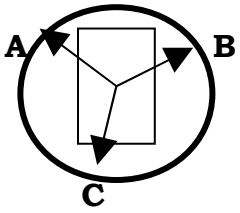
ADDITION OF FORCES: EQUILIBRIUM

WHEN TWO OR MORE FORCES ACT SIMULTANEOUSLY AT THE SAME POINT, THEY ARE SAID TO BE ACTING CONCURRENTLY AND ARE CALLED CONCURRENT FORCES. THE DIAGRAM BELOW ILLUSTRATES THREE FORCES ACTING CONCURRENTLY ON POINT P. SINCE POINT P IS NOT ACCELERATING, IT IS SAID TO BE IN **EQUILIBRIUM**. YOU WILL DETERMINE THE VECTOR SUM OF ANY TWO OF THE CONCURRENT FORCES (THE RESULTANT) AND INVESTIGATE THE RELATIONSHIP OF THE RESULTANT TO THE THIRD FORCE (CALLED THE EQUILIBRANT).



OBJECTIVE:

DURING THIS INVESTIGATION, YOU WILL APPLY THE LAWS OF VECTOR ADDITION TO INVESTIGATE EQUILIBRIUM.

PROCEDURES:

A. THE VECTOR SUM OF TWO FORCES

1. SET UP THE APPARATUS AS INDICATED ABOVE AND CHECK EACH SPRING SCALE TO BE SURE THE NEEDLE POINTS TO ZERO WHEN NO LOAD IS ATTACHED. ATTACH THE SCALES TO THE FORCE BOARD SO THAT EACH SCALE REGISTERS A FORCE MIDRANGE ON THE SCALES.

2. PLACE A 1/2 PIECE OF PAPER BENEATH THE SPRING SCALE ARRANGEMENT. USING A PENCIL, MARK TWO POINTS ALONG THE LINE OF ACTION OF EACH FORCE (UNDER THE PULLLING ARM). **DO THESE twice FOR EACH MEMBER OF YOUR LAB GROUP!!** RECORD THE READING OF EACH SPRING SCALE NEXT TO THE CORRESPONDING LINE.

3. REMOVE THE PAPER, AND USING THE POINTS YOU'VE MARKED, CONSTRUCT LINES A, B, AND C BACK TO WHERE THEY APPEAR TO COME FROM (THE CENTER OF THE RING!).

4. USING A SUITABLE NUMBER SCALE, CONSTRUCT VECTORS FROM THE ORIGIN ALONG LINES **A**, **B**, AND **C** TO REPRESENT EACH FORCE. IF THE SPRING SCALES ARE NOT CALIBRATED IN NEWTONS, YOU CAN USE THE READINGS IN GRAMS OR KILOGRAMS TO REPRESENT THE FORCE BECAUSE THE READINGS IN kg ARE DIRECTLY PROPORTIONAL TO THE FORCES.

5. USE ONE OF YOUR SHEETS AND ADD VECTOR **A** TO VECTOR **B** GRAPHICALLY USING THE HEAD-TO-TAIL OR PARALLELOGRAM METHODS.

6. DRAW AND LABEL THE VECTOR REPRESENTING THE VECTOR SUM OF **A + B**, THE RESULTANT. LIST THE MAGNITUDE OF THE RESULTANT IN TERMS OF THE NUMBER SCALE USED.

B. THE VECTOR SUM OF THE THREE FORCES IN EQUILIBRIUM

7. USING YOUR OTHER SHEET ADD VECTORS **A**, **B**, AND **C** USING THE HEAD-TO-TAIL METHOD.

INTERPRETATION: (Answer in conclusion section.)

1. COMPARE THE MAGNITUDE AND DIRECTION OF THE RESULTANT FORCE OF **A + B** WITH FORCE **C**. WHAT IS THE ANGLE BETWEEN THE RESULTANT OF **A + B** AND VECTOR **C**. EXPLAIN YOUR FINDINGS. SHOULD THIS ANGLE BE CLOSE TO 0° OR 180°?

2. DESCRIBE THE RESULTS OF YOUR ADDITION OF **A + B + C** IN PROCEDURE B. EXPLAIN. IS THE RESULTANT SMALL, LARGE, ETC… WHAT SHOULD IT BE? REMEMBER, THIS IS **EQUILIBRIUM**!

3. SUPPOSE YOU HAD ADDED **B** TO **C**. WHAT RESULTANT WOULD YOU EXPECT?(DESCRIBE ITS MAGNITUDE AND DIRECTION IN TERMS OF VECTOR **A**).

4. TRY *SKETCHING* THE SUM OF **B + C + A** IN YOUR LAB BOOK. SHOW YOUR WORK AND DISCUSS YOUR FINDINGS IN TERMS OF THE IMPORTANCE OF THE *O*RDER OF VECTOR ADDITION. *DOES THE ORDER MATTER?*