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Smarter practice. Stronger understanding

WORKSHEETS
ATTEMPT | CHECK | CORRECT | IMPROVE

AQA AS Vectors, Equilibrium and Moments worksheet

35–40 minutes independent practice + 15–20 minutes review | 40 marks

Specification points covered

• 3.4.1.1(a–b) Scalars, vectors and vector representation. • 3.4.1.1(c–d) Addition and resolution of vectors. • 3.4.1.1(e–j) Resultant forces and equilibrium of coplanar forces. • 3.4.1.2(a) Moment of a force.	• 3.4.1.2(b) Principle of moments. • 3.4.1.2(c) Couples and torque. • 3.4.1.2(d–f) Centre of mass, support forces and stability.

Offshore turbine-blade change

A maintenance vessel lifts, supports and tests a replacement turbine blade before installation.
Use force components and moments to keep every stage in translational and rotational equilibrium.

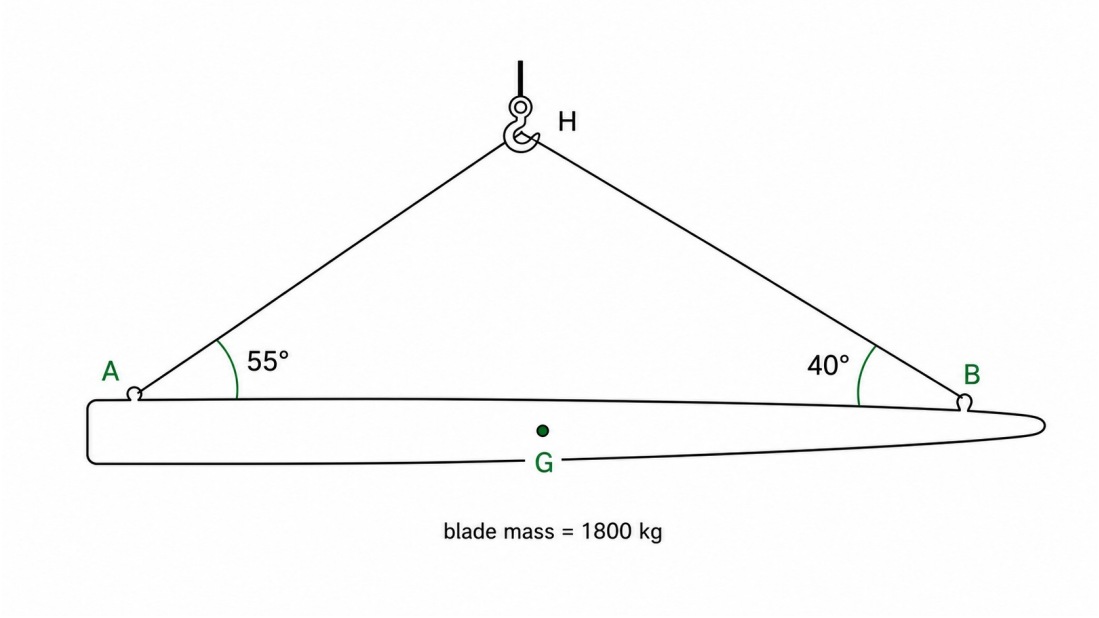
1. Vector audit

1. Classify each quantity as scalar or vector: mass, speed, displacement and force. **[4 marks]**

2. A service boat travels 1.20 km east and then 0.900 km north. Calculate the magnitude and direction of its resultant displacement. **[3 marks]**

2. Lifting the blade

3. The figure shows a stationary 1800 kg turbine blade suspended by two cables. Copy or annotate the diagram to show every force acting on the blade. Each force arrow must start at an appropriate point and have a label. [3 marks]



4. The left and right cables make angles of 55.0° and 40.0° to the horizontal. By resolving forces horizontally and vertically, calculate the tension in each cable. [4 marks]

3. Equilibrium on supports

5. State the two conditions for a rigid body to be in equilibrium. Explain why equilibrium does not always mean that an object is stationary. [2 marks]

6. Each lifting cable has a working tension limit of 18.0 kN. Determine the smallest safety factor during the lift, using your answers to Question 4. [2 marks]

7. Define the moment of a force about a point. State precisely which distance is used in the calculation. [2 marks]

8. The blade is then placed horizontally on supports A and B at positions 1.0 m and 10.0 m from its root. Its centre of mass is 5.0 m from the root. Calculate the vertical reaction force at each support. [4 marks]

4. Controlling rotation and stability

9. A 400 kg test fixture is attached 9.0 m from the root while the 1800 kg blade has its centre of mass 5.0 m from the root. Calculate the position of the combined centre of mass from the root. **[3 marks]**

10. A technician applies a couple using two equal and opposite 250 N forces whose parallel lines of action are 1.40 m apart. Calculate the moment of the couple. **[2 marks]**

11. A mobile crane has a restoring weight of 120 kN acting 2.50 m to the left of an outrigger pivot. Its suspended load acts 6.00 m to the right of the pivot. Calculate the greatest load force before tipping and determine the moment safety margin when the load is 35.0 kN. **[3 marks]**

12. A component of weight 850 N rests in equilibrium on a smooth slope at 12.0° to the horizontal, held by a cable parallel to the slope. Calculate the cable tension and the normal contact force. **[3 marks]**

5. Planning a safe lift

13. The lift supervisor can move the cable attachment points, change the cable angles or add a spreader beam. Explain how vectors, moments and centre of mass should be used to choose a stable lifting arrangement. Include the effect of making a cable more horizontal and explain how the team should check against the tension limits. [5 marks]

Review and improve

- □ I resolve forces in directions that simplify the problem.
- □ I use perpendicular distances in moment calculations.
- □ I check both resultant force and resultant moment.