

Newton's Laws Equations Worksheet

Level: GCSE / AP Physics 1 / IB SL | Difficulty: Intermediate | Topic: Mechanics

Master Newton's three laws of motion with 10 problems covering net force, weight, friction, and tension. Each problem includes a full worked solution.

Equations you will need

$F = ma$	Newton's 2nd law: net force = mass x acceleration
$W = mg$	Weight: mass x gravitational field strength
$f = \mu N$	Friction: coefficient x normal force
$\sum F = 0$	Newton's 1st law (equilibrium)
$F_{1\ 2} = -F_{2\ 1}$	Newton's 3rd law (equal and opposite)

Symbol key

Symbol	Quantity	Unit
F	force	N (newtons)
m	mass	kg
a	acceleration	m/s ²
W	weight	N
g	gravitational field strength	9.8 m/s ² (Earth)
μ	coefficient of friction	dimensionless
N	normal force	N

Practice problems

1. A 5 kg box is pushed with a horizontal force of 20 N on a frictionless surface. Find the acceleration.
2. Find the weight of a 70 kg person on Earth. ($g = 9.8\text{ m/s}^2$)
3. A 2 kg object accelerates at 3 m/s^2 across a rough surface. The applied force is 10 N. Find the friction force.
4. A 10 kg block sits on a surface with $\mu = 0.3$. Find the friction force needed to start moving it. ($g = 9.8\text{ m/s}^2$)
5. Two forces act on a 4 kg object: 12 N right and 8 N left. Find the acceleration.

6. A car of mass 1200 kg decelerates from 20 m/s to rest in 5 s. Find the braking force.
7. A 3 kg mass hangs from a rope. Find the tension when it is stationary. ($g = 9.8 \text{ m/s}^2$)
8. Same 3 kg mass now accelerates upward at 2 m/s^2 . Find the new tension.
9. A 50 kg sled is pulled by a 200 N force on ice ($\mu = 0.1$). Find acceleration. ($g = 9.8 \text{ m/s}^2$)
10. An 80 kg astronaut pushes off a 200 kg satellite with a force of 100 N for 0.5 s. Find each one's acceleration.

Answer key

Full worked solutions for each problem.

1. $a = F/m = 20/5 = 4 \text{ m/s}^2$
2. $W = mg = 70 \times 9.8 = 686 \text{ N}$
3. $F_{\text{net}} = ma \rightarrow 10 - f = 2(3) \rightarrow f = 4 \text{ N}$
4. $N = mg = 98 \text{ N}$; $f = \mu N = 0.3(98) = 29.4 \text{ N}$
5. $F_{\text{net}} = 12 - 8 = 4 \text{ N}$; $a = 4/4 = 1 \text{ m/s}^2$
6. $a = -4 \text{ m/s}^2$; $F = ma = 1200(-4) = -4800 \text{ N}$ (4800 N opposing motion)
7. $T = mg = 3(9.8) = 29.4 \text{ N}$
8. $T - mg = ma \rightarrow T = m(g + a) = 3(11.8) = 35.4 \text{ N}$
9. $f = 0.1(50)(9.8) = 49 \text{ N}$; $F_{\text{net}} = 151 \text{ N}$; $a = 3.02 \text{ m/s}^2$
10. $a_{\text{astronaut}} = 100/80 = 1.25 \text{ m/s}^2$; $a_{\text{satellite}} = 100/200 = 0.5 \text{ m/s}^2$ (opposite direction)