Forces worksheet 1

1. **a** A body of mass 8 kg is moving with an acceleration of 4 m/s2 in a straight line. Find the resultant force acting on the body.

$F = ma \quad F = 8 \times 4 = 32\ N$

b A body of mass 10 kg is moving in a straight line. The resultant force acting on the body is 5 N. Find the magnitude of the acceleration of the body.

$a = \frac{F}{m} \quad a = \frac{5}{10} = 0.5\ m s^{-2}$

2. **a** A force of 10 N acts on a particle of mass m kg and produces an acceleration of 2.5 $m\ s^{-2}$. Find the value of m.

$m = \frac{F}{a} \quad m = \frac{10}{2.5} = 4\ kg$

b A force of F N acts on a particle of 2 kg and produces an acceleration of 3.5 $m\ s^{-2}$. Find the value of F.

$F = 2 \times 3.5 = 7\ N$

3. An electron of mass 9×10^{-31} kg in a magnetic field has at a given instant, an acceleration of $6 \times 10^{16}\ m\ s^{-2}$. Find the resultant force on the electron at that instant.

$F = ma \quad F = 9 \times 10^{-31} \times 6 \times 10^{16} = 5.4 \times 10^{-14}\ N$

4. A truck of mass 25 tonnes is travelling at 50 km/h when its brakes are applied. What constant force is required to bring it to rest in 10 seconds?

$50\ km/h \div 3.6 = 13.9\ m s^{-1} \quad a = \frac{v-u}{t} = \frac{13.9}{10} = 1.39\ m s^{-2}$

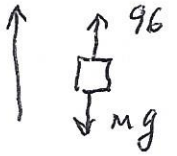
$F = ma = 25000 \times 1.39 = 3.475 \times 10^{5}\ N$

5. What force is necessary to accelerate a train of mass 200 tonnes at 0.2 $m\ s^{-2}$ against a resistance of 20 000 N? What will be the acceleration if the train free-wheels against the same resistance?

$F - F_r = ma \qquad F = 60000\ N$

$F - 20000 = 200000 \times 0.2$

6. What size mass would be accelerated upwards at 1.2 $m\ s^{-2}$ by the vertical force of 96 N?

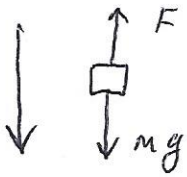


$96 - mg = m \times 1.2$

$m(9.8 + 1.2) = 96$

$m = 8.7\ kg$

7. A parachutist of mass 75 kg, whose parachute only partly opens, accelerates downwards at $1\ m\ s^{-2}$. What upward force must her parachute be providing?

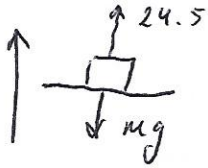


$mg - F = ma$

$75 \times 9.8 - F = 75 \times 1$

$F = 660\ N$

8. In a lift that is accelerating upwards at $2\ m\ s^{-2}$ the normal reaction is 24.5 N. What would be the normal reaction if the lift were at rest?



$24.5 - mg = m \times 2$

$m(g+2) = 24.5$

$m = 2.076\ kg$

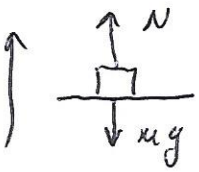
At rest $N - mg = 0$

$N = mg$

$N = 2.076 \times 9.8$

$= 20.3\ N$

9. A box of mass 10 kg lies on the horizontal floor of a lift which is accelerating upwards at $1.5\ m\ s^{-2}$. Find the reaction, in newtons, of the lift floor on the box.



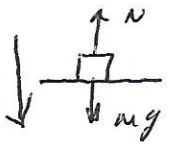
$N - mg = ma$

$N = m(g+a)$

$N = 10(9.8+1.5) = 113\ N$

10. In a lift that is accelerating downwards at $1\ m\ s^{-2}$, a normal reaction is 24.5 N. What would be the normal reaction if the lift was:

a at rest?



$mg - N = ma$

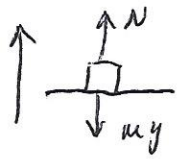
$N = m(g-a)$

$m = \frac{N}{g-a} = \frac{24.5}{8.8} = 2.784\ kg$

At rest $N - mg = 0$

$N = mg \quad N = 27.3\ N$

b accelerating upwards at $2\ m\ s^{-2}$?



$N - mg = ma$

$N = m(g+a)$

$N = 2.784 \times 11.8 = 32.9\ N$

11. A reindeer is hauling a heavy sled of mass 300 kg across a rough surface. The reindeer exerts a horizontal force of 600 N on the sled while the resistance to the sled's motion is 550 N. If the sled is initially at rest, find the velocity of the sled after three seconds.

$F - F_r = ma$

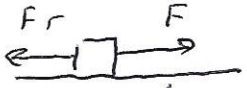
$a = \frac{F - F_r}{m}$

$a = \frac{600 - 550}{300} = 0.17\ ms^{-2}$

$v = at$

$v = 0.17 \times 3 = 0.51\ ms^{-1}$

12. The engine of a train of mass 200 tonnes exerts a force of 78400 N, and the total air and rail resistance is 196 N/tonne. How long will it take the train on level ground to acquire a speed of 30 km/h from rest?



$30\ km/h \div 3.6 = 8.3\ ms^{-1}$

$F_r = 196 \times 200 = 39200\ N$

$F - F_r = ma$

$a = \frac{78400 - 39200}{200\,000} = 0.196\ ms^{-2}$

$t = \frac{v}{a} = \frac{8.3}{0.196} = 42.3\ s$

13. One man can push a wardrobe of mass 250 kg with an acceleration of magnitude $0.15\ m\,s^{-2}$. With help from another man pushing just as hard (i.e. with the same force), the wardrobe accelerates at $0.4\ m\,s^{-2}$. How hard is each man pushing and what is the resistance to sliding?

$F - F_r = ma_1 \quad (1)$

$2F - F_r = ma_2 \quad (2)$

$(2) - (1) \quad F = m(a_2 - a_1)$

$F = 250(0.4 - 0.15) = 62.5\ N$

$F_r = F - ma_1$

$F_r = 62.5 - 250 \times 0.15 = 25\ N$

14. A load of 200 kg is being raised by a cable. Find the tension in the cable when:
a the load is lifted at a steady speed of 2 m/s

$T - Mg = 0$

$T = mg$

$T = 200 \times 9.8 = 1960\ N$

b the load is lifted with an upward acceleration of $0.5\ m\,s^{-2}$

$T - mg = ma$

$T = m(g + a)$

$T = 200(9.8 + 0.5) = 2060\ N$