SUPER PHYSICS

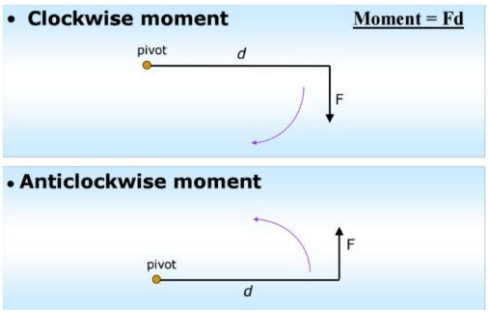
Chapter 5 Notes

Turning Effect of Forces

Turning Effect of Forces

- The turning effect of a force about a point is the product of the force and the perpendicular distance from the point to its line of action of the force
    - Also known as '*moment*' or '*torque*'
- Moment = F x d
    - d refers to its perpendicular distance!

- Clockwise vs. Anti-Clockwise Moments
- Unit is Nm (newton meter)



How to find the moment

1. Draw the line of action of force
2. Connect it to the pivot
3. Make sure it's perpendicular

Principle of Moments

- When an object is in **equilibrium**, the **sum of clockwise moments** about a point = the **sum of anticlockwise moments** about same point
- Conditions for Equilibrium of an Object
    - Resultant force acting on it is zero
    - Resultant moment about a pivot is zero

Chapter 5: Turning Effect of Forces

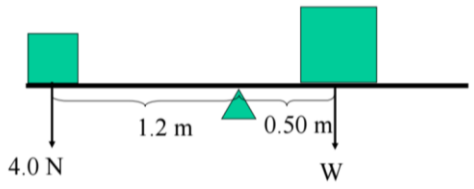
Example 1:

Taking moments of forces about the pivot,

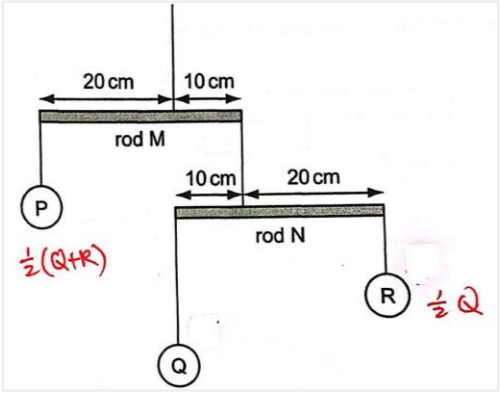
Total clockwise moments = Total anti-clockwise moments

W (0.50) = (4.0) (1.2)

W = 9.6 N



Example 2:



The masses of P, Q, and R are such that the rods are horizontal. What are their possible masses?

- R: 2x distance from pivot → ½ mass of Q
- P: 2x distance from pivot → ½ mass Q+R

Object R falls off. Describe what happens to rod N.

- Only Q left on rod N, creating an anticlockwise moment about pivot, so rod N rotates anticlockwise about its pivot

Example 3:

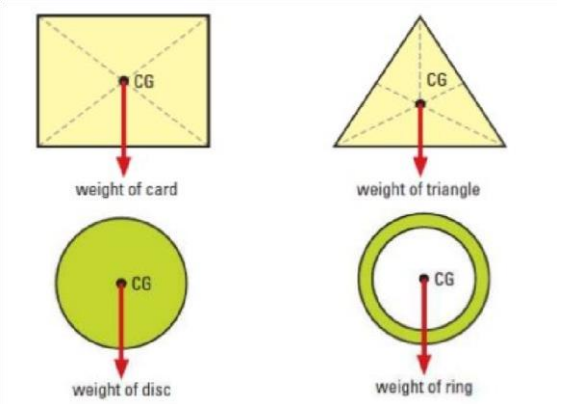
Describe how the largest moment about the pivot can be produced at A.

- With force at A, perpendicular distance of line of action of force from pivot is greatest
- Using formula 'moment = F x d_h', this generates largest moment about pivot

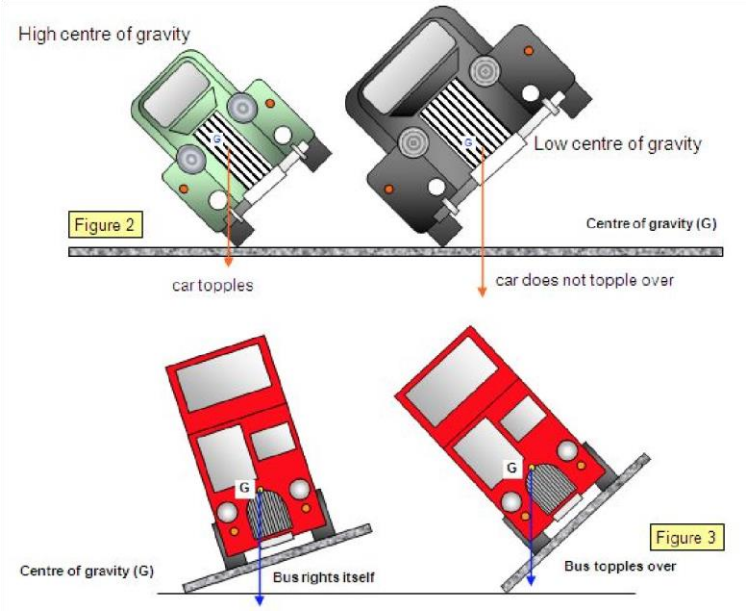
Chapter 5: Turning Effect of Forces

Centre of Gravity

- The point through which its whole weight appears to act



- An object will only balance in equilibrium if the point of balance is **directly below** the center of gravity
- For any uniform/regular object, the C.G. is located at its geometrical center
- If you place the pivot at any point that is NOT C.G., sum of clockwise moments will not be = sum of anticlockwise moments

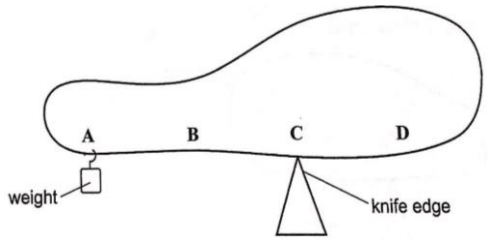


Chapter 5: Turning Effect of Forces

***Example 1**: The front of a helicopter tilts down, while its CG stays at the same height. How?*

- Lift <u>force</u> from front rotor decreased, while lift force from back rotor increased

***Example 2**: Where is the CG of the object?*



Most of mass is on right of knife, so CG is to right of it → Exerts clockwise moment to counter anticlockwise moment caused by suspended weight

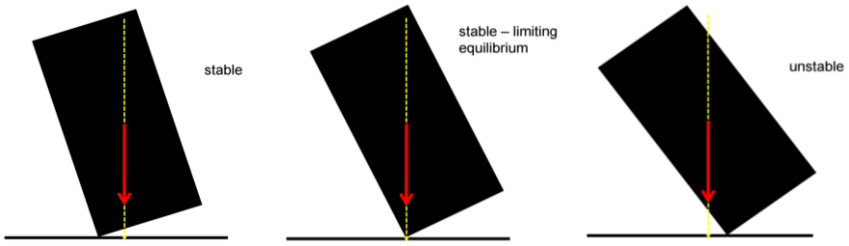
Stability

- Definition: Measure of a body's ability to maintain its original position (after being tilted)
- For something to be **stable**, the **line of action** must fall within the **base area**
    - Stability can be increased by **lowering center of gravity** + **increasing base area**
    - An object with a lower CG and a larger base area has to be tilted at a <u>larger angle</u> before the line of action falls outside base area, so it is more stable

Chapter 5: Turning Effect of Forces

Types of Equilibrium

- **Stable** Equilibrium : Object returns to original position after being displaced slightly
    - Limiting Equilibrium: Maximum orientation of an object before it topples
- **Unstable** Equilibrium: Object continues to move away from original position
- **Neutral** Equilibrium: Object remains where it is displaced (new position)



- *Currently in neutral equilibrium position (ramp) → Tilted further, line of action of weight outside base area → Resultant clockwise moment about right wheel → Tilts over*