [DU JB 07-08]
- (a) 1 foot (b) 2 feet  
(c) 3 feet (d) 4 feet
49. The magnitude of one force of two forces acting at a point is twice of the other and the resultant force is perpendicular to smallest one. What is the angle between forces? [DU 06-07, 05-06, 03-04]
- (a)  $110^\circ$  (b)  $120^\circ$  (c)  $135^\circ$  (d)  $150^\circ$
50. Two equal forces of magnitude  $\sqrt{3}$  unit are acting at a point at an angle  $120^\circ$ . The value of the resultant force — [DU 11-12]
- (a)  $\sqrt{3}$  unit (b)  $4\sqrt{3}$  unit  
(c) 3 unit (d)  $2\sqrt{3}$  unit
51. Two objects of weight 10.5 kg and 24.5 kg are attached to the end points of a light rod of 5 metre length. A man wants to carry the objects with rod. What is the distance between carrying point and lower weights end point? [BUET 11-12]
- (a) 1.5m (b) 2m (c) 3.5 m (d) 3 m
52. Two men carrying a bar of weight 30 kg and length 6m. One man carrying it 1m apart from one end and other man 2m apart from other end. What is the weights each of them carrying? [BUET 10-11]
- (a) 10 kg, 20 kg (b) 15 kg, 15 kg  
(c) 12 kg, 8 kg (d) None of those
53. If the square of resultant force of two equal forces is equal to three times of their product then the angle between them — [BUET 10-11]
- (a)  $90^\circ$  (b)  $60^\circ$  (c)  $45^\circ$  (d)  $30^\circ$
54. The resultant of two equal forces P and P is  $P\sqrt{2+\sqrt{2}}$ . What is the angle of resultant force with any of them? [BUTEX 13-14]
- (a)  $22.5^\circ$  (b)  $45^\circ$  (c)  $120^\circ$  (d)  $90^\circ$
55. Two forces of magnitude 3N & 5N acting at a point in opposite direction. What is the value of resultant force? [RUET 13-14]
- (a) 2N (b) 3N (c) 5N (d) 8N
56. If a force of 9 unit and a unknown force are acting at a point such that the resultant force is two third of unknown force and perpendicular to known force then what is the unknown force? [KUET 13-14]
- (a)  $\frac{27}{\sqrt{5}}$  unit (b)  $\frac{27}{\sqrt{2}}$  unit  
(c)  $\frac{18}{\sqrt{5}}$  unit (d)  $\frac{18}{\sqrt{2}}$  unit
57. Two forces are acting at a point at  $45^\circ$  angle and the resultant force is  $\sqrt{10}$  N. If one force of them is  $\sqrt{2}$ N then what is the other force? [KUET 13-14]
- (a) 2N (b) 4N (c)  $\sqrt{6}$  N (d)  $\sqrt{8}$  N
58. If a force of 12 unit and a unknown force are acting at a point such that the resultant force is half of unknown force and perpendicular to known force then what is the unknown force? [KUET 12-13]
- (a)  $\frac{1}{\sqrt{3}}$  unit (b)  $\frac{8}{\sqrt{3}}$  unit  
(c)  $8\sqrt{3}$  unit (d)  $12\sqrt{3}$  unit
59. Three forces of magnitude 2,  $\sqrt{5}$  & 3 are acting at a point. If they are in equilibrium then what is the angle between first two forces? [BIT 02-03]
- (a)  $0^\circ$  (b)  $90^\circ$  (c)  $180^\circ$  (d)  $360^\circ$