**SHEET 1**

**PENANG SANGAM HIGH SCHOOL**

**P. O. BOX 44, RAKIRAKI**

**LESSON NOTES - 23**

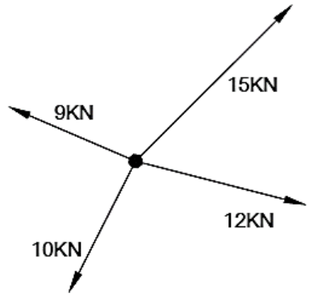
**SCHOOL: PENANG SANGAM HIGH** **SUBJECT: TECHNICAL DRAWING** **YEAR/ LEVEL: 11 C/D**

| | |
|---|---|
| Strand | TD11.4 APPLIED MECHANICS |
| Sub - Strand | TD11.4.1 FORCES |
| Content Learning Outcome | TD11.4.1.1 Recognize the impact of forces in nature and analyze Coplanar, Concurrent and Non-concurrent force systems. |

## TYPES OF FORCE SYSTEMS

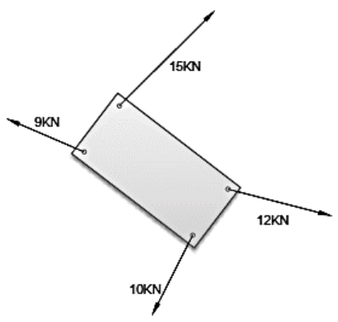
### Concurrent Coplanar Forces

This force system exists when all the lines of action of all forces are acting within the same plane and pass through a common point.



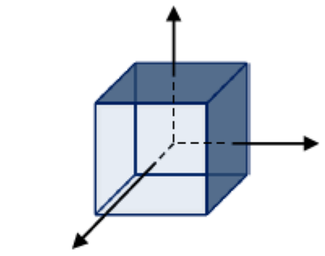

### Non-Concurrent Coplanar Forces

This force system exists when all the lines of action of all forces are acting within the same plane but do not pass through a common point.



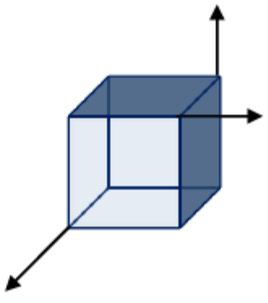

### Concurrent non-coplanar forces

This force system exists when all the lines of action of all forces are not acting within the same plane but do pass through a common point.



### Non-Concurrent Non-Coplanar Forces

This force system exists when all the lines of action of all forces are not acting within the same plane and do not pass through a common point.



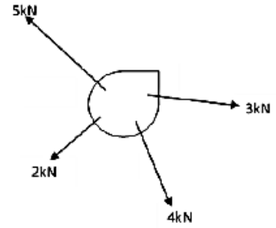


**WORKED EXAMPLE**

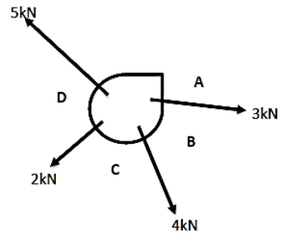
**Given:** a system of non-concurrent coplanar forces.

**Required:**

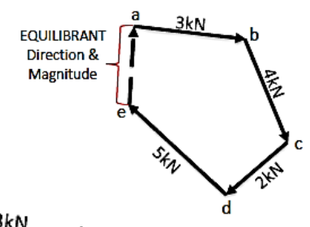
1. Using starting point **X** a provided, draw the vector diagram and locate the position and the direction of the resultant forces.
2. Show the direction and magnitude of the equilibrant forces on the space diagram.



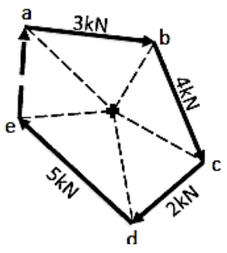

STEP 1
Label the spaces between the forces as shown using bow's notation




STEP 2
Construct a vector polygon (diagram) using the known forces to a suitable scale and close the polygon. This will be the equilibrant ($F_5$) giving its magnitude and direction.




STEP 3
Label the points of the vector diagram by small letters *a, b, c, d, e*. Thus, this vector *ab* will represent force F (3kN) which is lying between AB

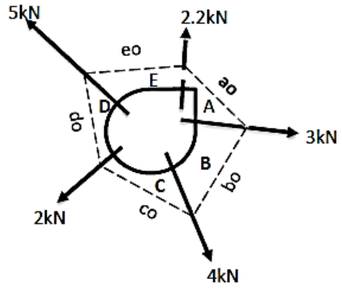



STEP 4
Select a suitable point *o* in the middle of the vector polygon (diagram)

STEP 5
Join *abcde* to the point *o*.

STEP 6
In the space diagram in space B, draw a line parallel to *ob*; in space C, a line to *oc*, and so forth completing the diagram with lines *od*, *oe*, *oa*.

STEP 7
The point where *oe* and *oa* intersect, this will give the point through which the equilibrant ($F_5$) maybe drawn parallel to *ae*.

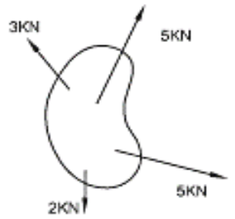


## EXAMPLE 3 - NON-CONCURRENT CO-PLANER FORCES

GIVEN: A SYSTEM OF NON-CONCURRENT FORCES ACTING ON THE SAME PLANE

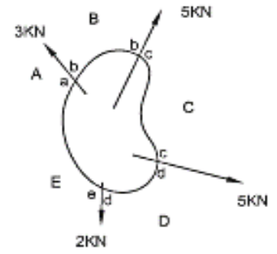
REQUIRED: 1. FIND THE MAGNITUDE AND DIRECTION OF THE RESULTANT FORCE
2. LOCATE THE POSITION OF THE RESULTANT FORCE ON THE GIVEN PLANE

NOTE: USE THE GIVEN STARTING POINT TO LOCATE THE FIRST VECTOR.




START HERE — SCALE 4mm : 1KN

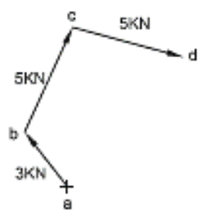
STEP 1
LABEL THE SPACES BETWEEN THE FORCES USING BOW'S NOTATION, USE CAPITAL LETTERS IN A CLOCKWISE DIRECTION



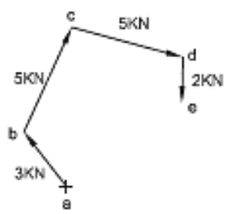

STEP 2
TRANSFER THE FIRST VECTOR IDENTIFIED AS 'ab' TO THE GIVEN STARTING POINT, MEASURE AND MARK THE SCALED LENGTH.


STEP 3
ADDING THE SECOND VECTOR TO THE FIRST VECTOR, PLACE THE TAIL OF THE SECOND VECTOR IDENTIFIED AS 'bc' TO THE HEAD OF THE FIRST VECTOR. MEASURE AND MARK THE SCALED LENGTH.

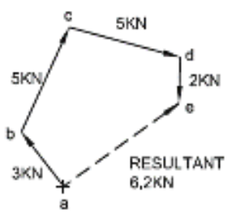

STEP 4
ADDING THE THIRD VECTOR TO THE SECOND VECTOR, PLACE THE TAIL OF THE THIRD VECTOR IDENTIFIED AS 'cd' TO THE HEAD OF THE SECOND VECTOR, MEASURE AND MARK THE SCALED LENGTH.



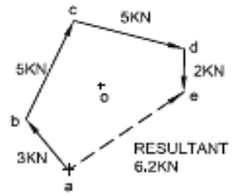

STEP 5
ADDING THE FOURTH VECTOR TO THE THIRD VECTOR, PLACE THE TAIL OF THE FOURTH VECTOR IDENTIFIED AS 'de' TO THE HEAD OF THE THIRD VECTOR, MEASURE AND MARK THE SCALED LENGTH.



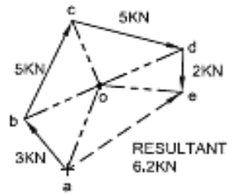

STEP 6
DRAWING THE RESULTANT VECTOR, DRAW A LINE FROM THE TAIL OF THE FIRST VECTOR TO THE HEAD OF THE LAST VECTOR, USING THE GIVEN SCALE MEASURE THE SCALED LENGTH.




STEP 7
LOCATE POLAR POINT 'O'. POLAR POINT 'O' SHOULD BE LOCATED AT THE APPROXIMATE CENTRE OF THE VECTOR POLYGON

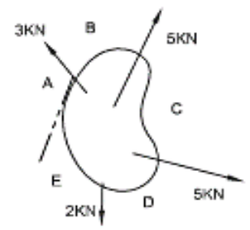



STEP 8
JOIN THE CORNERS OF EACH VECTOR TO THE POLAR POINT 'O'

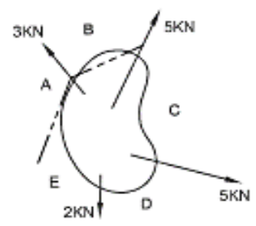



POLAR POLYGON

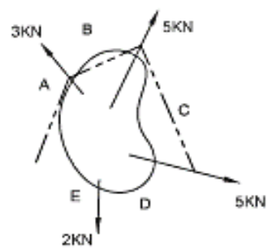
STEP 9
IN SPACE 'A' OF THE SPACE DIAGRAM DRAW A LINE PARALLEL TO 'oa' AS SHOWN. LINE 'oa' TO BE AS CLOSE AS POSSIBLE TO THE PLANE.



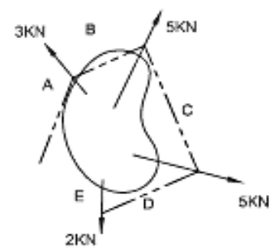

STEP 10
IN SPACE 'B' OF THE SPACE DIAGRAM DRAW A LINE PARALLEL TO 'ob' AS SHOWN, LINE 'ob' TO START FROM THE END OF LINE 'oa'.



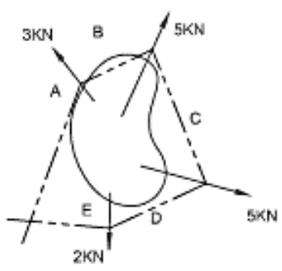

STEP 11
IN SPACE 'C' OF THE SPACE DIAGRAM DRAW A LINE PARALLEL TO 'oc' AS SHOWN, LINE 'oc' TO START FROM THE END OF LINE 'ob'.



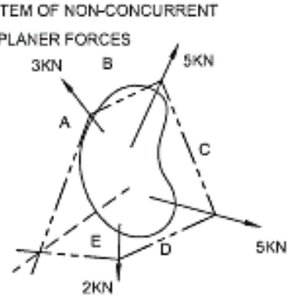

STEP 12
IN SPACE 'D' OF THE SPACE DIAGRAM DRAW A LINE PARALLEL TO 'od' AS SHOWN, LINE 'od' TO START FROM THE END OF LINE 'oc'.



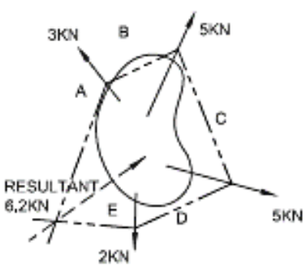

STEP 13
IN SPACE 'E' OF THE SPACE DIAGRAM DRAW A LINE PARALLEL TO 'ce' AS SHOWN, LINE 'ce' TO START FROM THE END OF LINE 'cd' AND EXTEND TO INTERSECT LINE 'oa'




STEP 14
INTERSECTION OF LINES 'ce' AND 'oa' GIVES THE POINT THROUGH WHICH THE RESULTANT VECTOR WILL PASS, TRANSFER THE LINE OF ACTION OF RESULTANT VECTOR TO THE GIVEN SYSTEM OF NON-CONCURRENT CO-PLANER FORCES




STEP 15
NEATLY OUTLINE THE RESULTANT VECTOR AND CLEARLY LABEL ITS MAGNITUDE AND INDICATE ITS DIRECTION WITH THE ARROW HEAD.



**SHEET 3**

## EXAMPLE 4 – NON-CONCURRENT CO-PLANER FORCES

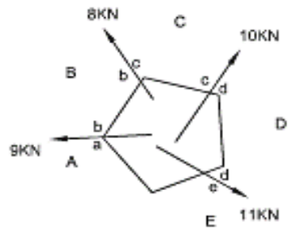
GIVEN: A SYSTEM OF NON-CONCURRENT FORCES ACTING ON THE SAME PLANE

REQUIRED: 1. FIND THE MAGNITUDE AND DIRECTION OF THE EQUILIBRANT FORCE
2. LOCATE THE POSITION OF THE EQUILIBRANT FORCE ON THE GIVEN PLANE

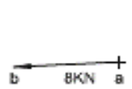
NOTE; USE THE GIVEN STARTING POINT TO LOCATE THE FIRST VECTOR,


START HERE → SCALE 2mm : 1KN

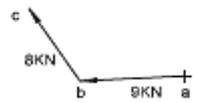
STEP 1
LABEL THE SPACES BETWEEN THE FORCES USING BOW'S NOTATION. USE CAPITAL LETTERS IN A CLOCKWISE DIRECTION



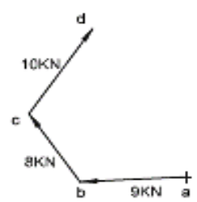

STEP 2
TRANSFER THE FIRST VECTOR IDENTIFIED AS 'ab' TO THE GIVEN STARTING POINT, MEASURE AND MARK THE SCALED LENGTH,



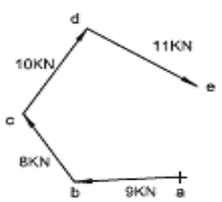

STEP 3
ADDING THE SECOND VECTOR TO THE FIRST VECTOR. PLACE THE TAIL OF THE SECOND VECTOR IDENTIFIED AS 'bc' TO THE HEAD OF THE FIRST VECTOR, MEASURE AND MARK THE SCALED LENGTH.



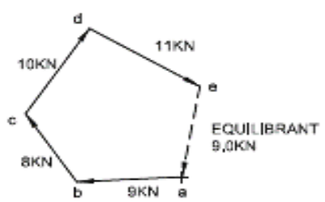

STEP 4
ADDING THE THIRD VECTOR TO THE SECOND VECTOR. PLACE THE TAIL OF THE THIRD VECTOR IDENTIFIED AS 'cd' TO THE HEAD OF THE SECOND VECTOR, MEASURE AND MARK THE SCALED LENGTH.



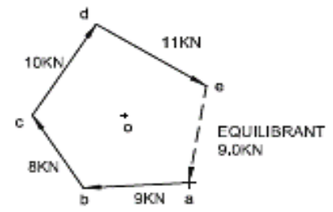

STEP 5
ADDING THE FOURTH VECTOR TO THE THIRD VECTOR. PLACE THE TAIL OF THE FOURTH VECTOR IDENTIFIED AS 'de' TO THE HEAD OF THE THIRD VECTOR, MEASURE AND MARK THE SCALED LENGTH.



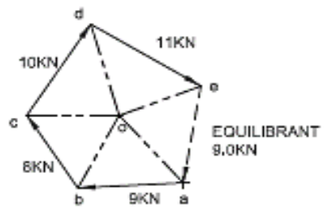

STEP 6
DRAWING THE EQUILIBRANT VECTOR. DRAW A LINE FROM THE TAIL OF THE FIRST VECTOR TO THE HEAD OF THE LAST VECTOR, USING THE GIVEN SCALE MEASURE THE SCALED LENGTH.




STEP 7
LOCATE POLAR POINT 'O'. POLAR POINT 'O' SHOULD BE LOCATED AT THE APPROXIMATE CENTRE OF THE VECTOR POLYGON

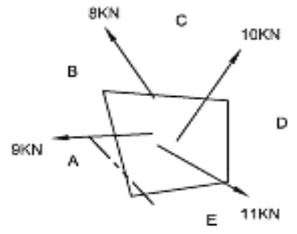



STEP 8
JOIN THE CORNERS OF EACH VECTOR TO THE POLAR POINT 'O'

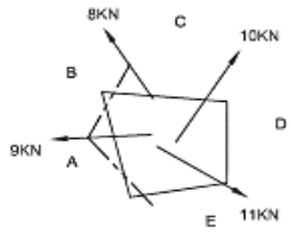



POLAR POLYGON

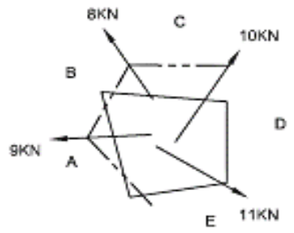
STEP 9
IN SPACE 'A' OF THE SPACE DIAGRAM DRAW A LINE PARALLEL TO 'oa' AS SHOWN, LINE 'oa' TO BE AS CLOSE AS POSSIBLE TO THE PLANE,



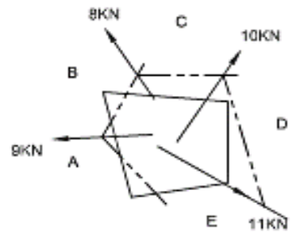

STEP 10
IN SPACE 'B' OF THE SPACE DIAGRAM DRAW A LINE PARALLEL TO 'ob' AS SHOWN, LINE 'ob' TO START FROM THE END OF LINE 'oa',



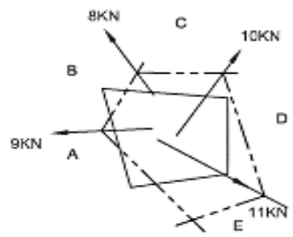

STEP 11
IN SPACE 'C' OF THE SPACE DIAGRAM DRAW A LINE PARALLEL TO 'oc' AS SHOWN, LINE 'oc' TO START FROM THE END OF LINE 'ab',



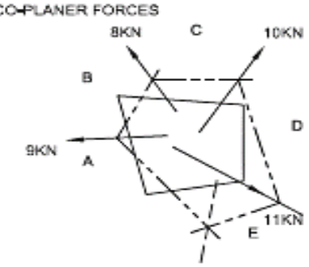

STEP 12
IN SPACE 'D' OF THE SPACE DIAGRAM DRAW A LINE PARALLEL TO 'od' AS SHOWN, LINE 'od' TO START FROM THE END OF LINE 'oc',



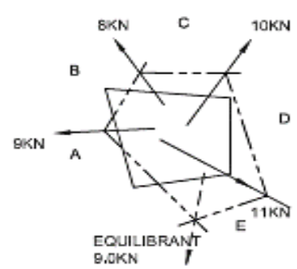

STEP 13
IN SPACE 'E' OF THE SPACE DIAGRAM DRAW A LINE PARALLEL TO 'oe' AS SHOWN, LINE 'oe' TO START FROM THE END OF LINE 'od' AND EXTEND TO INTERSECT LINE 'ca'




STEP 14
INTERSECTION OF LINES 'oe' AND 'ca' GIVES THE POINT THROUGH WHICH THE RESULTANT VECTOR WILL PASS. TRANSFER THE LINE OF ACTION OF RESULTANT VECTOR TO THE GIVEN SYSTEM OF NON-CONCURRENT CO-PLANER FORCES




STEP 15
NEATLY OUTLINE THE RESULTANT VECTOR AND CLEARLY LABEL ITS MAGNITUDE AND INDICATE ITS DIRECTION WITH THE ARROW HEAD.

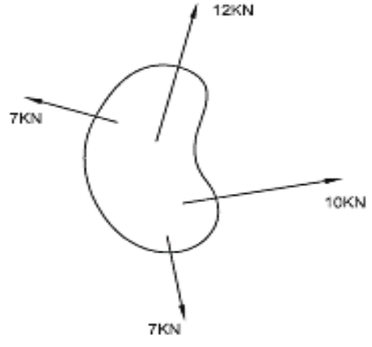


## EXERCISE 5 - NON-CONCURRENT CO-PLANER FORCES

GIVEN: A SYSTEM OF NON-CONCURRENT CO-PLANER FORCES

REQUIRED: 1. FIND THE MAGNITUDE AND DIRECTION OF THE RESULTANT FORCE
2. LOCATE THE POSITION OF THE RESULTANT FORCE ON THE GIVEN PLANE

NOTE: USE THE GIVEN STARTING POINT TO LOCATE THE FIRST VECTOR.




START HERE

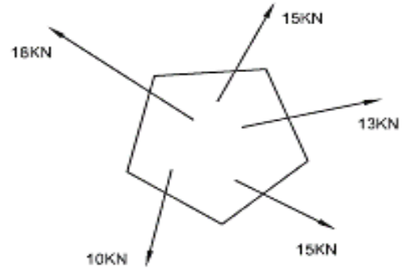
SCALE 4mm : 1KN

## EXERCISE 6 - NON-CONCURRENT CO-PLANER FORCES

GIVEN: A SYSTEM OF NON-CONCURRENT CO-PLANER FORCES

REQUIRED: 1. FIND THE MAGNITUDE AND DIRECTION OF THE RESULTANT FORCE
2. LOCATE THE POSITION OF THE RESULTANT FORCE ON THE GIVEN PLANE

NOTE: USE THE GIVEN STARTING POINT TO LOCATE THE FIRST VECTOR.




START HERE

SCALE 2mm : 1KN

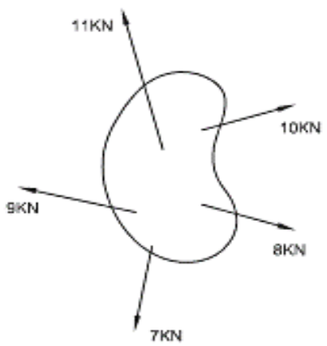
**THE END**

## EXERCISE 7 - NON-CONCURRENT CO-PLANER FORCES

GIVEN: A SYSTEM OF NON-CONCURRENT CO-PLANER FORCES

REQUIRED: 1. FIND THE MAGNITUDE AND DIRECTION OF THE EQUILIBRANT FORCE
2. LOCATE THE POSITION OF THE EQUILIBRANT FORCE ON THE GIVEN PLANE

NOTE: USE THE GIVEN STARTING POINT TO LOCATE THE FIRST VECTOR.




START HERE

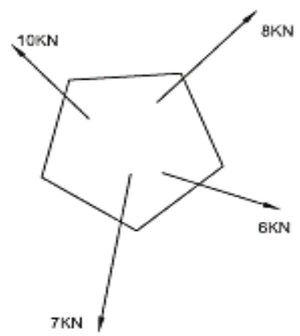
SCALE 4mm : 1KN

## EXERCISE 8 - NON-CONCURRENT CO-PLANER FORCES

GIVEN: A SYSTEM OF NON-CONCURRENT CO-PLANER FORCES

REQUIRED: 1. FIND THE MAGNITUDE AND DIRECTION OF THE EQUILIBRANT FORCE
2. LOCATE THE POSITION OF THE EQUILIBRANT FORCE ON THE GIVEN PLANE

NOTE: USE THE GIVEN STARTING POINT TO LOCATE THE FIRST VECTOR.




START HERE

SCALE 5mm : 1KN