Achievable

ASVAB DUMP SHEET

Forces, motion, and energy

Mass and weight

- **Matter:** anything with mass that takes up space
- **Mass:** the amount of matter; the same everywhere
- **Weight:** the force of gravity on a mass; less on the Moon, where gravity is weaker

Forces

- **Force:** a push or a pull; **net force:** all the forces added by direction, so opposite forces subtract
- **Gravity** attracts masses; **compression** squeezes; **tension** pulls
- **Friction** opposes the motion of surfaces that touch:
  - **Static:** stops a book sliding
  - **Sliding:** slows a pushed box
  - **Rolling:** bicycle tires
  - **Fluid:** air resistance
- **Balanced** forces (net force zero) are in **equilibrium**, like an even tug-of-war; **unbalanced** forces change motion
- **Center of gravity:** the balance point of an object's weight; it tips over once that point moves outside its base, so a high load tips sooner

Newton's laws

- **1st, inertia:** an object at rest stays at rest, and one in motion keeps moving the same way, unless a force acts on it
- **2nd:** $F = ma$: more force, more acceleration; more mass, less. 20 N on 10 kg gives $2\ \mathrm{m/s^2}$
- **3rd:** every force has an equal and opposite force, on the **other** object, so they do not cancel; you push the ground down and it pushes you up

Describing motion

- **Frame of reference:** what the motion is measured against
- **Distance:** the whole path; **displacement:** start to finish in a straight line, with a direction. 100 m down a hall and back: 200 m, displacement 0
- **Speed:** distance per unit of time, the slope of a distance-time graph; **velocity:** speed in a direction
- **Momentum:** mass × velocity; a cart has more than a marble at the same speed

Torque, work, and power

- **Torque** $T = F \times d$ (newton-meters): a turning force; more distance from the pivot, more torque, which is why a longer wrench helps
- **Work** $W = F \times d$ (joules): done only if the object moves
- **Power** $P = \dfrac{W}{t}$ (watts): how fast work is done
- Lift a 20 N box 3 m: $W = 60$ J; in 6 s, $P = 10$ W

Energy

- **Energy:** the capacity to do work
- **Kinetic:** energy of motion: moving objects, heat (thermal), sound, electricity, sunlight
- **Potential:** energy stored by position or condition: gravitational, chemical, nuclear

Pressure and fluids

- **Pressure** $P = \dfrac{F}{A}$ (pascals, psi, mmHg): the same force on a smaller area gives more pressure, so a sharp knife cuts better
- Fluids flow from **high pressure to low**
- **Pascal's principle:** pressure on a closed fluid pushes equally every way, so $\dfrac{F_1}{A_1} = \dfrac{F_2}{A_2}$: a small force on a small piston lifts a large load on a large one
- **Hydraulics** use liquids; **pneumatics** use gases
- **Faster air has lower pressure:** a wing's shape makes lower pressure above it, which gives **lift**
- **Water pressure rises with depth:** a hole low in a tank squirts harder than one near the top