Newton's Laws and Apparent Weight

08/11/25 Physics

Context

- Newton's laws of motion remain the same as at Nat 5, they are useful to memorise for OEQs, explain questions etc.
- Apparent weight is the phenomenon that occurs when you feel heavier or lighter in a lift. It can be explained in terms of Newton's second law.

Definitions

- Newton's First Law - an object will remain at rest or move with constant velocity unless acted on by an unbalanced force.
- Newton's Second Law - an unbalanced force will cause an acceleration. This acceleration is directly proportional to the force applied and inversely proportional to the mass of the object.
- Newton's Third Law - if object A exerts on a force on object B, object B will exert a reaction force on A which is equal in magnitude but opposite in direction.

Equations

- Newton's Second Law - $F = ma$
- Weight (derived from Newton II) - $W = mg$

Technique

- A person stands on scales in a lift. The scales show a reading greater than the person's weight. How is the lift moving?
- Here, the person's apparent weight is greater than their actual weight.
- The sum of the forces acting on the person in the lift are their weight, and the normal force on the scales pushing them back up.

$\Rightarrow F = N - mg$

- But by Newton's Second Law, $F = ma$. Therefore:
  $\Rightarrow \quad ma = N - mg$
- Rearranging leaves us with
  $N = mg + ma$
  $\Rightarrow N = m(g + a)$
- The normal force is the same as apparent weight!
- So if a person feels heavier, a must be positive, so they are accelerating upwards. Notably, however, this could also mean that they are decelerating downwards.

Thing to Remember

- Put simply, when someone feels heavier they are accelerating upwards (a.k.a decelerating downwards), and vice versa.

Internal Forces & Forces Acting on a Slope

08/11/25 Physics

Context

- Two kinds of problems involving forces come up commonly
- Internal forces are more commonly known as tension questions and hinge around Newton's Second Law
- Forces acting on a slope are usually used with problem solving questions around practicals, or in coupling with tension questions

Definitions

- Tension - 'internal force that holds two components of a system

Equations

- Weight component - $W_{\parallel} = mg\sin\theta$

Technique

- Tension: a train formed of two carriages is travelling with an engine thrust of 4.8kN. The front carriage is the driver's and has a mass of 800kg. The back carriage is filled with passengers and has a mass of 1400kg. Calculate the tension on the coupling between them if the frictional force acting on the system is 0.4kN
- Find F_{nb} $\Rightarrow$ $F_{nb} = 4.8 - 0.4 = 4.4kN$
- Use $F = ma$:

  $F = ma$ $\quad 4.4 \times 10^3 = (800+1400)a$ $\quad a = 2ms^{-2}$
- Now think about the back carriage on its own. The force required to accelerate it at the same rate as the rest of the system will be the same as the tension in the bar.

  $\Rightarrow F_a = ma$
- $F = 1400 \times 2 = 2800N$

- Forces on a slope: a brick is sliding down a slope with an angle of $30°$ at a constant velocity. If the brick has a mass of 18.2 kg what is the magnitude of the frictional forces acting on the brick?
- By Newton I, the forces on the brick are balanced.
  $\therefore$ FRICTION = $W_{//}$
- $F_F = mg \sin\theta$
  $F_F = 18.2 \times 9.8 \times \sin 30$
  $= 89.2\,N$

Thing to Remember

- In tension, make sure to work out carefully which object the tensile force is applying to.