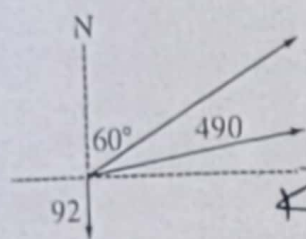


- B 4. Determine the magnitude and direction (to the nearest degree, relative to the first force) of the *resultant* of each of the following systems of forces:
- forces of 7 N and 8 N acting at an angle of 90° to each other
 - forces of 62 N and 48 N acting at an angle of 60° to each other
 - forces of 12 N and 31 N acting at an angle of 153° to each other.

5. Determine the magnitude and direction (to the nearest degree) of the *equilibrant* of each of the following systems of forces:

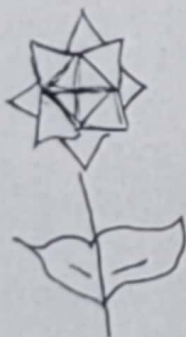
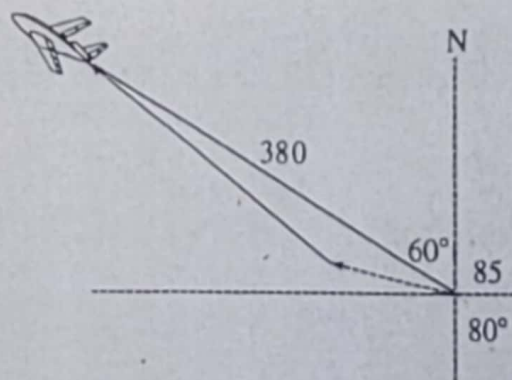
- forces of 55 N and 37 N acting at an angle of 30° to each other
- forces of 12 N and 9 N acting at an angle of 120° to each other
- forces of 11 N and 15 N acting at an angle of 34° to each other.



6. A plane is steering $N60^\circ E$ at an air speed of 490 km/h. The wind is from the north at 92 km/h. Find the groundspeed and track of the plane.

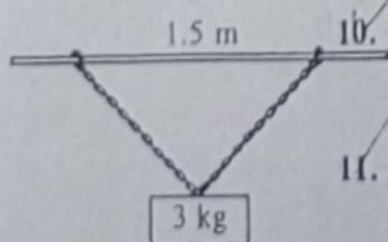
7. If the wind is from the east at 91 km/h and a plane is steering southwest at an airspeed of 340 km/h, find the velocity of the plane.

8. A pilot wants his plane to track $N60^\circ W$ with a groundspeed of 380 km/h. If the wind is from $S80^\circ E$ at 85 km/h, what heading should the pilot steer and at what airspeed should he fly?



9. A ship is steering west at 12 kn. A submarine 3 M to the north is steering southwest at 16 kn.

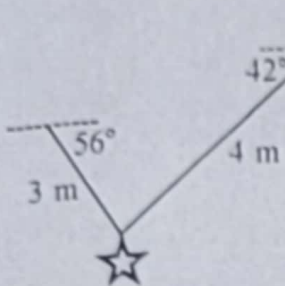
- Find the velocity of the submarine relative to the ship.
- Will the submarine pass in front of or behind the ship?



10. A 3 kg metal bar is suspended from the middle of a 2 m chain whose ends are attached to a support beam 1.5 m apart. Find the tensions in each part of the chain.

11. Two tug boats pull a barge directly against the current of the river. The tow ropes from the tugs are at an angle of 37° to each other; the forces exerted by the tugs along the ropes are both 4200 N. If the current produces a force of 45 N, what is the force with which the barge is pulled forward?

12. A ship is steering north at 16 kn. Radar detects a submarine 2 M to the east with a relative velocity of 13 kn at $S75^\circ E$. What is the actual velocity of the submarine?
13. A pilot maps out her flight plan and determines that to reach her destination on time her plane must travel $S10^\circ E$ at 510 km/h. If the wind is from $S40^\circ W$ at 55 km/h, what heading should the pilot steer and at what airspeed should she fly the plane?
14. Ropes of 3 m and 4 m in length are fastened to a holiday decoration to be suspended over the town square. The decoration has a mass of 5 kg. The ropes, fastened at different heights, make angles of 56° and 42° respectively with the horizontal. Calculate the tension in each rope.
15. A plane is heading $S70^\circ W$ with a groundspeed of 625 km/h. If the pilot is steering west at an airspeed of 665 km/h, what must be the windspeed and wind direction?



- C 16. A submarine detects a ship 5 M to the north. The ship is steering east at 20 kn. The submarine's attack speed is 30 kn. What course should the submarine steer to intercept the ship?
17. Three forces act on an object. Two of the forces (one 25 N, the other 12 N) are at an angle of 100° to each other. The third is perpendicular to the plane of these two forces and has a magnitude of 45 N. Calculate the magnitude of the equilibrant in this situation.
18. A boater wishes to cross a canal which is 3.0 km wide. He wishes to land at a point 2.0 km upstream from his starting point. If the current in the canal flows at 3.5 km/h and the speed of his boat is 13 km/h,
- what course should he steer?
 - how long will the trip take?

1.4 MULTIPLYING VECTORS BY SCALARS

When the orthopedic surgeon checks on the progress of her patient, she may add more mass to the situation to increase the pull on the broken bone or remove some mass to decrease the force. Such actions are modelled by the operation of scalar multiplication of vectors.

In light of what we know so far about geometric vectors, what would make sense as a meaning for the expression $3\vec{u}$? Consider the following diagram.

