

GENERAL AWARENESS · SCIENCE (PHYSICS) · CHAPTER 1

Units, Measurement & Motion

The SI system and its seven base units, prefixes, the special units exams love (light year, parsec, angstrom, knot, horsepower), measuring instruments, motion and its graphs, Newton's laws, and gravitation: g , mass and weight, Kepler's laws, satellites and escape velocity.

SSC CGL Tier 1

SSC CHSL Tier 1

RRB NTPC · Group D

QUESTIONS PER
PAPER

SSC 1–2 · RRB 1–2

PYQ FREQUENCY

Units (light year, $hp = 746\text{ W}$, base units 7), instruments, inertia, g at poles, escape velocity 11.2 km/s , Kepler

PREREQUISITE

None (first Science chapter) · leads to SC-02 Work, Energy & Matter

STUDY TIME

80 min theory + 30 min practice

Why this chapter matters: Units and instruments are the most repeated physics questions in SSC and RRB papers. CGL 2017–2025 asked light year, parsec, horsepower, inertia, Galileo and Kepler; CHSL asked anemometer, seismograph, altimeter, the unit of G and Newton's third law; NTPC 2025–26 asked base units, momentum units and Galileo; Group D asks units of weight and pressure in almost every shift.

IN THIS CHAPTER

02 Concepts

06 29 PYQs

03 Rule box

07 Practice MCQs

04 Shortcuts

07 Answer key

05 Traps

08 Quick revision

PART 2

2 Concepts & theory

2.1 Physical quantities and the SI system

- 1 A **physical quantity** can be measured: it has a number and a **unit** (5 kg, 10 m/s).
- 2 **Fundamental (base) quantities** do not depend on others (length, mass, time). **Derived quantities** are made from them (speed = length ÷ time, force = mass × acceleration).
- 3 Systems of units: **CGS** (centimetre, gram, second), **FPS** (foot, pound, second), **MKS** (metre, kilogram, second) and **SI** (Système International), adopted by the General Conference on Weights and Measures (**CGPM**) in **1960**. SI has **7 base units**.
- 4 CGS ↔ SI: 1 dyne = 10^{-5} newton (force); 1 erg = 10^{-7} joule (energy).
- 5 Since **20 May 2019** (World Metrology Day) all seven base units are defined by fixed constants of nature; the kilogram is no longer a metal cylinder.

The 7 SI base units (adopted 1960)

Length	metre (m): the distance light travels in vacuum in $1/299,792,458$ of a second
Mass	kilogram (kg): fixed by the Planck constant since 20 May 2019 (before that, a platinum-iridium cylinder kept at Sèvres, France)
Time	second (s): 9,192,631,770 vibrations of radiation from a caesium-133 atom
Electric current	ampere (A): fixed by the charge of an electron (elementary charge e)
Temperature	kelvin (K): fixed by the Boltzmann constant; $0\text{ K} = -273.15\text{ °C}$ (absolute zero)
Amount of substance	mole (mol): 6.022×10^{23} particles (Avogadro number)
Luminous intensity	candela (cd): brightness of a light source in a given direction

All other units are derived from these seven (newton = kg m s^{-2} , joule = N m , pascal = N m^{-2}). Radian (plane angle) and steradian (solid angle) were 'supplementary units' until 1995; they are now derived units.

Big prefix	Value	Small prefix	Value
deca (da)	10^1	deci (d)	10^{-1}
hecto (h)	10^2	centi (c)	10^{-2}
kilo (k)	10^3	milli (m)	10^{-3}
mega (M)	10^6	micro (μ)	10^{-6}
giga (G)	10^9	nano (n)	10^{-9}
tera (T)	10^{12}	pico (p)	10^{-12}
peta (P) · exa (E)	$10^{15} \cdot 10^{18}$	femto (f) · atto (a)	$10^{-15} \cdot 10^{-18}$
ronna (R) · quetta (Q)	$10^{27} \cdot 10^{30}$ (added 2022)	ronto (r) · quecto (q)	$10^{-27} \cdot 10^{-30}$ (added 2022)

Quantity	SI unit (named after)	Quantity	SI unit (named after)
Force, weight	newton (N) · Isaac Newton	Pressure	pascal (Pa = N/m ²) · Blaise Pascal
Work, energy	joule (J) · James Joule	Power	watt (W = J/s) · James Watt
Frequency	hertz (Hz) · Heinrich Hertz	Electric charge	coulomb (C) · Charles Coulomb
Potential difference	volt (V) · Alessandro Volta	Resistance	ohm (Ω) · Georg Ohm
Density	kg/m ³ (no special name)	Momentum	kg m/s (no special name)

2.2 Special units of distance, speed and power

- 1 Astronomical distances use the **astronomical unit**, the **light year** and the **parsec**; atomic sizes use the **angstrom** and the **fermi**.
- 2 Ships and aircraft use the **nautical mile** (1.852 km) and the **knot** (speed). Engines are rated in **horsepower**.
- 3 Speed conversion: 1 km/h = 5/18 m/s, so 72 km/h = 20 m/s.

Special units asked again and again

Light year

Distance light travels in one year = 9.46×10^{15} m. A unit of DISTANCE, not time

Parsec

3.26 light years = 3.09×10^{16} m: the largest unit of distance

Astronomical unit

Mean Earth–Sun distance $\approx 1.496 \times 10^{11}$ m (about 15 crore km)

Angstrom ($\text{\AA}$)

10^{-10} m: wavelength of light, size of atoms

Fermi (fm)

10^{-15} m: size of an atomic nucleus

Micron (μm)

10^{-6} m: size of cells and bacteria

Nautical mile

1,852 m (1.852 km): distance at sea and in air. Knot = 1 nautical mile per hour (speed of ships and aircraft)

Horsepower

1 hp = 746 W (power of engines and motors)

Smallest to largest length: fermi < angstrom < micron < metre < nautical mile < AU < light year < parsec.

2.3 Measuring instruments

- 1 The ending tells you the job: **-meter** measures and **-graph** records (a **seismograph** draws a **seismogram**).
- 2 **Least count** is the smallest reading an instrument can take: metre scale 1 mm, vernier calliper 0.1 mm, screw gauge 0.01 mm. A smaller least count means a more precise instrument.

Instrument → what it measures

Altimeter

altitude of an aircraft

Anemometer

wind speed

Fathometer

depth of the sea (echo sounding)

Hygrometer

humidity of air

Manometer

pressure of gases

Speedometer

speed of a vehicle

Seismograph

earthquake waves

Screw gauge

thickness of a wire (least count 0.01 mm)

Venturimeter

rate of flow of a liquid in a pipe

Ammeter

electric current

Barometer

atmospheric pressure

Hydrometer

density / specific gravity of liquids

Lactometer

purity (density) of milk

Odometer

distance travelled by a vehicle

Rain gauge

rainfall (udometer, pluviometer)

Sphygmomanometer

blood pressure

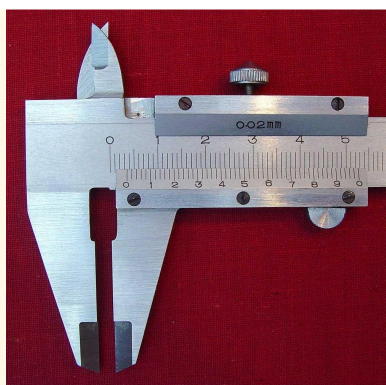
Vernier calliper

lengths and diameters (least count 0.1 mm)

Tachometer

speed of rotation (rpm)

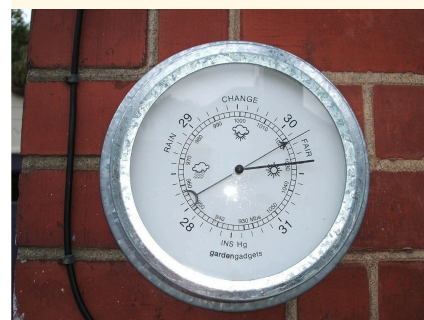
Richter scale (magnitude) and Mercalli scale (intensity) are scales, not instruments; the seismograph is the instrument. A barometer reading that falls suddenly warns of a storm.



Vernier calliper: a main scale and a sliding vernier scale.



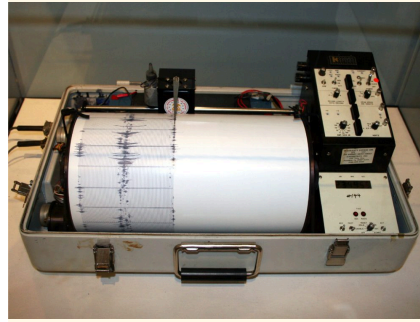
Screw gauge (micrometer): thickness of thin wires and sheets.



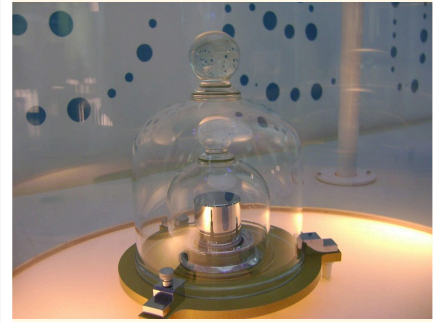
Aneroid barometer: atmospheric pressure without any liquid.



Cup anemometer: wind speed.



Seismograph: records earthquake waves on a drum.

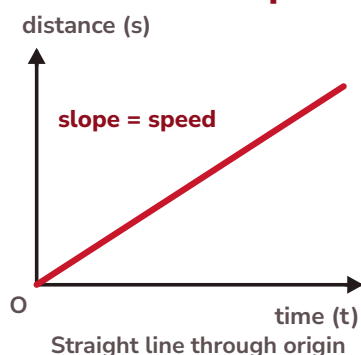


Replica of the **prototype kilogram**, the mass standard until 2019.

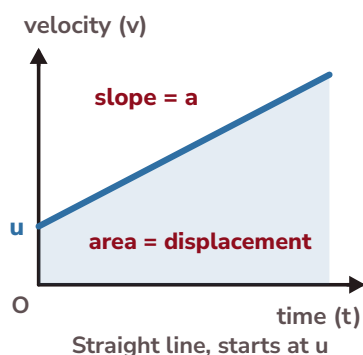
2.4 Motion: distance, velocity and acceleration

- 1 A **scalar** has only magnitude (mass, distance, speed, time, work, energy, power, temperature). A **vector** has magnitude and direction (displacement, velocity, acceleration, force, weight, momentum).
- 2 **Distance** is the total path length (never negative). **Displacement** is the shortest straight-line distance from start to finish, with direction; it can be zero (one full round of a circular track).
- 3 **Speed** = distance $\div$ time; **velocity** = displacement $\div$ time. Both are measured in **m/s**. The speedometer of a vehicle shows instantaneous speed.
- 4 **Acceleration** = rate of change of velocity, unit **m/s²**. Slowing down is **retardation** (negative acceleration). A body moving with constant velocity has zero acceleration.
- 5 **Uniform circular motion:** speed is constant but direction changes all the time, so the velocity changes and the motion is **accelerated**. The **centripetal force** acts towards the centre; **centrifugal force** is the apparent outward pull used in cream separators and washing-machine dryers.
- 6 **Free fall:** in a vacuum all bodies fall with the same acceleration g (9.8 m/s^2), whatever their mass. **Galileo** first concluded this.

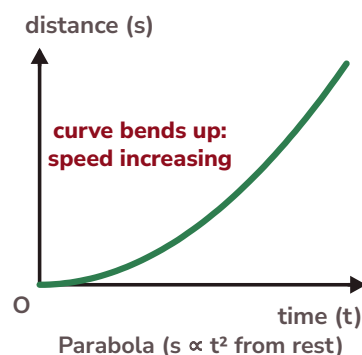
s–t: uniform speed



v–t: uniform acceleration



s–t: accelerated motion



Three equations of uniformly accelerated motion (u = initial velocity, v = final velocity, a = acceleration)

$$v = u + at$$

velocity after time t

$$s = ut + \frac{1}{2}at^2$$

distance in time t

$$v^2 = u^2 + 2as$$

without time

Free fall: put $a = g = 9.8 \text{ m/s}^2$ (downward). Flat v – t line = uniform velocity; flat s – t line = body at rest.

Slope of an s – t graph gives speed; slope of a v – t graph gives acceleration; area under a v – t graph gives displacement.

2.5 Newton's laws of motion

- 1 Isaac Newton** stated three laws of motion in **Principia** (1687). The first law builds on **Galileo's law of inertia**; Aristotle had wrongly held that a force is needed to keep a body moving.
- 2 Inertia** is the property by which a body resists any change in its state of rest or motion. It depends on **mass**.
- 3 Momentum** ($p = mv$) and **impulse** ($F \times t = \text{change in momentum}$) explain why a long stopping time reduces the force: catching a ball, airbags, shock absorbers.

Newton's laws of motion (Principia, 1687)

First law

Law of inertia. A body stays at rest or in uniform motion in a straight line unless an external unbalanced force acts. Examples: passengers jerk backward when a bus starts and forward when it stops; dust leaves a beaten carpet

Second law

$F = ma$. Force = rate of change of momentum = mass $\times$ acceleration. 1 newton = 1 kg m/s². Examples: a fielder pulls his hands back to catch a ball; airbags and sand pits increase the stopping time

Third law

Action–reaction. For every action there is an equal and opposite reaction, acting on different bodies. Examples: rockets and jet engines, recoil of a gun, swimming, walking

Momentum

$p = mv$; a vector; unit kg m/s. With no external force the total momentum is conserved: gun recoil, rocket propulsion

Inertia

Inertia of rest, of motion and of direction. Mass is the measure of inertia: a heavier body has more inertia

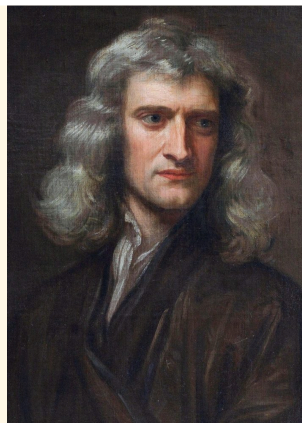
Friction

Opposes motion. Static > sliding > rolling friction; ball bearings and lubricants reduce it

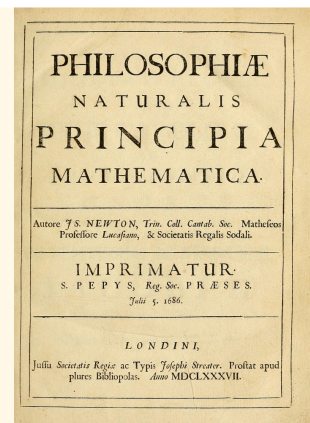
Galileo first described inertia; Newton stated it as his first law. Impulse = force $\times$ time = change in momentum.



Galileo Galilei (1564–1642): inertia and free fall.



Isaac Newton, portrait by Godfrey Kneller (1689).



Title page of **Principia** (1687): laws of motion and gravitation.

2.6 Gravitation, g, mass and weight

- Universal law of gravitation** (Newton): every two bodies attract each other with a force $F = G m_1 m_2 / r^2$. The force is directly proportional to the product of the masses and **inversely**

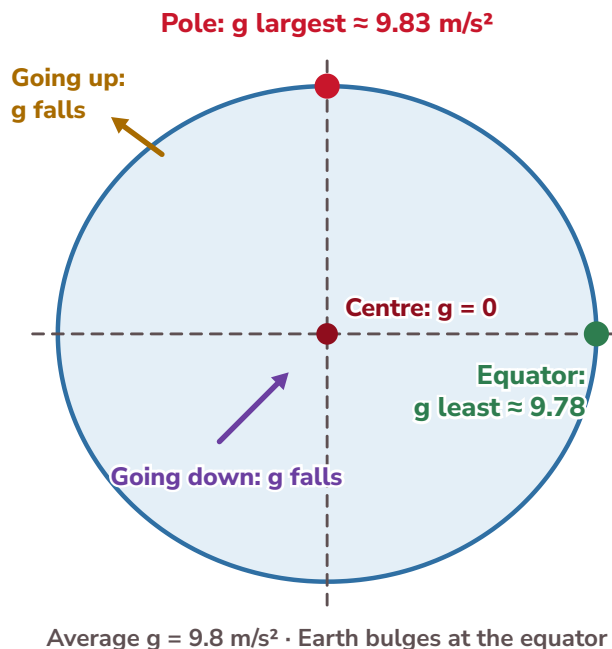
proportional to the square of the distance. Double both masses $\rightarrow$ force $\times 4$; double the distance $\rightarrow$ force $\div 4$.

2 **G** (universal gravitational constant) = $6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$; the same everywhere.
Henry Cavendish's torsion-balance experiment (1798) gave the first value of G.

3 **g** (acceleration due to gravity) = 9.8 m/s^2 on average; it changes from place to place. $g = GM/R^2$.

4 Gravity holds the Moon in orbit, keeps planets around the Sun and causes **tides** (mainly the pull of the Moon and the Sun).

How g changes, and mass vs weight



Mass

Quantity of matter; scalar; kg; same everywhere (even on the Moon); measured by a beam balance

Weight

Force of gravity on a body, $W = mg$; vector; newton; changes with g; measured by a spring balance

On the Moon

g is about 1/6 of Earth's, so weight becomes 1/6; mass does not change

Weight in a lift

Rest / uniform speed	normal (mg)
Accelerating up	more than mg
Accelerating down	less than mg
Free fall (cable cut)	zero: weightless

g is largest at the poles because the poles are nearer the centre of the Earth and the effect of the Earth's spin is least there. Astronauts in orbit feel weightless because they are in continuous free fall.



Henry Cavendish, who first measured G (1798).

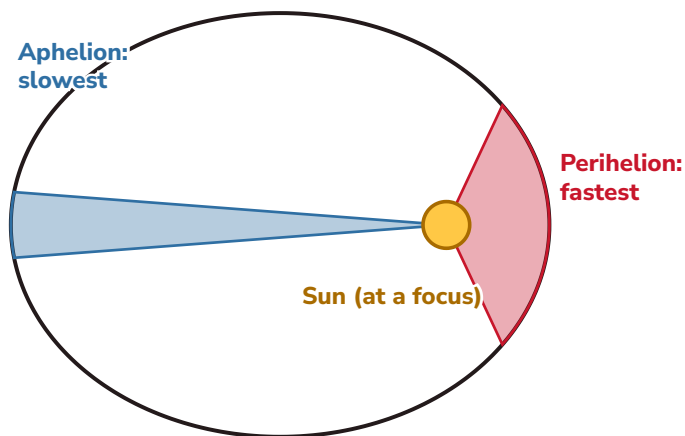


Apple tree at **Woolsthorpe Manor**, Newton's birthplace, linked to the falling-apple story.

2.7 Kepler's laws, satellites and weightlessness

- 1** **Johannes Kepler** gave three laws of planetary motion: orbits are ellipses (law of orbits), equal areas in equal times (law of areas), and $T^2 \propto a^3$ (law of periods). A planet moves fastest when nearest the Sun.
- 2** A **satellite** is kept in orbit by gravity, which supplies the centripetal force. **Sputnik 1** (USSR, 1957) was the first artificial satellite; **Aryabhata** (1975) was India's first.
- 3** A **geostationary** satellite orbits about **35,786 km** above the equator from west to east with a period of **24 hours**, so it seems fixed over one place. **Polar** (sun-synchronous) satellites fly lower, a few hundred km up, for remote sensing.
- 4** **Escape velocity**: the least speed needed to escape a planet's gravity: **11.2 km/s** for Earth (about 2.4 km/s for the Moon). It does not depend on the mass of the body.
- 5** Astronauts are **weightless** in orbit because they and their spacecraft fall freely together, not because gravity is absent.

Kepler's laws and satellites



1 Law of orbits

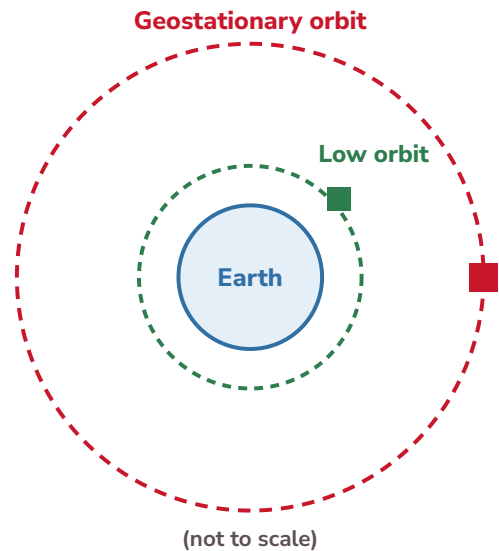
Each planet moves in an ellipse with the Sun at one focus

2 Law of areas

Line Sun–planet sweeps equal areas in equal times

3 Law of periods

$T^2 \propto a^3$ (period² $\propto$ size of orbit³)



Geostationary

35,786 km above the equator; period 24 h; moves west to east; looks fixed (communication, weather)

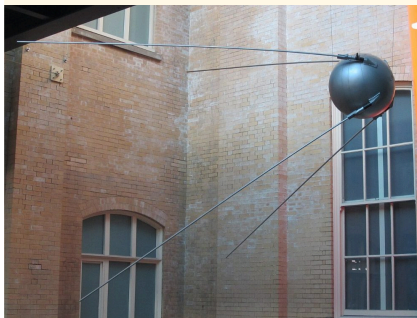
Escape velocity

11.2 km/s from Earth's surface; orbital speed near the surface 7.9 km/s

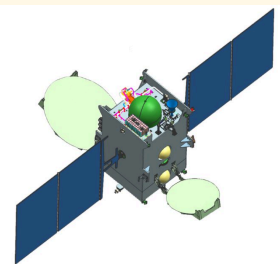
Kepler published laws 1 and 2 in 1609 and law 3 in 1619. Escape velocity does not depend on the mass of the body thrown. The Moon's escape velocity is about 2.4 km/s.



Johannes Kepler (1571–1630): three laws of planetary motion.



Replica of **Sputnik 1** (1957), the first artificial satellite.



GSAT-9 (South Asia Satellite, 2017), an ISRO geostationary satellite.



NASA astronaut **Catherine Coleman** floating aboard the ISS: weightlessness.



Shubhanshu Shukla aboard the ISS (Axiom-4, 2025).

As of October 2026:

- **28th CGPM** (Versailles, 13–15 October 2026): leap seconds will end; "continuous UTC" begins on 20 May 2027, with the gap between UTC and Earth-rotation time allowed to grow to 1 hour.
- **Second**: still defined by the caesium-133 atom; a new optical-clock definition is planned for the 29th CGPM (2030).
- **Shubhanshu Shukla**: first Indian on the International Space Station (Axiom-4, launched 25 June 2025, returned 15 July 2025); second Indian in space after Rakesh Sharma (1984).
- **Gaganyaan**: the first uncrewed flight (G1, carrying the robot Vyommitra) had not yet flown by mid-October 2026; the first crewed flight is planned for 2027.
- **Indian Standard Time** (UTC +5:30, 82.5° E) is kept by CSIR-NPL, New Delhi; draft Legal Metrology (IST) Rules (January 2025) aim at "One Nation, One Time".

Rule box

Memorise these 10

MUST KNOW

- | | | |
|----|--|-----------|
| 1 | SI has 7 base (fundamental) units | NTPC 2025 |
| 2 | Light year is a unit of distance (9.46×10^{15} m) | CGL 2022 |
| 3 | Parsec = distance; light year is NOT time | CGL 2017 |
| 4 | 1 horsepower = 746 watts | CGL 2019 |
| 5 | Acceleration = rate of change of velocity (m/s^2) | CGL 2021 |
| 6 | First law = law of inertia (Galileo's idea) | CGL 2025 |
| 7 | Momentum kg m s^{-1} ; force = rate of change of momentum | NTPC 2026 |
| 8 | Rockets and jets work on Newton's third law | CHSL 2025 |
| 9 | g and weight are largest at the poles | CGL 2017 |
| 10 | Escape velocity 11.2 km/s; geostationary period 24 h | NTPC 2016 |

Shortcuts & exam tricks

7 base units

"Man Kills Some Ants, Kills More Cockroaches":
metre, kilogram, second, ampere, kelvin, mole,
candela.

Prefix ladder

Each step is $\times 1000$: kilo $\rightarrow$ mega $\rightarrow$ giga $\rightarrow$ tera
 $\rightarrow$ peta $\rightarrow$ exa. Down: milli $\rightarrow$ micro $\rightarrow$ nano $\rightarrow$
pico $\rightarrow$ femto $\rightarrow$ atto.

Length ladder

Fermi < Angstrom < Micron ... AU < Light year <
Parsec. Parsec is the Papa (largest).

Read the root

Anemo = wind · Baro = pressure · Hygro =
moisture · Lacto = milk · Seismo = earthquake ·
Fatho = fathom (depth) · Alti = height.

Poles pull more

g: Poles max, Equator min, Centre zero; going up or down both reduce g. Lift: Up = heavy, Down = light, Cable cut = float.

Kepler E-A-P

Ellipse, equal **A**reas, **P**eriods ($T^2 \propto a^3$: "two-three"). Near the Sun = faster.

5

PART 5

Common mistakes & traps

WATCH OUT

- | | |
|---|--|
| ✗ A light year is a unit of time. | ✓ It is a unit of distance: how far light travels in one year. |
| ✗ Mass becomes one-sixth on the Moon. | ✓ Weight becomes one-sixth; mass stays the same. |
| ✗ The Richter scale is the instrument that records earthquakes. | ✓ The seismograph records them; the Richter scale expresses magnitude. |
| ✗ g is the universal gravitational constant. | ✓ G ($6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$) is universal; g (9.8 m/s^2) varies. |
| ✗ Weight of a body is greatest at the equator. | ✓ It is greatest at the poles and least at the equator. |

Previous year questions

29 SSC and RRB questions with their official tags and wording. The correct option is highlighted and the solution follows. Cover the solution and attempt each question first.

SSC CGL**Units, inertia, Galileo, Kepler, gravity · 2017–2025****SSC CGL 2025 Tier 1****14 Sep 2025 · Shift 1**

It is difficult to start motion with a heavy box and also difficult to stop it once it's moving. This best exemplifies:

(a) The concept of power

(b) Conservation of energy

(c) Property of inertia

(d) Action-reaction principle

Solution: Inertia resists any change in a body's state of rest or motion; a heavier box has more mass and so more inertia.

SSC CGL 2022 Tier 1**7 Dec 2022 · Shift 1**

Which of the following is a unit of distance?

(a) Newton

(b) Watt

(c) Light year

(d) Joule

Solution: A light year (9.46×10^{15} m) is the distance light travels in one year. Newton is force, watt is power, joule is energy.

SSC CGL 2022 Tier 1**7 Dec 2022 · Shift 1**

Which of the following has unit m/s^2 ?

(a) Speed

(b) Distance

(c) Acceleration

(d) Velocity

Solution: Acceleration = change in velocity (m/s) $\div$ time (s) = m/s^2 . Speed and velocity are in m/s; distance in m.

SSC CGL 2021 Tier 1

20 Apr 2022 · Shift 3

Acceleration is equal to the rate of change of _____.

(a) displacement

(b) position

(c) momentum

(d) velocity

Solution: Acceleration = rate of change of velocity. Rate of change of displacement is velocity; rate of change of momentum is force.

SSC CGL 2020 Tier 1

17 Aug 2021 · Shift 3

Who among the following was the first to conclude that in vacuum all objects fall with the same acceleration g and reach the ground at the same time?

(a) Albert Einstein

(b) Galileo Galilei

(c) Thomas Alva
Edison

(d) Isaac Newton

Solution: Galileo showed that, without air resistance, all bodies fall with the same acceleration whatever their mass.

SSC CGL 2020 Tier 1

16 Aug 2021 · Shift 1

Who among the following is credited with postulating three laws of planetary motion?

(a) Galileo Galilei

(b) Isaac Newton

(c) Tycho Brahe

(d) Johannes
Kepler

Solution: Kepler (laws 1–2 in 1609, law 3 in 1619) used Tycho Brahe's observations: elliptical orbits, equal areas, $T^2 \propto a^3$.

SSC CGL 2019 Tier 1

3 Mar 2020 · Shift 3

1 horsepower = approximately _____ watts.

(a) 674

(b) 647

(c) 764

(d) 746

Solution: 1 hp = 746 W. The watt (J/s) is the SI unit of power.

SSC CGL 2018 Tier 1

12 Jun 2019 · Shift 2

Which instrument is used to measure blood pressure?

(a) Thermometer

(b) Lactometer

(c) Glucometer

(d) Sphygmomanometer

Solution: Sphygmomanometer measures blood pressure (mm of Hg). Lactometer: milk; glucometer: blood sugar.

SSC CGL 2017 Tier 1

16 Aug 2017 · Shift 2

Which of the following pair is INCORRECT? I. Parsec - Distance II. Barrel - Liquid III. Light year - Time

(a) Only III

(b) Only I and III

(c) Only II

(d) All are correct

Solution: Light year measures distance, not time. Parsec (3.26 light years) is distance; barrel is a volume of liquid (oil).

SSC CGL 2017 Tier 1

8 Aug 2017 · Shift 1

What is the other name of Galileo's law of inertia?

(a) Law of motion

(b) Newton's first law of motion

(c) Newton's second law of motion

(d) Newton's third law of motion

Solution: Newton restated Galileo's law of inertia as his first law of motion.

SSC CGL 2017 Tier 1

11 Aug 2017 · Shift 1

At which of the following place, the weight of an object is maximum?

(a) At poles

(b) At equator

(c) At tropic of Capricorn

(d) At tropic of cancer

Solution: g is largest at the poles ($\approx 9.83 \text{ m/s}^2$) because they are closest to the Earth's centre and have no spin effect; $W = mg$.

SSC CHSL 2025 Tier 1

13 Nov 2025 · Shift 2

Newton's third law of motion states that _____.

(a) For every action, there is an equal and opposite reaction

(b) For every action, the reaction is opposite but greater in magnitude

(c) The rate of change of momentum of an object is proportional to the applied unbalanced force in the direction of force

(d) An object in motion remains in motion unless acted upon by a force

Solution: Action and reaction are equal, opposite and act on different bodies. Option (c) is the second law and (d) the first.

SSC CHSL 2020 Tier 1

4 Aug 2021 · Shift 1

What is the SI unit for measuring pressure?

(a) Pascal

(b) Candela

(c) Kelvin

(d) Ampere

Solution: Pressure = force ÷ area; 1 pascal = 1 N/m². Candela, kelvin and ampere are base units of other quantities.

SSC CHSL 2020 Tier 1

13 Apr 2021 · Shift 1

Which scientific instrument is used to measure the height of an aircraft above a fixed level?

(a) Barometer

(b) Fathometer

(c) Wattmeter

(d) Altimeter

Solution: The altimeter gives altitude. A fathometer measures sea depth; a barometer, air pressure; a wattmeter, electric power.

SSC CHSL 2019 Tier 1

18 Mar 2020 · Shift 2

The earthquake waves are recorded by an instrument called:

(a) Speedometer

(b) Odometer

(c) Richter scale

(d) Seismograph

Solution: The seismograph records seismic waves. The Richter scale is a scale of magnitude, not an instrument.

SSC CHSL 2017 Tier 1

16 Mar 2018 · Shift 3

An instrument that measures the wind speed is called _____.

(a) An anemometer

(b) An odometer

(c) A manometer

(d) A barometer

Solution: Anemometer (Greek anemos = wind). Odometer: distance travelled; manometer: gas pressure; barometer: air pressure.

SSC CHSL 2017 Tier 1

12 Mar 2018 · Shift 1

The SI unit of G , the universal gravitation constant is _____.

(a) $\text{N m}^2 \text{kg}^2$

(b) $\text{N m}^2 \text{kg}^{-2}$

(c) $\text{N m}^{-2} \text{kg}^{-2}$

(d) $\text{N m}^{-2} \text{kg}^2$

Solution: From $F = Gm_1m_2/r^2$, $G = Fr^2/m_1m_2$, so its unit is $\text{N m}^2 \text{kg}^{-2}$; value 6.67×10^{-11} .

SSC CHSL 2017 Tier 1

16 Mar 2018 · Shift 2

The gravitational force of attraction between two bodies is _____ the distance between the two bodies.

(a) Inversely proportional to the

(b) Directly proportional to the square of

(c) Inversely proportional to the square of

(d) Directly proportional to the

Solution: $F = Gm_1m_2/r^2$: inverse-square law. Doubling the distance makes the force one-fourth.

SSC CHSL 2017 Tier 1

11 Mar 2018 · Shift 1

The rate of change of linear momentum of a body is proportional to the _____ acting on it.

(a) Impulse

(b) Torque

(c) Force

(d) Kinetic Energy

Solution: Newton's second law: $F \propto dp/dt$, which gives $F = ma$. Impulse is force $\times$ time, equal to the change (not the rate of change) in momentum.

RRB NTPC Graduate CBT 1

22 Mar 2026 · Shift 1

Momentum of an object is defined as the product of its mass and velocity, hence what are its SI units?

(a) g m s^{-1} (b) kg m s^{-2} (c) kg m s (d) kg m s^{-1}

Solution: $p = mv \rightarrow \text{kg} \times \text{m/s} = \text{kg m s}^{-1}$. kg m s^{-2} is the newton (force).

RRB NTPC Graduate CBT 1

27 Mar 2026 · Shift 3

The foundational understanding of the law of inertia was established through the experiments of which physicist?

(a) Albert Einstein

(b) Michael Faraday

(c) Galileo Galilei

(d) Archimedes

Solution: Galileo's inclined-plane experiments led to the idea of inertia, later Newton's first law.

RRB NTPC Graduate CBT 1

24 Jun 2025 · Shift 3

What are the units for base quantities called?

(a) Standard basic units

(b) Fundamental or base units

(c) Basic constants

(d) Derived basic units

Solution: Units of the 7 base quantities (m, kg, s, A, K, mol, cd) are fundamental or base units; all others are derived units.

RRB NTPC CBT 2

17 Jan 2017 · Shift 1

How much time does a Geostationary satellite take to complete one orbit, at the height of 35790 km?

(a) 30 days

(b) 24 hours

(c) 365 days

(d) 12 hours

Solution: Its period equals one rotation of the Earth (about 24 hours), so it stays over the same point on the equator.

RRB NTPC CBT 2**18 Jan 2017 · Shift 1**

The escape velocity on the Earth's surface is about _____.

(a) 13.8 km/sec

(b) 11.2 km/sec

(c) 21.3 km/sec

(d) 4.3 km/sec

Solution: Escape velocity from Earth is 11.2 km/s; it does not depend on the mass of the body.

RRB Group D**23 Dec 2025 · Shift 2**

What happens to the gravitational force between two objects if both of their masses are doubled?

(a) The force becomes double

(b) The force becomes quadruple

(c) The force becomes 8 times

(d) The force becomes half

Solution: $F \propto m_1 m_2$, so $2 \times 2 = 4$ times the force (distance unchanged).

RRB Group D**10 Feb 2026 · Shift 1**

Which of the following is the SI unit of weight?

(a) Kilogram

(b) Newton

(c) Pascal

(d) Joule

Solution: Weight is a force ($W = mg$), measured in newtons. Kilogram is the unit of mass.

RPF SI CBT 1**9 Dec 2024 · Shift 3**

Which of the following is NOT one of Kepler's laws of planetary motion? A. The orbit of each planet around the Sun is an ellipse with the Sun at one of the two foci. B. The orbits of all planets around the Sun are coplanar. C. A line segment joining a planet and the Sun sweeps out equal areas during equal intervals of time. D. The square of the orbital period of a planet is directly proportional to the cube of the semi-major axis of its orbit.

(a) C

(b) D

(c) B

(d) A

Solution: A, C and D are Kepler's laws of orbits, areas and periods. Kepler made no law that all orbits are coplanar.

SSC CPO 2024 Paper 1

27 Jun 2024 · Shift 3

Which of the following statement/statements is/are true regarding the light year? 1. Light year is a unit of distance. 2. Light is a unit of time. 3. A light year is the distance that light travels in one Earth year. 4. Light year is the measurement of light intensity

(a) Only 1 is correct

(b) Only 1 and 2 are correct

(c) Only 1 and 3 are correct

(d) Only 2 is correct

Solution: A light year is a distance: the distance light covers in one year. Light intensity is measured in candela.

SSC GD 2026

29 Apr 2026 · Shift 2

If an astronaut's mass is 70 kg, what will be their weight on the Moon (1/6th of Earth's gravity)?

(a) 70 N

(b) 117 N

(c) 420 N

(d) 686 N

Solution: Weight on Earth $\approx 70 \times 10 = 700$ N (686 N with $g = 9.8$); on the Moon about $700 \div 6 \approx 117$ N. Mass stays 70 kg.

Trend: Units dominate every exam: light year, parsec, horsepower and the units of momentum, pressure, weight and G. CGL prefers concept questions (inertia, Galileo, Kepler, acceleration); CHSL and Group D test instruments and units; NTPC repeats escape velocity, geostationary satellites and base units. Expect questions next on the end of the leap second, Gaganyaan and the 2019 SI redefinition.



PART 7

Practice MCQs

Level 1 · Basic

Q1–Q7 · 15 sec each

Level 2 · Standard

Q8–Q14 · 25 sec each

Level 3 · Exam traps

Q15–Q20 · 35 sec each

Level 1

Q1 How many base units are there in the SI system?

- (a) 7
- (b) 5
- (c) 6
- (d) 9

Q2 The SI unit of force is the:

- (a) joule
- (b) newton
- (c) pascal
- (d) watt

Q3 A fathometer is used to measure:

- (a) height of an aircraft
- (b) wind speed
- (c) depth of the sea
- (d) humidity

Q4 Newton's first law of motion is also called the law of:

- (a) momentum
- (b) gravitation
- (c) action and reaction
- (d) inertia

Q5 1 angstrom is equal to:

- (a) 10^{-10} m
- (b) 10^{-9} m
- (c) 10^{-12} m
- (d) 10^{-15} m

Q6 The value of escape velocity from the Earth's surface is about:

- (a) 7.9 km/s
- (b) 11.2 km/s
- (c) 9.8 km/s
- (d) 2.4 km/s

Q7 Which of the following is a vector quantity?

- (a) Speed
- (b) Mass
- (c) Velocity
- (d) Work

Level 2

Q8 A body moving with constant velocity has an acceleration of:

- (a) 9.8 m/s^2
- (b) 1 m/s^2
- (c) infinity
- (d) zero

Q9 The weight of a body is least:

- (a) at the equator
- (b) at the poles
- (c) at the tropic of Cancer
- (d) at the tropic of Capricorn

Q10 If the distance between two bodies is doubled, the gravitational force between them becomes:

- (a) half
- (b) one-fourth
- (c) double
- (d) four times

Q11 A geostationary satellite is placed at a height of about:

- (a) 3,578 km
- (b) 1,000 km
- (c) 35,786 km
- (d) 3,57,860 km

Q12 The recoil of a gun when a bullet is fired is explained by:

- (a) Newton's first law
- (b) law of gravitation
- (c) Kepler's second law
- (d) conservation of momentum

Q13 1 knot is a speed of:

- (a) 1 nautical mile per hour
- (b) 1 mile per hour
- (c) 1 km per hour
- (d) 1 nautical mile per minute

Q14 The SI unit of luminous intensity is the:

- (a) lumen
- (b) candela
- (c) lux
- (d) watt

Level 3

Q15 Consider: 1. Mass of a body is the same on the Earth and the Moon. 2. Weight is measured with a beam balance. 3. In a freely falling lift a person feels weightless. Which are correct?

- (a) 1 and 2 only
- (b) 2 and 3 only
- (c) 1 and 3 only
- (d) 1, 2 and 3

Q17 Which pair is INCORRECTLY matched?

- (a) Parsec – time
- (b) Light year – distance
- (c) Knot – speed
- (d) Horsepower – power

Q19 The 28th CGPM (October 2026) decided that leap seconds will end and continuous UTC will begin from:

- (a) 1 January 2027
- (b) 20 May 2026
- (c) 20 May 2027
- (d) 1 January 2035

Q16 Match List I with List II:

List I	List II
P. Seismograph	1. Height of aircraft
Q. Hygrometer	2. Earthquake waves
R. Lactometer	3. Purity of milk
S. Altimeter	4. Humidity

- (a) P-2, Q-3, R-4, S-1
- (b) P-4, Q-2, R-3, S-1
- (c) P-1, Q-4, R-3, S-2
- (d) P-2, Q-4, R-3, S-1

Q18 Arrange from smallest to largest: 1. Light year 2. Fermi 3. Astronomical unit 4. Angstrom

- (a) 4, 2, 3, 1
- (b) 2, 4, 3, 1
- (c) 2, 4, 1, 3
- (d) 4, 2, 1, 3

Q20 In uniform circular motion, which of the following stays constant?

- (a) Velocity
- (b) Acceleration (as a vector)
- (c) Direction of motion
- (d) Speed

Score yourself: ____ / 20 · Time taken: ____ min

7.1 Answer key

1 A	2 B	3 C	4 D	5 A	6 B	7 C	8 D	9 A	10 B
11 C	12 D	13 A	14 B	15 C	16 D	17 A	18 B	19 C	20 D

Q1 Metre, kilogram, second, ampere, kelvin, mole and candela.

Q2 $1 \text{ N} = 1 \text{ kg m/s}^2$. Joule is energy, pascal is pressure, watt is power.

- Q3** Altimeter: height; anemometer: wind speed; hygrometer: humidity.
- Q5** 10^{-9} m is a nanometre; 10^{-15} m is a fermi.
- Q7** Speed, mass and work have magnitude only.
- Q9** g is least at the equator (≈ 9.78 m/s²) and greatest at the poles (≈ 9.83 m/s²).
- Q11** It orbits above the equator with a period of 24 hours.
- Q13** 1 nautical mile = 1.852 km; the knot measures the speed of ships and aircraft.
- Q15** Weight is measured with a spring balance; a beam balance compares masses.
- Q17** Parsec (3.26 light years) is a unit of distance.
- Q19** UTC may now drift up to 1 hour from Earth-rotation time.
- Q4** The third law is the law of action and reaction.
- Q6** 7.9 km/s is the orbital speed near the surface; 2.4 km/s is the Moon's escape velocity.
- Q8** Acceleration is the rate of change of velocity; no change means zero acceleration.
- Q10** $F \propto 1/r^2$, so $(1/2)^2 = 1/4$.
- Q12** Gun and bullet gain equal and opposite momentum (also Newton's third law).
- Q14** Lumen is luminous flux and lux is illuminance; both are derived units.
- Q16** Seismograph: earthquakes; hygrometer: humidity; lactometer: milk; altimeter: height.
- Q18** Fermi (10^{-15} m) < angstrom (10^{-10} m) < AU (1.5×10^{11} m) < light year (9.46×10^{15} m).
- Q20** Direction keeps changing, so velocity and the acceleration vector change; only speed is constant.

One-page quick revision

Night-before sheet · Units, Measurement & Motion

SC-01

TOP 10 POINTS

1. SI (1960): 7 base units m, kg, s, A, K, mol, cd.
2. Since 20 May 2019 all units fixed by constants.
3. Light year 9.46×10^{15} m; parsec 3.26 ly.
4. $\text{\AA}$ 10^{-10} m · fermi 10^{-15} m · 1 hp = 746 W.
5. Knot = 1 nautical mile (1.852 km) per hour.
6. Acceleration = $\Delta v \div t$, m/s^2 ; s–t slope = speed.
7. Inertia (Galileo) = 1st law; $F = ma$; rocket = 3rd.
8. $p = mv$, kg m/s; F = rate of change of momentum.
9. $G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$; g 9.8, max at poles.
10. Escape 11.2 km/s · geostationary 35,786 km, 24 h.

Moon: weight $\div 6$, mass same

TOP 3 TRAPS

- Light year is distance, not time.
- Seismograph records; Richter is a scale.
- G is universal; g varies.

SELF-CHECK

- ☐ Write the 7 base units and symbols
- ☐ Match 10 instruments to quantities
- ☐ State Newton's and Kepler's laws

Term	Meaning	Term	Meaning
CGPM	General Conference on Weights and Measures	Least count	Smallest reading of an instrument
Inertia	Resistance to change of motion (measured by mass)	Impulse	Force $\times$ time = change in momentum
Escape velocity	Least speed to leave a planet's pull	Geostationary	24-hour orbit above the equator

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SC-01 · v1.0 · Oct 2026