Introduction to BIT Undergraduate Entrance Test of Physics for International Students

This test is designed for those who have already taken an algebra-based introductory physics course in high school and are considering an engineering or natural science major in BIT. The students who take this test are supposed to get exposure to many facets of physics at the AP (Advanced Placement) Physics B level.

The students are required to have fundamental physics concepts which explores Newtonian mechanics, work, energy, power, mechanical waves and sound, fluid statics and dynamics, thermodynamics with kinetic theory, PV diagrams and probability, electrostatics, electrical circuits with capacitors, magnetic fields, electromagnetism, geometric optics, and atomic, nuclear physics.

Test Paper and Score

There are 35 questions and the time limit is 60 minutes. Questions in the test are each followed by five possible responses but only one of which is correct. Each right answer is worth 3 point. The test grade is scored by 105 points. There is no penalty for wrong answers. It is important to be familiar with the topics of physics at the AP (Advanced Placement) Physics B level. Test taker should understand the basics of the theory, to know the definitions of the fundamental quantities, and to recognize and be able to use the equations to solve problems.

Test Topics and Distribution

Content	Score Percentage
I. Newtonian Mechanics（35%）	
Kinematics (which includes vectors, vector algebra, coordinate systems, displacement, velocity, acceleration, one-dimensional motion, and projectile motion)	7%
Newton's Laws (which includes static and dynamic equilibrium, dynamics on one body, accelerated systems of two bodies, and friction)	9%

Work, Energy, and Power (which includes the work-energy theorem, work on a body, kinetic energy, gravitational and elastic potential energy, conservation of energy, and power)	5%
Linear Momentum (which includes impulse, conservation of momentum, and collisions of systems of particles)	4%
Circular Motion and Rotation (which includes torque, uniform circular motion, and rotational equilibrium)	4%
Oscillations and Gravitation (which includes simple harmonic motion, mass on a spring, simple pendulum, Newton's law of gravitation, and circular orbits)	6%
II. Fluid Mechanics and Thermal Physics (15%)	
Fluid Mechanics (which includes hydrostatic pressure, buoyancy, fluid flow, and Bernoulli's equations)	6%
Temperature and Heat (which includes mechanical equivalent of heat heat transfer, and linear expansions)	2%
Kinetic Theory and Thermodynamics (which includes ideal gases, kinetic Model, first law of thermodynamics-pV diagrams, second law of thermodynamics-heat engines)	7%
III. Electricity and Magnetism (25%)	
Electrostatics (includes static charges, Coulomb's law, electric fields, and electric potential)	5%
Conductors and Capacitors (includes capacitance, parallel plates, and electrostatics with conductors)	4%
Electric Circuits (includes direct current, Ohms law, resistance, resistivity, power, simple circuits, series circuits, parallel circuits, combination circuits, and capacitors in steady state)	7%
Magnetic Fields (includes forces on moving charges, forces on wires in external magnetic fields, and fields of long wires)	4%
Electromagnetism (includes induction, induced EMF, Faradays law and Lenz's law)	5%
IV Waves and Optics (15%)	
Wave motion (includes traveling waves, sound, superposition, and standing waves	5%
Geometric Optics (includes light, reflection, refraction, mirrors, and lenses)	5%
Physical Optics (includes diffraction, interference, dispersion, and electromagnetic radiation）	5%
V Atomic and Nuclear Physics（10%）	
Atomic Physics and Quantum Effects (includes photons, the photoelectric effect, the Compton effect, X rays, matter waves, wave-particle duality, and atomic energy levels)	5%
Nuclear Physics (includes conservation of mass number and charge and mass-energy equivalence）	5%

Sample Test

Kinematics

1. Which of the following is / are true?

I. If an object's acceleration is constant, then it must move in a straight line.

II. If an object's acceleration is zero, then its speed must remain constant.

III. If an object's speed remains constant, then its acceleration must he zero.

(A) I and II only

(B) I and III only

(C) II only

(D) III only

(E) II and III only

2. A stone is thrown horizontally with an initial speed of 10 m/s from a bridge. If air resistance could be ignored, how long would it take the stone to strike the water 80 m below the bridge?

(A) 1s

(B) 2s

(C) 4s

(D) 6s

(E) 8s

Newton’s Laws

1. If all of the forces acting on an object balance so that the net force is zero, then

(A) the object must be at rest

(B) the objects speed will decrease

(C) the object will follow a parabolic trajectory

(D) the objects direction of motion can change, but not its speed

(E) None of the above will occur

2. A crate of mass 100 kg is at rest on a horizontal floor. The coefficient of static friction between the crate and the floor is 0.4, and the coefficient of kinetic friction is 0.3. A force F of magnitude 344 N is then applied to the crate, parallel to the floor. Which of the following is true?

(A) The crate will accelerate across the floor at 0.5 m/s^2

(B) The static friction force, which is the reaction force to F as guaranteed by Newtons

Third Law, will also have a magnitude of 344 N

(C) The crate will slide across the floor at a constant speed of 0.5 m/s

(D) The crate will not move

(E) None of the above

Work, Energy and Power

1. An object of mass m is traveling at constant speed v in a circular path of radius r. How much work is done by the centripetal force during one-half of a revolution?

(A) πmv^2

(B) $2\pi mv^2$

(C) 0

(D) πmv^2r

(E) $2\pi mv^2r$

2. As a rock of mass 4 kg drops from the edge of a 40-meter-high cliff, it experiences air resistance, whose average strength during the descent is 20 N. At what speed will the rock hit the ground?

(A) 8 m/s

(B) 10 m/s

(C) 12 m/s

(D) 16 m/s

(E) 20 m/s

Linear Momentum

1. Two objects move toward each other, collide, and separate. If there was no net external force acting on the objects, but some kinetic energy was lost, then

(A) the collision was elastic and total linear momentum was conserved

(B) the collision was elastic and total linear momentum was not conserved

(C)the collision was not elastic and total linear momentum was conserved

(D) the collision was not elastic and total linear momentum was not conserved

(E) None of the above

2. A ball of mass 0.5 kg, initially at rest, acquires a speed of 4 m/s immediately after being kicked by a force of strength 20 N. For how long did this force act on the ball?

(A) 0.01s

(B) 0.02s

(C) 0.1s

(D) 0.2s

(E) 1s

Circular Motion and Rotation

1. Which of the following statements are true for a satellite in outer space orbiting the earth?

I. There are no forces acting on the satellite.

II. The force of gravity is the only force acting on the satellite.

III. The force of gravity is balanced by the outward force of the object.

(A) I only

(B) II only

(C) III only

(D) either I or III may be correct

(E) either II or III may be correct

2. The dwarf planet Pluto has 1/500 the mass and 1/15 the radius of Earth. What is the value of g (in m/s^2) on the surface of Pluto?

(A) 50/225

(B) 50/15

(C) 15/50

(D) 225/50

(E) 225/500

Oscillation and Gravitation

1. A block attached to an ideal spring undergoes simple harmonic motion. The acceleration of the block has its maximum magnitude at the point where

(A) the speed is the maximum

(B) the potential energy is the minimum

(C) the speed is the minimum

(D) the restoring force is the minimum

(E) the kinetic energy is the maximum

2. A spring-block simple harmonic oscillator is set up so that the oscillations are vertical The period of the motion is T If the spring and block are taken to the surface of the Moon, where the gravitational acceleration is 1/6 of its value here, then the vertical oscillations will have a period of

(A) T/6

(B) T/3

(C) T/$\sqrt{6}$

(D) T

(E)$T\sqrt{6}$

Fluid Mechanics

1. A large tank is filled with water to a depth of 6 m. If Point X is 1 m from the bottom and Point Y is 2 m from the bottom, how does Px, the hydrostatic pressure due to the water at Point X, compare to Py, the hydrostatic pressure due to the water at Point Y?

(A) Px=2Py

(B) 2Px=Py

(C) 5Px=4Py

(D) 4Px=5Py

(E) Px=4Py

2. A plastic cube 0.5 m on each side and with a mass of 100 kg floats in water. What fraction of the cubes volume is above the surface of the water?

(A) 1/5

(B) 1/4

(C) 1/2

(D) 3/4

(E) 4/5

Temperature and Heat

1. If the temperature and volume of a sample of an ideal gas are both doubled, then the pressure

(A) decreases by a factor of 4

(B) decreases by a factor of 2

(C) increases by a factor of 2

(D) increases by a factor of 4

(E) remains unchanged

2. Through a series of thermodynamic processes, the internal energy of a sample of confined gas is increased by 560 J. If the net amount of work done on the sample by its surroundings is 320 J, how much heat was transferred between the gas and its environment?

(A) 240 J absorbed

(B) 240 J dissipated

(C) 880 absorbed

(D) 880 J dissipated

(E) None of the above

Kinetic Theory and Thermodynamics

1. A container holds a mixture of two gases, CO_2 and H_2, in thermal equilibrium. Let K_C and K_H denote the average kinetic energy of a CO_2 molecule and an H_2 molecule, respectively. Given that a molecule of CO_2 has 22 times the mass of a molecule of H_2, the K_C/K_H is equal to

(A) 1/22

(B) $1/\sqrt{22}$

(C) 1

(D) $\sqrt{22}$

(E) 22

2. In one of the steps of the Carnot cycle, the gas undergoes an isothermal expansion. Which of the following statements is true concerning this step?

(A) No heat is exchanged between the gas and its surroundings, because the process is isothermal.

(B) The temperature decreases because the gas expands.

(C) This step violates the Second Law of Thermodynamics because all the heat absorbed is transformed into work.

(D) The internal energy of the gas remains constant.

(E) The internal energy of the gas decreases due to the expansion.

Electrostatics

1. A sphere of charge +Q is fixed in position. A smaller sphere of charge +q is placed near the larger sphere and released from rest. The small sphere will move away from the large sphere with

(A) decreasing velocity and decreasing acceleration

(B) decreasing velocity and increasing acceleration

(C) decreasing velocity and constant acceleration

(D) increasing velocity and decreasing acceleration

(E) increasing velocity and increasing acceleration

2. Which of the following statements is/are true?

I. If the electric field at a certain point is zero, then the electric potential at the same point is also zero

II. If the electric potential at a certain point is zero, then the electric field at the same point is also zero

III. The electric potential is inversely proportional to the strength of the electric field
(A) I only
(B) II only
(C) I and II only
(D) I and III only
(E) None are true

Conductors and Capacitors

1. A charge of -3Q is transferred to a solid metal sphere of radius R. Where will this excess charge reside?
(A) -Q at the center, and -2Q on the outer surface
(B) -2Q at the center, and-Q on the outer surface
(C) -3Q at the center
(D) -3Q on the outer surface
(E) -Q at the center, -Q in a ring of radius 2R, and-Q on the outer surface

2. A charge Q experiences a displacement within an electric field from Position A to Position B. The change in the electrical potential energy is ΔU_E, and the work done by the electric field during this displacement is W_E. Then
(A) $V_B - V_A = W/Q$
(B) $V_A - V_B = QW_E$
(C) $V_B - V_A = QW_E$
(D) $V_A - V_B = \Delta U_E/Q$
(E) $V_B - V_A = \Delta U_E/Q$

Electric Circuits

1. A wire made of brass and a wire made of silver have the same length, but the diameter of the brass wire is 4 times the diameter of the silver wire. The resistivity of brass is 5 times greater than the resistivity of silver. If R_B denotes the resistance of the brass wire, and R_S denotes the resistance of the silver wire, which of the following is true?
(A) $R_B = 5/16\ R_S$
(B) $R_B = 4/5\ R_S$
(C) $R_B = 5/4\ R_S$
(D) $R_B = 5/2\ R_S$
(E) $R_B = 16/5\ R_S$

2. How much energy is dissipated as heat in 20 s by a 100 Ω resistor that carries a current of 0.5A ?

(A) 50 J
(B) 100 J
(C) 250 J
(D) 500 J
(E) 1000 J

Magnetic Fields

1. Which of the following is/are true concerning magnetic forces and fields?
I. The magnetic field lines due to a current-carrying wire radiate away from the wire
II. The kinetic energy of a charged particle can be increased by a magnetic force
III. A charged particle can move through a magnetic field without feeling a magnetic force.
(A) I only
(B) II and III only
(C) I and II only
(D) III only
(E) I and III only

2. Two long, straight wires are hanging parallel to each other and are 1 cm apart. The current in Wire 1 is 5 A, and the current in Wire 2 is 10 A, in the same direction. Which of the following best describes the magnetic force per unit length felt by the wires?
(A) The force per unit length on Wire 1 is twice the force per unit length on Wire 2
(B) The force per unit length on Wire 2 is twice the force per unit length on Wire 1
(C) The force per unit length on Wire 1 is 0.0003 N/m, away from Wire 2
(D) The force per unit length on Wire 1 is 0.001 N/m, toward Wire2
(E) The force per unit length on Wire 1 is 0.001 N/m, away from Wire 2

Electromagnetism

1. The magnetic flux through a wire loop is independent of
(A) the shape of the loop
(B) the area of the loop
(C) the strength of the magnetic Aux
(D) the orientation of the magnetic field and the loop
(E) none of the preceding

2. A square loop of wire (side length = s) surrounds a long, straight wire such that the wire passes through the center of the square. If the current in the wire is I, determine the current induced in the square loop.

(A) $\frac{2\mu_0 Is}{\pi(1+\sqrt{2})}$

(B) $\frac{\mu_0 Is}{\pi\sqrt{2}}$

(C) $\frac{\mu_0 Is}{\pi}$

(D) $\frac{\mu_0 Is\sqrt{2}}{\pi}$

(E) 0

Waves

1. A transverse wave on a long horizontal rope with a wavelength of 8 m travels at 2 m/s At t=0, a particular point on the rope has a vertical displacement of +A, where A is the amplitude of the wave. At what time will the vertical displacement of this same point on the rope be -A?

(A) t =1/8 s

(B) t = 1/4 s

(C) t = 1/2 s

(D) t= 2s

(E) t = 4 s

2. A sound wave travels through a metal rod with wavelength λ and frequency f. Which of the following best describes the wave when it passes into the surrounding air?

	Wavelength	Frequency
(A)	Less than λ	Equal to f
(B)	Less than λ	Less than f
(C)	Greater than λ	Equal to f
(D)	Greater than λ	Less than f
(E)	Greater than λ	Greater than f

Optics

1. A bi-concave lens has both surfaces concave. Which of the following is true concerning a bi-concave lens?

(A) Its focal length is positive

(B) It cannot form real images

(C) It cannot form virtual images

(D) It can magnify objects

(E) None of the above

2. The image created by a converging lens is projected onto a screen that's 60 cm from

the lens. If the height of the image is 1/4 the height of the object, what's the focal length of the lens?

(A) 36 cm

(B) 45 cm

(C) 48 cm

(D) 72 cm

(E) 80 cm

Atomic and Nuclear Physics

1. The single electron in an atom has an energy of -40 eV when it's in the ground state, and the first excited state for the electron is at -10 eV. What will happen to this electron if the atom is struck by a stream of photons, each of energy 15 eV?

(A) The electron will absorb the energy of one photon and become excited halfway to the first excited state, then quickly return to the ground state, without emitting a photon.

(B) The electron will absorb the energy of one photon and become excited halfway to the first excited state, then quickly return to the ground state, emitting a 15 ev photon in the process.

(C) The electron will absorb the energy of one photon and become excited halfway to the first excited state, then quickly absorb the energy of another photon to reach the first excited state.

(D) The electron will absorb two photons and be excited to the he first excited state.

(E) Nothing will happen.

2. In an exothermic nuclear reaction. the difference in mass between the reactants and the products is m, and the energy released is Q In a separate exothermic nuclear reaction in which the mass difference between reactants and products is m/ 4. how much energy will be released?

(A) Q/4

(B) Q/2

(C) (Q/4)c^2

(D) (Q/2)c^2

(E) 4Q

Solutions to the Sample Test

Kinematics：C, C

Newton’s Laws：E, D

Work, Energy and Power：C, E

Linear Momentum：C, C

Circular Motion and Rotation：B, D

Oscillation and Gravitation：C, D

Fluid Mechanics：D, A

Temperature and Heat：E, A

Kinetic Theory and Thermodynamics：C, D

Electrostatics：D, E

Conductors and Capacitors：D, E

Electric Circuits：A, D

Magnetic Fields：D, D

Electromagnetism：A, E

Waves ：D, A

Optics：B, C

Atomic and Nuclear Physics：E, A