Edexcel GCSE Physics

Topic 9: Forces and their effects

Notes

(Content in bold is for Higher Tier only)

Object Interaction

- Examples of interaction of objects at a distance without contact:
  - Gravitational attraction
    - There is an attraction between two objects with mass, the larger mass gives greater attraction
  - Electrostatic attraction/repulsion
    - A Larger charge gives greater force
    - Like charges repel, opposite charges attract
  - Magnetic attraction/repulsion
    - A stronger magnet gives stronger field, having a greater force
    - Like poles repel, opposite poles attract
- Examples of interaction of objects with contact
  - Normal contact force
    - The force is perpendicular to the plane of contact
  - Friction
    - Surfaces that are rough cause friction when moved

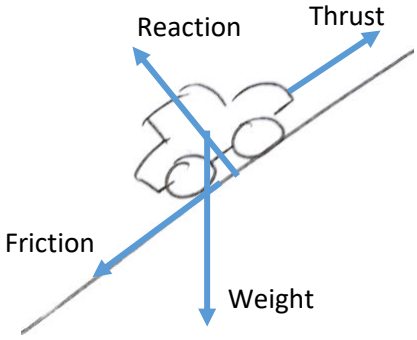
Vectors

- A vector has size and direction – e.g. a force of 10N directed downwards
  - Weight, velocity, force, displacement, etc.
- Scalar has just size – so direction plays no part in describing the value
  - Mass, distance, speed, etc.

Vector diagrams

Free body diagrams

- **Shows the direction of forces that are present in a situation**

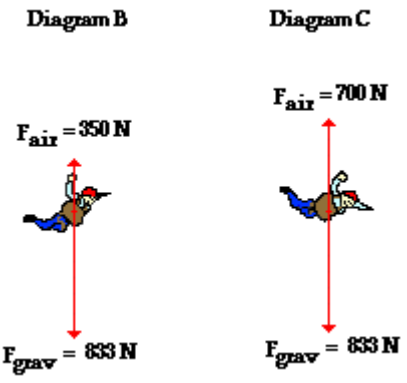


Points to note:

- **The reaction force always acts at the normal to the line of contact, from the point of contact**
- **Friction acts in the opposite direction to movement, along line of contact**
- **Weight always acts downwards, acting from Centre of Mass**

Scale Drawings

- **The length of each arrow represents its size (in relation to the other forces acting on the object)**
  - **So direction with larger arrows shows resultant force**
- **If arrows are in opposite directions with equal length**
  - **(Equal in magnitude but opposite in direction)**
  - **The forces cancel out**
  - **So the object is in equilibrium**
  - **So travels at a constant velocity**



http://www.physicsclassroom.com/

Diagram:

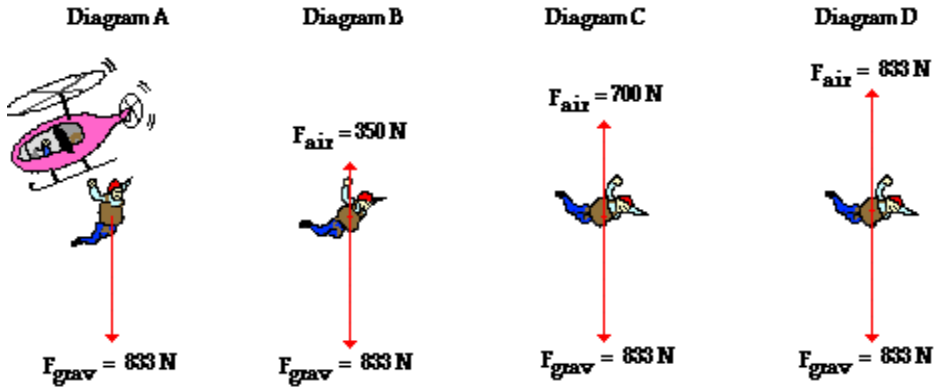
- **At B, the drag is a lot less than the weight, as shown by the arrows, so the resultant force causes him to accelerate**
- **At C, the difference in arrow lengths is less, so the resultant force is smaller, so smaller acceleration**

Isolated solid systems means no forces are present that come from a source outside the system

- **E.g. a magnetic ball just rolling down a hill, an external force would be a magnet at the top of the hill**

Skydiver

- **Forces that act are air resistance and weight**

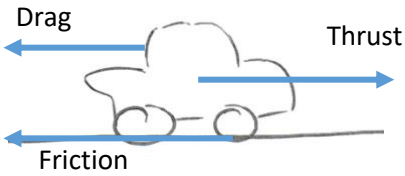


http://www.physicsclassroom.com/

- **Initially, the skydiver has no air resistance and the *only* force acting on him is weight**
- **As he falls, he accelerates, increasing his speed**
- **This makes air resistance increase**
- **Therefore, the *resultant* force *decreases***
- **Therefore, acceleration decreases as F=ma, so he is not speeding up as quickly**
- **Eventually weight and air resistance are equal and balanced, so there is *no* resultant force**
- **So there is *no* acceleration and terminal velocity is reached**

Vehicle

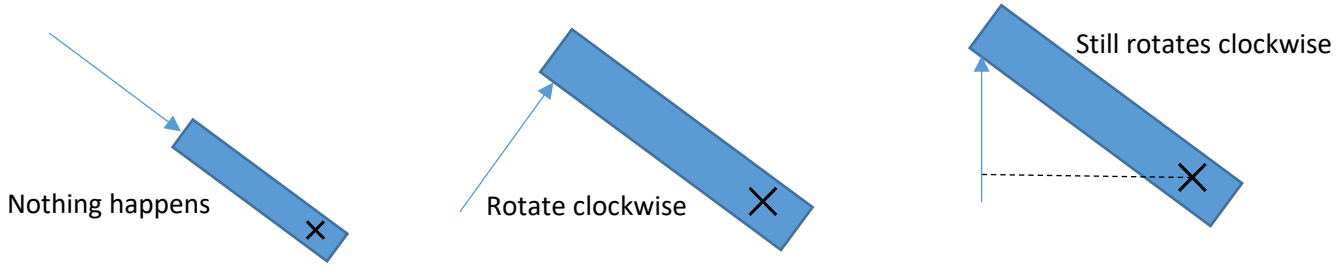
- **Initially, low air resistance and thrust is only hindered by friction**
- **Air resistance increases, decreasing resultant force**
- **Eventually the car is travelling at terminal velocity, where the thrust is balanced by drag and friction, so no resultant force acts**
    - **(This is immediately changed when more thrust is added, as it now becomes the resultant force until the drag increases to balance it again)**



Rotation (Physics Only)

Rotation occurs…

- If an object is attached to a pivot point
  - A point which it can rotate about, but cannot move away from
- And a force is applied not towards the point (see diagram)
  - The object will not rotate, and will just be held still, as there is no resultant force
- If the force is applied perpendicular to the object
  - It will move about the pivot in this direction
- If the Force is applied not perpendicular to the object
  - Need to find perpendicular distance from pivot to line of force
  - See which direction it will turn



$$Moment = Fd$$

Moment of a force (newton metre, N m) = force (newton, N) × distance perpendicular to the direction of the force (metre, m).

Bike Riding – pressing your foot down on the pedal, causes a moment about the pivot, turning the pedal arms

$$\text{equilibrium occurs when: sum of anticlockwise moments} = \text{sum of clockwise moments}$$

Levers and Gears (Physics Only)

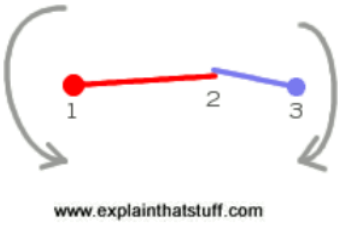
- Gears can change speed, force or direction by rotation

For an example when the first gear is supplying the force

- If connected to a gear with fewer teeth (i.e. a smaller gear)
  - The second gear will turn faster
  - But with less force
  - In opposite direction to first gear
- If connected to a gear with more teeth (i.e. a larger gear)
  - Turns slower
  - More force
  - In opposite direction

The second gear will always turn in the opposite direction

- The blue gear is supplying the power
- To increase the power, a larger gear is used for the secondary (red)
  - As the force on the red gear is a further distance from its pivot, the momentum of the larger gear is greater



Lubrication – reduces friction, so reduces unwanted energy transfer (so less heat loss etc.) and increases efficiency