c) $F_{net} = ma = 30 - F_f$

$5 \times a = 30 - 14.7$

$a = 3.1$ m s^{-2} to the right

7. $F_{net} = ma = 75 - \mu_s N$

$0 = 75 - \mu_s \times 40 \times 9.8$

$\mu_s = 0.19$

$F_{net} = ma = 60 - \mu_k N$

$0 = 60 - \mu_k \times 40 \times 9.8$

$\mu_s = 0.15$

8. $F_f = ma = \mu_k N$

$80 \times a = 0.03 \times 80 \times 9.8$

$a = 0.294$ m s^{-2} backwards

Let the forward direction be positive.

$v^2 = u^2 + 2as$

$0 = 5^2 + 2 \times -0.294 \times s$

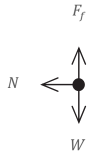
$s = 42.5$ m

9. $F_{net} = 0 = F_f - mg$

$F_f = \mu N = mg$

$0.7 \times N = 60 \times 9.8$

$N = 840$ N into the wall



10. $s = ut + \frac{1}{2}at^2$

$4.5 = 0 + \frac{1}{2}a \times 1.5^2$

$a = 4$ m s^{-2} down

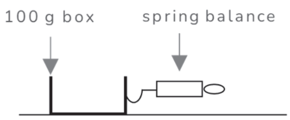
$F_{net} = ma = mg - \mu N$

$45 \times 4 = 45 \times 9.8 - 0.46 \times N$

$N = 567$ N perpendicular to the pole's surface

6.3 Experimental skills – Friction

1. Total mass of the box OR normal force on the box
2. Force needed to move the box at constant velocity
3. Pulling velocity, surface the box is moving on, same box
4. As the total mass of the box and contents increases, the force needed to keep the box moving at a constant velocity increases proportionally. This is because as weight increases, the normal force increases, so the friction that needs to be overcome by the pulling force increases, according to $\vec{F_f} = \mu\vec{N}$.
5. 1 Set up as shown:

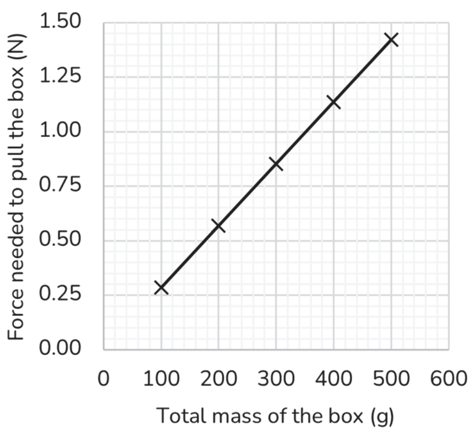


2 Drag the spring balance horizontally so that the box just starts to move across the bench top. Record the force required on the spring balance.

3 Repeat step 2 two more times.

4 Repeat steps 1 to 3, after adding 100 g, 200 g, 300 g, and 400 g in the box respectively.

6. a)



b) The force needed to pull the box is equal in magnitude to the frictional force F_f on the box:

$F_f = \mu N = \mu mg = \mu \times 9.8 \times \text{mass in grams} \div 1000$

As F_f is plotted on the y-axis and mass in grams on the x-axis, the gradient = $\mu \times 0.0098 = 0.0028$ from the graph. So the coefficient of friction μ is 0.29.

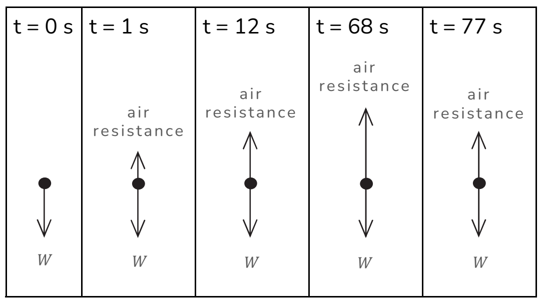
6.5 Air resistance

1. When a skydiver jumps out of the plane, they accelerate downwards at 9.8 m s^{-2}. As their velocity increases, air resistance increases, so acceleration decreases. When acceleration is zero, and forces are balanced, the skydiver has reached terminal velocity.

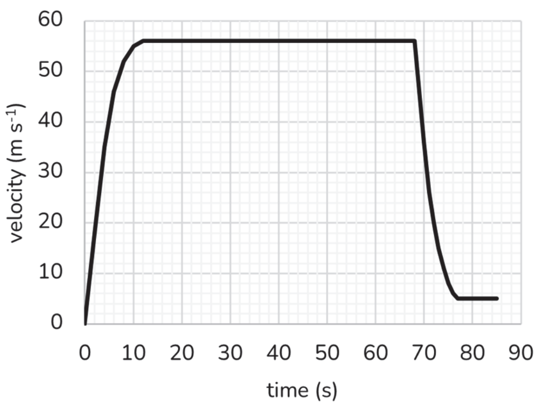
Opening a parachute at this time will increase air resistance so that it is greater than gravitational force. This means net force is upwards, so acceleration is upwards. The velocity is still downwards, but it decreases.

The decrease in velocity means that air resistance decreases, until it is the same magnitude as weight. At this point, the net force on the skydiver is zero and they reach a new, slower terminal velocity.

2.



3.



4. a) When just stepping out of the plane
b) After the parachute opens
c) When terminal velocity is reached

5. a) False – acceleration is not constant.
b) True
c) False – the area gives the displacement downwards from the plane.
d) False – air resistance is bigger than weight when the parachute opens, to decelerate the skydiver.
e) False – there is no net force at terminal velocity. Even if terminal velocity were not reached, gravitational force on the skydiver does not change.