Essentials of Mathematics, Physical and Chemical Sciences

ESSENTIALS OF PHYSICS

Unit II Syllabus

Definition and scope of physics-Measurements and Units- Motion of objects: Newtonian Mechanics and relativistic mechanics perspective- Laws of thermodynamics and significance- Acoustic waves and electromagnetic waves- Electric and magnetic fields and their interactions- Behavior of atomic and nuclear particles- Wave- particle duality, the Uncertainty principle- Theories and understanding of Universe.

By

Dr G SANKARANARAYANARAO

Dean, Mrs A V N College, Visakhapatnam

Essentials and applications of Mathematical, Physical and chemical sciences

Unit II

Essentials of Physics

Measurements - Units

1. Which one of the following is not the unit of heat ?
[A] Centigrade
[B] Calorie
[C] Erg
[D] Joule

2. Which one of the following quantities does not have unit ?
[A] Stress
[B] Force
[C] Strain
[D] Pressure
3. The unit of pressure is ?
[A] kg/cm2
[B] kg/cm
[C] kg/mm
[D] none of this
4. What is the unit of pressure ?
[A] N/ sq m
[B] N-m
[C] N
[D] N/m
5. Angstrom is a unit of ?
[A] Wavelength
[B] energy
[C] frequency
[D] velocity
6. Which one of the following physical quantities has the same unit as that of pressure ?
[A] Angular momentum
[B] Stress
[C] Strain
[D] Work
7. What is the measure of hertz ?
[A] Frequency

[B] energy
[C] heat
[D] quality
8. Frequency is measured in ?
[A] hertz
[B] m/s
[C] radian
[D] watt
9. What is the unit of the physical quantity, Momentum ?
[A] Newton second (N s)
[B] Joule second (J s)
[C] Erg second (E s)
[D] Pascal second (P s)
10. Identify the unit of measuring intensity of sound ?
[A] Knots
[B] Ampere
[C] Candela
[D] Decibel
11. Hertz is the SI unit of ?
[A] frequency
[B] force
[C] pressure
[D] energy
12. The SI unit of radioactivity is ?
[A] ampere
[B] becquerel
[C] decibel
[D] cobolt
13. The SI unit of weight is ?
[A] kilogram
[B] newton
[C] gram
[D] dyne
15. Which of the following quantities does not have any unit ?
[A] speed
[B] density
[C] relative density
[D] acceleration
16. The unit of momentum is ?
[A] kgms2

[B] kgms-1
[C] kgms
[D] kgms-2
17. Light year is the unit of ?
[A] length
[B] mass
[C] time
[D] area
18. Light year is a unit for measurement of ?
[A] very large distances
[B] time interval in years
[C] amount of light received on earth on in year
[D] mass of atoms
19. Which of the following is the unit of force ?
[A] pascal
[B] watt
[C] joule
[D] newton
20. Which of the following is the SI unit of temperature ?
[A] kelvin
[B] Reaumur scale
[C] candela
[D] ampere
21. The SI unit for electrical resistivity is ?
[A] ampere/metre
[B] volt/metre
[C] tesla
[D] ohm metre
22. Which of the following quantities have its SI unit named after Blaise Pascal ?
[A] energy
[B] pressure
[C] work
[D] power
23. Newton-metre (N-m) is the SI unit of which of the following quantity ?
[A] acceleration
[B] torque
[C] power
[D] force
24. Light year is ?
[A] light emitted by sun in one year.

[B] time taken by light to travel from sun to earth.
[C] the distance travelled by light in free space in one year.
[D] time taken by earth to go once around the sun.

25. A nautical mile is equal to ___ ?

[A] 2000 mts

[B] 1852 mts

[C] 1672 mts

[D] 2450 mts

26. Which one of the following is the value of 1 nanometer ?

[A] 10-7 cm

[B] 10-6 cm

[C] 10-4 cm

[D] 10-3 cm

27. 1 dyne is equal to ?

[A] 10^3 g-cm/s2

[B] 10^-3 g-cm/s2

[C] 10^5 kg-cm/s2

[D] 10^-5 kg-m/s2

28. If a physical quantity has the units-ampere meters per second squared, then what are it's dimensions ?

[A] [ILT^2]

[B] [ALT^2]

[C] [IMS^2]

[D] [AMS^-2]

29. Which instrument is used to measure humidity ?

[A] hydrometer

[B] hygrometer

[C] pyrometer

[D] lactometer

30. Electroencephaogram (ECG) is used in monitoring ?

[A] heart

[B] liver

[C] pancreas

[D] brain

31. Which one of the following thermometers is known as pyrometer ?

[A] Thermo-electric thermometers

[B] Radiation thermometers

[C] Gas thermometers

[D] liquid thermometers

32. Which one of the following devices is used to measure extremely high temperature?

[A] pyrometer

[B] photometer

[C] phonometer

[D] pycnometer

33. Pyrheliometer is used for measuring?

[A] sun spots

[B] solar radiation

[C] air temperature

[D] temperature of plants

34. The density of milk is measured by?

[A] lactometer

[B] hydrometer

[C] barometer

[D] hygrometer

35. What is the SI unit of length?

a. Kilogram

b. Meter

c. Second

d. Ampere

36. Which of the following is a unit of pressure?

a. Newton

b. Pascal

c. Joule

d. Watt

37. What is the symbol for the unit of electric current?

a. V

b. A

c. Ω

d. W

38. How many millimeters are in a meter?

a. 10

b. 100

c. 1000

d. 10000

39. Which of the following is a unit of energy?

a. Volt

b. Ampere-hour

c. Joule

d. Ohm

40. What is the SI unit of temperature?

a. Celsius

b. Kelvin

c. Fahrenheit

d. Rankine

41. How many seconds are in an hour?

a. 3600

b. 60

c. 600

d. 360

42. The unit of electric charge is

a. Volt

b. Coulomb

c. Ampere

d. Ohm

43. What is the SI unit of frequency?

a. Hertz

b. Newton

c. Watt

d. Pascal

44. The prefix "kilo" represents

a. 10^-3

b. 10^3

c. 10^-6

d. 10^6

Motion of Objects - Newtonian Mechanics

1. What is Newton's First Law of Motion?
a. F = ma
b. Every action has an equal and opposite reaction
c. An object at rest stays at rest, and an object in motion stays in motion with the same speed and in the same direction unless acted upon by an external force.
d. The force between two objects is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centers.

2. Which of the following is a unit of force in the International System of Units (SI)?
a. Newton
b. Joule
c. Watt
d. Pascal

3. What is the formula for calculating force (F)?
a. F = m/g
b. F = ma
c. F = mv
d. F = mg

4. If an object has no net force acting on it and is in motion, what will happen to its motion?
a. It will speed up.
b. It will slow down.
c. It will maintain a constant speed.
d. It will stop.

5. What is the relationship between mass and acceleration according to Newton's Second Law?
a. Directly proportional
b. Inversely proportional
c. No relationship
d. Exponential relationship

6. Which of the following statements is true about Newton's Third Law of Motion?
a. Objects in motion tend to stay in motion.
b. For every action, there is an equal and opposite reaction.
c. The force required to accelerate an object is proportional to its mass.
d. An object at rest tends to stay at rest.

7. If the net force acting on an object is zero, what can be said about its motion?
a. It is at rest.
b. It is moving with a constant velocity.
c. It is accelerating.
d. It is experiencing a gravitational force.

8. What is the gravitational force between two objects dependent on?
a. Mass of one object only
b. Distance between the objects only
c. Both the masses of the objects and the distance between them
d. Velocity of the objects

9. A 5 kg object experiences a gravitational force of 50 N. What is the acceleration due to gravity at its location?
a. 2 m/s^2
b. 5 m/s^2
c. 10 m/s^2
d. 20 m/s^2

10. In the absence of air resistance, what can be said about the horizontal motion of a projectile launched at an angle to the ground?
a. It follows a curved path.

b. It follows a straight line.
c. It moves in a circular motion.
d. It is not affected by gravity.

Relativistic mechanics

1. What happens to the mass of an object as its velocity approaches the speed of light according to special relativity?

a) Mass increases
b) Mass decreases
c) Mass remains constant
d) Mass becomes zero

2. According to special relativity, time dilation occurs when an object is

a) Accelerating
b) Moving with velocity comparable to velocity of light
c) At rest
d) Experiencing gravitational forces

3. In special relativity, the Lorentz contraction refers to:

a) Contraction of time
b) Contraction of length
c) Contraction of mass
d) Contraction of energy

4. The invariant mass in special relativity is:

a) The same as the rest mass
b) Dependent on the observer's frame of reference
c) Always zero for massless particles
d) Equal to the relativistic mass

5. The equation $E=mc^2$ relates:

a) Energy and mass
b) Energy and velocity
c) Momentum and mass

d) Time and energy

6. Which of the following is a consequence of the equivalence of mass and energy in special relativity?

a) Mass can be converted into energy
b) Energy can be converted into mass
c) Mass and energy are independent of each other
d) Mass and energy have opposite effects on motion

7. According to general relativity, the curvature of spacetime is caused by:

a) Gravity
b) Electromagnetic forces
c) Strong nuclear forces
d) Weak nuclear forces

8. Gravitational time dilation occurs in the presence of:

a) High velocity
b) Strong gravitational fields
c) Low temperature
d) Electromagnetic radiation

1. The theory of _____ was developed by Albert Einstein to describe the motion of objects at speeds approaching the speed of light.
Relativity

4. The Lorentz transformation equations relate the coordinates of an event as measured in two inertial frames in _____ motion.
Relative

5. The speed of light (\(c \)) is a fundamental constant and is approximately equal to _____ meters per second in a vacuum.
$3x\ 10^8$ m/s

7. The concept of length contraction in relativistic mechanics implies that the length of an object moving at a relativistic speed appears _____ when measured in the direction of motion.
decrease

1. True/False: According to special relativity, the speed of light is the same for all observers, regardless of their motion.

2. True/False: Time dilation implies that a clock in motion relative to an observer will tick more slowly than a stationary clock.

3. True/False: Mass dilation states that the mass of an object in motion increases as its speed approaches the speed of light.

4. True/False: In relativistic mechanics, momentum is conserved in all inertial reference frames.

5. True/False: Length contraction predicts that objects in motion appear shorter along the direction of motion when observed from a stationary frame.

6. True/False: According to special relativity, simultaneity is absolute, meaning that events happening at the same time for one observer will be simultaneous for all observers.

7. True/False: The Lorentz transformation equations describe the relationship between the coordinates of events as measured by observers in relative motion.

8. True/False: Special relativity predicts that as an object with mass accelerates and approaches the speed of light, its energy increases without bound.

9. True/False: In relativistic mechanics, the addition of velocities formula is the same as in classical mechanics.

10. True/False: Gravitational time dilation predicts that time passes more slowly in stronger gravitational fields.

11. Match the terms in column A with their corresponding descriptions in column B.

Column A	Column B
1. Force	A. The rate of change of velocity
2. Inertia	B. An interaction that can cause a change in motion
3. Acceleration	C. The tendency of an object to resist changes in its motion
4. Newton's First Law	D. The force exerted by a surface as an object moves across it
5. Friction	E. A measure of the amount of matter in an object

6. Mass | F. States that an object at rest will remain at rest, and an object in motion will remain in motion with a constant velocity unless acted upon by a net external force
7. Newton's Second Law | G. The force of gravity on an object
8. Weight | H. States that the net force acting on an object is equal to the mass of that object multiplied by its acceleration

Answers:

1. Force - B. An interaction that can cause a change in motion
2. Inertia - C. The tendency of an object to resist changes in its motion
3. Acceleration - A. The rate of change of velocity
4. Newton's First Law - F. States that an object at rest will remain at rest, and an object in motion will remain in motion with a constant velocity unless acted upon by a net external force
5. Friction - D. The force exerted by a surface as an object moves across it
6. Mass - E. A measure of the amount of matter in an object
7. Newton's Second Law - H. States that the net force acting on an object is equal to the mass of that object multiplied by its acceleration
8. Weight - G. The force of gravity on an object

Laws of Thermodynamics

1. First Law of Thermodynamics:
   a. What is the mathematical expression of the first law of thermodynamics?
      - A) $\Delta Q = \Delta U + \Delta W$
      - B) $\Delta U = \Delta Q + \Delta W$
      - C) $\Delta W = \Delta U + \Delta Q$
      - D) $\Delta Q + \Delta W = 0$

   b. The first law of thermodynamics is also known as:
      - A) Law of Conservation of Energy
      - B) Law of Entropy
      - C) Law of Heat Transfer
      - D) Law of Temperature

2. Second Law of Thermodynamics:
   a. According to the second law of thermodynamics, the total entropy of an isolated system:
      - A) Always decreases
      - B) Remains constant

- C) Always increases
- D) Fluctuates randomly

b. The second law is often expressed in terms of the concept of:
- A) Temperature
- B) Enthalpy
- C) Entropy
- D) Internal energy

3. Third Law of Thermodynamics:
a. The third law of thermodynamics deals with the behavior of systems at:
- A) Absolute zero
- B) Boiling point
- C) Triple point
- D) Room temperature

b. The third law is often stated in terms of the unattainability of:
- A) Absolute zero
- B) Infinite entropy
- C) Constant temperature
- D) Maximum pressure

4. Heat Engines and Refrigerators:
a. The efficiency of a heat engine is given by:
- A) Efficiency = 1 - (Qc / Qh)
- B) Efficiency = 1 - (Qh / Qc)
- C) Efficiency = Qh / W
- D) Efficiency = W / Qc

b. In a refrigerator, heat is transferred from:
- A) The outside to the inside
- B) The inside to the outside
- C) Inside to outside and outside to inside
- D) None of the above

5. Carnot Cycle:
a. The Carnot cycle is a theoretical cycle that consists of:
- A) Two isothermal and two adiabatic processes
- B) Two adiabatic and two isochoric processes
- C) Two isobaric and two isothermal processes

- D) Two isothermal and two isobaric processes

b. The efficiency of a Carnot engine depends only on the temperatures of the:
- A) Source and sink
- B) Adiabatic processes
- C) Isothermal processes
- D) Entire cycle

1. Zeroth Law of Thermodynamics:
Statement: If two systems are each in thermal equilibrium with a third system, then they are in thermal equilibrium with each other.
Answer: True

2. First Law of Thermodynamics:
Statement: Energy cannot be created or destroyed, only transferred or converted from one form to another.
Answer: True

3. Second Law of Thermodynamics:
-Statement: Heat energy can spontaneously flow from a colder object to a hotter object.
Answer: False

4. Second Law of Thermodynamics:
Statement: The total entropy of an isolated system can never decrease over time.
Answer: True

5. Third Law of Thermodynamics:
Statement: As the temperature of a system approaches absolute zero, the entropy of the system approaches a constant minimum.
Answer: True

6. Second Law of Thermodynamics:
Statement: A perpetual motion machine of the second kind is possible, violating the second law of thermodynamics.
Answer: False

7. First Law of Thermodynamics:
Statement: The change in internal energy of a system is equal to the heat added to the system minus the work done by the system.

Answer: True

8. Zeroth Law of Thermodynamics:
Statement: The zeroth law implies the existence of temperature as a measurable quantity.
Answer:True

9. Third Law of Thermodynamics:
Statement: It is impossible to cool a system to absolute zero in a finite number of steps.
Answer:True

10. Second Law of Thermodynamics:
Statement: All natural processes tend to increase the disorder or entropy of a closed system.
Answer:True

Very Short Answers to questions about the laws of thermodynamics:

1. Zeroth Law:Describes thermal equilibrium. If two systems are each in thermal equilibrium with a third system, then they are in thermal equilibrium with each other.

2. First Law (Conservation of Energy):Energy cannot be created or destroyed, only transferred or converted from one form to another.

3. Second Law (Entropy):In any energy transfer or transformation, the total entropy of a closed system will always increase over time.

4. Third Law (Absolute Zero):As temperature approaches absolute zero, the entropy of a perfect crystal approaches a minimum value. It is impossible to reach absolute zero in a finite number of steps.

Acoustic Electromagnetic waves

Acoustic Waves:

1. What is the medium through which acoustic waves travel?
a) Vacuum
b) Air
c) Glass
d) Metal

2. Which property of a sound wave determines its pitch?
   a) Amplitude
   b) Frequency
   c) Wavelength
   d) Speed

3. What is the unit of measurement for the intensity of sound?
   a) Decibels
   b) Hertz
   c) Joules
   d) Watts

4. In which direction do longitudinal waves in air travel during a sound wave?
   a) Perpendicular to the direction of sound
   b) Parallel to the direction of sound
   c) At an angle of 45 degrees to the direction of sound
   d) Randomly in all directions

Electromagnetic Waves

5. Which of the following is not a part of the electromagnetic spectrum?
   a) Radio waves
   b) Sound waves
   c) X-rays
   d) Microwaves

6. What is the speed of light in a vacuum?
   a) 300,000 km/s
   b) 150,000 km/s
   c) 1,000,000 km/s
   d) 500,000 km/s

7. Which color has the longest wavelength in the visible spectrum?
   a) Red
   b) Blue
   c) Green
   d) Violet

8. What type of electromagnetic waves are commonly used in microwave ovens?

a) Infrared
b) Ultraviolet
c) Microwaves
d) X-rays

Electric and Magnetic fields interactions

True or False:

1. Electric charges at rest produce magnetic fields.
   - Answer: False.

2. What is the SI unit of magnetic field strength?
   - A) Volts
   - B) Ampere-meters
   - C) Tesla
   - D) Coulombs

3. According to Maxwell's equations, changing electric fields produce what type of fields?
   - A) Gravitational fields
   - B) Magnetic fields
   - C) Thermal fields
   - D) Inertial fields

4. What is the relationship between current and magnetic field strength in Ampere's Law?
   - A) $B = \mu_0 I/2\pi r$
   - B) $B = \mu_0 I/4\pi r$
   - C) $B = \mu_0 I/\pi r$
   - D) $B = \mu_0 I/8\pi r$

5. In a magnetic field, the force experienced by a charged particle is maximum when the particle's velocity is:
   - A) Parallel to the magnetic field
   - B) Perpendicular to the magnetic field
   - C) At an angle of 45 degrees to the magnetic field
   - D) Irrelevant to the magnetic field

6. Which rule is used to determine the direction of the magnetic field produced by a current-carrying conductor?

- A) Ampere's Law
- B) Faraday's Law
- C) Fleming's Left-Hand Rule
- D) Fleming's Right-Hand Rule

7. What happens to the magnetic field inside a long straight current-carrying conductor?
- A) It becomes zero.
- B) It is uniform and parallel to the conductor.
- C) It forms loops around the conductor.
- D) It points towards the center of the conductor.

8. What is the relationship between electric field (E), magnetic field (B), and the speed of light (c) in vacuum, according to Maxwell's equations?
- A) E = B/c
- B) B = E/c
- C) E = Bc
- D) B = Ec

9. Which of the following particles is affected by both electric and magnetic fields?
- A) Neutron
- B) Electron
- C) Proton
- D) Photon

10. What is the phenomenon where a changing magnetic field induces an electromotive force (EMF) in a conductor?
- A) Ampere's Law
- B) Faraday's Law of Induction
- C) Ohm's Law
- D) Coulomb's Law

1. The unit of electric field intensity is _____.

Newton per Coulomb (N/C)

2. Coulomb's law describes the force between two point charges and is given by the equation F = _____.

(k * q1 * q2) / r^2

3. The SI unit of magnetic flux is _____.

Weber (Wb)

4. In a magnetic field, a moving charged particle experiences a force known as _____.

Lorentz force
5. The right-hand rule is commonly used to determine the direction of the _____ in a magnetic field.
Magnetic field (or magnetic force)
6. Ampere's law relates the magnetic field around a closed loop to the total _____ passing through the loop.
Current

7. The phenomenon where an electric current is induced in a coil due to a changing magnetic field is called _____.
Electromagnetic induction

8. The speed of light in a vacuum is approximately _____ meters per second.
3.00 x 10^8
9. In electromagnetic waves, the electric and magnetic fields oscillate _____ to each other and the direction of propagation.
Perpendicular

10. The electromagnetic spectrum includes various types of waves, such as radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, and _____.
Gamma rays

Behavior of Atomic and Nuclear particles

1. a. What is the charge of a proton?
   - A. Positive
   - B. Negative
   - C. Neutral
   - D. Variable

   b. Which subatomic particle is located outside the nucleus?
   - A. Proton
   - B. Neutron
   - C. Electron
   - D. Positron

   c. What is the mass of an electron compared to a proton?
   - A. Equal
   - B. Greater

- C. Smaller
- D. Variable

d. Which force holds the nucleus together?
- A. Gravitational force
- B. Electromagnetic force
- C. Strong nuclear force
- D. Weak nuclear force

2. True/False:
a. Electrons are located in the nucleus of an atom. (True/False)

b. Isotopes of an element have the same number of protons but a different number of neutrons. (True/False)

c. The mass number of an atom is the sum of its protons and electrons. (True/False)

d. Radioactive decay is a process by which unstable nuclei transform into stable nuclei by emitting particles or energy. (True/False)

3. Match the following particles with their respective charge:
- A. Proton 1. Negative
- B. Neutron 2. Positive
- C. Electron 3. Neutral

Answer: A - 2, B - 3, C - 1

4. Fill in the Blank:
a. The atomic number of an element represents the number of _____ in the nucleus.
Protons or electrons

b. The process of a nucleus splitting into two or more smaller nuclei is called _____.
Nuclear fission
c. The symbol for the speed of light in a vacuum is represented by the letter _____.
C
d. The emission of an alpha particle results in a decrease in the atomic number by _____.
2
1. The nucleus of an atom is composed of _____ and _____.
a. Protons, Electrons
b. Neutrons, Electrons

c. Protons, Neutrons

2. The charge of an electron is _____, and its mass is _____.
a. Positive, negligible
b. Negative, negligible
c. Negative, approximately 1 atomic mass unit

3. Isotopes of an element have the same number of _____ but a different number of _____.
a. Neutrons, Protons
b. Electrons, Neutrons
c. Protons, Neutrons

4. The process of a radioactive nucleus transforming into another element is called _____.
a. Nuclear fission
b. Nuclear fusion
c. Radioactive decay

5. The unit used to measure the activity of a radioactive substance is _____.
a. Sievert
b. Becquerel
c. Curie

6. In a nuclear reaction, the total number of protons and neutrons is conserved. This principle is known as _____.
a. Conservation of charge
b. Conservation of mass
c. Conservation of nucleons

7. The energy released in a nuclear reaction is often calculated using _____ equation.
a. Einstein's
b. Newton's
c. Planck's

8. Which particle is neutral and found in the nucleus of an atom?
a. Proton
b. Neutron
c. Electron

9. The process in which two light atomic nuclei combine to form a heavier nucleus is known as _____.

a. Nuclear fission
b. Nuclear fusion
c. Radioactive decay

10. The SI unit of electric charge is _____.

a. Ampere
b. Coulomb
c. Volt

Wave particle duality

1. What is wave-particle duality?

a. The dual nature of light
b. The simultaneous existence of both wave and particle properties in matter and radiation
c. The interference of waves only
d. The reflection of particles

2. Who proposed the wave-particle duality theory for electrons?

a. Isaac Newton
b. Max Planck
c. Albert Einstein
d. Louis de Broglie

3. Which experiment provided evidence for the wave-like nature of electrons?

a. Photoelectric effect
b. Double-slit experiment
c. Compton scattering
d. Davisson-Germer experiment

4. In the double-slit experiment, what pattern is observed when particles exhibit wave-like behavior?

a. Single bright band
b. Interference pattern
c. No pattern
d. Random scattered spots

5. Who formulated the de Broglie wavelength equation for particles?
   a. Werner Heisenberg
   b. Erwin Schrödinger
   c. Louis de Broglie
   d. Niels Bohr

6. Which equation relates the momentum and wavelength of a particle in quantum mechanics?
   a. Planck's equation
   b. Heisenberg's uncertainty principle
   c. de Broglie wavelength equation
   d. Schrödinger's equation

7. What is the minimum energy required to remove an electron from a material's surface in the photoelectric effect?
   a. Kinetic energy
   b. Threshold energy
   c. Potential energy
   d. Rest energy

8. According to wave-particle duality, which property is exhibited by both waves and particles?
   a. Mass
   b. Frequency
   c. Momentum
   d. Diffraction

9. Which scientist received the Nobel Prize for providing experimental evidence of the wave nature of matter?
   a. Max Planck
   b. Albert Einstein
   c. Davisson and Germer
   d. Werner Heisenberg

10. The Heisenberg uncertainty principle states that there is a fundamental limit to the simultaneous precision of which two properties of a particle?
   a. Mass and charge
   b. Position and momentum
   c. Energy and time
   d. Spin and angular momentum

1. In the double-slit experiment, when particles are fired one at a time, they exhibit _____ behavior.
wave

2. The de Broglie wavelength of a particle is inversely proportional to its _____.
momentum

3. According to wave-particle duality, particles like electrons and photons can exhibit both _____ and _____ properties.
wave, particle
4. The photoelectric effect supports the particle nature of light, demonstrating that light can be thought of as a stream of _____.
particles (photons)
5. The famous equation E=_____ describes the energy of a particle, where m is the mass and c is the speed of light.
mass times the speed of light squared (m*c^2)

6. The uncertainty principle, formulated by Heisenberg, states that it is impossible to simultaneously know the exact _____ and _____ of a particle.
position, momentum
7. The concept of wave-particle duality is central to the understanding of quantum mechanics and was initially proposed by _____.
Louis de Broglie
8. The Davisson-Germer experiment provided experimental evidence for the _____ nature of electrons.
wave
9. The phenomenon where electrons exhibit wave-like behavior when passing through a crystal lattice is known as _____ diffraction.
electron
10. The wave-particle duality is not limited to subatomic particles; even macroscopic objects, such as _____, can exhibit dual behavior under certain conditions.
fullerene (or other macroscopic objects)

Uncertainty Principle

1. What is the uncertainty principle?

a. It states that we can never know both the exact position and momentum of a particle simultaneously.
b. It defines the uncertainty of energy and time.
c. It describes the uncertainty in the angular momentum of an electron.

2. Who formulated the uncertainty principle?
a. Albert Einstein
b. Niels Bohr
c. Werner Heisenberg

3. The uncertainty principle is a consequence of:
a. Relativity
b. Wave-particle duality
c. Quantum entanglement

4. What is the mathematical expression of the uncertainty principle?
a. $\Delta x * \Delta p = \hbar$
b. $\Delta E * \Delta t = \hbar$
c. $\Delta L * \Delta \theta = \hbar$
D. All of the above

5. In the uncertainty principle, Δx represents:
a. Uncertainty in position
b. Uncertainty in momentum
c. Uncertainty in time

6. The constant 'ħ' in the uncertainty principle is called:
a. Planck's constant
b. Reduced Planck's constant
c. Quantum constant

7. Which pair of physical quantities is subject to the uncertainty principle?
a. Mass and velocity
b. Energy and temperature
c. Position and momentum

8. True or False: The uncertainty principle is a limitation of measurement devices.

9. According to the uncertainty principle, if the position of a particle is precisely known, what happens to the measurement of its momentum?

a. It becomes more precise.
b. It becomes less precise.
c. It remains unaffected.

10. The uncertainty principle challenges the classical concept of:
a. Determinism
b. Chaos theory
c. Entropy

Theories and understanding of Universe

1. What is the Big Bang theory?
- A. The sudden appearance of the universe from nothing.
- B. The steady expansion of the universe.
- C. The collapse of a previous universe.
- D. The continuous creation of matter.

2. What is dark matter?
- A. Matter that emits no light.
- B. Invisible matter that interacts with gravity.
- C. Anti-matter that opposes regular matter.
- D. Matter found in black holes.

3. What is the primary evidence supporting the Big Bang theory?
- A. Cosmic microwave background radiation.
- B. Dark matter observations.
- C. Earth's gravitational field.
- D. Solar flares.

4. Which scientist proposed the theory of general relativity?
- A. Isaac Newton.
- B. Albert Einstein.
- C. Stephen Hawking.
- D. Galileo Galilei.

5. What is the main role of the Hubble Space Telescope?
- A. Studying dark matter.
- B. Observing distant galaxies.
- C. Analyzing lunar craters.

- D. Monitoring space weather.

6. What is the fate of the universe according to current cosmological theories?
- A. Continuous expansion.
- B. Steady-state equilibrium.
- C. Contraction into a Big Crunch.
- D. Stable and unchanging.

7. What is a quasar?
- A. A type of comet.
- B. A highly luminous and energetic center of a galaxy.
- C. A type of dark matter.
- D. A rare type of star.

8. What is the concept of a black hole singularity?
- A. A point of infinite density at the center of a black hole.
- B. A region where time stops.
- C. A zone of intense gravitational pull.
- D. A portal to another universe.

9. What is the cosmic microwave background radiation?
- A. Radiation emitted by distant stars.
- B. Leftover radiation from the Big Bang.
- C. Radiation from cosmic rays.
- D. Microwave signals from extraterrestrial civilizations.

10. Who formulated the laws of planetary motion?
- A. Johannes Kepler.
- B. Copernicus.
- C. Galileo Galilei.
- D. Tycho Brahe.