Rockets

Propulsion

The rocket starts at rest.

The rocket pushes fuel out the back – backward. The fuel pushes the rocket forward. Newton’s third law pair.

The fuel acquires backward momentum
The rocket acquired forward momentum
The total momentum is conserved – remains zero.

Question

If there were no launch pad beneath the rocket at liftoff, the upward thrust of its engines would be

1. Approximately unchanged.
2. Approximately half as much.
3. Approximately zero.
Gravity

The acceleration due to gravity is only constant if the change in height is small.

The gravitation force between two massive objects is:

\[ F_{\text{Gravity}} = \frac{GMm}{r^2} \]

Near the earth’s surface the acceleration due to gravity is:

\[ g = \frac{GM}{r_{\text{earth}}^2} \]

Orbits

Newton’s cannon

Kepler’s laws

1. All planets move in circular orbits, with the sun at one focus of the ellipse.
2. A line stretching from the sun to the planet sweeps out equal areas in equal times.
3. The square of the planet’s orbital period is proportional to the cube of that planet’s mean distance from the sun.