

Solutions

2.1 Scalars: speed, mass, energy. Vectors: displacement, weight, acceleration.

2.2 Contact: the normal contact force from the table (or friction). Non-contact: gravity / the Earth's gravitational pull on the book.

2.3 $45 + 30 = \mathbf{75}$ N east; $45 - 30 = \mathbf{15}$ N east.

3.1 (a) Opposite directions, subtract: $R = 2100 - 900 = \mathbf{1200}$ N forward (C1, A1). (b) Two labelled arrows on the caravan: tow-bar force forward (from the car), drag/friction backwards; drawn from the caravan itself, labelled with names. (c) The resultant force is zero; the driving force balances all resistive forces – tow-bar plus air resistance plus friction.

3.2 (a) Scale stated, e.g. 1 cm : 10 N; both arrows drawn at right angles with correct lengths 3.0 cm and 4.0 cm; resultant drawn nose-to-tail / parallelogram; measured 5.0 cm $\rightarrow \mathbf{50}$ N at $\mathbf{53^\circ}$ east of north (accept 50 N, 37° north of east). (b) 50 N in the opposite direction to the resultant.

3.3 (a) Thrust balances drag horizontally, so the resultant of those two is zero – with weight also balanced, the total resultant force is **zero**. (b) Lift from the wings; 60 kN upward, balancing the weight. (c) Velocity is a vector: speed AND direction; turning changes the direction, so the velocity changes even at constant speed.