Physical World

Quick Revision

1. **Science** It is exploring, experimenting and predicting from what we see around us. It is a systematic attempt to understand natural phenomena.
2. **Physics** It refers to the study of the physical world, i.e. the study of the basic laws of nature and their manifestation in different natural phenomena.
3. **Scope and Excitement of Physics** To define the scope and excitement of Physics, it is categorised into two groups, on the basis of magnitude of physical quantities involved in it, i.e. **macroscopic** and **microscopic groups** of Physics.
4. **Macroscopic Group of Physics** It deals with the subjects included in **Classical Physics**. It consists of phenomena at the laboratory, terrestrial and astronomical scales.

   Classical physics can be classified as
   - **Mechanics** It deals with the study of motion of particles, rigid and deformable bodies and general system of particles. It is based on the law of gravitation and Newton's laws of motion.
   - **Electrodynamics** It deals with the study of electric and magnetic phenomena associated with charged and magnetic bodies. It is based on the laws given by Coulomb, Oersted, Ampere and Faraday.
   - **Optics** It deals with the study of phenomena related to light, working of human eye, telescope, microscope, etc.
   - **Thermodynamics** It deals with the study of the system in macroscopic equilibrium considering changes in internal energy, temperature, entropy, etc.
5. **Microscopic Group of Physics** It deals with the study of constituents and structure of matter at minute scale of length, i.e. at the scale of atoms and nuclei or even smaller than these. This group of Physics can be studied under the subject **Quantum Physics**.
6. **Fundamental Forces in Nature** There are following four fundamental forces in nature
   - **Gravitational Force** The force of mutual attraction between any two objects because of their masses is called gravitational force. This force was discovered by **Isaac Newton.**
   - **Electromagnetic Force** The force associated with charged particles is called electromagnetic force.
   - **Strong Nuclear Force** It is the force which binds the protons and neutrons together inside a tiny nucleus.
   - **Weak Nuclear Force** The force which appears only between elementary particles involved in nuclear processes of radioactivity like β-decay of a nucleus, etc.

7. **Comparison between Four Fundamental Forces**

Name	Relative strength	Range
Gravitational force	10^{-39}	Infinite
Weak nuclear force	10^{-13}	Very short, sub-nuclear size ($\sim 10^{-16}$ m)
Electromagnetic force	10^{-2}	Infinite
Strong nuclear force	1	Short, nuclear size ($\sim 10^{-15}$ m)

8. **Nature of Physical Laws** Physicists observed that during a physical phenomenon governed by different forces, several quantities may change with time but some special physical quantities remain constant with time. They are called **conserved quantities of nature** and this is called **law of conservation**.

   There are four laws of conservation in classical Physics

   - **Law of Conservation of Energy** It states that, energy can neither be created nor be destroyed, but it can be changed from one form to another, i.e. the total sum of all kinds of energy in this universe remains same.
   - **Law of Conservation of Mass** Earlier it was assumed that, mass is indestructible and law of conservation of mass states that, matter can neither be created nor be destroyed.

     But Einstein's theory of relativity (energy-mass relation, $E = mc^2$, where m is the mass and c is the speed of light in vacuum) has modified it.

     In a nuclear process, mass gets converted to energy (or *vice-versa*). This is the energy which is released in a nuclear power generation and nuclear explosion.
   - **Law of Conservation of Momentum** Momentum is the quantity of motion of a moving body (generally measured as the product of mass and velocity of the body). Momentum of an isolated system is also conserved. It can be classified into two types (linear momentum and angular momentum) and law of conservation is valid for both of them.

     (a) **Law of Conservation of Linear Momentum** This law states that, if no external force acts on a system, then its linear momentum remains constant, i.e.

     When $\Sigma \mathbf{F}_{ext} = 0$, then $\mathbf{p}$ = constant.

     (b) **Law of Conservation of Angular Momentum** It states that, if no external torque acts on a system, then its angular momentum remains constant, i.e. when $\Sigma \tau_{ext} = 0$, then L = constant.
   - **Law of Conservation of Charge** This law states that, the net charge of an isolated system remains constant.

Objective Questions

Multiple Choice Questions

1. Physics is the branch of science which deals with the study of
(a) practical purposes
(b) living things
(c) technologies
(d) nature and natural phenomena

2. In Physics, quantitative measurement is central to the growth of science because
(a) laws of nature are expressible in precise mathematical equations
(b) basic laws universally apply in different contexts
(c) strategy of approximation turned out to be very successful
(d) All of the above

3. With which phenomena, classical Physics deals mainly?
(a) Macroscopic (b) Microscopic
(c) Natural (d) None of these

4. Microscopic domain includes
(a) quantum theory (b) mechanics
(c) thermodynamics (d) sound

5. Observable universe has range of mass of
(a) 10^{20} kg (b) 10^{30} kg
(c) 10^{40} kg (d) 10^{55} kg

6. Maxwell's set of equation encapsulated basic laws such as
(a) Coulomb and Oersted's laws
(b) Ampere and Faraday's laws
(c) Faraday's and Optic laws
(d) Both (a) and (b)

7. The phenomena that optics deals with are
(a) light
(b) working of telescopes and microscopes
(c) colours exhibited by thin films
(d) All of the above

8. Conservation laws are such that
(a) it cannot be proved but can be verified
(b) it can neither be proved nor can be verified
(c) it can be proved and verified
(d) it can be proved but not verified

9. Radio and television are based on
(a) inverse square law of charges
(b) production, propagation and reception of electromagnetic waves
(c) digital logic
(d) mechanics

10. The person who had been awarded the title of the Father of Physics of 20th century is
(a) Madam Curie
(b) Sir C.V. Raman
(c) Neils Bohr
(d) Albert Einstein

11. In Physics, the range of time scales used is ..... .
(a) 10^{15} s to 10^{-15} s (b) 10^{-22} s to 10^{18} s
(c) 10^{-20} s to 10^{9} s (d) 10^{-17} s to 10^{20} s

12. According to Einstein's theory of relativity, energy-mass relation is ..... .
(a) $E = mc$ (b) $E = m/c^2$
(c) $E = mc^2$ (d) $E = 2mc^2$

13. ..... was discovered by Huygens'.
(a) Wave theory of light
(b) Quanta of light
(c) Particle nature of light
(d) None of the above

14. Which of the following statement is not correct?
(a) Physics is the study of nature and natural phenomena.
(b) Physics and technology are not related to each other.

(c) Electrodynamics deals with electric and magnetic phenomena associated with charged and magnetic bodies.
(d) The physical quantities that remain unchanged in a process are called conserved quantities.

15. Study the following statements regarding conservation law and choose the incorrect option.

(a) Conservation law is a hypothesis based on observations and experiments.
(b) Conservations laws do not have a deep connection with symmetries of nature.
(c) A conservation law cannot be proved.
(d) Conservation of energy, linear momentum and angular momentum are considered to be fundamental laws of physics.

16. Choose the correct statement from the following options.

(a) An axiom is self-evident truth while a model is a theory proposed to explain observed phenomena.
(b) Wireless communication followed the discovery of basic laws of electricity and magnetism.
(c) Bohr had dismissed the possibility of tapping energy from atoms.
(d) Both (a) and (b)

17. Match the Column I (domains) with Column II (relation) and select the correct option from the codes given below.

	Column I		Column II
A.	Mechanics	p.	electric and magnetic fields
B.	Electrodynamics	q.	macroscopic equilibrium
C.	Thermodynamics	r.	Newton's laws of motion

Codes

	A	B	C		A	B	C
(a)	p	q	r	(b)	r	p	q
(c)	p	r	r	(d)	q	r	p

18. Match the Column I (physical quantities) with Column II (scale) and select the correct option from the codes given below.

	Column I		Column II
A.	Size of electron or proton	p.	10^{-30} kg
B.	Mass of an electron	q.	10^{-14} m
C.	Extent of universe	r.	10^{26} m

Codes

	A	B	C
(a)	q	p	r
(b)	q	r	p
(c)	s	p	r
(d)	q	p	q

19. Match the Column I (name of physicists) with Column II (contribution/discovery) and select the correct option from the codes given below.

	Column I		Column II
A.	Johannes Kepler	p.	Nuclear model of the atom
B.	Tycho Brahe	q.	Planetary motion
C.	Nicolaus Copernicus	r.	Elliptical orbit theory
D.	Ernest Rutherford	s.	Circular orbit theory

Codes

	A	B	C	D
(a)	q	s	r	p
(b)	p	q	r	s
(c)	q	p	s	r
(d)	r	q	s	p

Assertion-Reasoning MCQs

*For question numbers 20 to 25, two statements are given-one labelled **Assertion** (A) and the other labelled **Reason** (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) are as given below*

(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is not the correct explanation of A.
(c) A is true but R is false.
(d) A is false and R is also false.

20. **Assertion** The concept of energy is central to Physics and its expression can be written for every physical system.

Reason Law of conservation of energy is not valid for all forces and for any kind of transformation between different forms of energy.

21. **Assertion** Physics generates new technology.

Reason Technology give rise to new physics.

22. **Assertion** Symmetry of laws of nature with respect to translation in space give rise to conservation of linear momentum.

Reason Isotropy of space does not underlies the law of conservation of angular momentum.

23. **Assertion** According to the principle of conservation of energy, all heat can be converted into mechanical work.

Reason Due to various losses, it is impossible to convert all heat into mechanical work.

24. **Assertion** Matter can neither be created nor be destroyed.

Reason This is law of definite proportions.

25. **Assertion** Electric force and magnetic force are jointly called electromagnetic force.

Reason Electric and magnetic effects are inseparable.

ANSWERS

Multiple Choice Questions

1. (d) 2. (d) 3. (a) 4. (a) 5. (d) 6. (d) 7. (d) 8. (a) 9. (b) 10. (d)
11. (b) 12. (c) 13. (a) 14. (b) 15. (b) 16. (d) 17. (b) 18. (a) 19. (a)

Assertion-Reasoning MCQs

20. (c) 21. (b) 22. (c) 23. (b) 24. (c) 25. (a)

SOLUTIONS

1. Nature and natural phenomena; for example motion of the moon around the earth, etc., are dealt with in Physics.

2. Quantitative measurement in Physics is central to the growth of science because all the basic universal laws apply in different context.

Also, laws of nature are expressible in mathematical equations and strategy of approximation turned out to be very successful.

3. Classical Physics deals mainly with macroscopic phenomena and includes subjects like mechanics, electrodynamics, optics and thermodynamics.

4. Quantum theory explains microscopic domain involving molecules, atoms, electrons and other elementary particles.

5. Mass of observable universe has a range of 10^{55} kg.

6. The basic laws regarding electromagnetism given by Oersted, Coulomb, Ampere and Faraday. These were encapsulated by Maxwell in his famous set of equations.

7. Optics deals with the study of phenomena related to light. So, the working of human eye, telescope, microscope, colours that exhibits by thin films etc., are all studied under this branch.

8. Conservation laws are basically hypothesis, based on observations and experiments. Thus, these laws cannot be proved but can be verified or disproved by experiments.

9. Radio and television are based on production (generation), propagation and reception (detection) of electromagnetic waves.

10. Albert Einstein was awarded the title of the Father of Physics of 20th century.

11. Range of time scales is 10^{-22} s to 10^{18} s.

12. Energy-mass relation is $E = mc^2$.

13. Huygens' discovered the wave theory of light.

14. The statement given in option (b) is incorrect and it can be corrected as,

Physics and technology are interdependent to each other.

15. The statement given in option (b) is incorrect and it can be corrected as,

Conservation laws have a deep connection with symmetries of nature. Symmetries of space and time and other types of symmetries play a central role in modern theories of fundamental forces in nature.

16. Wireless communication technology followed the discovery of the basic laws of electricity and magnetism in the nineteenth century.

Axiom is a self-evident truth that it is accepted without controversy while model is a theory proposed to explain observed phenomena.

17. A. Mechanics is based on Newton's laws of motion.

B. Electrodynamics deals with electric and magnetic phenomena associated with charged and magnetic bodies.

C. Thermodynamics in contrast to mechanics, does not deal with the motion of bodies as a whole. Rather, it deals with systems in macroscopic equilibrium and is concerned with changes in internal energy, temperature, entropy, etc., of the system through external work and transfer of heat.

Hence, A $\rightarrow$ r, B $\rightarrow$ p and C $\rightarrow$ q.

18. The correct match of this question is

A $\rightarrow$ q, B $\rightarrow$ p and C $\rightarrow$ r.

19. The correct match of this question is

A $\rightarrow$ q, B $\rightarrow$ s, C $\rightarrow$ r and D $\rightarrow$ p.

20. Law of conservation of energy is always valid for all forces and for any kind of transformation between different forms of energy.

Therefore, A is true but R is false.

21. Sometimes physics generates new technology and at others technology gives rise to new physics. Both have desired impact on society. Therefore, both A and R are true but R is not the correct explanation of A.

22. Symmetry of natural laws with respect to translation in space give rise to conservation of linear momentum.

Isotropy of space (no intrinsically preferred direction in space) underlies the law of conservation of angular momentum.

Therefore, A is true but R is false.

23. According to the law of conservation of energy, energy can neither be created nor it can be destroyed. Thus, it is physically possible to convert all of heat into mechanical work. But due to various energy losses, this cannot be achieved partically.

Therefore, both A and R are true but R is not the correct explanation of A.

24. Law of conservation of energy states that, matter can never be created nor be destroyed. Law of definite proportions states that, molecules will always have elements in a particular ratio which will also be fixed and not dependent on the method of preparation of the molecule.

Therefore, A is true but R is false.

25. Charges in motion produces magnetic effects, these effects give rise to a force on a moving charge. So, electric and magnetic effects are inseparable.

Therefore, it is named as electromagnetic force.

Therefore, both A and R are true and R is the correct explanation of A.