

USIII Physics Midterm Study Guide - Fall 2025

- 1) A scientific theory describes phenomena, while a scientific law predicts phenomena.
- 2) A scientific law is **not** more certain to be true than a scientific theory.
- 3) The scientific method has the following steps:
 - a) Collect Data / Make Observations
 - b) Form Hypothesis
 - c) Test the Predictions of that Hypothesis
 - d) Adjust the Hypothesis
 - e) Test New Predictions of Reworked Hypothesis
- 4) **Speed** does not measure the direction of travel, only the magnitude of the change in position. A speed with a direction is a **velocity**.
- 5) An **instantaneous** speed is how fast something travels at a specific moment. An **average** speed is how fast something travels over a period of time. The same distinction between instantaneous and average holds true for velocity, acceleration, etc.
- 6) Velocity and acceleration are related by this equation: $v = v_0 + a \times t$.
Example: If an object starts at 0 m/s ($v_0=0$) and accelerates at 20 m/s^2 , its velocity at the end of 10 seconds will be 200 m/s.
- 7) Acceleration and distance are related by this equation: $d = (v_0 \times t) + (a \times t^2)$.
Example: If an object starts at 10 m/s and accelerates at -2 m/s^2 , the distance travelled after 10 seconds will be $100\text{m} + -200\text{m} = -100\text{m}$.
- 8) Be able to draw a velocity graph.
- 9) As you move from **position** to **velocity** to **acceleration**, the curve on the graph transforms from a **parabola** to a **slanted straight line** to a **flat line (above the x-axis)** to a **flat line (on the x-axis)** with each step.

10.1) When an object is thrown upward, it has zero velocity at its high point. The initial velocity and the time-it-takes-to-reach-the-high-point are related by this equation: $0 = v_0 - (a \times t)$.

For example, a ball is thrown at 20 m/s, and gravity slows the velocity -10m/s every second, so it takes 2 seconds to bring the velocity to zero. The equation above is necessary for more difficult numbers.

10.2) It takes the same amount of time for an object to reach its high point as it does for it to fall back to the same place. That is, an object thrown from the ground takes twice as long to hit the ground as it did to reach the high point. That is, once you have found the time to get to the high point, double it and that is how long the ball was in the air.

11) The units of velocity, acceleration, and force are as follows:

- a) Velocity: m/s
- b) Acceleration: m/s/s or m/s^2
- c) Force: $\frac{m*kg}{s^2}$ (Note: The star means multiply.)

12) Newton's Laws of Motion (know all three)

- a) First Law of Motion: An object in motion tends to stay in motion unless acted upon by an outside force.
- b) Second Law of Motion: Force equals mass times acceleration.
- c) Third Law of Motion: For every action, there is an equal and opposite reaction.

13) Inertia is not a force. It is a quality of matter which relates force to acceleration.

14) Ptolemy used epicycles to describe planetary orbits in his geocentric model. An epicycle is a smaller circular motion inside a larger circular motion (i.e. a "loopy-loop").

15) Kepler's Laws of Planetary Motion (know any two of them)

- a) First Law: Planets follow elliptical orbits, not circular orbits.
- b) Second Law: A planet's radius vector sweeps out equal areas of the ellipse in equal times.
- c) Third Law: The ratio T^2/r^3 (T = period, r = average radius) is the same for all planets.

16) Newton's Law of Universal Gravitation:

$$F = \frac{Gm_1m_2}{r^2}$$

F = gravitational force; G = the gravitational constant (which is a mess of numbers and units); m and m are the masses of the two objects; r is the distance between the two objects

In the Midterm, you will be asked to choose one of the following prompts and write a 4-8 sentence response to it. You may contemplate these questions now, but you cannot bring written notes into the exam.

1. Why should the scientific method be trusted when it so obviously failed during the COVID crisis?
2. Why should the scientific method be trusted when it produces such bizarre theories that are contrary to common sense and intuition?
3. Why should the scientific method be trusted when scientists are constantly changing their theories? Does this not prove that science can never prove anything?
4. Why should Christians trust the scientific method when it is so often used to undermine Christian ideas?