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GENERAL SCIENCE

for

State Engineering Services Exams, SSC, PSUs, Banking, RRB and Other Exams

by **Mr. B. Singh**

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Preface

B. Singh (Ex. IES)

This comprehensive textbook on **General Science** provides all the requirements of the students, i.e., comprehensive coverage of theory, fundamental concepts and objective type questions articulated in a lucid language. This concise presentation will help the readers grasp the topics of **General Science** with clarity and apply them with ease to solve objective questions quickly.

This book covers the syllabus of States Engineering Services Exams including APPSC, MPPSC, MPSC, BPSC, UPPSC; SSC, PSUs, Banking, RRB and other examinations. All the topics are given the emphasis they deserve so that mere reading of the book clarifies all the concepts. The book incorporates theory as well as previous years of various State Engineering Services Examinations, UPSC ESE, etc. It also contains plenty of objective type questions for practice. This book has been very well targeted for aforementioned exams covering all the aspects of subject matter required for these examinations.

We have put-in our sincere efforts to present detailed theory and MCQs without compromising the accuracy of answers. For the interest of the readers, some notes, do you know and interesting facts are given in the comprehensive manner.

Our team has made their best efforts to remove all possible errors of any kind. Nonetheless, we would highly appreciate and acknowledge if you find and share with us any printing and conceptual errors. It is impossible to thank all the individuals who helped us, but we would like to sincerely thank all the authors, editors and reviewers for putting-in their efforts to publish this book.

B. Singh (Ex. IES)
CMD, MADE EASY Group

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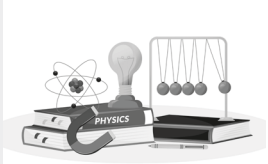
1 PHYSICS

Physics is a branch of science which is concerned with all aspects of nature on both the microscopic and macroscopic level. Its scope of study encompasses not only the behavior of objects under the action of forces but also the nature of gravitational, electromagnetic, nuclear forces among others. The ultimate objective of physics is to formulate comprehensive principles that bring together and explain all such phenomena.



Units & Measurement

- Unit is the chosen standard used for measuring a physical quantity.
- There are basically two types of unit:
  1. **Fundamental Unit:** These units are a set of measurements, defined arbitrarily and from which other units are derived. Examples: meter, kilogram, second, etc.

     The fundamental unit of some of the physical quantities are given below:

International System of Units (S.I.)		
Physical	**Fundamental**	**Symbol**
Mass	Kilogram	kg
Length	Metre	m
Time	Second	s
Temperature	Kelvin	K
Electric-current	Ampere	A
Luminous intensity	Candela	Cd
Quantity of matter	Mole	mol

Systems of units	Length	Mass	Time
C.G.S. System	Centimetre	Gram	Second
F.P.S. System	Foot	Pound	Second

Systems of units	Length	Mass	Time
M.K.S. System	Metre	Kilogram	Second

  2. **Derived Unit:** All the units which are expressed in terms of fundamental units are known as derived units. Examples: Newton, Joule, etc.
- Internationally, there are four types of unit systems. These are:
  1. **S.I. Units/System:** It is the modern form of the metric system, and is the most widely used system of measurement. It comprises a coherent system of units of measurement built on seven base units namely kilogram, meter, second, candela, ampere, kelvin and mol.
  2. **CGS System:** The centimeter-gram-second (CGS) system of units is a variant of the metric system based on centimetre as the unit of length, gram as unit of mass, and the second as the unit of time.
  3. **FPS System:** The foot-pound-second (FPS) system is a system of units built on three fundamental units: the foot for length, the pound for mass and the second for time.
  4. **MKS System:** The MKS system of units is a physical system of units that expresses any given measurement using base units of the metre, kilogram, and second.

Measurement of length

- A meter scale is used for lengths from 10^{-3} m to 10^{2} m.
- A vernier callipers is used for lengths to an accuracy of 10^{-4} m.
- A screw gauge and a spherometer can be used to measure lengths as less as to 10^{-5} m.
- Parallax method is used to measure large distances, for example the distance of earth from a planet.
- It is very difficult to determine the exact size of molecules however it is possible to estimate the sizes of molecules.

Measurement of Mass

- Mass is a basic property of matter. It does not depend on the temperature, pressure or location of the object in space. The SI unit of mass is kilogram (kg).
- In the case of atoms and molecules, there is an important standard unit of mass, called the unified atomic mass unit (u).

Measurement of Time

- **Atomic standard of time:** It is based on the periodic vibrations produced in a cesium atom. This is the basis of the caesium clock, sometimes called atomic clock,used in the national standards.
- In the caesium atomic clock, the second is taken as the time needed for 9,192,631,770 vibrations of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium-133 atom. The vibrations of the caesium atom regulate the rate of this caesium atomic clock just as the vibrations of a balance wheel regulate an ordinary wristwatch or the vibrations of a small quartz crystal regulate a quartz wristwatch.

Accuracy, Precision of Instrument, and Errors in measurement

- **Error:** The result of every measurement by any measuring instrument contains some uncertainty. This uncertainty is called an error.
- **Accuracy:** The accuracy of a measurement is a measure of how close the measured value is to the true value of the quantity.
- **Precision:** Precision tells us to what resolution or limit the quantity is measured.

Motions

Basics of Motion

A body is said to be in motion if it changes its position with respect to its surroundings as time goes on. A body is said to be at rest if it does not change its position with time, with respect to its surroundings.

Types of Motion

(i) When a particle or a body moves along a straight path, its motion is Rectilinear or translatory motion.

(ii) When a particle or a body moves in a circular path, its motion is circular motion. When a body spins about its own axis, it is said to be in rotational motion.

(iii) When a body moves to and fro or back and forth repeatedly about a fixed point in a definite interval of time, it is said to be in vibrational or oscillatory motion.

Position, Path length and Displacement

- **Reference point:** In order to specify position, we need to use a reference point and a set of axes. Generally rectangular coordinate system consisting of three mutually perpendicular axes, labeled X, Y, and Z-axes. The point of intersection of these three axes is called origin (O) and serves as the reference point.
- **Frame of reference:** To measure time, we position a clock in this system. This coordinate system along with a clock constitutes a frame of reference.
- If one or more coordinates of an object change with time, we say that the object is in motion. Otherwise, the object is said to be at rest with respect to this frame of reference.
- **Path length:** Path length is distance traveled by body from one point to another. Path length is a

scalar quantity — a quantity that has a magnitude only and no direction.

- **Displacement:** Displacement is defined as the change in position of an object. Displacement has both magnitude and direction. Such quantities are represented by vectors.

Speed

The time rate of change of position of an object in any direction i.e. the rate of change of distance of an object with respect to time is known as speed.

$$\text{Speed} = \frac{\text{displacement}}{\text{time taken}}$$

Velocity

The rate of change of displacement of an object with respect to time is known as velocity.

$$\text{Velocity} = \frac{\text{displacement}}{\text{time}}$$

Acceleration

The rate of change of velocity with respect to time is called acceleration.

$$\text{Acceleration} = \frac{\text{Change in velocity}}{\text{time taken}}$$

When a body completes equal displacement in equal interval of time, its velocity is constant and hence, it does not have an acceleration. When a body shows equal change in velocity in equal interval of time its velocity is not constant but it has a constant acceleration.

Equation of Motion

For a body moving with a uniform velocity

If a body completes a displacement 'S' in time 't' with a uniform velocity 'V', then,

$$\text{Displacement} = \text{velocity} \times \text{time}$$

or $$S = vt \quad \text{...(i)}$$

For a body moving with a uniform acceleration

If a body starting with an initial velocity 'u' moves with a uniform acceleration 'a' for a time 't' and attains a final velocity 'v' after travelling a displacement 's' then,

$$S = ut + \frac{1}{2}at^2 \quad \text{....(ii)}$$

$$v^2 = u^2 + 2as \quad \text{...(iii)}$$

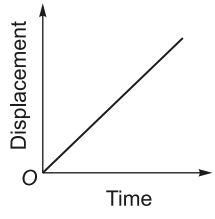
When the velocity of a body increases, it has a positive acceleration and when the velocity decreases, it has a negative acceleration.

This negative acceleration is called deceleration or retardation.

Position (Displacement)-Time Graphs

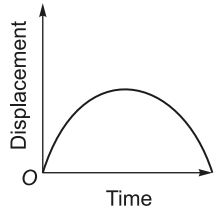
For a body moving with a uniform velocity

This graph comes as a straight line because in a uniform velocity the particle completes equal displacement in an equal interval of time.



For the motion of a body thrown vertically upwards

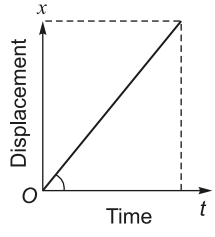
When the body moves up, its velocity continuously decreases due to gravity and finally becomes zero at the maximum height. Then, the body falls with an increasing velocity.



The slope of the position time graph is equal to the uniform velocity.

$$\text{Slope} = \frac{\text{Displacement}}{\text{Time}}$$

or $$V = \frac{x}{t}$$



Physical Quantities

Every material or object has physical quantities which are basically characteristic or property of the material or object that describe the laws of physics and can be measured or calculated.

Vectors

They have a definite magnitude and a definite direction, e.g. displacement, velocity, acceleration, force etc.

Scalars

They have definite magnitudes only and not direction. e.g. distance, speed, work, energy, power, electric charge etc.

Tensors

They have different magnitudes in different directions, e.g. Moment of interia, stress etc.

In a motion, a body can have a constant speed but variable velocity like the motion of a body along a circular path. A particle may have zero displacement and zero velocity but non-zero distance and speed. When a body completes one revolution along a circular path in a given time period, the net displacement and velocity of the body will be zero but the distance and speed of the body must be non-zero.

Linear-Momentum

It is the quantity of motion which a body possesses and is measured as the product of the mass and velocity of the body.

$$\text{Linear momentum} = \text{mass} \times \text{velocity}$$

Impulse

The total change in momentum is called the impulse. If a very large force acts for a very small time, the product of force and the time is equal to the impulse.

Inertia

The inability of a body to change by itself its state of rest or state of uniform motion along a straight line is called inertia of the body.

The inertia of a body is measured by its mass. Heavier the body, greater is the force required to change its state and hence greater is its inertia. Inertia of a body may be inertia of rest, inertia of motion or inertia of direction.

Collisions

Laws of momentum and energy conservation are physical quantities, which do not change in a physical process. These laws apply to a commonly encountered phenomena, namely collisions. Several games such as billiards, marbles or carrom involve collisions.

Elastic and Inelastic Collisions

- In all collisions the total linear momentum is conserved; the initial momentum of the system is equal to the final momentum of the system.
- The total kinetic energy of the system is not necessarily conserved. The impact and deformation during collision may generate heat and sound. Part of the initial kinetic energy is transformed into other forms of energy.
- A useful way to visualize the deformation during collision is in terms of a 'compressed spring'. If the 'spring' connecting the two masses regains its original shape without loss in energy, then the initial kinetic energy is equal to the final kinetic energy but the kinetic energy during the collision time is not constant. Such a collision is called an **elastic collision**. On the other hand the deformation may not be relieved and the two bodies could move together after the collision. A collision in which the two particles move together after the collision is called a completely **inelastic collision**.
- The intermediate case where the deformation is partly relieved and some of the initial kinetic energy is lost is more common and is appropriately called an **inelastic collision**.

Newton's Laws of Motion

First Law of Motion

Every body continues to be in a state of rest or uniform motion in a straight line, except in so far as it may be compelled by force to change that state.' Newton's first law of motion defines inertia.

1. **Inertia of Rest :** The inability of a body to change by itself its state of rest.
   - When a branch of a fruit tree is shaken, the fruits fall down. This is because the branch comes in motion and the fruits tend to remain at rest. Hence, they get detached.
   - The dirt particles in a durree fall off if it is stricken by a stick. This is because the striking sets the durree in motion whereas the dirt-particles tend to remain at rest and hence fall.
   - When a train starts suddenly, the passenger sitting inside tends to fall backwards. This is so

because the lower part of the passenger's body starts moving with the train but the upper part tends to remain at rest.

- If a smooth paper having a coin on it placed on a table is suddenly drawn, the coin remains at the same place on the table due to inertia of rest.
- When a horse starts suddenly, the rider tends to fall backwards due to inertia of rest

2. **Inertia of Motion :** The inability of a body to change by itself its state of uniform motion.
   - When a horse at full gallop stops suddenly, the rider on it falls forward because of inertia of motion of the upper part of the rider's body.
   - When an athelete takes a long jump, he runs first for a certain distance before the jump. This is because his feet come to rest on touching the ground and the remaining body continues to move owing to inertia of motion.
   - When train stops suddenly, a passenger sitting inside tends to fall forward. It happens because the lower part of the passenger's body comes to rest with the train but the upper part tends to continue its motion due to inertia of motion.
   - A person jumping out of a speeding train may fall forward due to inertia of motion of his body. Hence, he should run a few steps on the platform in the direction of motion of train.
3. **Inertia of Direction :** The inability of a body to change by itself its direction of motion.
   - The wheels of any moving vehicle throw out mud, if any, tangentially, due to the inertia of direction. The mud-guards over the wheels stop this mud, protecting the clothes, etc. of the person sitting on the bike.
   - Use of an umbrella to protect us from rain is based on the property of inertia of direction because the rain drops cannot change their direction of motion.
   - When a bus or a car rounds a curve suddenly, the person sitting inside is thrown outwards. It happens so because the person tries to maintain his direction of motion due to directional inertia while the vehicle turns.
   - When a knife is sharpened by pressing it against a grinding stone, the sparks fly off tangentially because of the inertia of direction.
   - When a stone tied to one end of a string is whirled and the string breaks suddenly, the stone spins off along the tangent of its circular path. It happens so because of the pull in the string was forcing the stone to move in a circle. As soon as the string breaks, the pull disappears. The stone becomes free and in a bid to move along the straight line flies off tangentially.

Second Law of Motion

The rate of change of linear momentum of a body is directly proportional to the external force applied on the body and this change takes place always in the direction of the applied force'.

The second law gives us a measure of force. When a force is applied on a body, its momentum and hence, velocity change. The change in velocity produces an acceleration in the body. The rate of change of linear momentum with time is equal to the product of the mass of the body and its acceleration which measures the magnitude of the applied force i.e.

$$\text{Force} = \frac{\text{Change in linear momentum}}{\text{time interval}}$$

$$= \text{mass} \times \text{acceleration}$$

or, $F = ma$

Third Law of Motion

''To every action, there is always, an equal and opposite reaction.''

Here, the action is the force exerted by one body on the other body while the reaction is the force exerted by the second body on the first.

Significance of Third Law

It signifies that forces in nature are always in pairs. A single isolated force is not possible. Force of action and reaction act always on different bodies.
They never cancel each other and each force produces its own effect. The forces of action and reaction may be due to actual physical contact of the two bodies or even from a distance. But they are always equal and opposite. This third law of motion is applicable whether the bodies are at rest or they are in motion. This law is applied to all types of forces e.g. gravitational, electric or magnetic forces, etc.

Principle of Conservation of Linear Momentum

The total sum of the linear momentum of all bodies in a system remains constant and is not affected due to their mutual action and reaction. It means in a system of the two bodies, the total momentum of the bodies before impact is equal to the total momentum of the two bodies after impact. The law of conservation of linear momentum is universal i.e. it applies to both, the microscopic as well as macroscopic system.

Uniform Circular Motion

When a body moves along a circular path or a curve with a uniform circular speed, the body is acted upon by an inward acceleration. This acceleration acts towards the centre of a circular path or curve and is called as radial or centripetal acceleration which gives rise to the centripetal force. The centripetal force is an essential condition of the circular motion. Centripetal force (F_c) = mass of the body (m) × centripetal acceleration (a_c)

or $$F_c = ma_c$$

Centripetal acceleration

$$a_c = \frac{v^2}{r} = r\omega^2$$

where v = linear speed, ω = angular speed or, r = radius of circular path or curve.

$$\therefore \quad F_c = ma_c = \frac{mv^2}{r} = mv\omega = mr\omega^2$$

The centripetal force acting on a body is an action and an equal and opposite force called centrifugal force appears as a reaction.

Rotational Motion

Torque (Moment of Force)

The product of force acting on a body and perpendicular distance of line of action of the force from the axis of rotation is called moment of force or torque.

Torque = Force × Perpendicular distance from axis rotation

Angular Momentum

It is equal to the product of linear momentum of a body and the perpendicular distance from the axis of rotation. It follows the principle of conservation. It means the total angular moment of an isolated system remains always constant.

Friction

When a body moves (slides or rolls) or even tries to move over the surface of another body a tangential force comes into action between their surfaces in contact, against their relative motion. This opposing force is termed as the force of friction.

The force of friction depends upon the mass of the body on a surface and roughness of the surfaces in contact between them and the magnitude of friction, which increases with increase in roughness and mass.

When a body is at rest on a surface, the friction is called static friction which is a self adjusting force. When the body is on the verge to move (slide or roll), the friction is called limiting friction but when the body moves, it gives rise to dynamic friction.

The limitting friction is the maximum force of friction and it is always more than static or dynamic friction.

Usually, smoothness decreases the force of friction. However, when the surfaces in contact are made too smooth by polishing, the binding force of adhesion increases and hence, the frictional force increases. This is called 'cold welding'.

Friction is a non-conservative force and hence, the mechanical energy (potential and kinetic energy) is not conserved. In fact, friction converts mechanical energy partly into heat, light (spark), sound, electricity, etc.

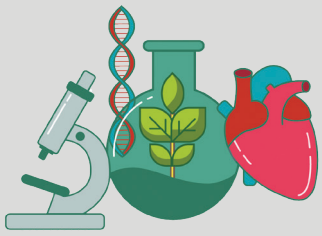
Generally, friction opposes motion. However, in certain cases friction is essential for motion. Without friction, motion cannot be started, stopped or transferred from one body to the other. Thus, friction is a necessary evil.

The force of friction can be reduced :

- By polishing : polishing causes smoothness.
- By lubricating : The lubricants, oils, grease etc. fill up the irregularities of the surfaces and hence, the surfaces become smoother.
- By using ball-bearings

The force of friction can be increased :

- by applying sand on the slippery ground.
- by applying sand on the road covered with snow.



Previous Years' Questions & Practice Questions

1. Deficiency of which of the following results in goitre and cretinism?
(a) Folic acid (b) Vitamin A
(c) Iodine (d) Zinc
[APPSC (AEE) : 2016]

Ans. (c)

2. World Health Organization recommends exclusive breast feeding from the date of birth of the infant up to the age of
(a) 3 months (b) 6 month
(c) 9 months (d) 2 year
[APPSC (AEE) : 2016]

Ans. (d)

3. Cerebral malaria is caused by
(a) Plasmodium falciparum
(b) P. ovale
(c) P. malariae
(d) None of the above
[BPSC (AE) : 1995]

Ans. (a)

4. The full for of HIV is
(a) Human immunodeficiency virus
(b) Human immunopositive virus
(c) Human immune virus
(d) None of the above
[BPSC (AE) : 1995]

Ans. (a)

5. The origin of life on this earth was written by
(a) Charles Darwin
(b) Wallace
(c) Alexander Oparin
(d) Gregor Mendal
[BPSC (AE) : 2001]

Ans. (c)

6. Ascorbic acid is
(a) Vitamin B (b) Vitamin C
(c) Vitamin D (d) Vitamin E
[BPSC (AE) : 2001]

Ans. (b)

7. The liver stores food in the form of
(a) albumen (b) glycogen
(c) glucose (d) proteins
[BPSC (AE) : 2001]

Ans. (b)

8. With increasing temperature, the respiratory rate will
(a) increase
(b) decrease slowly
(c) decrease rapidly
(d) remain unaffected
[BPSC (AE) : 2001]

Ans. (a)

9. An artery differs from a vein in having
(a) narrow lumen
(b) thicker walls
(c) valves to control direction of blood flow towards heart
(d) None of these
[BPSC (AE) : 2001]

Ans. (c)

10. In the human body, the number of bones is
(a) 205 (b) 306
(c) 206 (d) 305
[BPSC (AE) : 2001]

Ans. (c)

11. The hormone, insulin is produced in
(a) spleen (b) kidney
(c) liver (d) pancreas
[BPSC (AE) : 2001]

Ans. (d)

12. Selective accumulation of iodine occurs in the
(a) Thyroid (b) Thymus
(c) Liver (d) Pituitary
[BPSC (AE) : 2001]

Ans. (a)

13. If all the plants of the world die, all the animals will also die due to the shortage of
(a) nitrogen
(b) oxygen
(c) carbon monoxide
(d) carbon dioxide
[BPSC (AE) : 2001]

Ans. (b)

14. Pasteurization means
(a) sterilization by pressure cooker at 120°C for 15 minutes
(b) heating liquids or milk to 62°C for 30 minutes
(c) vaccination of a body against smallpox
(d) cooling the liquids to zero degree
[BPSC (AE) : 2001]

Ans. (b)

15. Bacteria do not need sunlight to grow because
(a) they do not like sunlight
(b) they prepare their own food without the help of sunlight
(c) they get killed
(d) they have to chlorophyll
[BPSC (AE) : 2001]

Ans. (b)

16. Penicillin was discovered by
(a) Felix Dujardin
(b) E. Strasburger
(c) Charles Darwin
(d) Alexander Fleming
[BPSC (AE) : 2001]

Ans. (d)

17. Mushrooms are
(a) Flowering plant (b) Fungi
(c) Alga (d) Lichen
[BPSC (AE) : 2001]

Ans. (b)

18. A clove is a
(a) fruit (b) seed
(c) vegetable bud (d) flower bud
[BPSC (AE) : 2001]

Ans. (d)

19. Which of the following is least effective in photosynthesis?
(a) Blue light (b) Red light
(c) Green light (d) Yellow light
[BPSC (AE) : 2001]

Ans. (c)

20. The ripening of fruits can be accelerated by
(a) keeping the fruits in a refrigerator
(b) reducing the supply of water to the plant when the fruits are maturing
(c) exposing the fruits to light
(d) Artificially adding ethylene gas to the atmosphere surrounding them
[BPSC (AE) : 2001]

Ans. (d)

21. Spraying of oil on stagnant water controls malaria because the
(a) oil kills material parasites in mosquitoes
(b) water becomes dirty fro mosquitoes
(c) mosquitoes larvae cannot breathe
(d) man's blood is not available
[BPSC (AE) : 2001]

Ans. (c)

22. Shortage of which food item causes the Goitre Disease?
(a) Proteins (b) Vitamins
(c) Iodine (d) Iron
[BPSC (AE) : 2006]

Ans. (c)