

University Physics Summer Assignment for GSIP Seniors 2018/19

The general areas covered by the University Physics course are subdivided into major categories. For each category, answer the conceptual questions in the form of a short paragraph. Although fewer topics are covered in University Physics than in College Physics a year before, they are covered in greater depth and with greater analytical and mathematical sophistication, including calculus applications. Note that the due date for this assignment is August 31.

Here are some internet links to instructional and necessary background materials:

http://apcentral.collegeboard.com/apc/public/courses/teachers_corner/2264.html
http://apcentral.collegeboard.com/apc/public/courses/teachers_corner/2263.html
<https://apstudent.collegeboard.org/apcourse/ap-physics-c-mechanics>
<https://apstudent.collegeboard.org/apcourse/ap-physics-c-electricity-and-magnetism>
<http://www.howstuffworks.com>
<http://www.howeverythingworks.org>
<http://www.physicsclassroom.com>
<http://www.physicscentral.com>

Here are some content resources regularly used in the physics classroom:

<http://www.bozemanscience.com/ap-physics>
<https://www.khanacademy.org/science/physics>
<https://www.youtube.com/user/1veritasium>
<https://www.youtube.com/user/minutephysics>

PART 1: MECHANICS

Watch the following three videos:

<http://www.flippingphysics.com/review-of-all-ap-physics-c-topics---mechanics-video-1-of-2.html>

<http://www.flippingphysics.com/review-of-all-ap-physics-c-topics---mechanics-video-2-of-2.html>

<http://www.flippingphysics.com/review-of-all-ap-physics-c-dimensions---mechanics.html>

and then answer sections A through F below.

A. Kinematics

1. Motion in one dimension

- Discuss the general relationships among position, velocity and acceleration for the motion of a particle along a straight line. (10 pts.)
- Describe the special case of motion with constant acceleration. (10 pts.)
- Explain how to deal with situations in which acceleration is a specified function of time. (10 pts.)

2. Motion in two dimensions

- Describe how to add, subtract and resolve displacement and velocity vectors. (10 pts.)
- Knowing functions $x(t)$ and $y(t)$, which describe the motion, determine the components, magnitude and direction of the particle's velocity and acceleration. (10 pts.)
- Discuss the motion of projectiles in uniform gravitational field. (10 pts.)

B. Newton's Laws of Motion

1. Static and dynamic equilibrium

- State Newton's first law. (10 pts.)

2. Dynamics of a single particle

- State Newton's second law. (10 pts.)
- Explain what a free-body diagram is. (10 pts.)
- Discuss static and kinetic friction. (10 pts.)
- Describe the effect of air drag on the motion of an object. (10 pts.)

3. Systems of two or more particles

- State Newton's third law (10 pts.)

C. Work, Energy, Power

1. Work and work-energy theorem

- Define work done by a constant and non-constant force. (10 pts.)
- Discuss work-energy theorem. (10 pts.)

2. Forces and potential energy

- Explain the concept of conservative and non-conservative force. (10 pts.)

- Discuss the concept of potential energy and how it is related to a conservative force. (10 pts.)

3. Conservation of energy

- State the conservation of mechanical energy. (10 pts.)

4. Power

- Discuss the difference between average and instantaneous power. (10 pts.)

D. Systems of Particles and Linear Momentum

1. Center of mass

- Discuss the concept of center of mass. (10 pts.)

2. Impulse and momentum

- Define impulse and momentum and how they are related to each other. (10 pts.)
- For a given function $F(t)$, find the change in momentum of an object. (10 pts.)
- State the relations between momentum and center-of-mass motion for a system of particles. (10 pts.)

3. Conservation of momentum, and collisions

- State the conservation of momentum. (10 pts.)
- Discuss different types of collisions. (10 pts.)

E. Circular Motion and Rotation

1. Uniform circular motion

- Describe uniform circular motion. (10 pts.)
- Analyze motion in a horizontal and vertical circle. (10 pts.)

2. Torque and rotational statics

- Explain the concept of torque. (10 pts.)
- Discuss the conditions for translational and rotational equilibrium. (10 pts.)
- Discuss rotational inertia of an object and how it can be calculated. (10 pts.)

3. Rotational kinematics and dynamics

- State Newton's second law for rotation, and discuss the analogy between translational and rotational kinematics. (10 pts.)

4. Angular momentum and its conservation

- State Newton's second law for rotation in terms of angular momentum. (10 pts.)
- Discuss the conservation of angular momentum. (10 pts.)

F. Oscillation and Gravitation

1. Simple harmonic motion

- Describe simple harmonic motion and how it relates to uniform circular motion (10 pts.)
- State the relations between acceleration, velocity and displacement. (10 pts.)
- Discuss kinetic and potential energy of an oscillating system as functions of time. (10 pts.)
- Explain damped oscillations and the resonance phenomenon. (10 pts.)

2. Pendula

- Discuss simple harmonic oscillator. (10 pts.)
- Discuss simple pendulum. (10 pts.)

3. Newton's law of gravity

- State Newton's law of universal gravitation. (10 pts.)
- Describe the gravitational force and strength of gravitational field inside and outside a uniform sphere. (10 pts.)
- Define the gravitational potential energy. (10 pts.)

4. Orbits of planets and satellites

- Analyze the motion of an object under the influence of gravity for a circular and general orbit. (10 pts.)
- Discuss orbital speed and escape velocity. (10 pts.)
- State Kepler's three laws. (10 pts.)

PART 2: ELECTROMAGNETISM

Watch the following three videos:

<http://www.flippingphysics.com/review-of-all-ap-physics-c-topics---electricity--magnetism-video-1-of-2.html>

<http://www.flippingphysics.com/review-of-all-ap-physics-c-topics---electricity--magnetism-video-2-of-2.html>

<http://www.flippingphysics.com/review-of-all-ap-physics-c-dimensions---electricity--magnetism.html>

and then answer sections G through K below.

G. Electrostatics

1. Charge and Coulomb's law

- Explain the concept of electric charge. (10 pts.)
- State Coulomb's law. (10 pts.)
- Discuss how the principle of linear superposition applies to electrostatic forces. (10 pts.)
- Analyze the motion of a charged particle under the influence of an electrostatic force. (10 pts.)

2. Electric field and electric potential

- Explain the concept of electric field. (10 pts.)
- Analyze the motion of a charged particle in a uniform electric field. (10 pts.)
- Explain the concept of electric potential and electrostatic potential energy. (10 pts.)

3. Gauss's law

- Discuss the relationship between electric field and electric flux. (10 pts.)
- State Gauss's law for electricity. (10 pts.)

4. Fields and potentials of other charge distributions

- Explain how to calculate electric field and electric potential of highly symmetric charge distributions. (10 pts.)

H. Conductors, Capacitors, Dielectrics

1. Electrostatics with conductors

- Discuss the boundary conditions for conductors. (10 pts.)
- Explain induced charge and electrostatic shielding. (10 pts.)

2. Capacitors

- Define capacitance. (10 pts.)
- Discuss the parallel-plate, cylindrical and spherical capacitors. (10 pts.)

3. Dielectrics

- Describe the behavior of dielectrics inserted inside a capacitor. (10 pts.)
- Analyze situations in which a dielectric slab is inserted between the plates of a capacitor. (10 pts.)

I. Electric current

1. Current, resistance, power

- Define electric current. (10 pts.)
- Discuss conductivity, resistivity and resistance. (10 pts.)
- State Ohm's law. (10 pts.)

2. Steady-state direct current circuits with batteries and resistors only

- Discuss the properties of ideal and real batteries. (10 pts.)
- State Kirchhoff's rules and how they apply to series and parallel circuits. (10 pts.)
- Discuss the properties of voltmeters and ammeters. (10 pts.)

3. Capacitors in circuits

- Discuss the steady-state behavior of capacitors connected in series and in parallel. (10 pts.)
- Discuss the charging and discharging of a capacitor through a resistor in series. (10 pts.)

J. Magnetic Fields

1. Forces on moving charges in magnetic fields

- Describe the force experienced by a charged particle in a magnetic field. (10 pts.)
- Discuss how the particle moves through crossed electric and magnetic fields. (10 pts.)

2. Forces on current-carrying wires in magnetic fields

- Discuss the force exerted on a carrying-current wire in a magnetic field. (10 pts.)
- Discuss the torque experienced by a rectangular loop of wire carrying current in a magnetic field. (10 pts.)

3. Fields of long current-carrying wires

- Discuss the magnetic field produced by a long straight current-carrying wire. (10 pts.)
- Discuss the force of attraction or repulsion between two long current-carrying wires. (10 pts.)

4. Biot-Savart law and Ampere's law

- State Biot-Savart law. (10 pts.)
- State Ampere's law. (10 pts.)

K. Electromagnetism

1. Electromagnetic induction

- Discuss the concept of magnetic flux and state Gauss's law for magnetism. (10 pts.)
- State Faraday's law and Lenz's law. (10 pts.)
- Explain how to find the direction of the induced current in the loop of wire or a conducting bar. (10 pts.)

2. Inductance

- Explain the concept of inductance and mutual inductance. (10 pts.)
- Discuss the transient and steady state behavior of DC circuits containing an inductor and resistor in series. (10 pts.)
- Discuss the behavior of LC circuit in series. (10 pts.)

3. Maxwell's equations

- Discuss how Maxwell modified Ampere's law. (10 pts.)
- State Maxwell equations. (10 pts.)