Formulas Newton Discovered

2nd of Newton's Laws of Motion

$$F = ma$$

Newton's Universal theory of Gravitation

$$F = G\frac{m_1 m_2}{r^2}$$

Acceleration of an object going in a circle

$$a = \frac{v^2}{r}$$

Examples — rework with me or Javier

* Acceleration of an object falling on Earth

NEED

$$G = 6.67 \times 10^{-11} \frac{Nm^2}{kg^2}$$

$$m_{Earth} = 5.97 \times 10^{24}\ kg$$

$$r_{Earth} = 6370\ km$$

* Acceleration of an object falling on the Moon

NEED

G

$m_{Moon} = 7.35 \times 10^{22}\,kg$

$r_{Moon} = 1740\ km$

* Weight of an astronaut on the Moon

NEED

G

m_{Moon}

r_{Moon}

$m_{Astronaut} = 80\,kg$

Conversion to familiar unit of force

$1\ N = 0.225\ lbs$

* Acceleration of Space Station

NEED Speed v of Space Station

Radius r for Space Station

from circular motion acceleration

Get speed from

$$C = \frac{2\pi r}{P}$$

$r = 6370\,km + 410\,km = 7180\,km$

$P = 93$ minutes

* Acceleration of Moon ⟵ from circular motion acceleration

<u>NEED</u> Speed v of Moon
Radius r for Moon's orbit

$r = 384{,}000$ km
$P = 27.3$ days

* Acceleration of Space Station from Newton's Universal Theory of Gravitation

* Acceleration of Moon from Newton's Universal Theory of Gravitation

* Acceleration of falling object on Mars

<u>NEED</u> $m_{Mars} = 6.39 \times 10^{23}$ kg
$r_{Mars} = 3390$ km

* Weight of astronaut on Mars

Density Definition and formulas

$$\rho \equiv \frac{M}{V}$$

← Archimedes knew these

$$V \text{ of a sphere} = \frac{4}{3}\pi R^3$$

Examples

* How many kilograms of water in a swimming pool?

NEED $\rho_{water} = \frac{1\,kg}{liter}$

l, w, d of pool

* How dense is Saturn?

NEED

$$m_{saturn} = 568.36 \times 10^{24}\,kg$$

$$r_{saturn} = 58{,}200\ km$$