mm लम्बाई से निकल रहा हो, जो 20.00°C सी के तापमान पर रखा गया हो और जिसमें 'सामान्य चीनी घोल के प्रति 100.000 cm^3' शुद्ध सुक्रोस के निर्वात में तोले गए 26. 0160 ग्राम है।

सुक्रोस का 26.0160 ग्राम का द्रव्यमान 26.000 ग्राम के बराबर है जब यह सुक्रोस 20°C के तापमान और 50 प्रतिशत की आपेक्षिक आर्द्रता पर 101325 पास्कल के मानक दाब पर वायु में 8000 kg/m^3 के घनत्व में बांट द्वारा वायु में तोला गया हो, अत: इस वायु का घनत्व 1.2 kg/m^3 होगा।

4. आपेक्षित आर्द्रता :- यह मापे के तापमान पर समतल द्रव्य जल धरातल के ऊपर संतृप्ति वाष्प दाब से उसी तापमान पर वायु में विद्यमान जल वाष्पों के वास्तविक वाष्प दाब का अनुपात है। इसे प्रतिशतता के रूप में शुद्ध संख्या के रूप में अभिव्य किया गया है।

5. ph तनु आयनी घोल में हाइड्रोजन आयन सान्द्रता के प्रतिलोम का लघुगणक है, जिसका आधार 10 है।

स्पष्टीकरण

एक 0.14 मोल हाइड्रोक्लोरिक अम्ल घोल में 10^{-14} मोल की हाइड्रोजन आयन सान्द्रता होगी और उसका ph मान 1.4 है। इसी प्रकार 0.001 मोल हाइड्रोक्लोरिक अम्ल घोल में 10^{-3} मोल की हाइड्राजन आयन होगी और उसका ph मान 3 है।

[फा. सं. डब्ल्यू एम-9(6)/2010 पार्ट]

राकेश कक्कड़, अपर सचिव

MINISTRY OF CONSUMER AFFAIRS, FOOD AND PUBLIC DISTRIBUTION

(Department of Consumer Affairs)

NOTIFICATION

New Delhi, the 31st January, 2011

S.O. 211(E).—In exercise of the powers conferred by sub-section (1) read with clauses (a), (b), (d) and (e) of sub-section (2) of section 52 of the Legal Metrology Act, 2009 (1 of 2010), the Central Government hereby makes the following rules, namely:-

CHAPTER 1

PRELIMINARY

1.   **Short title and commencement**-(1) These rules may be called the Legal Metrology (National Standards) Rules, 2011.

(2) They shall come into force on the 1st day of April, 2011.

2. Definitions- In these rules, unless the context otherwise requires:-

(a) "Act" means the Legal Metrology Act, 2009 (1 of 2010);

(b) "co-efficient" means those parameters without physical dimension 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 alcoholic strength, percentage of Sugar and hardness of materials, are examples of co-efficients.

(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 values of dimensionless 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) "General Conference on Weights and Measures" means the conference General des Poids et Mesures established under the Metre Convention to which India acceded in 1957;

(e) "International Bureau of Weights and Measures" means the Bureau International des Poids et Mesures established under the Convention du Metre, at Sevres in France;

(f) "International Organisation of Legal Metrology" means the Organisation Internationale de Metrologie Legale established under the Convention Instituant

Une Organisation Internationale de Metrologie Legale in 1955 to which India acceded in 1956;

(g) "International prototype of the kilogram" means the prototype sanctioned by the First General Conference on Weights and Measures held in Paris in 1889 and deposited at the International Bureau of Weights and measures;

(h) "International System of Units" of weights and measures means 'Le System 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, and

(ii) derived units; and

(iii) supplementary units;

(i) "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;

(j) "physical constants" means those constants which express the value of physical invariant in a given system of units and 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; Avogadro 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 of 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;

(k) "Schedule" means the Schedule appended to these rules;

(l) "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 along with the SI units;

(m) "special units" mean units, outside, the SI which are ordinarily used in specialised fields of scientific research and 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;

(n) "supplementary units" mean the units of weight or measure which have been specified as such by the General Conference on Weights and Measures.

Explanation: Supplementary units may be used to form derived units;

(o) "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;

(p) "temporarily accepted units" means the unit of weight of measure which have been recognised for the time being by the General Conference of weights and measures for use along with SI units.

CHAPTER II

UNITS OF WEIGHT OR MEASURE

3. Units of Weight or Measure to be based on metric system

(1) Every unit of weight or measure shall be based on the units of the metric systems.

(2) For the purpose of sub-rule (1)

(a) the international system of units as recommended by General Conference on weights and measures, and

(b) such additional units as may be recommended by the International Organisation of Legal Metrology,

shall be the units of metric systems.

4. (1) Base units of Length- The base unit of length shall be the metre.

(2) The "metre" is the length equal to 1650763.73 wavelength in vacuum of the radiation corresponding to the transition between the levels $2p_{10}$ and $5d_5$ of the krypton-86 atom.

5. (1) Base units of Mass- The Base unit of mass shall be the kilogram.

(2) The "kilogram" is the unit of mass; equal to the mass of international prototype of kilogram.

6. (1) Base unit of time- The base unit of time shall be the second.

(2) The "second" is the duration of 9 192 631 770 periods of radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium-133 atom.

7.   (1) **The base unit of electric current** - The base unit of electric current shall be the ampere.

(2) The "ampere" is that constant current which if maintained in two straight parallel conductors of infinite length of negligible circular cross-section, and placed one metre apart in vacuum, would produce between these conductors a force equal to 2×10^{-7} newton per metre of length.

8.   (1) **Base unit of thermodynamic temperature**- The Base unit of thermodynamic temperature shall be the kelvin.

(2) The "kelvin" is the fraction 1/273.16 of the thermodynamic temperature of triple point of water.

(3) The Kelvin shall also be used for expressing the interval or difference of temperature.

(4) Zero degree Celsius corresponds to 273.15 kelvin.

(5) The degree Celsius may also be used for expressing the interval or difference of temperature, unit degree Celsius being equal to unit Kelvin.

9. (1) **Base unit of luminous intensity.-** The base unit of luminous intensity shall be the candela.

(2) The "candela" is the luminous intensity, in the perpendicular direction, of a surface of 1/600,000 square metre of a black body at the temperature of freezing platinum under a pressure of 101 325 newtons per square metre.

10. (1) Base unit of amount of substance.- The base unit of amount of substance shall be the mole.

(2) The "mole" is the amount of substance of a system which contains as many elementary entities as there are atoms in 0.012 kilogram of carbon 12.

(3) When the mole is used, the elementary entities shall invariably be specified and may be atoms, molecules, ions, electrons, other particles, or specified groups of such particles.

11. 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.

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

13. 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.

14. 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.

15. Permitted units.- (1) The units specified in the Fourth Schedule may be used along with 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.

16. 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 units 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.

17. 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.

18. Units which should be progressively discontinued.- (1) Subject to sub-rule (2), the centimetre or gram or second units specified in the Seventh Schedule, and the units of weights and measures specified in the Eighth Schedule (being units 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 imparting education.

(2) The use of the units specified in the Seventh Schedule or, as the case may be, in the Eighth Schedule, shall not be used in any field except in the field of scientific and technological research.

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

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

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20. 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 coefficient 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.

21. 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 III

NATIONAL STANDARDS

22. National prototypes.- (1) The Central Government shall, for the purpose of deriving the value of kilogram, cause to be prepared a national prototype of the kilogram and shall cause its accuracy to be certified by the International Bureau of Weights and Measures equivalent to the international prototype of kilogram and shall thereupon deposit the same in the custody of the National Physical Laboratory, New Delhi.

(2) The Central Government shall, for the purpose of deriving the value of metre, cause to be prepared a national prototype of the metre and shall cause its accuracy to be certified by the International Bureau of Weights and Measures and shall thereupon deposit the same in the custody of the National Physical Laboratory, New Delhi.

23. 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).

24. 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 value of the national standards as recommended by the General Conference on Weights and Measures and inter compare them, or cause to be inter compared, 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 and   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 value and accuracy in relation to the national standards of base units.

25. 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, New Delhi.

(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 or 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, standards 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 on inter compared 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 and 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 the higher obtainable accuracy of such value in the country.

CHAPTER IV

REFERENCE, SECONDARY AND WORKING STANDARDS

26. Reference Standard.- The expression "reference standard" means set of standard weight or measure which is made or manufactured by or on behalf of the Central Government for the verification of any secondary standard.

27. Secondary Standard.- The expression "secondary standard" means set of standard weight or measure which is made or manufactured by or on behalf of the Central Government or State Government for the verification of any working standard.

28. Working Standard.- The expression "working standard" means set of standard weight or measure which is made or manufactured by or on behalf of the Central Government or State Government for the verification of any standard weight or measure, other than national prototype, reference standard or secondary standards.

29. 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 in Mumbai.

30. Places 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 Mumbai may also maintain such reference, secondary and working standards as may be necessary for carrying out the work referred to in rule 29.

31. 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.

32. 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.

33. Repeal and savings.- (1) The Standards of Weights and Measures (National Standards) Rules, 1988 (herein under referred to as the said rules) are hereby repealed.

Provided that such repeal shall not affect:

(a) the previous operations of the said rules or anything done or omitted to be done or suffered therein; or

(b) any right, privilege, obligation or liability acquired, accrued or incurred under the said rules; or

(c) any penalty, forfeiture or punishment incurred in respect of any offence committed against the said rules; or

(d) any investigation, legal proceedings or remedy in respect of any such right, privilege, obligation, liability, penalty, forfeiture or punishment as aforesaid.

And any such investigation, legal proceedings or remedy may be instituted, continued or enforced and any such penalty, forfeiture or punishment may be imposed as if the said rules had not been rescinded.

(2) Notwithstanding such repeal anything done or any action taken or purported to have been done or taken including approval of letter, exemption granted, fees collected, any adjudication, enquiry or investigation commenced, license and registration of manufacturers, dealers, importers of weights and measures, or show cause notice, decision, determination, approval, authorisation issued, given or done under the said rules shall if in force at the commencement of the said rules continue to be in force and have effect as if issued, given or done under the corresponding provisions of these rules.

(3) The provisions of these rules shall apply to any application made to the Central Government or as the case may be the State Government under the said rules for licence, registration of manufacturers, importers, dealers, repairers of weights and measures pending at the commencement of these rules and to any proceedings consequent thereon and to any registration granted in pursuance thereof.

(4) Any legal proceeding pending in any court under the said rules at the commencement of these rules may be continued in that court as if these rules had not been framed.

(5) Any appeal preferred to the Central Government or as the case may be the State Government under the said rules and pending shall be deemed to have been made under the corresponding provisions of these rules.

THE FIRST SCHEDULE

(See rule 12)

Supplementary Units and their symbols

1. Unit of plane angle- The unit of plain angle shall be the radian. (symbol: rad)

The radian is the plane angle between two radii of a circle which cutoff, on the circumference, an arc 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.

THE SECOND SCHEDULE

(See rule 13)

Derived Units and Their Symbols

Part I

Derived Unit in relation to Space and Time

1. Unit of Area: The unit of area shall be the square metre. (Symbol: m^2)

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: m^3)

' 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.

1Hz= 1/1s.

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 the 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 square. (Symbol: rad/s^2)

The radian per second squared is the angular acceleration of a body, rotating around the fixed axis, which when set in uniform 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 ms^{-1})

The metre per second is the velocity (speed) of a body, in motion which traverse 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 ms^{-2})

The metre per second squared is the acceleration of a body in motion which, when set in 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.

9. Unit of wave number: The unit of 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 be the metre raised to the 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 refractive index of unit.

Note 1: This unit is also called 'per metre' or 'dioptre'.

Note 2: The metre raised to the power minus one 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 of Mechanics

1. *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 Kgm^{-3})
   The kilogram per cubic metre is the density or mass density of a homogenous body having a mass of one kilogram and a volume of one cubic metre.

2. *Unit of concentration* - The unit of concentration shall be the kilogram per cubic metre (Symbol: kg/m^3 or Kgm^{-3})
   The kilogram per cubic metre is the concentration of a homogenous solution having a total volume of one cubic metre and containing a mass of one kilogram of the given substance.

3. *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.
   $1 N = 1 kg. 1m/s^2$

4. *Unit of moment of force* – The unit of moment of force shall be the newton metre.
   (Symbol: Nm)
   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.
   $1 N.m = m^2.kg.s^{-2}$
   Note: The unit of moment of force shall not be written as joule (J) because it is Nm.

5. *Unit of Pressure* – The unit of pressure shall be the Pascal (Symbol: Pa)
   The Pascal is the pressure which, acting on plane surface of one square metre exerts on that area a total force of one newton.
   $1 Pa = 1 N/m^2$ or $1 N.m^{-2}$

6. *Unit of tensile strength* – The unit of tensile strength shall be Mega Pascal. (Symbol: MPa or M N/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 homogenous 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.

$$1 \text{ Pa. s} = \frac{1 \text{ Pa.1m}}{1 \text{m/s}}$$

8. *Unit of kinematic viscosity* – The unit of kinematic viscosity shall be the square metre per second.(Symbol: m^2/s or $m^2.s^{-1}$)
    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.
    $$\frac{1 \text{ m}^2}{1\text{s}} = \frac{1 \text{ Pa.1s}}{1\text{kg/m}^3}$$

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 J = 1 N.1m.

11. *Unit of power, radiant flux and heat flux* – The unit of power, radiant flux and heat flux shall be the 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 W = 1 J/ 1s.

12. *Unit of volume flow* – The unit of volume flow shall be cubic metre per second. (Symbol: m^3/s or $m^3.s^{-1}$)
    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 $kg.s^{-1}$)
    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 the cubic metre per kilogram. (Symbol: m^3/kg)
    The cubic metre per kilogram is the specific volume of a homogenous 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 per 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 homogenous 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 homogenous 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 the joule per kilogram kelvin. [Symbol: J/ (kg.K)].
    The joule per kilogram kelvin is the specific heat capacity of a homogenous 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 homogenous 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 homogenous 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.

$$1 \text{ W/m.K} = \frac{1 \text{ W/m}^2}{1\text{K}/ 1\text{m}}$$

8. *Unit of energy density* – The unit of energy density shall be the joule per cubic metre. (Symbol: J/m^3)
    The joule per cubic metre is the energy density of a system of homogenous 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/m^2)
    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.
    $1 C = 1 A.1s$

2. *Unit of electric charge density* – The unit of electric charge density shall be the coulomb per cubic metre. (Symbol: C/m^3)
    The coulomb per cubic metre is the electric charge density of a homogenous 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 coulomb per square metre. (Symbol: C/m^2)
    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.
    $1 V = 1 W / 1 A.$

5. *Unit of electric field strength* – The unit of electric field strength shall be the 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.
    $$\frac{1 V}{1m} = \frac{1 N}{1C}$$

6. *Unit of electric resistance* – The unit of electric resistance shall be the ohm.
(Symbol: Ω)
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.
$1 \Omega = 1 V / 1A$.

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.
$1 S = 1 \Omega^{-1} = \dfrac{1}{\Omega}$

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.
$1 F = 1C / 1V$

9. *Unit of permittivity* – The unit of permittivity shall be 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 current in the circuit varies uniformly at the rate of one ampere per second.
$1 H = \dfrac{1V.1s}{1A}$

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, linking a circuit of one turn, would produce in it an electromotive force of one volt if it were reduced to zero at a uniform rate in one second.
$1 Wb = 1 V.1s$

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.

$1T = 1Wb/1m^2$

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: $W/m^2.sr$)

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 source 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 lm = 1 cd. 1 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.
$1 lx = 1 lm/ 1m^2$

PART VI
Derived Unit in Relation to ionizing Radiations

1. *Unit of activity (radioactivity)* – The unit of activity (of a radioactive source) shall be the becqueral. (Symbol:Bq)
The becqueral is the activity of a radioactive source in which one transformation or one transition takes place in one second
1 Bq = 1/1.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 an ionizing radiation, having a constant density of radiant flux,
1 Gy = 1 J/1 kg

PART VII
Derived Units in Relation to Physical Chemistry and Molecular Physics

1. *Unit of 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 homogenous 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: J/mol.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: J/mol.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.

THE THIRD SCHEDULE
(See rule 14)
NAMES, MAGNITUDES AND SYMBOLS OF SI PREFIXES AND PRINCIPLES OF USE OF SI PREFIXES

1. *Names, Magnitudes and Symbols of SI Prefixes* – The names of prefixes, their magnitudes and symbols shall be as given in Table 1

TABLE 1
Names of Prefixes, their Magnitudes and Symbols

Name of Prefix	Magnitude of Prefix	Symbol of Prefix
exa	10^{18}	E
peta	10^{15}	P
tera	10^{12}	T
giga	10^{9}	G
mega	10^{6}	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}	µ
nano	10^{-9}	n
pico	10^{-12}	p
femto	10^{-15}	f
atto	10^{-18}	a

Explanation: The unit of length is metre with symbol m: after adding a prefix c' for centi we get "cm" as new unit symbol. This can be raised to a positive exponent 3 to give the unit of volume. Similarly this can be combined with another unit say 'kg' and by giving it negative exponent 3 to indicate density in kg per cm^3.

$$Kg/cm^3 = kg/ 10^{-6} m^3 = 10^6 kg/m^3$$
Similarly $g/cm^3 = 1000 kg/m^3$

2. *Symbol how to be combined with units* – (a) The symbol of the prefix shall be placed before the unit symbol without any intermediary space or dot.

(b) The combination shall form the symbol of the multiple and sub-multiple of the unit.

(c) The symbol for the prefix shall be considered to be combined with the symbol of the unit to which it is directly linked together, forming a new unit symbol, which can be combined with other unit symbols to form composite unit symbols.

3. *Errors how to be avoided* – To avoid errors in calculations, all quantities shall be expressed in SI units, and powers of 10 shall be used.

4. *Exponents* – An exponent affixed to a symbol containing a prefix indicates that the multiple or sub-multiple of the unit is raised to the power expressed by the exponent.
ILLUSTRATION
$1 cm = 10^{-2} m$ gives $1 cm^3 = 10^{-6} m^3$ and $1 cm^{-1} = 10^2 m^{-1}$

5. *Compound units how to be formed* – Only one prefix shall be used in forming the multiples of a compound unit, and compound prefixes shall not be used.
ILLUSTRATION
Write nm (nano metre), instead of mμm.

6. *Use of prefixes with unit mass* – Notwithstanding that the base unit of mass contains a prefix, names of decimal multiples or sub-multiples of the unit of mass shall be formed by attaching prefixes to the word gram.
ILLUSTRATION
Write milligram (mg) but not micro kilogram (μkg).

7. *Printing:* (1) Symbols of units -
(a) Shall be printed in roman (upright) type irrespective of the type used in the rest of the text;
(b) Shall remain unaltered in the plural;
(c) Shall be written, without a final full stop (period) unless the context otherwise requires; and
(d) shall be placed after the complete numerical value in the expression for a quantity, leaving a space between the numerical value and the unit.

(2) The symbol for units of weight or measure shall be printed in lower case letters except that the first letter shall be printed in upper case when the name of the unit is derived from a proper name.

ILLUSTRATION
m - metre
s - second
A - Ampere
Wb - weber

8. *Multiplication of units* – (1) When a compound unit is formed by multiplication of two or more units, the multiplication may be indicated in one of the following ways:
m, N, N.m, Nm

(2) In using a symbol of a unit of weight or measure which coincides with the symbol for a prefix, special care shall be taken to avoid confusion.
ILLUSTRATION
The unit 'newton metre' shall be written Nm or m.N to avoid confusion with mN, the millinewton.

9. Division of Units – (1). When a compound is formed by dividing one unit by another the division shall be indicated in one of the following ways: -
m/s or by writing the product of m and s^{-1} as ms^{-1}

(2). The letter p shall not be used to denote division.
ILLUSTRATION
Do not write kmph, write km/h or $km.h^{-1}$

(3). In no case shall more than one solidus (oblique stroke) on the same line be included in such a combination unless a parenthesis is inserted to avoid ambiguity:
ILLUSTRATION
Write m/s^2 or $m.s^{-2}$ but not m/s/s/

(4). In complicated cases, negative powers or parenthesis shall be used.
ILLUSTRATION
Write $m.kg/(s^3.A)$ or $m.kg.s^{-3}A^{-1}$ but not $m.kg/s^3A$

10. *Expression of results* – (1) The appropriate integral multiple and sub-multiple to which a unit is to be expressed shall be selected in such a manner that the numerical value to be expressed is between 0.1 and 1000
ILLUSTRATION
1.2×10^4N may be written as 12 kN
0.00 394 m may be written as 3.94 mm
1 40 1 Pa may be written as 1.401 kPa
3.1×10^{-8}s may be written as 31 ns

(2) In a table of values for the same quantity or in a discussion of such values within a given context the same integral multiple or sub-multiple of a unit may be used for all items, even when some of the numerical values may be outside the range of 0.1 to 1000.

(3) For the purpose of expression of dimensions in mechanical engineering drawings only the millimetre shall be used.

11. *Expression of Numbers -*

(1) To express numbers in connection with units of weights and measures, the dot shall be used to separate the integral part of numbers from the decimal part.

(2) Numbers shall be divided in groups of three starting from the decimal point in order to facilitate regarding and neither dots nor commas shall be inserted in the space between such group of numbers.

ILLUSTRATION

Write 3211 468.022 82

Not 3.211.468.022.82

or 3,211,468.022.82

THE FOURTH SCHEDULE
(See rule 15)
Units 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)

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 to $\pi/180$ radian (Symbol: °),

(ii) The minute, equal to $\pi/10800$ radian or $(1/60)°$ (Symbol: ′), and

(iii) The second equal to $\pi/648000$ radian or (1/60) (Symbol: ″).

3. *Permitted unit of volume* – (1) The permitted unit of volume shall be litre (Symbol: l). The litre shall be equal to one thousand part of the cubic metre.

$$1 \, l = 1 \, dm^3 = 10^{-3} \, m^3$$

(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 shall be equal to 1000 kilograms.

(2) Only the prefixes "kilo", "mega", "giga" and "tera" specified in the Third Schedule may be used with the tonne.

THE FIFTH SCHEDULE
(See Rule 16)
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.

$$1 \, eV = 1.602 \, 177 \, 33 \times 10^{-19} \, J$$

2. *Special unit of atomic mass-* The special unit of mass of an atom shall be 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
$1\ u = 1.660\ 5402 \times 10^{-27}\ kg$

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 ephemeris seconds.
$1\ AU = 149\ 600 \times 10^6\ m$
Note: The symbol for stellar distance is not internationally uniform, for example the symbol used for stellar distance is UÅ in France, ÅU in England and ÅE in Germany.
(2) The second special unit of stellar distance shall be parsec. (Symbol: pc)
The parsec is the distance at which one astronomical unit subtends an angle of one second of arc.
$1\ pc = 206\ 265\ ÅU = 30857 \times 10^{12}\ m.$

THE SIXTH SCHEDULE
(See Rule 17)
Temporarily accepted Units

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

2. *Unit of nautical velocity* - The unit of nautical velocity for use in marine and aerial navigation shall be the knot. The knot is the velocity equal to one nautical mile per hour.
$1\ kont = (1852 / 3600)\ m/s$, i.e. 0.514 444 m/s.

3. *Unit of wavelength of light*-(1)The unit of wavelength of light shall be the angstrom. (Symbol: Å). The angstrom is equal to 0.1 nanometre.
$$1Å = 0.1nm = 10^{-10}m$$

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.

$1\ a = dam^2 = 10^2 m^2$

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

(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 100 square femtometres.
$$1 \text{ b} = 10^{-28} \text{ m}^2$$

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 on Weights and Measures.

8. *Special unit for acceleration due to gravity* - The special unit for acceleration due to gravity for use in geodesey 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 roentgen. (Symbol: R)
The roentgen is the exposure dose of an ionizing 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.
$$1c = 200mg$$

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 food grain, farm produce and other consumer commodities.

THE SEVENTH SCHEDULE
(See rule 18)
C.G.S units with special names

Name of Unit	Symbol	Value in terms of base, supplementary or derived unit
(1) erg	erg	1 erg = 10^{-7} J
(2) dyne	dyn	1 dyn = 10^{-5} N
(3) poise	P	1 P-1dyns/cm^2 = 0.1 Pa.s
(4) stokes	st	1 st = 1 cm^2/s = 10^{-4} m^2/s
(5) gauss	Gs	1 Gs = 10^{-4} T
(6) oersted	Oe	1 Oe = $\dfrac{1000}{4\pi}$ A/m
(7) maxwell	Mx	1 Mx = 10^{-8} Wb
(8) stilb	sb	1 sb = 1 cd/cm^2 = 10^4 cd/m^2
(9) phot	ph	1 ph = 10 lx

THE EIGHT SCHEDULE
(See rule 18)
Units outside the International System

	Name of Unit	Value in terms of base, supplementary or derived units
(1)	fermi	1 fermi= 1 fm = 10^{-15} m
(2)	torr	1 torr = $\dfrac{101325}{760}$ Pa
(3)	kilogram-force(kgf)	1 kgf = 9.806 65 N
(4)	calorie (cal)	1 cal = 4.1868 J
(5)	micron (μ)	1 μ = 1 μm = 10^{-6} m
(6)	X unit	1 X unit = 1.002 = 10^{-6} nm approximately
(7)	stere (st)	1 st = 1 m^3
(8)	gamma (γ)	1 γ = 1nT = 10^{-9} T
(9)	γ	1 γ = 1μg = 10^{-9} kg
(10)	λ	1 λ = 1μl= 10^{-6}l

* is 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 firewood.

THE NINTH SCHEDULE
(See Rule 19)
Important Physical Constants

Quantity	Symbol	Value	Units	Relative Uncertainty (ppm)
GENERAL CONSTANTS				
Universal Constants				
speed of light in vacuum	c	299792458	ms^{-1}	(exact)
permeability of vacuum	μ_o	$4\pi \times 10^{-7}$ $=12.566370614...$	NA^{-2} $10^{-7} NA^{-2}$	(exact)
permittivity of vacuum	ε_o	$1/\mu_o c^2$ $=8.854187817...$	$10^{-12} Fm^{-1}$	(exact)
Newtonian constant of gravitation	G	6.67259(85)	10^{-11} $m^3 kg^{-1} s^{-2}$	128
Planck constant in electron volts, $h / \{e\}$	h	6.6260755(40) 4.1356692(12)	$10^{-34} Js$ $10^{-15} eVs$	0.60 0.30
$h / (2\pi)$ in electron volts $h / \{e\}$	$\hbar$	1.05457266(63) 6.5821220(20)	$10^{-34} Js$ $10^{-16} eVs$	0.60 0.30
Planck mass, $(hc/G)^{1/2}$	m_p	2.17671(14)	$10^{-8} kg$	64
Planck length $h/m_p c = (hG/c^3)^{1/2}$	l_p	1.61605(10)	$10^{-35} m$	64
Planck time $t_p/c = (hG/c^5)^{1/2}$	t_p	5.39056(34)	$10^{-44} s$	64
ELECTROMAGNETIC CONSTANTS				
elementary charge	e	1.60217733(49)	$10^{-19} C$	0.30
	e/h	2.41798836(72)	$10^{14} AJ$	0.30
Magnetic flux quantum, h/2e	Φ_o	2.06783461(61)	$10^{-15} Wb$	0.30
Josephson frequency-voltage ratio	2e/h	4.8359767(14)	$10^{-14} H_z V^{-1}$	0.30
quantized Hall conductance	e^2/h	3.87404614(17)	$10^{-5} S$	0.045
quantized Hall resistance, $h/e^2=1/2\mu_0 \varepsilon/\alpha$	R_H	25812.8056(12)	Ω	0.045
Bohr magneton, $e\hbar/2me$	μB	9.2740154(31)	$10^{-24} JT^{-1}$	0.34
in electron volts, $\mu B/\{e\}$		5.78838263(52)	$10^{-5} eVT^{-1}$	0.089
in hertz, $\mu B/h$		1.39962418(42)	$10^{-10} HzT^{-1}$	0.30
in wavenumbers, $\mu B/hc$		46.686437(14)	$m^{-1} T^{-1}$	0.30
in kelvins, $\mu B/k$		0.6717099(57)	KT^{-1}	8.5
nuclear magneton, $e\hbar/2mp$	μN	5.0507866(17)	$10^{-27} JT^{-1}$	0.34
in electon volts, $\mu N/ \{e\}$		3.15245166(28)	$10^{-8} eVT^{-1}$	0.089
in hertz, $\mu N/h$		7.6225914(23)	$MHzT^{-1}$	0.30
in wavenumbers, $\mu N/hc$		2.54262281(77)	$10^{-2} m^{-1} T^{-1}$	0.30
in kelvins, $\mu N/k$		3.658246(31)	$10^{-4} KT^{-1}$	8.5
ATOMIC CONSTANTS				

fine-structure constant, $\frac{1}{2}\mu_0 ce^2/h$	α	7.29735308(33)	10^{-3}	0.045
inverse fine-structure constant	α^{-1}	137.0359895(61)		0.045
Rydberg constant, $\frac{1}{2}m_e ca^2/h$	R_∞	10973731.534(13)	m^{-1}	0.0012
in hertz, $R_\infty c$		3.2898419499(39)	10^{15}Hz	0.0012
in joules, $R_\infty hc$		2.1798741(13)	10^{-18}J	0.60
in eV, $R_\infty hc/\{e\}$		13.6056981(81)	eV	0.30
Bohr radius, $\alpha/4\pi R_\infty$	a_0	0.529177249(24)	10^{-10}m	0.045
Hartree energy, $e^2/4\pi\varepsilon_0 a_0 = 2R_\infty hc$	E_h	4.3597482(26)	10^{-8} J	0.60
in eV, Eh/{e}		27.2113961(81)	eV	0.30
quantum of circulation	$h/2m_e$	3.63694807(33)	$10^{-4}m^2 s^{-1}$	0.089
	h/m_e	7.27389614(65)	$10^{-4}m^2 s^{-1}$	0.089
ELECTRON				
electron mass	m_e	9.1093897(54)	10^{-31} kg	0.59
		5.48579903(13)	10^{-4} u	0.023
in electron volts, $m_e c^2/\{e\}$		0.51099906(15)	MeV	0.30
electron-muon mass ratio	m_e/m_μ	4.83633218(71)	10^{-3}	0.15
electron-proton mass ratio	m_e/m_p	5.44617013(11)	10^{-4}	0.020
electron-deuteron mass ratio	m_e/m_d	2.72443707(6)	10^{-4}	0.020
electron-α-particle mass ratio	m_e/m_α	1.37093354(3)	10^{-4}	0.021
electron specific charge	$-e/m_e$	-1.75881962(53)	10^{11}Ckg^{-1}	0.30
electron molar mass	M(e), Me	5.48579903(13)	10^{-7}kg/mol	0.023
Compton wavelength, $h/m_e c$	λc	2.42631058(22)	10^{-12}m	0.089
$\lambda_c/2\pi = \alpha a_0 = a^2/4\pi R_\infty$	λc	3.86159323(35)	10^{-13}m	0.089
classical electron radius, $\alpha^2 a_0$	r_e	2.81794092(38)	10^{-15}m	0.13
Thomson cross-section, $(8\pi/3)r^2 e$	σ_e	0.66524616(18)	10^{-23}m^2	0.27
electron magnetic moment	μ_e	928.47701(31)	10^{-26}JT^{-1}	0.34
in Bohar magnetons	μ_e/u_B	1.001 159 .652 193(10)		1×10^{-5}
in nuclear magnetons	μ_e/μ_N	1838.282000(37)		0.020
electron magnetic moment anomaly, $\mu e/\mu_B - 1$	a_e	1.159652193(10)	10^{-5}	0.0086
electron g-factor, $2(1+a_e)$	g_e	2.002319304386(20)		1×10^{-3}
electron-muon magnetic moment ratio	μ_e/μ_μ	206.766967(30)	0.15	
electron-proton magnetic moment ratio	μ_e/μ_p	658.2106881(66)		0.010
MUON				
muon mass	m_μ	1.8835327(11)	10^{-28}kg	0.61
		0.113428913(17)	u	0.15
in electron volts, $m_\mu c^2/\{e\}$		105.658389(34)	MeV	0.32

muon-electron mass ratio	m_μ/m_e	206.768262(30)		0.15
muon molar mass	$M(\mu), M_\mu$	1.134289 13(17)	10^{-4}kg/mol	0.15
muon magnetic moment	μ_μ	4.4904514(15)	10^{-26}JT^{-1}	0.33
in Bohr magnetons	μ_μ/μ_B	4.84197097(71)	10^{-3}	0.15
in nuclear magnetons	μ_μ/μ_N	8.8905981(13)		0.15
muon magnetic moment anomaly $[\mu_\mu/(eh/2m\mu)]$-1	a_μ	1.1659230(84)	10^{-3}	7.2
muon g-factor, $2(1+a_\mu)$	$g\mu$	2.002331846(17)		0.0084
muon-proton magnetic moment ratio	μ_μ/μ_P	3.18334547(47)		0.15
PROTON				
proton mass	m_P	1.6726231(10)	10^{-27}kg	0.59
		1.007276470(12)	u	0.012
in electron volts, $m_pc^2/\{e\}$		938.27231(28)	MeV	0.30
proton- electron mass ratio	m_p/m_e	1836.152701(37)		0.020
proton-muon mass ratio	m_p/m_μ	8.8802444(13)		0.15
proton specific charge	e/m_p	9.5788309(29)	10^7Ckg^{-1}	0.30
proton molar mass	$M(p), M_P$	1.007276470(12)	10^{-3}kg/mol	0.012
proton Compton wavelength, h/m_pc	λcp	1.32141002(12)	10^{-15}m	0.089
$\lambda cp/2\pi$	λcp	2.10308937(19)	10^{-16}m	0.089
proton magnetic moment	μ_p	1.41060761(47)	10^{-26}JT^{-1}	0.34
in Bohr magnetons	$\mu_p\mu_B$	1.521032202(15)	10^{-23}	0.010
in nuclear magnetons	μ_p/μ_N	2.792847386(63)		0.023
diamagnetic shielding correction for protons in pure water, spherical sample, 25^0C, $1 - \mu_p/\mu_p$	σH_2o	25.689(15)	10^{-6}	
shielded proton moment (H_2O, sph. 25^0C)	μ_p	1.41057138(47)	10^{-26} JT^{-1}	0.34
in Bohar magnetons	μ_p/μ_B	1.520993129(17)	10^{-3}	0.011
in nuclear magnetons	μ_p/μ_N	2.792775642(64)		0.023
proton gyromagnetic ratio	γ_p	26752.2128(81)	10^4s^{-1}T^{-1}	0.30
	$\gamma_p/2\pi$	42.577469(13)	MHzT^{-1}	0.30
uncorrected (H_2O, sph. 25^0C)	γ_p	26751.5255(81)	10^{-4}s^{-1}T^{-1}	0.30
	$\gamma_p/2\pi$	42.576375(13)	MHzT^{-1}	0.30
NEUTRON				
neutron mass	m_n	1.6749286(10)	10^{-27} kg	0.59
		1.008664904(14)	u	0.014
in electron volts, $m_nc^2/\{e\}$		939.56563(28)	Mev	0.30
neutron-electron mass ratio	m_n/m_e	1838.683662(40)		0.022
neutron-proton mass ratio	m_n/m_p	1.001378404(9)		0.009
neutron molar mass	$M(n), M_n$	1.008664904(14)	10^{-3} kg/mol	0.014
neutron Compton wavelength, h/m_nc	$\lambda_{c,n}$	1.31959110(12)	10^{-15} m	0.089
$\lambda_{c,n}/2\pi$	$\lambda_{c,n}$	2.10019445(19)	10^{-16} m	0.089
neutron magnetic moment	μ_n	0.96623707(40)	10^{-26} JT^{-1}	0.41
in Bohr magnetons	μ_n/μ_B	1.04187563(25)	10^{-3}	0.24

in nuclear magnetons	μ_n / μ_N	1.91304275(45)		0.24
neutron-electron magnetic moment ratio	μ_n / μ_e	1.04066882(25)	10^{-3}	0.24
neutron-proton magnetic moment ratio	μ_n / μ_p	0.68497934(16)		0.24

DEUTRERON

deuteron mass	m_d	3.3435860(20)	10^{-27}kg	0.59
		2.013553214(24)	u	0.012
in electron mass, $m_d c^2/\{e\}$		1875.61339(57)	MeV	0.30
deuteron-electron mass ratio	m_d / m_e	3670.483014(75)		0.020
deuteron-proton mass ratio	m_d / m_p	1.999007496(6)		0.003
deuteron molar mass	$M(d), M_d$	2.013553214(24)	10^{-27} kg/mol	0.012
deuteron magnetic moment	μ_d	0.43307375(15)	10^{-26} JT^{-1}	0.34
in Bohr magnetons	μ_d / μ_B	0.4669754479(91)	10^{-3}	0.019
in nuclear magnetons	μ_d / μ_N	0.857438230(24)		0.028
deutron-electron magnetic moment ratio	μ_d / μ_e	0.4664345460(91)	10^{-3}	0.019
deutron-proton magnetic moment ratio	μ_d / μ_p	0.3070122035(51)		0.017

PHYSICO-CHEMICAL CONSTANTS

Avogadro constant	N_A, L	6.02213367(36)	10^{23} mol^{-1}	0.59
atomic mass constant $m_u = 1/12 m(^{12}C)$	m_u	1.6605402(10)	10^{-27} kg	0.59
in electron volts, $m_u c^2/\{e\}$		931.49432(28)	Mev	0.30
Faraday constant	F	96485.309(29)	Cmol^{-1}	0.30
molar Planck constant	$N_A h$	3.99031323(36)	10^{-10}Jsmol^{-1}	0.089
	$N_A hc$	0.11962658(11)	Jm mol^{-1}	0.089
molar gas constant	R	8.314510(70)	Jmol^{-1}K^{-1}	8.4
Boltznann constant R/N_A	k	1.380658(12)	10^{-23} J K^{-1}	8.5
in electron volts, $k/\{e\}$		8.617385(73)	10^{-5} eVK^{-1}	8.4
in hertz, k/h		2.083674(18)	10^{10}Hz K^{-1}	8.4
in wavenumbers, k/hc		69.50387(59)	m^{-1}K^{-1}	8.4
molar volume (ideal gas), RT/p T = 273.15 K p = 101325 Pa	V_m	22.41410(19)	L/mol	8.4
Loschmidt constant, N_A/V_m	n_0	2.686763(23)	10^{-25} m^{-3}	8.5
T=273.15K, p=100 kPa	V_m	22.71108 (19)	L/mol	8.4
Sackur-Tetrode constant (absolute entropy constant)**	S_0/R	-1.151693(21)		18
$5/2 + \ln\{(2\pi m_u kT_1/h^2)^{3/2} kT_1/p_0\}$ T = 1 k, p_0 = 100 kPa		-1.164856(21)		18

$p_o = 101\,325$ Pa				
Stefan-Boltzmann constant, $(\pi^2/60)k^4/h^3c^2$	σ	5.67051(19)	$10^{-8}\,Wm^{-2}K^{-4}$	34
first radiation constant $2\pi hc^2$	c_1	3.7417749(22)	$10^{-16}\,Wm^2$	0.60
second radiation constant, hc/k	c_2	0.01438769(12)	mK	8.4
Wien displacement law constant, $b = \lambda_{max}T = C_2/4.96511423\ldots$	b	2.897756(24)	$10^{-3}\,mK$	8.4

* 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 $\mu_d = \mu_p + \mu_n$, is approximately satisfied.
** The entropy of an ideal monoatomic gas of relative atomic weight A_r is given by $S = S_o + 3/2\,RhA_r - Rln(p/p_o) + 3/2\,Rln\,(T/K)$

THE TENTH SCHEDULE
(See Rule 20)

The following co-efficients shall be used for the purpose of these rules: -
1. Alcoholic strength – (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 the aqueous solution of alcohol, the International Recommendation No. 22 on Alcoholometry, together with the International Alcoholometric Tables, shall be used.

2. 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 Standards 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 Standards 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 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 Blocks, 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 or sugar degree (^0S):-

(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 Director of Legal Metrology or the International Organisation of Legal Metrology prepares such document.

(b) Sugar degree on the international sugar scale is defined as follows:-

The 100^0 S point of the International Sugar Scale is fixed by the optical rotation 'μ' undergone by the polarized light of the green line of the mercury isotope 198 (μ-546.2271 mm in vacuum). When passing through a 200.000 mm length of sucrose solution in pure water, kept at a temperature of 20.00^0C, 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 8000 kg/m^3 in air, at a standard pressure of 101325 Pascal, at a temperature of 20^oC 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 $10^{-1.4}$ 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.

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