Gravity and Weight

Starter

1. **(Review of last lesson)** A train of mass 20 tonnes accelerates under a driving force of 50000 N. Resistance to motion is 28000 N. Starting from rest, how long does it take to travel 1 km, given that it accelerates for the whole time.
Remember: 1 tonne $\equiv 1000$ kg

Working: $F = ma$: $\quad 50000 - 28000 = 20000a$

$$a = 1.1$$

$u = 0, a = 1.1, s = 1000, t = ?$

No $v \quad \Rightarrow \quad s = ut + \frac{1}{2}at^2$: $\quad 1000 = 0 + \frac{1}{2} \times 1.6 \times t^2$

$$t = 42.6 \text{ s}$$

The train takes 42.6 s to travel 1 km

Assume the acceleration due to gravity g is 9.8 m/s².

2. Find the weight of a body of mass 5 kg.

Working: Weight $= 5 \times 9.8 = 49$ N

3. What is the mass of a sack of potatoes of weight 147 N?

Working: Mass $= \frac{147}{9.8} = 15$ kg

4. What is the weight of a tennis ball of mass 60 grams?

Working: Weight $= 0.06 \times 9.8 = 0.588$ N

5. On the moon the acceleration due to gravity is 1.2 m/s². What would be the answers above?

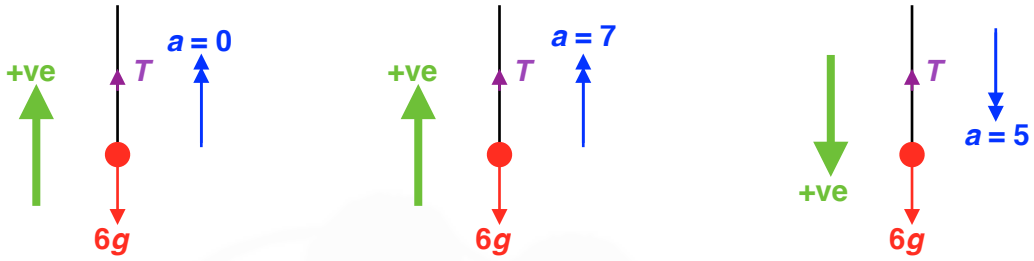
Working: (a) Weight $= 5 \times 1.2 = 6$ N

(b) Mass $= \frac{147}{1.2} = 122.5$ kg

(c) Weight $= 0.06 \times 1.2 = 0.072$ N

E.g. 1 A mass of 6 kg is moving vertically at the end of a light string. Find the tension in the string when the mass has an acceleration of:

(a) zero (b) 7 m/s² upwards (c) 5 m/s² downwards.



Students may need help with (b) - show +ve up and +ve down

Working: (a) $F = ma$: $T - 6g = 0$

$T = 58.8$ N

Or, there is no acceleration so we could resolve vertically

$R(\uparrow)$: $T = 6g$

$T = 58.8$ N

(b) ***Upwards is positive***

$F = ma$: $T - 6g = 6 \times 7$

$T = 6 \times 7 + 6g$

$T = 100.8$ N

(c) ***Downwards is positive***

$F = ma$: $6g - T = 6 \times 5$

$6g - 30 = T$

$T = 28.8$ N

E.g. 2 The tension in a string, which has a particle of mass m kg attached to its lower end, is 70 N. Find the value of m if the particle has:

(a) an acceleration of 3 m/s² upwards

(b) an acceleration of 9 m/s² downwards

(c) a constant velocity of 4 m/s upwards

(d) a constant velocity of 4 m/s downwards.

Working:

(a) ***Upwards is positive***

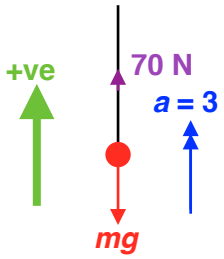
$F = ma$: $\quad 70 - mg = m \times 3$

$$70 = m(3 + g)$$

$$m = \frac{70}{3 + g} \text{ N}$$

$$m = 5.46875$$

The mass of the particle is 5.47 kg (3 s.f.)



(b) ***Upwards is positive***

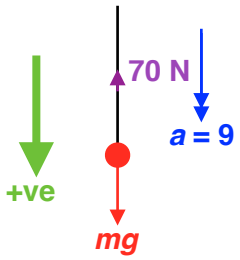
$F = ma$: $\quad mg - 70 = m \times 9$

$$m(g - 9) = 70$$

$$m = \frac{70}{g - 9} \text{ N}$$

$$m = 87.5$$

The mass of the particle is 87.5 kg



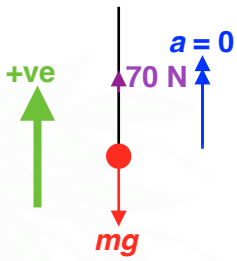
(c) Since there is no acceleration, we can resolve vertically rather than using $F = ma$.

$R(\uparrow)$: $\quad 70 = mg$

$$m = \frac{70}{g}$$

$$m \approx 7.14$$

The mass of the particle is 7.14 kg (3 s.f.)



(d) The same working for (c) can be used in this question
So the mass of the particle is 7.14 kg (3 s.f.)

Video: Gravity vs. weight

Solutions to Starter and E.g.s

Exercise

p497 21D Qu 1i, 2i, 3i, 4-13