GENERAL

ap physics newtons laws practice test

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Mastering Newton’s Laws: A Complete AP Physics Practice Test Guide

When you’re preparing for the AP Physics exam, one of the most critical topics that consistently appears on the test is Newton’s Laws of Motion. These foundational principles are not only central to high school physics but also form the backbone of many real world applications—from designing cars and rockets to predicting how everyday objects move. However, the way the AP exam frames these laws can be tricky: questions often mix conceptual understanding with quantitative calculations, require multiple steps, and test your ability to translate everyday scenarios into equations.

In this comprehensive guide, we’ll walk you through a full practice test focused on Newton’s Laws. You’ll find a series of carefully crafted problems that mirror the style of the AP exam, detailed explanations for each answer, and actionable study strategies to help you internalize the concepts. By the end, you’ll have a solid grasp of how to tackle any Newton’s Laws question—whether it’s a quick conceptual check or a multi step calculation.

Why Newton’s Laws Are a Cornerstone of the AP Physics Exam

Newton’s Laws of Motion—commonly known as the first, second, and third laws—are the fundamental framework that describes how forces affect motion. They appear in every section of the AP exam, from the free response problems to the multiple choice questions. The exam designers use these laws because they:

- Encourage conceptual reasoning: Students must explain why an object behaves a certain way, not just plug numbers into a formula.
- Test quantitative skills: Calculations involving mass, acceleration, and force are standard.
- Bridge to advanced topics: Newton’s Laws lay the groundwork for energy, momentum, and rotational dynamics.

Because of this, mastering Newton’s Laws is not optional—it’s essential for a high AP Physics score.

Key Concepts You Must Know Before the Test

Newton’s First Law (Law of Inertia)

This law states that an object will remain at rest or move at a constant velocity unless acted upon by an external net force. In practice, this means that if all forces on an object cancel each other out, its motion stays unchanged.

Newton’s Second Law (F = ma)

The net force on an object is equal to its mass multiplied by its acceleration. This equation is the bridge between forces and motion and is the most frequently used formula on the AP exam.

Newton’s Third Law (Action–Reaction)

For every action, there is an equal and opposite reaction. This means that forces always come in pairs, and they act on different objects.

Common Misconceptions to Avoid

- “Zero net force means zero acceleration”—True, but it also means the object’s velocity stays constant, not that

it stops.

- “Mass is the same as weight”—Mass is invariant; weight changes with gravity.
- “All forces are applied in the same direction”—Forces can be vectorial; direction matters.

Structure of the Practice Test

To mimic the AP exam environment, the practice test is divided into four sections:

1. Conceptual Questions (20 minutes) – Short answer and multiple choice questions that test your understanding of the principles.
2. Quantitative Problems (30 minutes) – Problems requiring calculations using F = ma and related equations.
3. Real World Application (25 minutes) – Scenarios where you must apply Newton’s Laws to everyday situations.
4. Free Response (45 minutes) – Two open ended questions that require full explanations and calculations.

After each section, we provide a detailed solution and explanation, so you can see exactly where you went right or wrong.

Practice Test: Newton’s Laws Section

Section 1: Conceptual Questions

1. Which of the following best describes Newton’s First Law?
2. A) The force on an object is proportional to its acceleration.
3. B) An object will change its motion only if a net force acts on it.
4. C) For every action, there is an equal and opposite reaction.
5. D) The sum of forces equals zero.

- A) 0.5 m/s²
- B) 1.0 m/s²
- C) 2.0 m/s²
- D) 10 m/s²

- A) 75 N
- B) 150 N
- C) 300 N
- D) 0 N

Section 2: Quantitative Problems

1. A car with a mass of 1200 kg accelerates from rest to 20 m/s over 10 seconds. Calculate the average net force acting on the car.
2. A 0.5 kg object is moving upward with an acceleration of 2 m/s². What net force is acting on the object? (Assume g = 9.8 m/s² downward.)
3. A 2 kg block slides across a horizontal surface with a coefficient of kinetic friction 0.3. If a horizontal force of 15 N is applied, what is the block’s acceleration?

Section 3: Real World Application

1. A skateboarder of mass 70 kg pushes off a wall with a force of 400 N. If the skateboarder’s initial velocity is 0, estimate the speed achieved after 2 seconds.
2. A 5 kg cart is pulled up a 30° incline with a force of 50 N. Neglect friction. What is the cart’s acceleration along the incline?
3. A rocket engine expels gas at a velocity of 3000 m/s, pushing a 2000 kg rocket upward. What is the thrust force produced by the engine?

Section 4: Free Response Questions

1. Problem A: A 1500 kg car traveling at 25 m/s collides with a stationary 1000 kg car. The collision lasts 0.4 seconds. Assume the collision is perfectly inelastic (the cars stick together). Calculate:\n\na) The final velocity of the combined cars.
2. b) The impulse each car experiences.
3. c) The average force on each car during the collision.

- a) The time of flight.
- b) The horizontal range.
- c) The velocity vector just before impact.

Answers & Explanations

Section 1: Conceptual Questions

1. B – The first law states that an object will maintain its state of motion unless acted upon by a net force.
2. B – Using F = ma, a = F/m = 10 N / 5 kg = 2 m/s². (Answer B is 2 m/s², not 1.0. Correction: The correct answer is 2.0 m/s², which is option C. Apologies for the typo.)
3. B – Newton's third law: the force exerted by the first astronaut on the second is equal in magnitude and opposite in direction to the force exerted by the second on the first, i.e., 150 N.

Section 2: Quantitative Problems

Weight = m·g = 0.5 kg × 9.8 m/s² = 4.9 N downward. Net upward force = m·a = 0.5 kg × 2 m/s² = 1 N upward. Therefore, total upward force must balance weight plus net force: F_net = weight + m·a = 4.9 N + 1 N = 5.9 N upward.

Friction force = ;Åö° · N. Normal force N = m·g = 2 kg × 9.8 m/s² = 19.6 N. Friction = 0.3 × 19.6 N "H 5.88 N. Net force = 15 N – 5.88 N "H 9.12 N. Acceleration a = F_net / m = 9.12 N / 2 kg "H 4.56 m/s².

Section 3: Real World Application

Component of gravity along the incline: m·g·sin;€ = 5 kg × 9.8 m/s² × sin30° "H 24.5 N. Net force = applied force – gravitational component = 50 N – 24.5 N = 25.5 N. Acceleration a = F_net / m = 25.5 N / 5 kg = 5.1 m/s².

Thrust force = A·v_exhaust. Mass flow rate A = mass of rocket / time? For a simplified constant thrust scenario, we use F = A·v. If we assume 1 kg/s of exhaust is expelled, thrust = 1 kg/s × 3000 m/s = 3000 N. If the exhaust mass rate is different, adjust accordingly. In many textbook problems, thrust is directly given by F = A·v_exhaust.

Section 4: Free Response Questions

1. Problem A:\n\na) Conservation of momentum: (1500 kg)(25 m/s) + (1000 kg)(0) = (2500 kg)(v_final). Thus, v_final = (1500 × 25) / 2500 = 15 m/s.
2. b) Impulse on each car = 9G . For the 1500 kg car: 9G Ò Ûs”v = 1500 kg × (15 m/s – 25 m/s) = –15,000 kg·m/s (negative indicates direction). For the 1000 kg car: 9G Ò ¶r r ƒ R Ò÷2 b ’ Ò RÃ ¶{vÒ÷0.
3. c) Average force = Impulse / 9GBà For each car, |F_avg| = 15,000 kg·m/s / 0.4 s = 37,500 N. The forces are equal in magnitude and opposite in direction.

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