Chapter # 1 Physical Quantities and Units

Physical Quantity :-

A quantity that can be measured.

e.g:- length, mass, velocity etc.

Unit :-

specific value/amount whose multiples give us magnitude.

Kinds of Physical Quantities

(According to Priority)

Base Physical Quantities

Derived.

(According to Nature)

Scalars

Vectors

BASE PHYSICAL QUANTITIES and base Units

SNo	Quantity	Symbol	SI Unit	Abbriviation
1.	Length	L	meter	m
2.	Mass	m	Kilogram	kg
3.	Time	t	Second	s
4.	Temperature	T	Kelvin	K
5.	Current	I	Ampere	A
6.	Amount of substance	A	mole	mol
7.	intensity of light	I	Candela	Cd

DERIVED PHYSICAL QUANTITIES and derived Units

S.No.	Derived Quantity	Formula	Derived Unit
1.	Area (A)	$A = l \times b$	$m \times m = m^2$
2.	Volume (V)	$V = l \times b \times h$	$m \times m \times m = m^3$
3.	Density (ρ)	$\rho = \frac{m}{V}$	$\frac{kg}{m^3}$ or kgm^{-3}
4-	Speed/velocity (v)	$v = \frac{S}{t}$	$\frac{m}{s}$ or ms^{-1}
5-	Acceleration (a)	$a = \frac{\Delta v}{t}$	$\frac{ms^{-1}}{s}$ or ms^{-2}
6-	Force (F) (weight)	$F = ma$	$N = kgms^{-2}$ Derived SI unit of force SI base units of force.
7-	work (w)	$W = FS$	$J = kgm^2s^{-2}$
8-	Power (P)	$P = \frac{w}{t}$	$w = kgm^2s^{-3}$ watt

Work:-

Work = force × parallel displacement

$$J = \underline{\underline{Nm}}$$

Derived SI unit of work/energy

$$J = (kgms^{-2})\,m$$

$$\boxed{J = kgm^2s^{-2}}$$

Power (P)

$$\text{Power} = \frac{\text{work}}{\text{time}}$$

S/No.	Derived Quantity	Formula	Derived unit
9.	Pressure (P)	$P = \frac{F}{A}$	$P_a = kgm^{-1}s^{-2}$
10.	Torque (τ)	$\tau = F \times d$	kgm^2s^{-2}
11.	Momentum (P)	$P = mv$	$kgms^{-2} = Ns$
12.	Efficiency (E)	$E = \frac{output}{input}$	no unit.
13.	Stress (σ)	$\sigma = \frac{Force}{Area}$	$P_a = kgm^{-1}s^{-2}$
14.	Strain (ϵ)	$\epsilon = \frac{\Delta l}{l}$	$\frac{m}{m}$ = no unit
15.	Young's Modulus (E)	$E = \frac{Stress}{Strain}$	$P_a = kgm^{-1}s^{-2}$
16.	Electric charge (Q)	$Q = It$	$C = As$
17.	Electric field intensity	$E = \frac{F}{Q}$	$\frac{N}{C} = kgms^{-3}A^{-1}$

$$Power = \frac{work}{time}$$

$$\omega(watt) = \frac{J}{s}$$

$$= \frac{kgm^2s^{-2}}{s}$$

$$\boxed{W = kgm^2s^{-3}}$$

$$P = \frac{w}{t}$$

$$P = \frac{FS}{t}$$

$$= \frac{mas}{t}$$

$$\omega = \frac{kgms^{-2} \cdot m}{s}$$

$$\omega = kgm^2s^{-3}$$

Pressure (P)

$$Pressure = \frac{Force}{Area\ (contacting)}$$

$$P_a = \frac{N}{m^2} = \frac{kgms^{-2}}{m^2}$$

$$\boxed{P_a = kgm^{-1}s^{-2}}$$

Efficiency (E)

$$\text{Efficiency} = \frac{\text{Output work}}{\text{input work}} = \frac{\cancel{J}}{\cancel{J}}$$

* no unit as it is a ratio.

so, efficiency is dimensionless quantity.

Stress (σ)

$\sigma \rightarrow$ sigma

$$\text{Stress} = \frac{\text{Force (Restoring)}}{\text{Area (Cross-Section)}}$$

$$Pa = \frac{N}{m^2} = kg\,m^{-1}s^{-2}$$

strain (ϵ)

$$\text{Strain} = \frac{\text{change in length}}{\text{original length}} = \frac{\cancel{m}}{\cancel{m}} = \text{no unit.}$$

Torque / moment of a force (τ)

Torque = Force × perpendicular displacement

$$\tau = F \times d = N \cdot m \neq J$$

$$= kg\,m\,s^{-2} \cdot m$$

$$= kg\,m^2 s^{-2}$$

Momentum (p)

Momentum = mass × velocity

$$p = mv$$

$$= kg\,m\,s^{-1} = N.s$$

$$\leftarrow kg\,m\,s^{-2} \times s$$

Young's Modulus (E)

$$\text{Young's Modulus} = \frac{\text{Stress}}{\text{Strain}}$$

$$= \frac{Pa}{1}$$

$$= Pa = kg\,m^{-1}s^{-2}$$

Electric charge (Q)

$I = \frac{Q}{t}$ $\because$ $\text{Current} = \frac{\text{charge}}{\text{time}}$

$\Rightarrow Q = It$ $\Rightarrow$ charge = current × time

(Coulomb) $\boxed{C = As}$

Potential difference (V)

$$\text{Potential difference} = \frac{\text{work}}{\text{charge}}$$

$W = Fs = mas$

(volt) $V = \frac{J}{C}$

$\because J = kg\,m^2s^{-2}$

$C = As$

$$V = \frac{kg\,m^2s^{-2}}{As}$$

$$\boxed{V = kg\,m^2s^{-3}A^{-1}}$$

Electrical Resistance (R)

$\because V = IR$ (ohm's Law)

$\Rightarrow R = \frac{V}{I}$

(ohm) $\Omega = \frac{V}{A} = \frac{kg\,m^2s^{-3}A^{-1}}{A}$

$$\Rightarrow \boxed{\Omega = kg\,m^2s^{-3}A^{-2}}$$

Resistivity

$$R = \rho \frac{l}{A}$$

(Rho) $\rho = \frac{RA}{l}$

$$= \frac{\Omega\, m^2}{\cancel{m}}$$

$$\rho = \Omega m$$

$$= (kg\, m^2 s^{-3} A^{-2})\, m$$

$$\rho = kg\, m^3 s^{-3} A^{-2}$$

Ω m ✓

$$\because R = \frac{V}{I}$$

$$R = \frac{W}{QI} = \frac{FS}{QI} = \frac{mas}{It \times I}$$

$$\Omega = \frac{J}{CA}$$

$$= \frac{kg\, m^2 s^{-2}}{As\ \ A}$$

$$\Omega = kg\, m^2 s^{-3} A^{-2}$$

$$\Omega m = kg\, m^3 s^{-3} A^{-2}$$

$$E = \frac{N}{C} \text{ or } NC^{-1}$$

$$= \frac{kg\, m s^{-2}}{As}$$

$$\boxed{E = kg\, m\, s^{-3} A^{-1}}$$

* Heat capacity (c)

$$\text{Heat capacity} = \frac{\text{Amount of heat}}{\text{inc. in Temperature (Kelvin)}}$$

$$C = \frac{J}{K} = kg\, m^2 s^{-2} K^{-1}$$

Electric field Strength (E)

$$\text{Electric field strength} = \frac{\text{Force}}{\text{charge}}$$

* Specific heat capacity (C)

$$\text{Sp. Heat Capacity} = \frac{\text{Amount of heat}}{\text{mass} \times \text{increase in Temp.}}$$

$$C = \frac{J}{kg\, K} = m^2 s^{-2} K^{-1}$$

S.No.	Derived Quantity	Formula	Derived Unit
18.	Potential Diff (V)	$V = \frac{W}{Q}$	$V = \frac{J}{C} = kg\,m^{2}s^{-3}A^{-1}$
19.	Electric Resistance (R)	$R = \frac{V}{I}$	$\Omega = kg\,m^{2}s^{-3}A^{-2}$
20.	Resistivity (ρ)	$\rho = \frac{RA}{l}$	$\frac{\Omega m^{2}}{m} = kg\,m^{3}s^{-3}A^{-2}$
21. *	Heat Capacity (C)	$C = \frac{Q}{\Delta T}$	$\frac{J}{K} = kg\,m^{2}s^{-2}K^{-1}$
22. *	Sp. heat Capacity (c)	$c = \frac{Q}{m\Delta T}$	$\frac{J}{kgK} = m^{2}s^{-2}K^{-1}$
23.	Intensity of waves (I)	$I = \frac{P}{A}$	$W m^{-2}$ or $J m^{-2}s^{-1}$ or $kg\,s^{-3}$

Intensity of a wave (I)

Power reached per unit area to the surface placed perpendicular to the direction of motion of waves.

$$\text{Intensity (wave)} = \frac{\text{Power}}{\text{Area}}$$

$$= \frac{\text{Energy}}{\text{Area} \times \text{time}}$$

$$= \frac{J}{m^{2} \times s} = \frac{kg\,m^{2}s^{-2}}{m^{2}s}$$

$$= kg\,s^{-3}$$

Homogenity (Dimensional Consistancy)

" Each and every term of a physical Law (equation or formula in physics) has same Unit. (or Same dimensions)

$2 + 3 = 5 \rightarrow$ Sum

Terms of 5

$2 \times 3 = 6 \rightarrow$ Product

factors

Q) Check homogenity of the following equations.

i) $v = u + at$

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

iii) $2as = v^2 - u^2$

v = Final velocity
u = Initial "
a = Acceleration
t = time
s = displacement

Solution :-

i) $v = u + at$

Unit of $v = ms^{-1}$ ✓

" " $u = ms^{-1}$ ✓

" " $at = ms^{-2}. s = ms^{-1}$ ✓

∴ i) is homogenous as same unit of each term.

ii) $S = ut + \frac{1}{2}at^2$ *Coeff's not considered but powers in homogenity

Unit of $s = m$

Unit of $ut = ms^{-1}.s = m$

coefficient

Unit of $\boxed{\frac{1}{2}}at^2 = ms^{-2}.s^2 = m$

∴ each term same unit

∴ above eq. is homogenous

iii) $2as = v^2 - u^2$

Unit of $2as = ms^{-2}.m = m^2s^{-2}$

" " $v^2 = (ms^{-1})^2 = m^2s^{-2}$

" " $u^2 = (ms^{-1}) = m^2s^{-2}$

∴ Same unit of each term

∴ Above eq. is homogenous.

Use of Knowledge of homogenity :-

① Correctness of a formula

② finding unit of unknown constant.

③ finding unknown powers of the variables in a formula.

① Correctness of a formula :-

Q) $P = \frac{1}{2}\rho v^2$

where P = Pressure

ρ = Density

v = Speed of a fluid.

$$P = \frac{1}{2}\rho v^2$$

$\because F = ma$
$N = kg\,m\,s^{-2}$

$$\text{Unit of Pressure} = \overset{P}{Pa} = \frac{\overset{F}{N}}{\underset{A}{m^2}} = \frac{kg\,m\,s^{-2}}{m^2} = kg\,m^{-1}s^{-2} \checkmark$$

$$\text{Unit of } \frac{1}{2}\rho v^2 = \underbrace{kg\,m^{-3}}_{\rho}(m\,s^{-1})^2 = kg\,m^{-3}m^2s^{-2}$$

$$= kg\,m^{-1}s^{-2} \checkmark$$

So, above eq. is homogenous
So, the formula may be correct.

② finding unit of unknown Constant.

eg:- Find SI base unit of G (gravitational constant) where, m_1 and m_2 are the two masses seperated by a distance 'r' b/w their centres.

Force of gravitation 'F'

$$F = G\frac{m_1m_2}{r^2}$$

Sol

$$G = \frac{Fr^2}{m_1m_2}$$

$$\checkmark = \frac{N\,m^2}{kg^2}$$

$$= \frac{kg\,m\,s^{-2} \times m^2}{kg^2}$$

$$G = kg^{-1}m^3s^{-2}$$

① wrong coefficient
② extra term
③ Missing term
May make a homogenous eq wrong.

*All physical laws are homogenous but all homogenous equations are not physical Laws.

Q) Find the unit of α and β ? ?
where,

$$C = \alpha T + \beta T^3$$

C is specific heat capacity
T = Thermodynamic temperature
α, β are constants.

Solution :-

$\because$ Specific heat capacity $c = J\,kg^{-1}\,K^{-1}$

So, $\alpha T = J\,kg^{-1}\,K^{-1}$ (as homogenity)

$\alpha K = J\,kg^{-1}\,K^{-1}$

$$\boxed{\alpha = J\,kg^{-1}\,K^{-2}}$$ ✓

If base units ; $W = Fs$
$N.m = kg\,m\,s^{-2}.m$
$= kg\,m^2\,s^{-2}$

$\alpha = \cancel{(kg\,m^2\,s^{-2})} \times kg^{-1}\,K^{-2}$

$\alpha = m^2\,s^{-2}\,K^{-2}$

Now, unit of βT^3 = unit of C

$\beta T^3 = J\,kg^{-1}\,K^{-1}$

$\beta K^3 = J\,kg^{-1}\,K^{-1}$

$$\boxed{\beta = J\,kg^{-1}\,K^{-4}}$$

SI base units ; $\beta = \cancel{kg}\,m^2\,s^{-2} \times \cancel{kg^{-1}}\,K^{-4}$

SI base units $\boxed{\beta = m^2\,s^{-2}\,K^{-4}}$

③ Finding Unknown powers of the Variables in a formula

Q) Given that time period 'T,' of a simple pendulum depends on its length 'l' and acceleration due to gravity 'g'. Find the formula linking these variables.

Solution

$T \propto l^x g^y$

$T = K l^x g^y$ —— ①

where, 'k' is dimensionless constant.

Now, using knowledge of homogenity;

$s = m^x (ms^{-2})^y$

$s = m^x m^y s^{-2y}$

$m^0 \quad s^{1} = m^{x+y} s^{-2y}$

$x + y = 0$ $\qquad$ $-2y = 1$

$\boxed{x = \frac{1}{2}}$ $\qquad$ $\boxed{y = -1/2}$

① ⇒ $T = K l^{1/2} g^{-1/2}$

$\therefore \boxed{T = k\sqrt{\frac{l}{g}}}$

$T = 2\pi\sqrt{l/g}$

Q) Pressure 'P' of a fluid depends on it's density 'ρ' and its speed 'v'.
Find a formula relating these variables.

Sol

$$P \propto \rho^{x} v^{y}$$

$$P = k \rho^{x} v^{y} \quad \text{——— ①}$$

where 'k' is dimensionless constant.

$$\text{Unit of } P = \frac{F}{A} = \frac{ma}{A} = \frac{kg\,m\,s^{-2}}{m^{2}} = kg\,m^{-1}s^{-2}$$

$$\text{unit of } \rho = kg\,m^{-3}$$

$$\text{unit of } v = m\,s^{-1}$$

$$① \Rightarrow kg\,m^{-1}s^{-2} = (kg\,m^{-3})^{x}(m\,s^{-1})^{y}$$

$$kg\,m^{-1}s^{-2} = kg^{x}\,m^{-3x}\,m^{y}\,s^{-y}$$

$$kg^{1}\,m^{-1}s^{-2} = kg^{x}\,m^{-3x+y}\,s^{-y}$$

equating powers;

$$\boxed{x = 1}$$

$$-y = -2$$

$$\Rightarrow \boxed{y = 2}$$

$$-3x + y = -1$$
$$-3(1) + y = -1$$
$$-3 + y = -1$$
$$y = 3 - 1$$
$$\boxed{y = 2}$$

$$\therefore \boxed{P = k \rho v^{2}}$$

Actual : $P = \frac{1}{2} \rho v^{2}$

Prefixes of Units :-

For very large and very small values of the physical quantities these prefixes of the Units are used.

Prefix name	Value	Symbol
Kilo	10^3	K
Mega	10^6	M
Giga	10^9	G
Tera	10^{12}	T

Prefix name	Value	Symbol
deci	10^{-1}	d
Centi	10^{-2}	c
milli	10^{-3}	m
micro	10^{-6}	μ
neno	10^{-9}	n
Pico	10^{-12}	p

Conversion of Units :-

i) Express 5Gg into g.

$$5Gg = 5\times10^{9}g$$

ii) Express 200μm into m.

$$200\mu m = 200\times10^{-6} m$$
$$= 2\times10^{-4} m.$$

iii, Express 5000ng into g.

$5000ng = 5000 \times 10^{-9} g$

$= 5 \times 10^{-6} g$ or $5 \mu g$

iv, Express 3000μs into Ps.

∴ $\frac{\mu}{P} = \frac{10^{-6}}{10^{-12}} = 10^{6}$

∴ $1 \mu s = 10^{6} Ps$

So, $3000 \mu s = 3000 \times 10^{6} Ps$

$= 3 \times 10^{9} Ps$

v, Express 250Mm into km.

(Given) (Required) $\frac{M}{k} = \frac{10^{6}}{10^{3}} \Rightarrow M_m = 10^{3} km$

$250 Mm = 250 \times 10^{3} km$

$= 2.5 \times 10^{5} km$

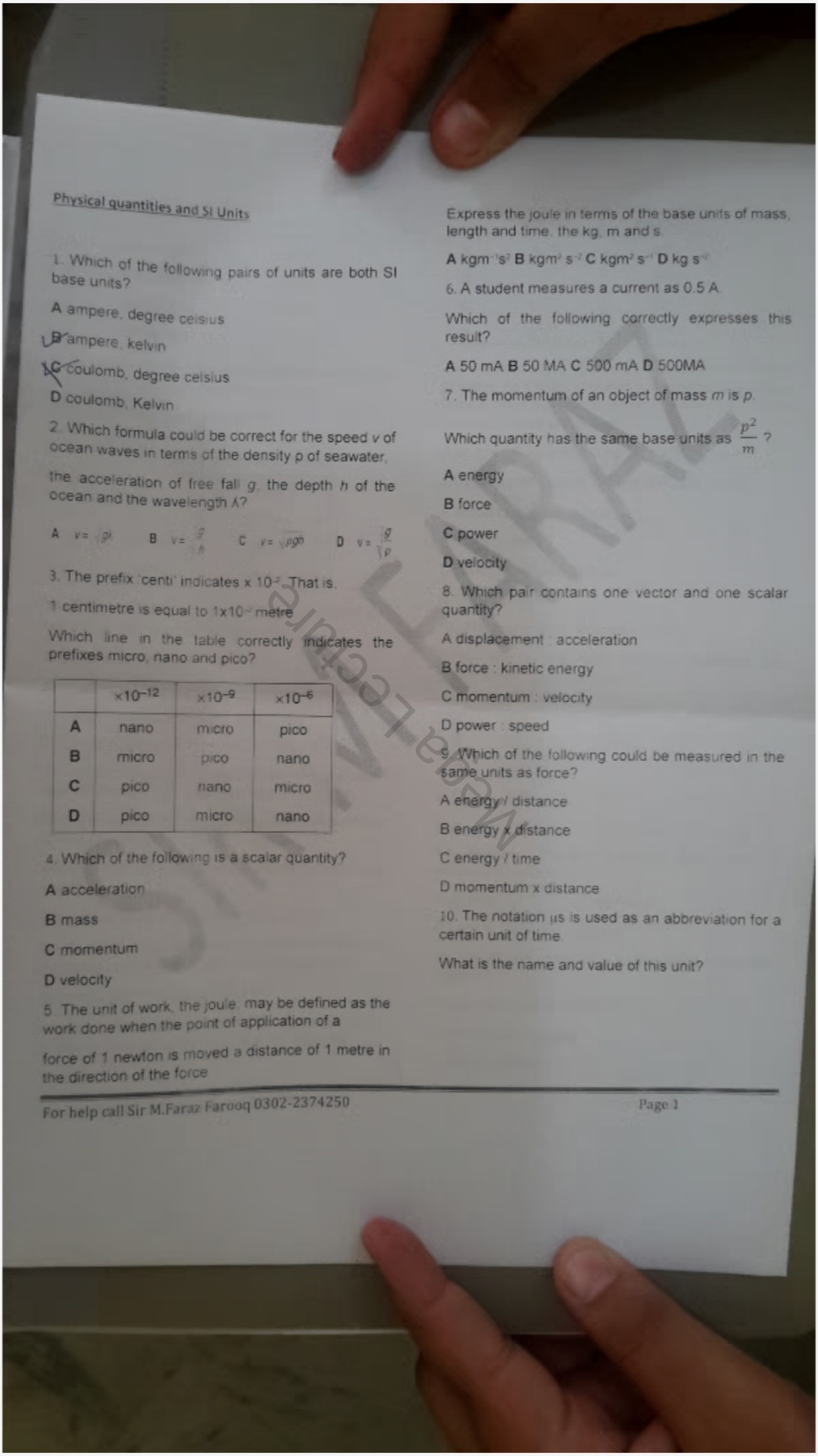
Scalars	Vectors
i, Those physical quantities which are completely described by magnitude in a suitable unit only.	i, Those physical quantities which are completely described by magnitude in a suitable unit as well as direction.
ii, Examples:- Distance, time, mass, temperature, area, Volume, density, work, energy, power Vector x Vector	ii, Examples:- displacement, Velocity, acceleration, Force, weight, Torque, momentum vector x vector

Scalar x Scalar = Scalar

Scalar x vector = Vector

* Vector x Vector = Scalar (mostly)

* Vector x Vector = Vector (Sometimes)



Physical quantities and SI Units

1. Which of the following pairs of units are both SI base units?

A ampere, degree celsius

B ampere, kelvin

C coulomb, degree celsius

D coulomb, Kelvin

2. Which formula could be correct for the speed *v* of ocean waves in terms of the density ρ of seawater,

the acceleration of free fall *g*, the depth *h* of the ocean and the wavelength λ?

A $v = \sqrt{g\lambda}$ **B** $v = \sqrt{\frac{g}{h}}$ **C** $v = \sqrt{\rho g h}$ **D** $v = \sqrt{\frac{g}{\rho}}$

3. The prefix 'centi' indicates x 10^{-2}. That is,

1 centimetre is equal to 1×10^{-2} metre

Which line in the table correctly indicates the prefixes micro, nano and pico?

	×10		

4. Which of the following is a scalar quantity?

A acceleration

B mass

C momentum

D velocity

5. The unit of work, the joule, may be defined as the work done when the point of application of a

force of 1 newton is moved a distance of 1 metre in the direction of the force

Express the joule in terms of the base units of mass, length and time, the kg, m and s.

A $kgm^{-1}s^{2}$ **B** $kgm^{2}s^{-2}$ **C** $kgm^{2}s^{-1}$ **D** $kg\,s^{-2}$

6. A student measures a current as 0.5 A.

Which of the following correctly expresses this result?

A 50 mA **B** 50 MA **C** 500 mA **D** 500MA

7. The momentum of an object of mass *m* is *p*.

Which quantity has the same base units as $\frac{p^2}{m}$?

A energy

B force

C power

D velocity

8. Which pair contains one vector and one scalar quantity?

A displacement : acceleration

B force : kinetic energy

C momentum : velocity

D power : speed

9. Which of the following could be measured in the same units as force?

A energy / distance

B energy x distance

C energy / time

D momentum x distance

10. The notation μs is used as an abbreviation for a certain unit of time.

What is the name and value of this unit?

	name	value
A	microsecond	10^{-6} s
B	microsecond	10^{-3} s
C	millisecond	10^{-6} s
D	millisecond	10^{-3} s

11. Which line of the table gives values that are equal to a time of 1 ps (one picosecond) and a

distance of 1Gm (one gigametre)?

	time of 1 ps	distance of 1 Gm
A	10^{-9} s	10^{9} m
B	10^{-9} s	10^{12} m
C	10^{-12} s	10^{9} m
D	10^{-12} s	10^{12} m

12. Which of the following definitions is correct and uses only quantities rather than units?

A Density is mass per cubic metre.

B Potential difference is energy per unit current.

C Pressure is force per unit area.

D Speed is distance travelled per second.

13. When a beam of light is incident on a surface, it delivers energy to the surface. The intensity of

the beam is defined as the energy delivered per unit area per unit time.

What is the unit of intensity expressed in SI base units?

A kg m^{-2} s^{-1} B kg m^{2} s^{-2} C kg s^{-2} D kg s^{-3}

14. Decimal sub-multiples and multiples of units are indicated using a prefix to the unit. For example,

the prefix milli (m) represents 10-3

Which of the following gives the sub-multiples or multiples represented by pico (p) and giga (G)?

	pico (p)	giga (G)
A	10^{-9}	10^{9}
B	10^{-9}	10^{12}
C	10^{-12}	10^{9}
D	10^{-12}	10^{12}

15. A metal sphere of radius r is dropped into a tank of water. As it sinks at speed v, it experiences a drag force F given by F = kr v, where k is a constant. What are the SI base units of k?

A kg $m^{2}s^{-1}$ B kg $m^{-2}s^{-2}$ C kg $m^{-1}s^{-1}$ D kg m s^{-2}

16. Which pair of units are both SI base units?

A ampere, degree celsius

B ampere, kelvin

C coulomb, degree celsius

D coulomb, kelvin

17. The prefix 'centi' indicates x 10^{-2}.

Which line in the table correctly indicates the prefixes micro, nano and pico?

	x 10^{-12}	x 10^{-9}	x 10^{-6}
A	nano	micro	pico
B	nano	pico	micro
C	pico	nano	micro
D	pico	micro	nano

18. Which expression involving base units is equivalent to the volt?

A kg $m^{2}s^{-1}A^{-1}$ B kg m s^{-2}A

C kg $m^{2}s^{-1}$A D kg $m^{2}s^{-3}A^{-1}$

19. Which pair contains one vector and one scalar quantity?

A displacement, acceleration

B force, kinetic energy

C power, speed

D work; potential energy

20 The following physical quantities can be either positive or negative.

s : displacement of a particle along a straight line

θ : temperature on the Celsius scale

q : electric charge

V : readings on a digital voltmeter

Which of these quantities are vectors?

A: s, θ, q, V B: s, q, V

C: θ, V D: s only

21. Which product-pair of metric prefixes has the greatest magnitude?

A pico × mega B nano × kilo

C micro × giga D milli × tera

2. In the expressions below **a** is acceleration,

is force,m is mass,t is time,**v** is velocity.

Which expression represents energy?

A: Ft B: Fvt C: $\frac{2mv}{t}$ D:$at^2/2$

23 Which row of the table shows a physical quantity and its correct unit?

physical quantity	unit
A electric field strength	$kg\,m\,s^{-2}C^{-1}$
B specific heat capacity	$kg^{-1}m^2s^{-2}K^{-1}$
C tensile strain	$kg\,m^{-1}s^{-2}$
D the Young modulus	$kg\,m^{-1}s^{-3}$

24. Which is a pair of SI base units?

A ampere	joule
B coulomb	second
C kilogram	kelvin
D metre	newton

25. What is the ratio

$$\frac{1\,\mu m}{1Gm}$$

A 10^{-3} B 10^{-9} C 10^{-12} D 10^{-15}

Answers : Quantities and units

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

$V = \frac{W}{Q}$

$\Rightarrow W = VQ$ (energy)

How can both sides of this equation be written in terms of base units?

A $[N\ m^{-1}] = [kg\ m^{-3}]\ [m\ s^{-1}]\ [m]$

B $[N\ m^{-2}] = [kg\ m^{-3}]\ [m\ s^{-2}]\ [m]$

C $[kg\ m^{-1}s^{-2}] = [kg\ m^{-3}]\ [m\ s^{-2}]\ [m]$

D $[kg\ m^{-1}s^{-1}] = [kg\ m^{-1}]\ [m\ s^{-2}]\ [m]$

27. Five energies are listed.

5 kJ,5 mJ,5 MJ,5 nJ

Starting with the smallest first, what is the order of increasing magnitude of these energies?

A 5 kJ → 5 mJ → 5 MJ → 5 nJ

B 5 nJ → 5 kJ → 5 MJ → 5 mJ

C 5 nJ → 5 mJ → 5 kJ → 5 MJ

D 5 mJ → 5 nJ → 5 kJ → 5 MJ

28. Which of the following correctly expresses the volt in terms of SI base units?

A : AΩ B : W A^{-1} C: kg $m^2s^{-1}A^{-1}$ D: kg $m^2s^{-3}A^{-1}$

29. At temperatures close to 0 K, the specific heat capacity c of a particular solid is given by $c = bT^3$,

where T is the thermodynamic temperature and b is a constant characteristic of the solid.

What are the units of constant b, expressed in SI base units?

A: $m^2s^{-2}K^{-3}$ B: $m^2s^{-2}K^{-4}$ C: kg $m^2s^{-2}K^{-3}$

D: kg $m^2s^{-2}K^{-4}$

30. Which statement, involving multiples and sub-multiples of the base unit metre (m), is correct?

A: 1 pm = 10^{-9}m B: 1 nm = 10^{-6}m

What are the base units of the constant k ?

A: kg m^5s^{-4} B: kg $m^{-2}s^{-1}$

C: kg m^{-3} D: kg $m^{-4}s^2$

32. The table contains some quantities, together with their symbols and units.

quantity	symbol	unit
gravitational field strength	g	N kg^{-1}
density of liquid	ρ	kg m^{-3}
vertical height	h	m
volume of part of liquid	V	m^3

Which expression has the units of energy?

A: ρhVg B: (ρ hV)/g C: hVρ g

D: ρ g^2h

33. The product of pressure and volume has the same SI base units as

A energy. B force. C area/force.

D length/force

34. Which physical quantity would result from a calculation in which a potential difference is multiplied by an electric charge?

A electric current B electric energy

C electric field strength D electric power

35. The frictional force F on a sphere falling through a fluid is given by the formula F = 6πaηv

where a is the radius of the sphere, η is a constant relating to the fluid and v is the velocity of the sphere. What are the units of η ?

A: kg m s^{-1} B: kg $m^{-1}s^{-1}$ C: kg m s^{-3} D: kg m^3s^{-3}

36. Which definition is correct and uses only quantities rather than units?

A Density is mass per cubic metre.

B Potential difference is energy per unit current.

C Pressure is force per unit area.

D Speed is distance travelled per second.

37. Stress has the same SI base units as

A:force/mass B:force/ length.C:force/ area.

D: energy.

38. To check calculations, the units are put into the following equations together with the numbers.

Which equation must be incorrect?

A force = 300 J / 6 m

B power = 6000 J × 20 s

C time = 6 m / 30 m s^{-1}

D velocity = 4 m s^{-2} × 30 s

39. Which statement using prefixes of the base unit metre (m) is not correct?

A: 1 pm = 10^{-12}m

B: 1 nm = 10^{-9}m

C: 1 Mm = 10^{6}m

D: 1 Gm = 10^{12}m

40. Which group of quantities contains only vectors?

A acceleration, displacement, speed

B acceleration, work, electric field strength

C displacement, force, velocity

D power, electric field strength, force

41. Which quantity can be measured in electronvolts (eV)?

A electric charge

B electric potential

C energy

D power

42 What is the ratio $\frac{10^{-3} THz}{10^{3} kHz}$

A :10^{-6} B: 10^{-4} C: 10^{6} D: 10^{3}

43. A cylindrical tube rolling down a slope of inclination θ moves a distance L in time T. The equation relating these quantities is

$$L\left(3+\frac{a^2}{P}\right)=QT^2\sin\theta$$

Where **a** is the internal radius of the tube and P and Q are constants.

Which line gives the correct units for P and Q?

	P	Q
A	m^2	$m^2 s^{-2}$
B	m^2	$m s^{-2}$
C	m^2	$m^3 s^{-2}$
D	m^3	$m s^{-2}$

44. When a force **F** moves its point of application through a displacement **s** in the direction of the force, the work W done by the force is given by

W = **F s**

How many vector quantities and scalar quantities does this equation contain?

A one scalar quantity and two vector quantities

B one vector quantity and two scalar quantities

C three scalar quantities

D three vector quantities

45. What is a possible unit for the product VI, where V is the potential difference across a resistor

and I is the current through the same resistor?

A newton per second (N s^{-1})

B newton second (N s)

C newton metre (N m)

D newton metre per second (N m s^{-1})

46. What is the unit watt in terms of SI base units?

A: J s^{-1} B: m^2kg s^{-1} C: m^2kg s^{-3}

D : N m s^{-1}

47. What is the unit of weight in terms of S/ base unit(s)?

A: kg m s^{-1} B: kg m s^{-2} C: N D: J m^{-1}

48. Which list contains only scalar quantities?

A area, length, displacement

B kinetic energy, speed, power

C potential energy, momentum, time

D velocity, distance, temperature

49. Which quantity has the same base units as momentum?

A: density × energy B: density×volume × velocity

C: pressure × area D: weight ÷ area

50. Three of these quantities have the same unit.

Which quantity has a different unit?

A energy/distance

B force

C power × time

D rate of change of momentum

Answers : Quantities and units

26. C
27. C

28. D
29. B
30. D
31. C
32. A
33. A
34. B
35. B
36. C
37. C
38. B
39. D
40. C
41. C
42. D
43. B
44. A
45. D
46. C
47. B
48. B
49. B
50. C

Q43

$$L\left(3+\frac{a^2}{p}\right) = QT^2\sin\theta$$

a = radius

L = length

T = Time

P = ?

Q = ?

Sol

$$3L + \frac{a^2}{p}L = QT^2\sin\theta$$

Now, unit of 3L = m

" " $\frac{a^2}{p}L = m$ (∵ homogeneity)

$$\frac{m^2 \times m}{p} = m$$

$\Rightarrow m^3 = mp$

$\Rightarrow \boxed{p = m^2}$

Similarly;

unit of $QT^2\sin\theta = m$

$Q \times s^2 = m$

$Q = ms^{-2}$

Q50)

A: $\frac{W}{s}$ $\quad \frac{J}{m} = \frac{kgm^2s^{-2}}{m} = kgms^{-2}$

B: $F = N = kgms^{-2}$

(C): $Pt = \frac{W}{\cancel{t}}\times\cancel{t} = W = J = kgm^2s^{-2}$

$= kgm^2s^{-2}$

D: $\frac{\Delta P}{t}$

$$\frac{kgms^{-1}}{s} = kgms^{-2}$$

Q42)

$$\frac{10^{-3}\,THz}{10^3\,KHz} = \frac{10^{-3}\times10^{12}}{10^3\times10^3} = 10^{-3+12-6} = 10^3$$

Q49) $P = mv = kg\,ms^{-1}$ $\quad$ J = N·m $\quad$ $N = kgms^{-2}$

A: $\rho W \rightarrow kgm^{-3}\times J = kgm^{-3}\times \underline{kgm^2s^{-2}} = kg^2m^{-1}s^{-2}$ ✗

(B): $\rho V v \rightarrow kg\,\cancel{m^{-3}}\times\cancel{m^3}\times ms^{-1} = kgms^{-1}$ ✓

C: PA

D: $\frac{E}{A}$

xpress the unit of force and of charge in terms of the S.I. base units kilogram, etre, second and ampere. Hence, with reference to Coulomb's law:

$$F = \frac{1}{4\pi\varepsilon_0}\frac{Q_1Q_2}{r^2}$$

−2

xpress the unit of ε_0, the permittivity of a vacuum, in terms of these base units. unit for μ_0, the permeability of a vacuum, is kg m s^{-1} A^{-2}. Use this unit and our unit for ε_0 to decide which one of the following relations between ε_0, μ_0 and , the speed of light in a vacuum, is dimensionally consistent.

$$\varepsilon_0\mu_0 = c^2\,, \qquad \varepsilon_0\mu_0 = c\,, \qquad \varepsilon_0\mu_0 = c^{-1}\,, \qquad \varepsilon_0\mu_0 = c^{-2}\,.$$

(June 82)

n the meaning of the terms **(a)** base unit, **(b)** dimensions of a physical quantity. o you check a formula for dimensional consistency? dimensionally consistent may nevertheless be