

STANDARDS OF WEIGHTS AND MEASURES (NATIONAL STANDARDS) RULES, 1988

CONTENTS

CHAPTER 1 :- Preliminary

1. Short title and commencement
2. Definitions

CHAPTER 2 :- Units of Weight or Measure

3. Rules of construction
4. Supplementary units
5. Derived units
6. Decimal multiples and sub-multiples of units
7. Permitted units
8. Special units
9. Temporarily accepted units
10. Units which should be progressively discontinued
11. Physical constants
12. Coefficient and symbol
13. Formation of new units

CHAPTER 3 :- National Standards

14. Custody, maintenance, etc. of national standards of weights and measures
15. Realisation and establishment of the national standards of weights and measures based on SI units
16. Custody and maintenance of prototype standards

CHAPTER 4 :- Reference, Secondary and Working Standards

17. Standards which are to be fabricated by the Mint
18. Place where reference, secondary and working standards be kept
19. Period and manner of verification of reference, secondary and working standards
20. Maintenance of Reference, Secondary and Working Standards

SCHEDULE 1 :- THE FIRST SCHEDULE

SCHEDULE 2 :- THE SECOND SCHEDULE

SCHEDULE 3 :- THE THIRD SCHEDULE

SCHEDULE 4 :- THE FOURTH SCHEDULE

SCHEDULE 5 :- THE FIFTH SCHEDULE

SCHEDULE 6 :- THE SIXTH SCHEDULE

SCHEDULE 7 :- THE SEVENTH SCHEDULE

SCHEDULE 8 :- THE EIGHTH SCHEDULE

SCHEDULE 9 :- THE NINTH SCHEDULE

SCHEDULE 10 :- THE TENTH SCHEDULE

STANDARDS OF WEIGHTS AND MEASURES (NATIONAL STANDARDS) RULES, 1988

¹1. Published in the Gazette of India. Extraordinary. Pt. II, Sec. 3(i). No. 589. dated 16th November, 1988. G.S.R. 1076(E), dated 16th November, 1988.-In exercise of the powers conferred by Section 83 of the Standards of Weights and Measures Act, 1976 (60 of 1976), the Central Government hereby makes the following rules, namely :

CHAPTER 1

Preliminary

1. Short title and commencement :-

(1) These rules may be called the Standards of Weights and Measures (National Standards) Rules, 1988.

(2) They shall come into force on the date¹ of the their publication in the official Gazette.

1. Enforced w.e.f. 16th November, 1988.

2. Definitions :-

In these rules, unless the context otherwise requires,-

(a) 'Act' means the Standards of Weights and Measures Act, 1976 (60 of 1976).

(b) 'coefficient' means those parameters without physical dimensions or ratios of quantities of the same kind, which are necessary for particular measurements or for characterising properties of substances or mixtures of certain substances.

Illustration Degree of alcholic strength, percentage of sugar, and hardness of materials, are examples of coefficients.

(c) 'derived units' means units, expressed algebraically in terms of base units, or in terms of base and supplementary units of weights or measures, by means of mathematical symbols of multiplication or division, or both.

Explanation I.-Derived units having special names and symbols (such as 'newton', with symbol 'N') may, by themselves, be used to express other derived units in a simpler way than in terms of the base units of weights and measures.

Explanation II.-The value of dimension less quantities (such as, refractive index, specific gravity, relative permeability or relative permittivity) are expressed by numbers. In such cases the corresponding unit shall be the ratio of the relevant two units and may be expressed by a number;

(d) International System of Units' of weights and measures means 'Le Systeme International d Units', with the international abbreviation 'SI'. established by the General Conference on Weights and Measures.

Explanation.-'SI' is divided into three classes of units, namely-

(i) base units, as defined in the Act;

(ii) derived units; and

(iii) supplementary units;

(e) 'permitted Units' means the units which though not part of the SI, are recognised and permitted by the General Conference on Weights and Measures for general use along with SI units;

(f) 'Physical constants' means those constants which express the value of physical invariants in a given system of units. These constants include :

(i) those which correlate two or more physical quantities to express a physical phenomenon in quantitative terms independent of any material properties; for example, gravitational constant, velocity of light, etc.,

(ii) those which correlate the microscopic properties of elementary particles (atoms, molecules, etc.) to the corresponding microscopic properties; for example; Avagadro constant, Faraday constant, etc.,

(iii) those conversion factors used to express the same parameter in

terms of independently defined units for example, the conversion factor relating the astronomical unit or parsec to the metre and atomic mass unit to kilogram;

(iv) those which describe the material properties of pure substances, for example, thermal conductivity, specific resistance, etc.,

(g) 'Schedule' means Schedule appended to these rules,

(h) 'SI prefix' means the name and symbol of a prefix used for forming decimal multiples and sub-multiples of SI units, and of such other units as are permitted subject to any exception or modification by the General Conference on 'Weights and Measures or the International Organisation of Legal Metrology, or both, to be used alongwith the SI units,

(i) 'special units' means units, outside the SI, which are ordinarily used in specialised fields of scientific research. The values of those units expressed in SI units can only be obtained by experiment, and are, therefore, not known exactly.

Explanation.-The value of electron volt (the unit of energy) depends upon the experimentally determined value of the charge of an electron.

(j) 'supplementary units' means the units of weight or measure which have been specified as such by the General Conference on Weights and Measure

Explanation.-Supplementary units may be used to form derived units;

(k) 'symbol' means a letter or a group of letters, written or combined in the specified manner for the convenient representation of a unit or a group of units;

(l) 'temporarily accepted units' means the units of weight or measure which have been recognised for the time being by the General Conference of Weights and measures, for use along with SI units.

CHAPTER 2

Units of Weight or Measure

3. Rules of construction :-

In these rules, wherever the expression 'Weight' has been used as

symbolising the quantity of matter, such expression shall be construed as representing mass.

4. Supplementary units :-

The units defined and specified in the First Schedule shall be the supplementary units and the symbol assigned to each such unit in that Schedule shall be the symbol of that unit.

5. Derived units :-

The units defined and specified in the Second Schedule shall be derived units and the symbol assigned to each such unit in that Schedule shall be the symbol of that unit and no other units shall be used for the entities specified in the Second Schedule except for the purpose of scientific or technological research.

6. Decimal multiples and sub-multiples of units :-

(1) Decimal multiples and sub-multiples of base, supplementary, derived or other units shall be formed, unless otherwise specified, by using either the full name, or symbol of the Si-prefix specified in the Third Schedule.

(2) The Si-prefixes shall be used in the manner specified in the Third Schedule.

7. Permitted units :-

(1) The units specified in the Fourth Schedule may be used alongwith the SI units, subject to such limitations as are specified in that Schedule.

(2) The multiples and sub-multiples of the units of time and plane angle specified in the Fourth Schedule, shall be formed only in the manner specified in the Schedule.

8. Special units :-

(1) The units specified in the Fifth Schedule shall be used in such manner that their values may be expressed in terms of such SI unit or combination of SI units, as may be appropriate.

(2) The multiples and sub-multiples of the units specified in the Fifth Schedule shall be formed with the help of SI prefixes specified in the Third Schedule.

9. Temporarily accepted units :-

The unit of weight or measure specified in the Sixth Schedule may

also be used, subject to the condition that the Central Government shall, at least once in every ten years after the commencement of these rules, review the need, or otherwise, for the continuance for general use of such units : Provided that such review may be undertaken earlier by the Central Government either on its own motion or on the basis of a recommendation made by the General Conference on Weights and Measures, or the International Organisation of Legal Metrology.

10. Units which should be progressively discontinued :-

(1) Subject to the provisions of sub-rule (2), the CGS (i.e. centimetre, gram, second) units specified in the Seventh Schedule, and the units of weights and measures specified in the Eighth Schedule (being unit outside the SI), shall not ordinarily be used except for the purpose of scientific and technological research and no such unit shall ordinarily be used for the purpose of teaching.

(2) The use of the units specified in the Seventh Schedule or, as the case may be, the Eighth Schedule, shall be progressively discontinued so that no such unit is used in any field (except in the field of scientific and technological research) after the expiry of a period of ten years from the commencement of these Rules.

(3) While using, for the purpose of scientific and technological research the units specified in the Seventh Schedule, or, as the case may be, the Eighth Schedule, such units shall be used only with the corresponding symbols specified in the said schedules.

11. Physical constants :-

The physical constants specified in the Ninth Schedule and their corresponding numerical values shall be used for all purposes except for the purposes of research connected with the determination of their values.

12. Coefficient and symbol :-

(1) Coefficients include the terms defined and specified in the Tenth Schedule; the symbol assigned to any such coefficient in that Schedule shall be the symbol of such coefficient.

(2) Ordinarily, the coefficients and their respective symbols specified in the Tenth Schedule shall be used : Provided that any coefficient which is not specified in the Tenth Schedule but which corresponds to any coefficient specified In that Schedule, may be

used for a period of five years from the commencement of these rules : Provided further where any new coefficient added in the Tenth Schedule, any coefficient corresponding to the coefficient so added may be used for a period of five years from the date of addition of such coefficient.

(3) On the expiry of the period of aforesaid five years, the use of coefficient and their respective symbols as specified in the Tenth Schedule shall be compulsory.

Explanation.-In the case of a coefficient the use of which is permissible under any of the provisos to sub-rule (2), the symbol, if any, attached to such coefficient may also be used for the same period for which the corresponding coefficient is permitted to be used.

13. Formation of new units :-

No new unit or weight or measure shall be formed or used except for the purpose of scientific and technological research without the previous approval of the Central Government.

CHAPTER 3

National Standards

14. Custody, maintenance, etc. of national standards of weights and measures :-

(1) The work relating to the realisation, establishment, custody, maintenance, determination, reproduction and updating of national standards of weights and measures shall, on the commencement of these rules, be the responsibility of the National Physical Laboratory.

(2) The Central Government may call for such reports from, or issue such directions to, the National Physical Laboratory as it may think fit. In relation to all or any of the matters specified in sub-rule (1).

15. Realisation and establishment of the national standards of weights and measures based on SI units :-

(1) The National Physical Laboratory shall discharge the responsibility of realising and establishing the national standards of weights and measures on the basis of recommendations made from time to time, by the General Conference on Weights and Measures or the International Organisation of Legal Metrology, as the case may be.

(2) The standards of weights and measures, so realised and established, shall be self-consistent.

(3) For the purpose of establishing the national standards for the base units other than of mass, the National Physical Laboratory shall-

(a) prepare or cause to be prepared such objects, or equipments, or reproduce such phenomena, or both, as may be necessary for the purpose; and

(b) determine or cause to be determined the values of the national standards as recommended by the General Conference on Weights and Measures and intercompare them, or cause them to be intercompared, with the corresponding international standards.

(4) For the purpose of deriving the value of the kilogram, the National Physical Laboratory shall arrange the periodical determination of the value of the national prototype of the kilogram in terms of the international prototype of the kilogram and the national prototype of the kilogram, the value of which is so determined, shall be the national standards of mass.

(5) For the purpose of establishing the national standards for the derived and supplementary units, the National Physical Laboratory shall prepare such standards, or objects or equipments, or both, and determine periodically their values and accuracy in relation to the national standards of base units.

16. Custody and maintenance of prototype standards :-

(1) The national prototype of the kilogram and other standards, equipments and objects shall remain in the custody of the National Physical Laboratory.

(2) The national prototype of the kilogram, and every other national standard, standard equipments and objects shall be maintained and realised periodically in accordance with such instructions as the General Conference on Weights and Measures on the international Organisation of Legal Metrology or any organisation constituted by either of them may issue from time to time.

(3) Where no instructions have been issued by the International Organisation referred to in sub-rule (2), any Consultative Committee constituted, may compile instructions for the proper

maintenance of national prototype, national standards, standard equipments and objects.

(4) The National Physical Laboratory shall arrange, where necessary, to have the national prototype and national standards of physical measurements realised and established in accordance with the recommendations of the General Conference on Weights and Measures and to get them calibrated or intercompared with reference to the appropriate international standards of physical measurements, at periodical Interval of not more than ten years.

(5) The value of the national prototype and other national standards shall be the value determined by the National Physical Laboratory or assigned by the National Physical Laboratory on the basis of the technical information provided by the International Bureau of Weights and Measures. The National Physical Laboratory shall publish such values periodically but in any case at least once in every five years.

(6) The value determined in accordance with sub-rule (5) shall be deemed to represent that highest obtainable accuracy of such value in the country.

CHAPTER 4

Reference, Secondary and Working Standards

17. Standards which are to be fabricated by the Mint :-

Unless otherwise specified by the Central Government, all the reference, secondary and working standards of mass and length and secondary and working standards of capacity shall be fabricated by the Metrological Wing of the Government of India Mint at Bombay.

18. Place where reference, secondary and working standards be kept :-

(1) There shall be established by the Central Government, at such places as it may think fit. Reference Standard Laboratories for maintaining such reference, secondary and working standards as may be needed by the Central Government for the purpose of the Act.

(2) The Indian Institute of Legal Metrology or any other Laboratory specified by the Central Government for this purpose may also maintain such reference, secondary and working standards, as may be necessary, for their functioning as a Metrological Laboratory of

the level of a Reference Standard Laboratory.

(3) The Government of India Mint at Bombay may also maintain such reference, secondary and working standards as may be necessary for carrying out the work referred to in rule 17.

19. Period and manner of verification of reference, secondary and working standards :-

(1) Every reference standard shall be verified and certified in terms of the National Standards by the National Physical Laboratory, at an interval not exceeding three years. Provided that in the case of length measures such interval shall not exceed five years.

(2) Every secondary standard shall be verified against the appropriate reference standard by the Reference Standard Laboratory, at an Interval not exceeding two years.

(3) Every working standard shall be verified against the appropriate secondary standard, by any of the laboratories where secondary standards are maintained, at an Interval not exceeding one year.

20. Maintenance of Reference, Secondary and Working Standards :-

Every reference standard, every secondary standard and every working standard irrespective of the place where they are kept, shall be maintained as far as practicable in accordance with the guidelines issued by the National Physical Laboratory from time to time.

SCHEDULE 1

THE FIRST SCHEDULE

(See rule 4) Supplementary units and their symbols 1. Unit of plane angle.- The unit of plane angle shall be the radian (symbol: rad). The radian is the plane angle between two radii of a circle which cuts off, on the circumference and are equal in length to the radius. 2. Unit of solid angle.- The unit of solid angle shall be the steradian. (Symbol : sr) The steradian is the solid angle which, having its vertex in the centre of a sphere, cuts off an area of the surface of the sphere equal to that of a square with sides of length equal to the radius of the sphere.

SCHEDULE 2

THE SECOND SCHEDULE

(See rule 5) Derived units and their symbols PART I Derived Units in relation to Space and Time 1. Unit of area.-The unit of area shall be the square metre. (Symbol : m²). The square metre is the area of a square with sides of one metre each. 2. Unit of volume.-The unit of volume shall be the cubic metre (Symbol : m³). The cubic metre is the volume of a cube

with sides of one metre each. 3. Unit of frequency.-The unit of frequency shall be the hertz. (Symbol : Hz). The hertz is the frequency of a periodic phenomenon, the period of which is one second. $1 \text{ Hz} = 1/\text{s}$ 4. Unit of angular velocity.-The unit of angular velocity shall be the radian per second. (Symbol : rad/s). The radian per second is the angular velocity of a body, rotating around a fixed axis, which rotates through one radian in one second, when set in uniform rotation. 5. Unit of angular acceleration.-The unit of angular acceleration shall be the radian per second squared. (Symbol : rad/s^2). The radian per second squared is the angular acceleration of a body, rotating around a fixed axis, which when set into a uniformly varying rotation, changes angular velocity at the rate of one radian per second in one second. 6. Unit of speed and velocity.-The unit of speed and velocity shall be the metre per second. (Symbol : m/s or $\text{m} \cdot \text{s}^{-1}$) The metre per second is the velocity (speed) of a body in motion which traverses a distance of one metre in one second when set in uniform motion. 7. Unit of acceleration.-The unit of acceleration shall be the metre per second squared. (Symbol : m/s^2 or $\text{m} \cdot \text{s}^{-2}$) The metre per second squared is the acceleration of a body in motion which, when set in a uniformly varying motion, changes its velocity at the rate of one metre per second in one second. 8. Unit of rotational frequency.-The unit of rotational frequency shall be the second raised to the power minus one. (Symbol: s^{-1}) The second raised to the power minus one is the rotational frequency of a uniform rotatory movement which produces one complete revolution in one second. Note 1.- This unit is also called : revolutions per second. Note 2.-The unit 'revolutions per minute' may also be used. 9. Unit of wave number.-The unit wave number shall be the metre raised to the power minus one. (symbol: m^{-1}) The metre raised to the power minus one is the number of waves of a monochromatic radiation which can be accommodated. In the direction of its propagation, in a length equal to one metre. 10. Unit of vergency of optical system.-The unit of vergency of optical system shall also be the metre raised to be power minus one. (symbol: m^{-1}) The metre raised to the power minus one is the vergency of an optical system, the focal distance of which is one metre in a medium having a refractive Index of unit. Note 1.- This unit is also called : 'per metre' or 'diopetre'. Note 2.-The metre raised to the power minus one with symbol m^{-1} is the unit of wave number as well as that of vergency of optical system. The context in which the said unit is used will indicate whether the unit relates to the wave number or vergency of optical system.

PART II Derived units in Relation to Mechanics

- Unit of density and mass density.-The unit of density and mass density shall be the kilogram per cubic metre.(symbol : kg/m^{-3} or $\text{kg} \cdot \text{m}^{-3}$) The kilogram per cubic metre is the density or mass density of a homogeneous body having a mass of one kilogram and a volume of one cubic metre.
- Unit of concentration.-The unit of concentration shall be the kilogram per cubic metre. (symbol : kg/m^{-3} or $\text{kg} \cdot \text{m}^{-3}$) The kilogram per cubic metre is the concentration of homogeneous solution having a total volume of one cubic metre and containing a mass of one kilogram of the given substance.
- Unit of force.-The unit of force shall be the newton. (symbol: N) The newton is the force which gives to a mass of one kilogram an acceleration of one metre per second squared. $1 \text{ N} = 1 \text{ kg} \cdot 1 \text{ m/s}^2$
- Unit of moment of force.-The unit of moment of force shall be the metre newton. (symbol: N.m) The newton metre is the moment of force produced in a body by a force of one newton acting at a perpendicular distance of one metre from the fixed axis around which the body turns. $1 \text{ N} \cdot \text{m} = 1 \text{ kg} \cdot \text{s}^{-2}$ Note.-The unit of moment of force shall not be written as joule (J) because it is N. m.
- Unit of pressure.-The unit of pressure shall be the pascal. (symbol: Pa) The pascal is the pressure which, acting on a plane surface of one square metre

exerts on that area a total force of one newton. $1 \text{ N} = 1 \text{ Pa} \cdot \text{m}^2$ or $1 \text{ N} \cdot \text{m}^2$

6. Unit of tensile strength.-The unit of tensile strength shall be Mega Pascal. (symbol : MPa or MN/m^2) The tensile strength is the highest force, when applied normal to the cross-section of a test piece which it can withstand, divided by the original area of the cross-section.

7. Unit of dynamic viscosity.-The unit of dynamic viscosity shall be the Pascal second. (symbol: Pa. s) The pascal second is the dynamic viscosity of a homogeneous liquid in which the straight and uniform movement of a plane surface of one square metre produces a retarding force of one newton, when there is a velocity difference of one metre per second between two parallel planes separated by one metre. $1 \text{ Pa} \cdot \text{s} = \frac{1 \text{ m}^2}{\text{s}}$

8. Unit of Kinematic viscosity.-The unit of kinematic viscosity shall be square metre per second. (symbol m^2/s or : $\text{m}^2 \cdot \text{s}^{-1}$) The square metre per second is the kinematic viscosity of a liquid which has a dynamic viscosity of one pascal second and a density of one kilogram per cubic metre. $1 \text{ m}^2/\text{s} = 1 \text{ Pa} \cdot \text{s} / 1 \text{ kg}/\text{m}^3$

9. Unit of surface tension.-The unit of surface tension shall be the newton per metre. (symbol: N/m) The newton per metre is the surface tension produced when a force of one newton acts over a length of one metre on the surface of a liquid separating that liquid from the material surrounding it.

10. Unit of work, energy and quantity of heat.-The unit of energy, work and quantity of heat shall be the joule. (symbol: J) The joule is the work done when the point of application of one newton moves a distance of one metre in the direction of the force. $1 \text{ J} = 1 \text{ N} \cdot 1 \text{ m}$

11. Unit of power, radiant flux and heat flux.-The unit of power, radiant flux and heat flux shall be watt. (symbol: W) The watt is the power of an energy system in which one joule of energy is uniformly transferred in one second. $1 \text{ W} = 1 \text{ J}/1 \text{ s}$

12. Unit of volume flow.-The unit of volume flow shall be the cubic metre per second. (symbol : m^3/s or $\text{m}^3 \cdot \text{s}^{-1}$) The cubic metre per second is the volume delivered by the uniform discharge of one cubic metre traversing the given cross-section in one second.

13. Unit of mass flow.-The unit of mass flow shall be the kilogram per second. (symbol : kg/s or $\text{kg} \cdot \text{s}^{-1}$) The kilogram per second is the mass delivered by the uniform discharge of a mass of one kilogram traversing the given cross section in one second.

14. Unit of specific volume.-The unit of specific volume shall be cubic metre per kilogram. (symbol: m^3/kg) The cubic metre per kilogram is the specific volume of a homogeneous body having a volume of one cubic metre and a mass of one kilogram.

PART III Derived Units in Relation to Heat

1. Unit of entropy.-The unit of entropy shall be the joule per kelvin. (symbol: J/K) The joule pr kelvin is the Increase of entropy of a system receiving a quantity of heat equal to one joule at the constant thermodynamic temperature of one kelvin, provided that no irreversible change takes place in the system.

2. Unit of specific entropy.-The unit of specific entropy shall be the joule per kilogram kelvin. [symbol: J/(kg. K)] The joule per kilogram kelvin Is the specific entropy of a system of homogeneous mass of one kilogram receiving a quantity of heat equal to one joule at the constant thermodynamic temperature of one kelvin, provided that no irreversible change takes place in the system.

3. Unit of heat capacity.-The unit of heat capacity shall be the joule per kelvin. (symbol: J/K) The joule per kelvin is the heat capacity of a homogeneous body in which a quantity of heat equal to one joule produces an increase of one kelvin in the thermodynamic temperature.

4. Unit of specific heat capacity.-The unit of specific heat capacity shall be joule per kilogram kelvin. [symbol : j/(kg. K)] The joule per kilogram kelvin is the specific heat capacity of a homogeneous body having a mass of one kilogram in which quantity of heat equal to one joule produces an increase of one kelvin in the thermodynamic temperature.

5. Unit of latent heat.-The unit of latent heat shall be the joule per kilogram.

(symbol: J/kg) The joule per kilogram is the heat exchanged by one kg of substance to change from one phase to another at the temperature of its changing phase.

6. Unit of specific energy.-The unit of specific energy shall be the Joule per kilogram. (symbol: J/kg) The joule per kilogram is the specific energy of a system of homogeneous mass of one kilogram having the internal energy of one joule.

7. Unit of thermal conductivity.-The unit of thermal conductivity shall be the watt per metre kelvin. [symbol: W/(m.K)] The watt per metre kelvin is the thermal conductivity of a homogeneous body in which a difference of one kelvin in the thermodynamic temperature produces a radiant flux of one watt between two parallel planes, each having an area of one square metre, placed one metre apart. $1 \text{ Wm}^{-2} = 1 \text{ W/m.k.} = \dots\dots\dots 1/\text{K}/1\text{m}$

8. Unit of energy density.-The unit of energy density shall be the joule per cubic metre. (symbol: J/m³) The joule per cubic metre is the energy density of a system of homogeneous mass of volume one cubic metre and having the radiant energy of one joule.

9. Unit of heat flux density.-The unit of heat flux density shall be the watt per square metre. (symbol: W/m²) The watt per square metre is heat flux density of a surface of one square metre in area radiating out energy at the rate of one joule per second.

PART IV Derived Units in relation of Electricity and Magnetism

1. Unit of quantity of electricity and electric charge.-The unit of quantity of electricity and electric charge shall be the coulomb. (symbol: C) The coulomb is the quantity of electricity carried in one second by a current of one ampere. $1\text{C} = 1\text{A} \cdot 1\text{s}$

2. Unit of electric charge density.-The unit of electric charge density shall be the coulomb per cubic metre. (symbol: C/m³) The coulomb per cubic metre is the electric charge density of a homogeneous mass or system of volume one cubic metre and having a charge of one coulomb.

3. Unit of electric flux density.-The unit of electric flux density shall be the coulomb per square metre. (symbol: C/m²) The coulomb per square metre is the electric flux density when a condenser, having plates of infinite area/size, parallel to each other, is charged, in vacuum, with a quantity of electricity equal to one coulomb per one square metre of area of the plates.

4. Unit of electric tension, electric potential and electromotive force.- The unit of electric tension, electric potential and electromotive force shall be the volt. (symbol: V) The volt is the potential difference between two points of a conducting wire carrying a constant current of one ampere, when the power dissipated between these points is equal to one watt. $1\text{V} = 1\text{W} / 1\text{A}$

5. Unit of electric field strength.-The unit of electric field strength shall be volt per metre. (symbol: V/m) The volt per metre is the electric field strength of an electric field which produces a force equal to one newton in a body charge with a quantity of electricity equal to one coulomb. $1\text{V} = 1\text{N}/1\text{m} = 1\text{C}$

6. Unit of electric resistance.-The unit of electric resistance shall be the ohm (symbol: Q) The ohm is the electric resistance between two points of a conductor when a constant potential difference of one volt, applied to these points, produces in the conductor a current of one ampere, the conductor not being the seat of any electromotive force.

7. Unit of conductance.-The unit of conductance shall be the Siemens. (symbol: S) The Siemens is the conductance of a conductor having a resistance of one ohm. $1\text{s} = 1\text{Q}^{-1} = 1/\text{Q}$

8. Unit of capacitance.-The unit of capacitance shall be the farad. (symbol: F) The farad is the capacitance between the conductors of a capacitor across which there appears a potential difference of one volt when it is charged by a quantity of electricity of one coulomb. $1\text{C} = 1\text{F} = \dots\dots\dots 1\text{V}$

9. Unit of permittivity.-The unit of permittivity shall be the farad per metre.(symbol: F/m) The farad per metre is the permittivity of the medium which gives a capacitance of one farad per square metre of area of two parallel plates separated by a distance of one metre.

10. Unit of Inductance.-The unit of inductance shall be the henry. (symbol: H) The

henry is the inductance of a closed circuit in which an electromotive force of one volt is produced when the electric in the circuit varies uniformly at the rate of one ampere per second. $1\text{V} = 1\text{S} \cdot 1\text{H} = \dots\dots\dots 1\text{A}$

11. Unit of permeability.-The unit of permeability shall be the henry per metre. (symbol: H/m) The henry per metre is the permeability of a material surrounded by a single turn of flat sheet conductor including an area of one square metre and length one metre which gives an inductance of one henry.

12. Unit of magnetic flux and flux of magnetic Induction.-The unit of magnetic flux and flux of magnetic induction shall be the weber. (symbol: Wb) The weber is the magnetic flux which produce in it an electromotive force of one volt if it were reduced to zero at a uniform rate in one second. $1\text{Wb} = 1\text{V} \cdot 1\text{s}$

13. Unit of magnetic induction and magnetic flux density.-The unit of magnetic induction and magnetic flux density shall be the tesla. (symbol: T) The tesla is the uniform magnetic induction which, distributed evenly over a surface of one square metre, produces a total magnetic flux of one weber while passing over the surface. $1\text{Wb} = 1\text{T} \cdot 1\text{m}^2$

14. Unit of magnetic field strength.-The unit of magnetic field strength shall be the ampere per metre. (symbol : A/m or A m^{-1}) The ampere per metre is the magnetic field strength produced in vacuum along the surface of a circular cylinder with a circumference of one metre, by a current of intensity of one ampere, maintained in a straight conductor of infinite length, of negligible circular cross-section, which forms the axis of the said cylinder.

15. Unit of current density.-The unit of current density shall be the ampere per square metre. (symbol: A/m^2) The ampere per square metre is the current density in a linear conductor when a current of intensity one ampere flows uniformly through a cross-section of the conductor equal to one square metre, perpendicular to the direction of flow of the current.

PART V Derived Units in Relation to Electromagnetic Radiation and Light

1. Unit of radiant Intensity.-The unit of radiant intensity shall be the watt per steradian. (symbol: W/sr) The watt per steradian is the radiant intensity of a point source uniformly emitting a radiant flux of one watt within a solid angle of one steradian.

2. Unit of Irradiance.-The unit of irradiance shall be the watt per square metre. (symbol: W/m^2) The watt per square metre is the irradiance produced by a radiant flux of one watt, distributed uniformly over an element having a surface of one square metre. [See also (1) above.]

3. Unit of radiance.-The unit of radiance shall be the watt per square metre steradian. (symbol: $\text{W/m}^2 \text{sr}$) The watt per square metre steradian is the radiance of a source radiating one watt per steradian per square metre of projected area.

4. Unit of luminance.-The unit of luminance shall be the candela per square metre. (symbol: cd/m^2) The candela per square metre is the luminance perpendicular to the plane surface of one square metre of a source, the luminous intensity of which perpendicular to this, is one candela.

5. Unit of luminous flux.-The unit of luminous flux shall be the lumen. (symbol: lm) The lumen is the luminous flux emitted In a solid angle of one steradian by a uniform point source having a luminous intensity of one candela. $1\text{lm} = 1\text{cd} \cdot 1\text{sr}$

6. Unit of illuminance.-The unit of illuminance shall be the lux. (symbol: lx) The lux is the illuminance produced by a luminous flux of one lumen, uniformly distributed over a surface of area one square metre. $1\text{lm} = 1\text{lx} \cdot 1\text{m}^2$

PAKT VI Derived Unit in relation to Ionising Radiations

1. Unit of activity (radio activity).-The unit of activity (of a radioactive source) shall be the becquerel. (symbol: Bq) The becquerel is the activity of a radioactive source in which one transformation or one transition takes in one second. ($1\text{Bq} = 1/1\text{s}$)

2. Unit of absorbed dose.-The unit of absorbed dose shall be gray which is equivalent to one Joule per kilogram. (symbol: Gy) The gray is the dose absorbed in an element of substance of mass one kilogram to which an

energy of one joule is communicated by ionising radiation, having a constant density of radiant flux, $1 \text{ Gy} = 1 \text{ J/kg}$. PART VII Derived Units in Relation to Physical Chemistry and Molecular Physics

1. Unit concentration (of amount of substance).-The unit of concentration (of amount of substance) shall be the mole per cubic metre. (symbol: mol/m^3) The mole per cubic metre is the concentration of a homogeneous solution having a total volume of one cubic metre and containing one mole of the given substance.

2. Unit of molar energy.-The unit of molar energy shall be the joule per mole (Symbol: J/mol). The joule per mole is the molar energy of one mole of substance having the energy of one joule.

3. Unit of molar entropy.-The unit of molar entropy shall be the joule per mole kelvin. (symbol: $\text{J/mol} \cdot \text{K}$) The joule per mole kelvin is the molar entropy of a system of homogenous mass having a substance equal to one mole receiving a quantity of heat equal to one joule at the constant thermodynamic temperature of one kelvin provided that no irreversible change takes place in the system.

4. Unit of molar heat capacity.-The unit of molar heat capacity shall be the joule per mole kelvin. (symbol: $\text{J/mol} \cdot \text{K}$) The joule per mole kelvin is the molar heat capacity of a homogenous body having an amount of substance equal to one mole, in which a quantity of heat equal to one joule produces an increase of one kelvin in the thermodynamic temperature.

SCHEDULE 3

THE THIRD SCHEDULE

(See rule 6) Names, Magnitudes and Symbols of SI Prefixes and principles of use of SI Prefixes.

1. Name, Magnitudes and Symbols of SI prefixes.-The names of prefixes, their Magnitudes and Symbols shall be as given in Table I.

TABLE I		
Name of Prefixes, their Magnitudes and Symbols		
Name of Prefix	Magnitude of Prefix	Symbol of Prefix
exa	10^{18}	E
peta	10^{16}	P
tera	10^{12}	T
giga	10^6	G
mega	10^5	M
kilo	10^3	k
hecta	10^2	h
deca	10^1	da
deci	10^{-1}	d
centi	10^{-2}	c
milli	10^{-3}	m
micro	10^{-6}	u
nano	10^{-9}	n
pico	10^{-12}	p
femto	10^{-15}	f
atto	10^{-18}	a

SCHEDULE 4

THE FOURTH SCHEDULE

(See rule 7) Unit Permitted to be used with Base, Supplementary or Derived Units

1. Permitted units of time.-(1) The permitted units in relation to time shall be as follows, namely: (i) the minute, equal to 60 second (symbol : min), (ii) the hour, equal to 3600 seconds or 60 minutes (symbol : h), and (iii) the day, equal to 86,000 seconds or 24 hours (symbol : d). (2) The week, month and year shall correspond to the Saka calendar or the Gregorian calendar.

2. Permitted units of plane angle.-The permitted units in relation to plane angle shall be as follows, namely : (i) The degree, equal or $T/180$ radian (symbol : *), (ii) The minute, equal to $*/10800$ radian or $(1/60)*$. (symbol : '), and (iii) The second equal to $n/648000$ radian or $(1/60)$ (symbol : ").

3. Permitted unit of volume.-(1) The permitted unit of volume shall be the litre (symbol : l). The litre shall be equal to one thousandth part of the cubic metre. $1\text{-}1\text{dm}^3 = 10^{-3}\text{ m}^3$ (2) The litre shall not be used for work involving precise measurements.

4. Permitted unit of mass.-(1) The permitted unit of mass shall be the tonne. (symbol : t) The tonne is equal to 1000 kilograms. (2) Only the prefixes 'kilo', 'mega', 'giga' and 'tera' specified in the Third Schedule may be used with the tonne.

SCHEDULE 5

THE FIFTH SCHEDULE

(See rule 8) Special Units and their Symbols

1. Special unit of energy.-The special unit of energy acquired by an electron shall be the electron volt. (symbol : eV) The electron volt is the energy acquired by an electron in passing through a potential difference of one volt in vacuum. $1\text{ eV} = 1.602\ 177\ 33 \times 10^{-19}\text{ J}$

2. Special unit of atomic mass.-The special unit of mass of an atom shall be the unified atomic mass unit. (symbol : u) The unified atomic mass unit is equal to the fraction $1/12$ of the mass of an atom of the nucleus ^{12}C $1\text{u} = 1.660\ 5402 \times 10^{-27}\text{kg}$

3. Special units of stellar distance.-(1) The first special unit of stellar distance shall be the astronomical unit. (symbol : AU) The astronomical unit of distance is the length of the radius of the unperturbed circular orbit of a body of negligible mass moving round the Sun with a sidereal angular velocity of $0.017\ 202\ 098\ 950$ radian per day of $86\ 400$ ephermeris seconds. $1\text{ AU} = 149\ 600 \times 10^6\text{ m}$ Note.-The symbol for stellar distance is not internationally uniform, for example the symbol used for stellar distance is UA in France, AU in England and AE in Germany. (2) The second special unit of stellar distance shall be the persec. (symbol : pc). The persec is the distance at which one astronomical unit subtends an angle of one second of arc. $1\text{ pc} = 206\ 265\text{ AU} = 30857 \times 10^{12}\text{ m}$.

SCHEDULE 6

THE SIXTH SCHEDULE

(See rule 9) Temporarily accepted Units

1. Unit of nautical distance.-The unit of distance for use in marine and aerial navigation shall be the nautical mile. The nautical mile is equal to a distance of 1852 metres.

2. Unit of nautical velocity.- The unit of velocity for use in marine and aerial navigation shall be the knot. The knot is the velocity equal to one nautical mile per hour. $1\text{ Knot} = (1\ 852/3600)\text{m/s}$ Le. $0.514\ 444\text{ m/s}$

3. Unit of wave length of light.-(1) The unit of wavelength of light shall be the angstrom, (symbol: Å). The angstrom is equal to 0.1 nanometre. $1\text{ Å} = 0.1\text{ nm} = 10^{-10}\text{ m}$

4. Unit of land measurement.-(1) The first unit for

measurement of land area shall be the 'are', (symbol : a) The 'are' is the area of a square with sides of length 10 metres. $1 \text{ a} = 1 \text{ dam}^2 = 10^2 \text{ m}^2$

(2) The second unit for measurement of land area shall be the hectare, (symbol : ha) The hectare is the area of a square with sides of length 100 metres. $1 \text{ ha} = 1 \text{ hm}^2 = 10^4 \text{ m}^2$

(3) The prefixes specified in the Third Schedule shall not be used with the 'are' or hectare.

5. Unit of nuclear cross-section.-The unit of nuclear cross-section shall be the barn. (symbol : b) The barn is the nuclear cross-section area equal to 10^{-28} m^2

6. Unit of pressure of fluid.-The unit of pressure of fluid shall be the bar (symbol: bar). The bar shall be equal to 100 000 pascals.

7. Unit of Standard atmosphere.-The unit of standard atmosphere shall be 101 325 pascals. The standard atmosphere is the pressure exerted by air at mean sea level under the standard conditions specified by the General Conference of Weights and Measures.

8. Special unit or acceleration due to gravity.- The special unit of acceleration due to gravity for use in geodesy and geophysics shall be the gal. (symbol: Gal) The gal is equal to $1/100$ metre per second square.

9. Unit of activity of radio-nuclides.-The unit of activity of radio nuclides shall be the curie, (symbol : Ci) The curie is the quantity of any radioactive nuclide in which the number of disintegrations per second is 3.7×10^{10} or $1 \text{ Ci} = 3.7 \times 10^{10} \text{ Bq}$.

10. Unit of exposure dose.-The unit of exposure dose shall be the rontgen (symbol: R). The rontgen is the exposure dose of an ionising radiation which can produce in a quantity of air having a mass of one kilogram, ions of the same sign carrying a total charge 2.58×10^{-4} coulomb, the density of energy flux being the same throughout the quantity of air taken. $R = 2.58 \times 10^{-4} \text{ C/kg}$

11. Unit of velocity.-The unit of velocity shall be kilometre per hour. (symbol : km/h) The kilometre per hour is the velocity of a body in motion which when set in a uniform traverses a distance of one kilometre in one hour.

12. Unit of mass of special value.-The unit of mass of special value shall be the caret, (symbol : c) The caret is equal to five thousandth part of the kilogram. It shall be used for commercial transactions In diamonds, pearls and precious stones. $1 \text{ c} = 200 \text{ mg}$

13. Unit of mass for special use.-The unit of mass for special use shall be the quintal, (symbol: q) The quintal is equal to 100 kilograms. The quintal may be used in large commercial transactions in foodgrain, farm produce and other consumer commodities.

SCHEDULE 7

THE SEVENTH SCHEDULE

(See rule 10)

C.G.S. Units with special, names		
Name of unit	Symbol	Value in terms of base supplementary or derived unit
1	2	3
(1) erg	erg	$1 \text{ erg} = 10^{-7} \text{ J}$
(2) dyne	dyn	$1 \text{ dyn} = 10^{-5} \text{ N}$
(3) poise	p	$1 \text{ P} = 1 \text{ dyn/cm}^2 = 0.1 \text{ Pa}$
(4) stokes	st	$1 \text{ St} = 1 \text{ cm}^2/\text{s} = 10^{-4} \text{ m}^2/\text{s}$
(5) gauss	GS.G	$1 \text{ Gs} = 10^{-2} \text{ T}$
(6) Oersted	Oc	$1000/10c \text{ A/M} = 4 \text{ n}$
(7) maxwell	MX	$1 \text{ MX} = 10^{-2} \text{ Wb}$

(8) stilb	sb	$sb = 1 \text{ cd/cm}^2 = 10^4 \text{ cd/m}^2$
(9) phot	ph	$1 \text{ ph} = 10^8 \text{ lx}$

SCHEDULE 8

THE EIGHTH SCHEDULE

(See rule 10) □ *This value is that of the IT' calorie (5th International Conference on Properties of Steam, London, 1956). **This special unit was employed to express wavelengths of X-rays. ***This special unit was used to measure fire-wood.

SCHEDULE 9

THE NINTH SCHEDULE

(See rule 11) □□□ * The scalar magnitude of the neutron moment is listed here. The neutron magnetic dipole is directed oppositely to that of the proton, and corresponds to the dipole associated with a spinning negative charge distribution. The vector sum, $d = \mu_p + \mu_n$, is approximately satisfied. ** The entropy of an ideal monatomic gas of relative atomic weight A_i is given by $S = S_0 + \frac{5}{2} R \ln(p/p_0) + \frac{3}{2} R \ln(T/K)$.

SCHEDULE 10

THE TENTH SCHEDULE

(See rule 12) The following coefficients shall be used for the purpose of these rules :

- Alcoholic strengths.-(a) The 'alcoholic strength by volume' of a mixture of water and alcohol is the ratio of the volume of alcohol, measured at 20°C, contained in the mixture to the total volume of the mixture, measured at the same temperature. The symbol is '% vol'. (b) The 'alcoholic strength by mass' of a mixture of water and alcohol is the ratio of the mass of alcohol contained in the mixture to the total mass of the mixture. The symbol is '% mass'. For the purpose of the inter-relation between these two strengths and between the density of aqueous solution of alcohol, the International recommendation No. 22 on Alcolometry, together with the International Alcolometric Tables, shall be used.
- Hardness numbers for materials.-(a) Brinell Hardness Number.-A number related to the size of the permanent impression made by a ball indenter of specified size, pressed into the surface of the material under a specified load. The surface area of the impression is determined from the average measured diameter of the rim of the impression and from the ball diameter. In reporting Brinell hardness number, the International Recommendation No. 9 on Verification and Calibration of Brinell Hardness Standardised Blocks, shall be used. (b) Diamond Pyramid or Vickers Hardness Number.-A number obtained by dividing the load in kilograms applied to a square-based pyramidal diamond indenter having included face angles of 136° by the surface area of the impression calculated from the measured diagonal of the impression. In reporting diamond pyramid hardness, the International Recommendation No. 10 on Verification and Calibration of Vickers-Hardness Standardised Blocks, shall be used. (c) Rockwell Hardness Number.-A number derived from net increase in depth of impression as the load on an indenter is increased from a fixed minimum load to a high load and then returned to the minimum load. In reporting Rockwell hardness number on Rockwell B scale, the International Recommendation No. 11 on Verification and Calibration of Rockwell B Hardness Standardised Blocks shall be used. Similarly, in reporting Rockwell

hardness number on Rockwell C scale, the International Recommendation No. 12 on Verification and Calibration of Rockwell C Hardness Standardised Block shall be used. 3. For the purpose of determining the sugar content present in the sugar solutions either of the two following coefficients may be used.-Degree Brix of Sugar degree ($^{\circ}\text{S}$): (a) Degree Brix is the percentage of sucrose present by mass in the sugar solution. In reporting the degree Brix, Indian Standard specification for Brix hydrometers : (IS : 7324-1974) shall be used, till such time, the Directorate of Legal Metrology or the International Organisation of Legal Metrology prepare such document. (b) Sugar degree on the international sugar scale is defined as follows : The 100°S point of the International Sugar Scale is fixed by the optical rotation 'u' undergone by the polarized light of the green line of the mercury isotope 198 ($\lambda = 546.2271 \text{ nm}$ in vacuum) when passing through a 200.000 mm length of sucrose solution in pure water, kept at a temperature of 20.00°C , and containing 26.0160 g , weighed in a vacuum of pure sucrose per 100.000 cm^3 of solution 'normal' sugar solution. A mass of 26.0160 g of sucrose corresponds to 26.000 g when this sucrose is weighed in air by means of weights with a density of 8.000 kg/m^3 in air, at a standard pressure of 101325 pascal , at a temperature of 20°C and a relative humidity of 50% , the density of this air therefore being 1.2 kg/m^3 . 4. Relative humidity.- It is the ratio of the actual vapour pressure of water vapours present in air at the temperature of measurement of the saturation vapour pressure over a plane liquid water surface at the same temperature. This is expressed as a pure number as percentage. 5. pH is the logarithm to the base 10 of the inverse of the hydrogen ion concentration in a dilute ionic solution. Explanation.-A 0.04 molar hydrochloric acid solution will have hydrogen ion concentration of $10^{-1.4} \text{ mol}$ and its pH value is 1.4. Similarly, 0.001 mol hydrochloric acid solution will have the hydrogen ion concentration of 10^{-3} mol and its pH value is 3.