InkPhysics

QUESTION WORKBOOK

Scalars and vectors

Mechanics · Year 12

AQA 3.4.1.1 · CIE 1.4.1, 1.4.2, 1.4.3, 4.2.3 · OCR A 2.3.1(a), 2.3.1(b), 2.3.1(c), 2.3.1(d), 3.2.3(f)

20 questions · 66 marks

NAVY SCREEN EDITION

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SECTION A · Warm-up

A1 For each of these quantities, state whether it is a scalar or a vector: distance, velocity, energy, momentum, temperature, force, speed, displacement. [4]

	scalar	vector
distance	☐	☐
velocity	☐	☐
energy	☐	☐
momentum	☐	☐
temperature	☐	☐
force	☐	☐
speed	☐	☐
displacement	☐	☐

A2 State the difference between a scalar quantity and a vector quantity, giving one example of each. [2]

A3 Two forces act on a box along the same straight line: 9.0 N to the right and 4.0 N to the left. Calculate the magnitude of the resultant force and state its direction. [2]

SECTION B · Standard

B1 Forces of 3.0 N and 4.0 N act on a particle at right angles to each other. Calculate the magnitude of the resultant force and the angle it makes with the 3.0 N force. [4]

B2 A force of 12.0 N acts at 30° above the horizontal. Calculate the horizontal and vertical components of the force. [3]

B3 An aircraft climbs with a velocity of 60 m s^{-1} at 25° above the horizontal. Calculate the horizontal and vertical components of its velocity. [3]

B4 A walker travels 3.0 km due east, then 4.0 km due north. Calculate (a) the total distance travelled, (b) the magnitude of the displacement, and (c) the bearing of the displacement. [4]

B5 A crate of weight 20 N rests on a slope inclined at 35° to the horizontal. Calculate the components of the weight parallel to and perpendicular to the slope. Show that your two components are consistent with the original weight. [4]

SECTION C · Stretch

C1 Two forces act on a particle: 6.0 N due east and 8.0 N due north. A third force keeps the particle in equilibrium. Determine the magnitude of the third force and its direction as a bearing. [4]

C2 Forces of 5.0 N and 8.0 N act on a point with an angle of 60° between their directions. By resolving into components (or otherwise), calculate the magnitude of the resultant and the angle it makes with the 8.0 N force. [5]

C3 Three forces of 5.0 N, 12 N and 13 N act on a particle which remains in equilibrium. Explain, using a vector triangle, how this is possible, and state the angle between the 5.0 N and 12 N forces. [3]

SECTION A · Warm-up

A4 State the condition for three coplanar forces acting at a point to be in equilibrium. [1]

A5 A survey drone flies 8.0 km due north, then 6.0 km due south. Calculate the total distance it travels and its final displacement. [2]

A6 Two forces of 7.0 N act on the same object. State the angle between the two forces that gives a resultant of (a) zero, (b) 14 N. [2]

SECTION B · Standard

B6 A swimmer heads directly across a river at 1.4 m s^{-1} relative to the water. The river is 42 m wide and the current flows at 0.50 m s^{-1} parallel to the banks. Calculate (a) the magnitude of the swimmer's resultant velocity, (b) the time taken to cross, and (c) the distance downstream at which the swimmer reaches the far bank. [4]

B7 A shop sign of weight 24 N hangs at rest from two chains. Each chain makes an angle of 55° with the horizontal. Calculate the tension in each chain. [3]

B8 A barge is pulled along a canal by two cables, one from each bank. Each cable is pulled with a force of 850 N at 25° to the canal's direction, one on each side. Explain why the resultant force on the barge is directed along the canal, and calculate its magnitude. [3]

SECTION C · Stretch

C4 A cable-car cabin of weight 1800 N hangs at rest from the midpoint of a support cable. Each half of the cable makes an angle of 12° with the horizontal. The cable manufacturer quotes a maximum safe tension of 4.5 kN. Deduce whether the tension in the cable is within the safe limit. [4]

C5 An orienteer runs 4.0 km due east, then 3.0 km on a bearing of 030°. Determine the magnitude of her resultant displacement and its bearing. [4]

C6 A crate of weight 620 N is hauled up a ramp at constant speed by a rope parallel to the ramp surface. The crate runs on rollers, so assume frictional forces are negligible. (a) Show that when the ramp is at 20° to the horizontal the tension in the rope is about 210 N. (b) The rope's maximum safe tension is 260 N. Determine the greatest ramp angle at which the crate can be hauled at constant speed. [5]