

# Resultant Force Vector Diagrams

## Mark Scheme



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1. Whether it is an aeroplane fighting a heavy crosswind or two tugboats pulling a ship, vector diagrams visually map out exactly what happens when forces collide at an angle

For each of the following questions **circle** the letter of the correct answer.

- a) On the figure shown below, what is the magnitude of the resultant force of the two vectors?

|                                        |                      |
|----------------------------------------|----------------------|
| <b>B – is the only correct answer.</b> | <b>1 mark</b>        |
|                                        | <b>Total: 1 mark</b> |

- b) The figure below shows two forces acting at right angles to each other.  
In which direction will the resultant force act?

|                                        |                      |
|----------------------------------------|----------------------|
| <b>C – is the only correct answer.</b> | <b>1 mark</b>        |
|                                        | <b>Total: 1 mark</b> |

- c) A child pulls a toy cart with a diagonal force of 50 N.

Which diagram correctly shows the horizontal and vertical components of this 50 N force?

|                                        |                      |
|----------------------------------------|----------------------|
| <b>A – is the only correct answer.</b> | <b>1 mark</b>        |
|                                        | <b>Total: 1 mark</b> |

- d) Two forces, P and Q, act on an object.  
A student draws a vector diagram to find the resultant force, R.

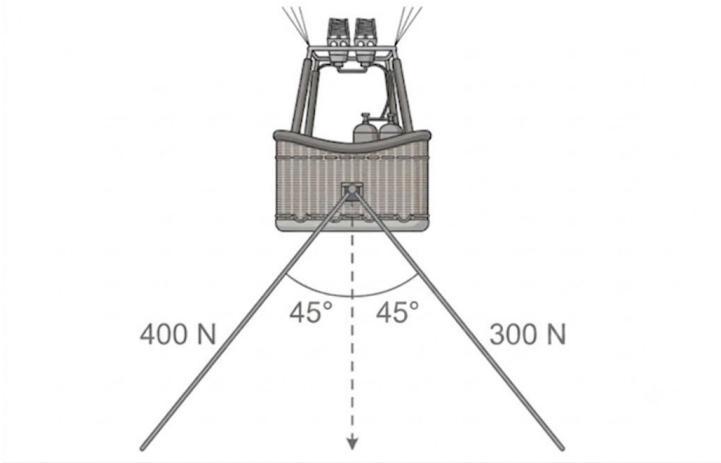
Which diagram correctly shows how the resultant force R should be drawn?

|                                        |                      |
|----------------------------------------|----------------------|
| <b>B – is the only correct answer.</b> | <b>1 mark</b>        |
|                                        | <b>Total: 1 mark</b> |

(Total for Question 1 is 4 marks)

2. This question is about forces.

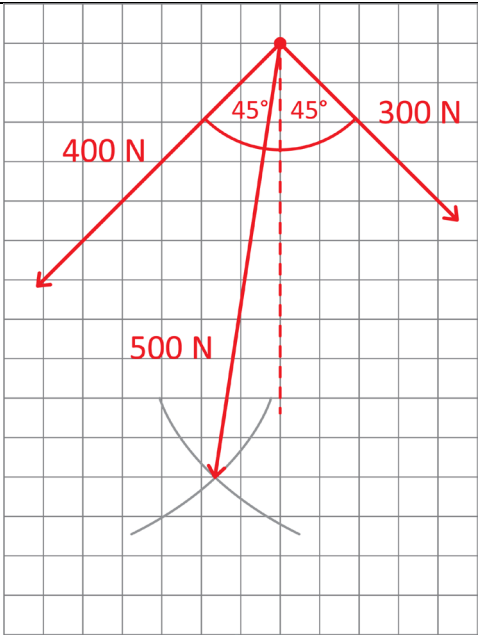
The figure below shows a hot air balloon tethered to the ground by two ropes.



The hot air balloon is held in place by two ropes.

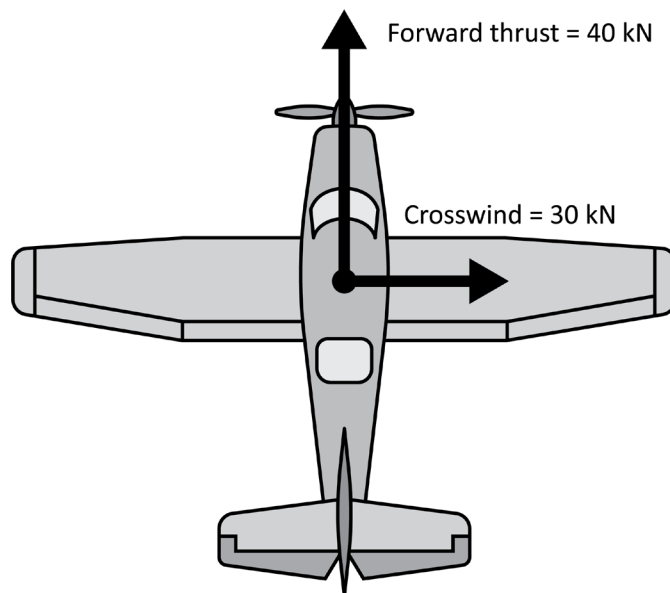
On the grid below, draw a scale drawing to find the magnitude of the resultant force acting downwards on the balloon. Use a scale of 1 cm = 50 N.

Clearly label the 400 N force, the 300 N force, and the resultant force on your drawing.

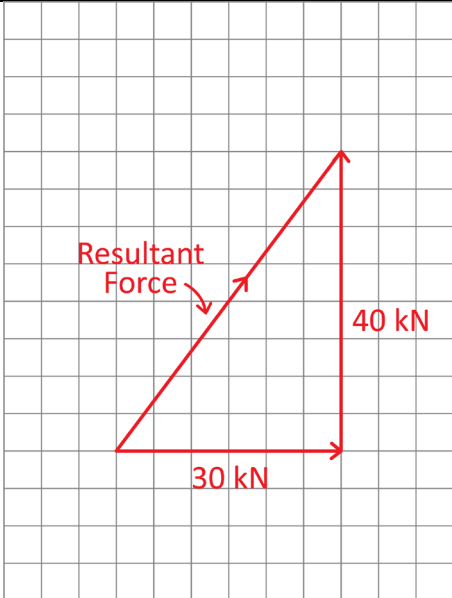
|                                                                                                                                                                                                                           |        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
|                                                                                                                                         |        |
| <p><b>Note:</b> your diagram may look slightly different to this one.</p> <p>Also, I have scaled this figure down to fit on the page so on my original answer the 400 N line was 8cm long and the 300 N line was 6cm.</p> |        |
| Award 1 mark for correct scale used.                                                                                                                                                                                      | 1 mark |
| Award 1 mark for evidence of the correct resultant force (construction lines).                                                                                                                                            | 1 mark |
| Award 1 mark for the correct resultant force of 500 N.      Accept 490 to 510 N.                                                                                                                                          | 1 mark |
| Total: 3 marks                                                                                                                                                                                                            |        |

(Total for Question 2 is 3 marks)

3. A small aeroplane is landing on a runway. The figure below shows the plane.

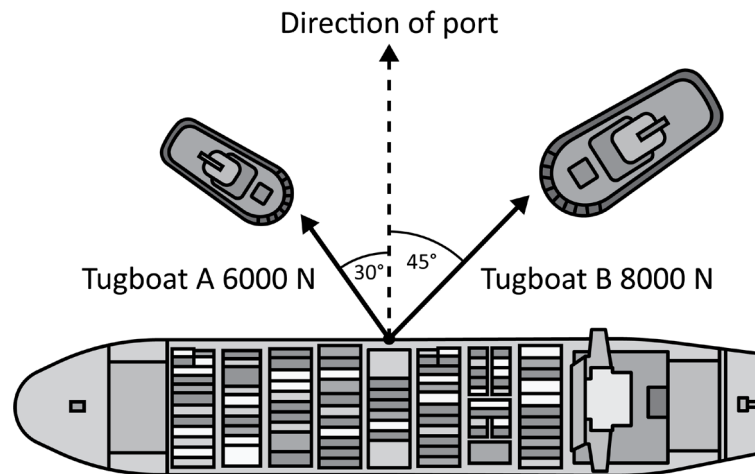


You **must** measure the angle of the resultant force relative to the forward direction of the runway.

|                                      |                                                                                                                                                                 |                |
|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
|                                      |                                                                               |                |
| <b>Magnitude of resultant force:</b> | $a^2 + b^2 = c^2$ $40^2 + 30^2 = X^2$ $X^2 = \sqrt{2500}$ $X = 50 \text{ kN}$                                                                                   | 3 marks        |
| <b>Angle:</b>                        | $\text{Tan}(\theta) = \frac{\text{Opposite}}{\text{Adjacent}} = \frac{30}{40}$ $\theta = \tan^{-1}(0.75)$ $\theta = 36.9^\circ \qquad \text{Accept: } 37^\circ$ | 2 marks        |
|                                      |                                                                                                                                                                 | Total: 5 marks |

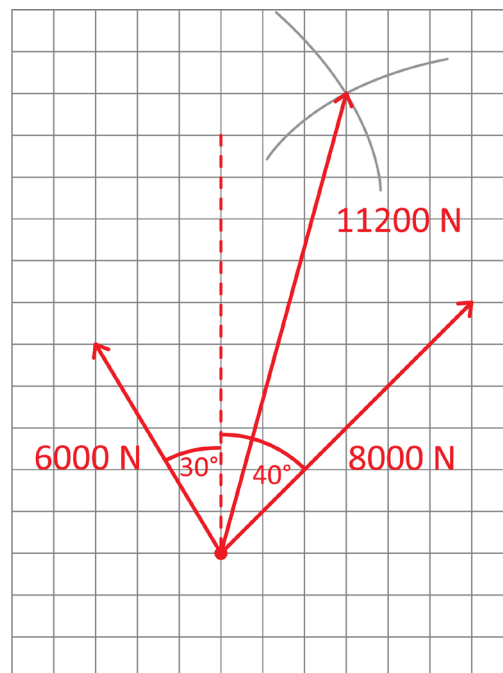
(Total for Question 3 is 5 marks)

4. A large cargo ship is being guided into port by two small tugboats.



In the space below, draw a scale vector diagram to determine the magnitude and direction of the resultant force acting on the cargo ship. Use a scale of 1 cm = 1000 N.

You **must** state the angle of the resultant force relative to the forward direction.



Magnitude of resultant force = 11.2 cm

Convert it back to Newtons =  $11.2 \times 1000 = 11,200 \text{ N}$

**Accept:** any answer between 11,000 to 11,400 N based on their diagram.

3 marks

**Angle:**

Place the protractor on the original dot, lined up with that central line.

Measure the angle between the dashed line and your new resultant line.

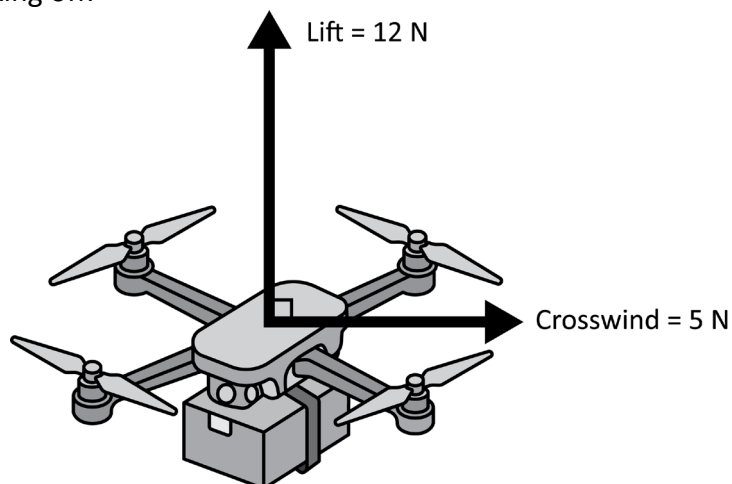
It should measure 14° to the right (allow anything between 13° and 16°).

2 marks

Total: 5 marks

(Total for Question 4 is 5 marks)

5. A delivery drone is taking off.



The drone's rotors produce a vertical lift force of 12 N. Suddenly, a horizontal crosswind blows to the right with a force of 5 N. The two forces act at right angles (90°) to each other.

a) Calculate the magnitude of the resultant force acting on the drone.

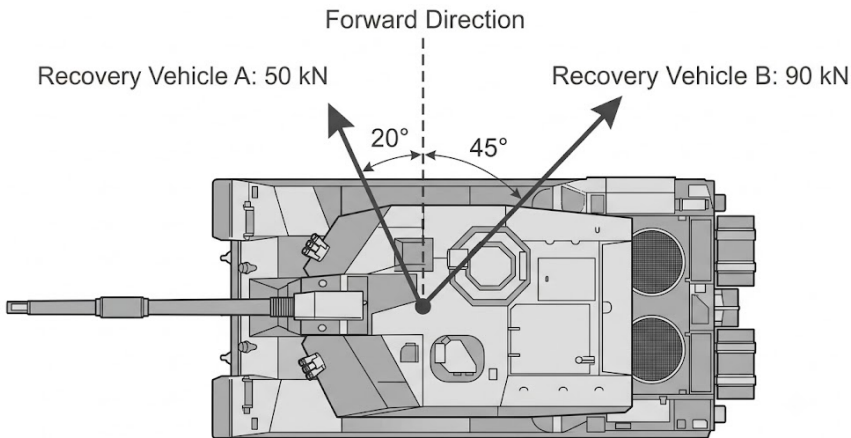
|                                                                                                                    |                |
|--------------------------------------------------------------------------------------------------------------------|----------------|
| <b>Magnitude of resultant force:</b><br>$a^2 + b^2 = c^2$ $12^2 + 5^2 = X^2$ $X^2 = \sqrt{169}$ $X = 13 \text{ N}$ |                |
|                                                                                                                    | 3 marks        |
|                                                                                                                    | Total: 3 marks |

b) Calculate or measure the angle of the resultant force relative to the vertical lift force.

|                                                                                                                                            |                |
|--------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| <b>Angle:</b><br>$\tan(\theta) = \frac{\text{Opposite}}{\text{Adjacent}} = \frac{5}{12}$ $\theta = \tan^{-1}(0.416)$ $\theta = 22.6^\circ$ |                |
|                                                                                                                                            | 2 marks        |
|                                                                                                                                            | Total: 2 marks |

(Total for Question 5 is 5 marks)

6. A 62-tonne Challenger 2 main battle tank has become stuck in deep mud during a military exercise. Two armoured recovery vehicles are using heavy-duty winches to pull it out.

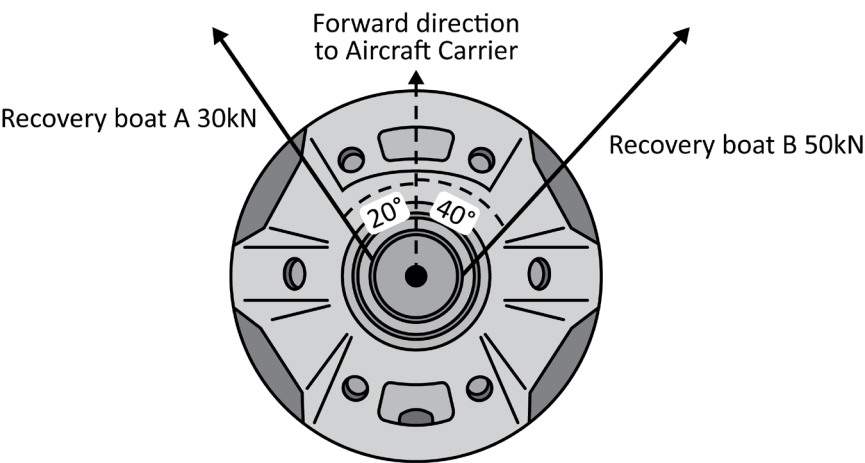


In the space below, draw a scale vector diagram to determine the magnitude and direction of the resultant force acting on the Challenger 2 tank. **Use a scale of 1 cm = 10 kN.**

|                                                                                                             |                |
|-------------------------------------------------------------------------------------------------------------|----------------|
|                                                                                                             |                |
| Award 1 mark for correct scale used.                                                                        | 1 mark         |
| Award 1 mark for evidence of the correct resultant force (construction lines).                              | 1 mark         |
| Award 1 mark for the correct resultant force of 120 kN.      Accept 118 to 122 kN.                          | 1 mark         |
| <b>Angle:</b> Student measures the angle between the resultant force and the dotted line to find it is 20°. | 2 marks        |
|                                                                                                             | Total: 5 marks |

(Total for Question 6 is 5 marks)

7. A space capsule weighing several tonnes has just splashed down in the Pacific Ocean. Two fast recovery boats are using tow cables to pull the capsule towards the main aircraft carrier.



To prevent the cables from tangling, the boats must pull at different angles:

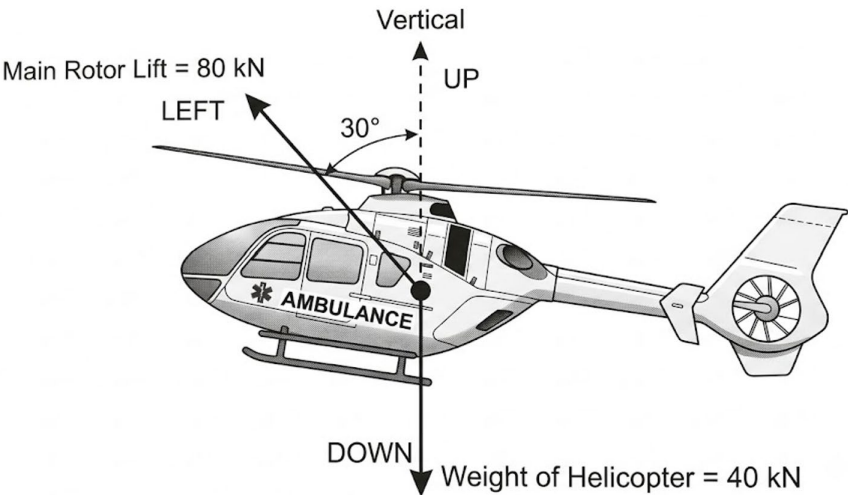
On the grid below, draw a scale vector diagram to determine the magnitude and direction of the resultant force acting on the space capsule. **Use a scale of 1 cm = 10 kN.**

You must state the angle of the resultant force relative to the forward direction.

|                                                                                                             |                |
|-------------------------------------------------------------------------------------------------------------|----------------|
|                                                                                                             |                |
| Award 1 mark for correct scale used.                                                                        | 1 mark         |
| Award 1 mark for evidence of the correct resultant force (construction lines).                              | 1 mark         |
| Award 1 mark for the correct resultant force of 70 kN. Accept 68 to 72 kN.                                  | 1 mark         |
| <b>Angle:</b> Student measures the angle between the resultant force and the dotted line to find it is 18°. | 2 marks        |
|                                                                                                             | Total: 5 marks |

(Total for Question 7 is 5 marks)

8. An air ambulance is taking off from a hospital helipad to respond to an emergency.



To climb and accelerate forwards at the same time, the pilot tilts the helicopter forward.

In the space below, draw a scale vector diagram to determine the magnitude and direction of the resultant force acting on the helicopter. Use an appropriate scale.

|                                                                                                      |                |
|------------------------------------------------------------------------------------------------------|----------------|
|                                                                                                      |                |
| Award 1 mark for correct scale used.                                                                 | 1 mark         |
| Award 1 mark for evidence of the correct resultant force (construction lines).                       | 1 mark         |
| Award 1 mark for the correct resultant force of 50 kN. Accept 48 to 52 kN.                           | 1 mark         |
| Angle: Student measures the angle between the resultant force and the dotted line to find it is 54°. | 2 marks        |
|                                                                                                      | Total: 5 marks |

(Total for Question 8 is 5 marks)