4. Mind Map: Work Done by Gravity

Work Done by Applied Force

- Work Done by Applied Force
  - Lifting:
    1. Applied force is upward. If lifting slowly (no acceleration), the applied force balances weight, so F_a = mg
    2. Displacement is also upward → θ = 0°
    3. Work done by the applied force = $F_a \cdot d \cdot \cos(\theta)$ = $mg \cdot d \cdot \cos(0°)$ = +mgd

    Work done by gravity = –mgd, since the gravitational force acts downward while displacement is upward (θ = 180°)
  - Lowering:
    1. Displacement is downward
    2. If you're lowering gently, your applied force is still upward (opposite to displacement) → θ = 180°
    3. Work (applied force) = (mg) d Cos(180°) = –mgd

    Work done by gravity = +mgd, because force and displacement are in the same direction (θ = 0°)
- Work-Energy Theorem (Total Work = Change in KE)
  - ΔKE = Total work done = Work by applied force + Work by gravity
  - When object starts and ends at rest (like lifting or lowering an object slowly)
    - ΔKE = 0 → Work by applied force + Work by gravity = 0 or Work by applied force = - Work by gravity
    - So: Wa + Wg = 0 → Wa = –Wg

The work done by the applied force only depends on
- Object's weight (mg)
- Vertical displacement (d)
True even if the applied force varies throughout the lift (e.g., pulling a mug quickly then slowly).