Units and Measurements

Q1. A screw gauge has 50 divisions on its circular scale. The circular scale is 4 units ahead of the pitch scale marking, prior to use. Upon one complete rotation of the circular scale, a displacement of 0.5 mm is noticed on the pitch scale. The nature of zero error involved and the least count of the screw gauge, are respectively:
(1) Positive, 0.1 mm
(2) Positive, 0.1μ m
(3) Positive, 10μ m
(4) Negative, 2μ m
Ans.[3]
Sol. $= L.C = \frac{0.5}{50}$ mm $= 1 \times 10^{-5}$ m $= 10\mu$ m

Q2. The workdone by a gas molecule in an isolated system is given by, $W = \alpha\beta^2 e^{-\frac{x^2}{\alpha kT}}$, where x is the displacement, k is the Boltzmann constant and T is the temperature α and β are constants. Then the dimensions of β will be -
(1) $[M^0LT^0]$
(2) $[M^2LT^2]$
(3) $[MLT^{-2}]$
(4) $[ML^2\ T^{-2}]$

Ans.[3]

Sol. given : work $= \alpha \cdot \beta^2 \cdot e^{-\frac{x^2}{\alpha \cdot K \cdot T}}$
$k =$ boltzmann constant
$T =$ temperature
$x =$ displacement
we know that, $\frac{x^2}{\alpha.k.T} =$ dimensionless

$$\left[\frac{x^2}{\alpha.K.T}\right] = [M^0\ L^0\ T^0]$$

$$[\alpha] = \left[\frac{L^2}{K.T}\right]$$

$$\Rightarrow [K] = [M^1\ L^2\ T^{-2}\ K^{-1}]$$

$$[T] = [K]$$

$$\Rightarrow [\alpha] = \left[\frac{L^2}{M^1\ L^2\ T^{-2}\ K^{-1} \times K}\right] \Rightarrow [\alpha] = [M^{-1}\ T^2]$$

$$\Rightarrow \omega = \alpha \cdot \beta^2$$

$$\Rightarrow \frac{[M^1\ L^1\ T^{-2}][L^{-1}]}{[M^{-1}\ T^2]} = [\beta^2] = [M^2\ L^2\ T^{-4}]$$

$$[\beta] = [MLT^{-2}]$$

Q3. Match the LIST-I with LIST-II

	LIST-I		LIST-II
A.	Boltzmann constant	I.	$ML^2\ T^{-1}$
B.	Coefficient of viscosity	II.	$MLT^{-3}\ K^{-1}$
C.	Planck's constant	III.	$ML^2\ T^{-2}\ K^{-1}$
D.	Thermal conductivity	IV.	$ML^{-1}\ T^{-1}$

Choose the correct answer from the options given below:
(1) A-III, B-IV, C-I, D-II
(2) A-II, B-III, C-IV, D-I
(3) A-III, B-II, C-I, D-IV
(4) A-III, B-IV, C-II, D-I

Ans.[1]

Sol. (A) $[k] = \frac{PV}{NT} = \frac{ML^2\ T^{-2}}{K} = ML^2\ T^{-2}\ K^{-1}$

(B) $[\eta] = \frac{F}{6\pi rv} = \frac{MLT^{-2}}{L^2\ T^{-1}} = ML^{-1}\ T^{-1}$

(C) $[h] = \frac{E}{f} = \frac{ML^2\ T^{-2}}{T^{-1}} = ML^2\ T^{-1}$

(D) $\frac{dQ}{dt} = k\frac{AdT}{dx}$

$$k = \frac{(ML^2\ T^{-3})L}{L^2 \cdot K} = MLT^{-3}\ K^{-1}$$

Q4. The dimension of $\sqrt{\frac{\mu_0}{\epsilon_0}}$ is equal to that of :
($\mu_0 =$ Vacuum permeability and $\epsilon_0 =$ Vacuum permittivity)
(1) Voltage
(2) Capacitance