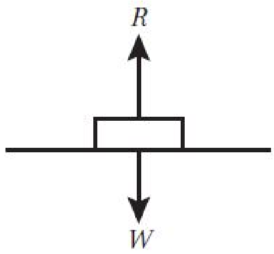
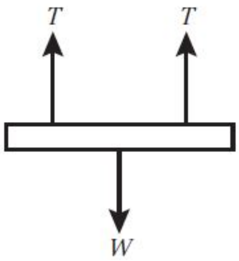
Exercise 4A

1 R is the normal reaction of the table on the box.
W is the weight of the box.

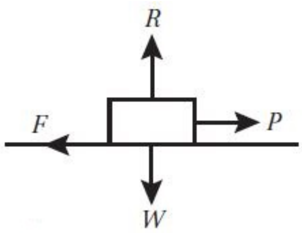


2 T is the tension in each of the ropes.
W is the weight of the bar.



3 W is the weight of the apple.

4 R is the normal reaction of the road on the car.
W is the weight of the car.
F is the sum of the frictional forces on the car.
P is the forward force produced by the car's engine.



5 W is the weight of the rescuer.
T is the tension in the rope.

6 Although its speed is constant, the satellite is continuously changing direction. This means the velocity changes. Therefore, there must be a resultant force acting on the satellite.

7 5 N

8 Since each particle is stationary, the overall force in each case is zero.

a Considering vertical forces:
$P - 10 = 0$
$P = 10$ N

8 **b** Considering horizontal forces only:
$P - 30 = 0$
$P = 30$ N

c Considering horizontal forces only:
$P + 1.5P - 50 = 0$
$2.5P = 50$
$P = 20$ N

9 **a** Since the platform is moving at constant velocity, the total vertical force is zero.
$T + T = 400$
$T = 200$
The tension in each rope is 200 N.

b If the tension in each rope is reduced by 50 N, there is a resultant downward force on the platform. It will therefore accelerate downward.

10 Since the particle is at rest, both horizontal and vertical forces must be balanced.
Considering horizontal forces only:
$p - 50 = 0$
$p = 50$
Considering vertical forces only:
$5q - (q + 10) - 3p = 0$
$4q - 10 - (3 \times 50) = 0$
$4q = 160$
$q = 40$
The values of p and q are 50 and 40 respectively.

11 Since the particle is moving with constant velocity, both horizontal and vertical forces must be balanced.
Considering horizontal forces only:
$2P + Q = 25$
$Q = 25 - 2P$
Considering vertical forces only:
$3P - 2Q = 20$
Substituting for Q:
$3P - 2 \times (25 - 2P) = 20$
$3P - 50 + 4P = 20$
$7P = 20 + 50 = 70$
$P = 10$ N
Using this value of P in the horizontal equation:
$(2 \times 10) + Q = 25$
$Q = 25 - 20 = 5$
$Q = 5$ N
P is 10 N and Q is 5 N.

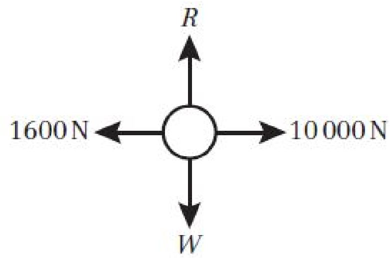
12 **a** **i** Overall horizontal force = 100 – 100 = 0
Overall vertical force = 40 – 20 = 20
The resultant force is 20 N upward.

ii The particle accelerates vertically upward.

12 b i Overall horizontal force = 25 – 5 = 20
Overall vertical force = 10 – 10 = 0
The resultant force is 20 N to the right.

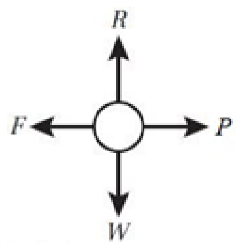
ii The particle accelerates to the right.

13 a R is the normal reaction of the road on the car.
W is the weight of the car.
The forward thrust of the car's engine acts to the right in the diagram.
The car is travelling to the right (positive direction).
The frictional forces on the car are acting to the left.

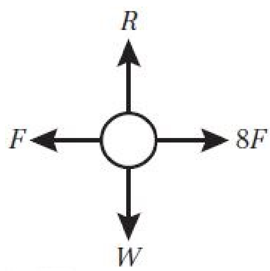


b Considering horizontal forces only:
Resultant force = 10 000 – 1600
There is no overall vertical force: R and W must be balanced, otherwise the car would lift off the road or sink into it.
The resultant force is 8400 N in the direction of travel.

14 a R is the normal reaction of the road on the car.
W is the weight of the car.
P is the driving force produced by the car's engine.
F is the resistance to the car's motion.



b The magnitude of the driving force is eight times the magnitude of the resistance force, so



$P = 8F$

The resultant force is the difference between the forward force P and the resistance force F, so

$8F - F = 7F = 4200$

$F = \frac{4200}{7} = 600$

The magnitude of the resistance force is 600 N.