

Question:

If there were no launch pad beneath the space shuttle at lift-off, the upward thrust of its engines would be

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2. approximately half as much.
3. approximately zero.

Momentum Conservation

- A rocket's momentum is initially zero.
- The momentum redistributes after launch.
 - Ship pushes on fuel; fuel pushes on ship.
 - Ship's momentum becomes forward.
 - Fuel's momentum becomes backward.
- Rocket's total momentum remains zero.

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Ship's Speed

- Increases as
 - relative mass of fuel increases.
 - exhaust speed of fuel increases.
- Would be mass ratio (fuel/ship) times exhaust speed if fuel were released at once.
- Less than that value because
 - fuel is released while rocket is moving.
 - fuel containers add to ship mass.

Gravity

- The acceleration due to gravity is only constant for small changes in height.
- When the distance between objects changes substantially, the full relationship is:

Orbits

- An object that has a sideways velocity doesn't fall directly toward the earth.
- The object follows a trajectory called an orbit around the earth.
- Orbits can be closed or open, and are ellipses, parabolas, and hyperbolas.