07-05

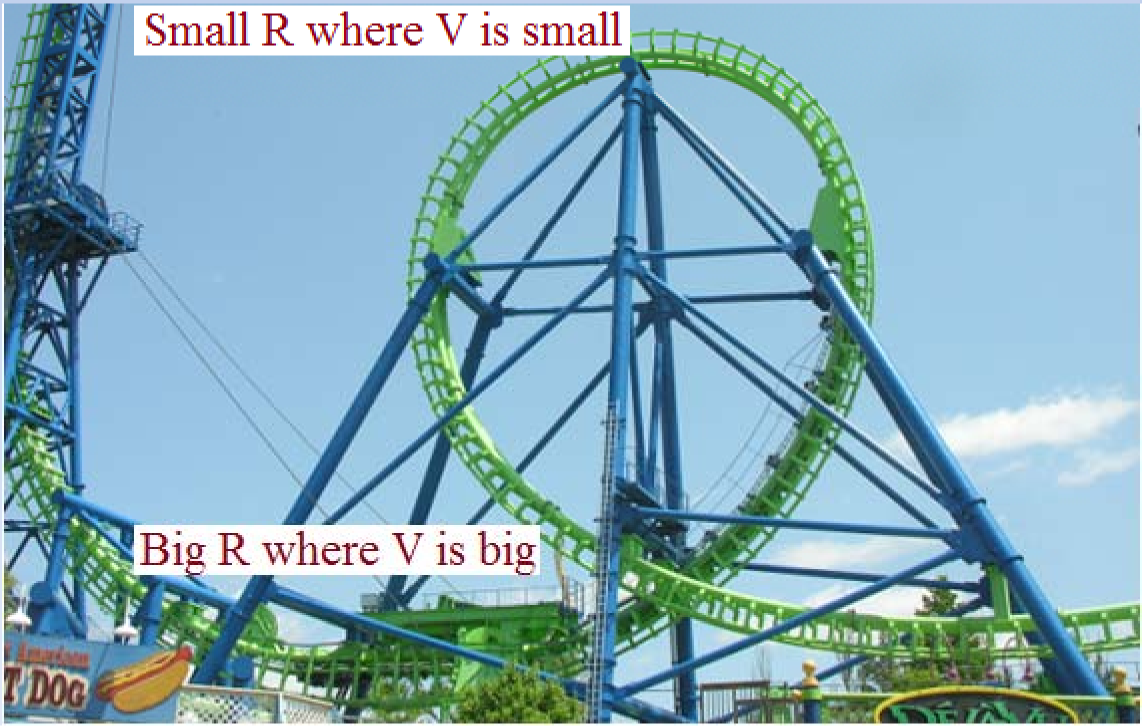
Circular Motion – Blackouts, red outs, klothoid loops and three simple machines

Blackouts/Red outs

- Circular motion: liquids flung to the outside
- Coaster design:
  - Passenger feet on outside of loop = blood flung to feet…Blackout! (can pass out, get sick)
  - Passenger head on outside of loop = blood flung to head…Red out! (can brain bleed, eye and brain hemorrhages, can die!)
- Centripetal acceleration produces G-forces, $a_c = v^2/r$
- G-forces tell us how strongly blood is flung
- G-force = 1 means acceleration is normal, -9.8 m/s^2, flung to feet
  - Right now I'm feeling 1 g and so are you!
  - Standing on your head would be -1 g
- G-force = 2 means double the ordinary force of gravity: acceleration of 19.6 m/s^2, flung to feet

Blackouts/Red outs – the Klothoid cure

- G-forces come from $a_c = v^2/r$, so we reduce by:
  - Making r bigger
  - Making v smaller
- Klothoid loops make r big where it needs to be big and small where it needs to be small, see why?



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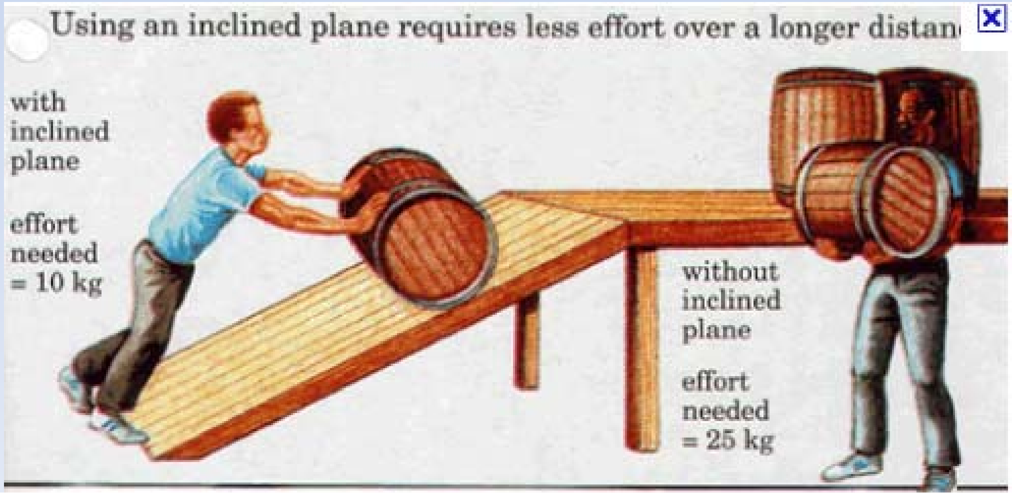
Goal of a simple machine

- Lift something heavy with only a tiny force
- What you sacrifice: You don't get to lift it very high
- Look at the inclined plan below
- Pushes along 8 feet, to lift it up 3 feet
- Get: a heavy barrel lifted with small force
- Give: Don't lift up very high

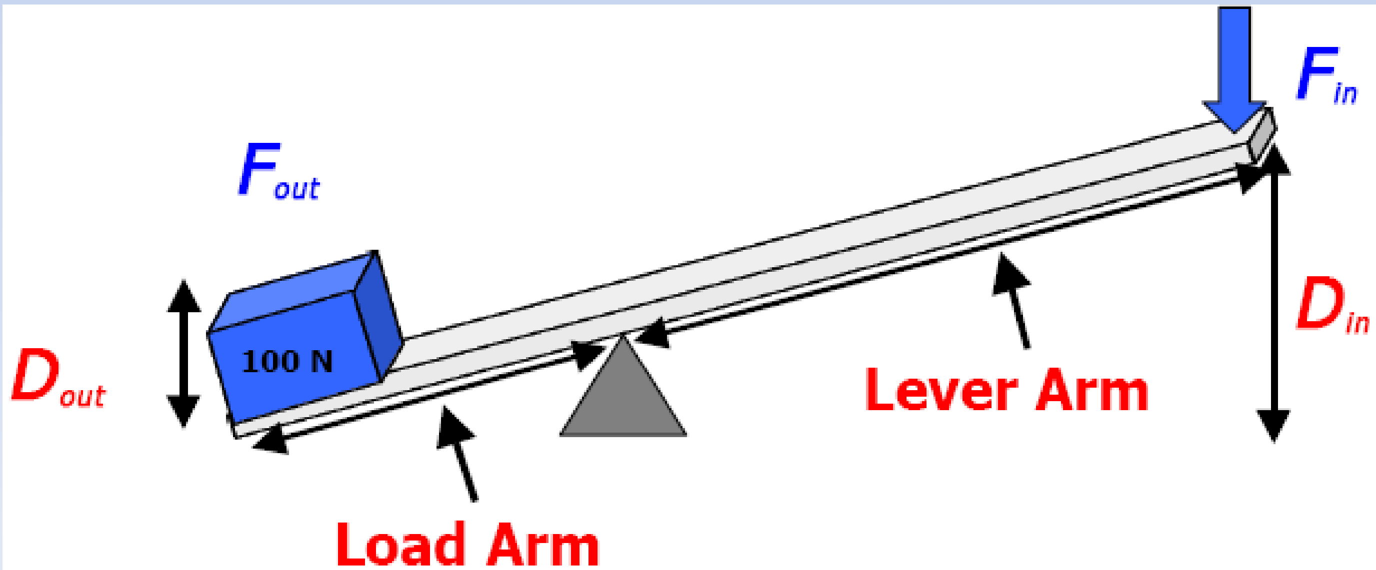


Identifying Forces & Distances

- Simple machines trade force for distance
- Pairing
  - Small distance/BIG force
  - BIG distance/small force
- Force in is the force directly applied to the machine to "get it going"
- Force out is what the machine accomplishes

Simple machines

- AMA: Actual mechanical advantage (Force you get (lift)/Force you lift or push)
  - AMA = F_{out}/F_{in}
- IMA: Ideal mechanical advantage
  - Same value as AMA if 100% efficient
  - IMA = d_{in}/d_{out}



Examples

- $AMA = F_{out}/F_{in}$
- $Efficiency = W_{out}/W_{in}$
- $IMA = d_{in}/d_{out}$

- Inclined plane: (sketch it)
  - Pushing a barrel up a ramp:
    - What's the input?
    - What's the output?
    - (For IMA or AMA) How many variables are there?
    - How many will you be given?
- Lever: (sketch it)
  - Lifting up a car with a tire jack:
    - What's the input?
    - What's the output?
    - (For IMA or AMA) How many variables are there?
    - How many will you be given?

Pulleys

- Key idea: Tension in rope same on both sides
- Fig. A: Pull down with 100 lbs on right
  - – How hard is it pulling down on left?
  - – How heavy is L being lifted?
  - – Pull rope down 2 ft:
    - How high is L lifted?
- Fig. B: Pull down with 100 lbs
  - – How much weight L can you lift?