fo/u fopkjr Hkh# tu] ugh vkjEHk dke] foifr n[k NkM rjr e/;e eu dj ';keA
i#"k flg ldYi dj] lgr foifr vud] ^cuk^ u NkM /;; dk] j?kcj jk[k VdAA

jfprk eksuo /ke i.krk
Inx# Jh j.kNkMnkl th egkjkt

STUDY PACKAGE

Subject : PHYSICS

Topic : UNITS & DIMENSIONS

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Index

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EXERCISE

Q.1 If force, acceleration and time are taken as fundamental quantities, then the dimensions of length will be:
(A) FT^2 (B) $F^{-1}A^2T^{-1}$ (C) FA^2T (D) AT^2

Q.2 In a certain system of units, 1 unit of time is 5 sec, 1 unit of mass is 20 kg and unit of length is 10 m. In this system, one unit of power will correspond to
(A) 16 watts (B) $\frac{1}{16}$ watts (C) 25 watts (D) none of these

Q.3 Three forces P, Q & R are acting at a point in the plane . The angle between P & Q and Q & R are 150º & 120º respectively, then for equilibrium, forces P, Q & R are in the ratio
(A) 1 : 2 : 3 (B) 1 : 2 : $\sqrt{3}$ (C) 3 : 2 : 1 (D) $\sqrt{3}$: 2 : 1

Q.4 The resultant of two forces F_1 and F_2 is P. If F_2 is reversed, then resultant is Q. Then the value of $(P^2 + Q^2)$ in terms of F_1 and F_2 is
(A) $2(F_1^2 + F_2^2)$ (B) $F_1^2 + F_2^2$ (C) $(F_1 + F_2)^2$ (D) none of these

Q.5 A man rows a boat with a speed of 18km/hr in northwest direction. The shoreline makes an angle of 15° south of west. Obtain the component of the velocity of the boat along the shoreline.
(A) 9 km/hr (B) $18\frac{\sqrt{3}}{2}$ km/hr (C) 18 cos15°km/hr (D) 18 cos75° km/hr

Q.6 A bird moves from point (1, – 2, 3) to (4, 2, 3) . If the speed of the bird is 10 m/sec, then the velocity vector of the bird is :
(A) $5\left(\hat{i}-2\hat{j}+3\hat{k}\right)$ (B) $5\left(4\hat{i}+2\hat{j}+3\hat{k}\right)$ (C) $0.6\hat{i}+0.8\hat{j}$ (D) $6\hat{i}+8\hat{j}$

Q.7 The dimensions $ML^{-1}T^{-2}$ can correspond to :
(A) moment of a force or torque (B) surface tension
(C) pressure (D) co-efficient of viscosity.
(useful relation are $\vec{\tau} = \vec{r} \times \vec{F}$, $S = F/l$, $F = 6\pi\eta r v$, where symbols have usual meaning)

Q.8 The pressure of 10^6 dyne/cm^2 is equivalent to
(A) 10^5 N/m^2 (B) 10^6 N/m^2 (C) 10^7 N/m^2 (D) 10^8 N/m^2

Q.9 If area (A) velocity (v) and density (ρ) are base units, then the dimensional formula of force can be represented as.
(A) $Av\rho$ (B) $Av^2\rho$ (C) $Av\rho^2$ (D) $A^2v\rho$

Q.10 If the resultant of two forces of magnitudes P and Q acting at a point at an angle of 60° is $\sqrt{7}$ Q, then P / Q is
(A) 1 (B) 3 / 2 (C) 2 (D) 4

Q.11 For a particle moving in a straight line, the position of the particle at time (t) is given by
$x = t^3 - 6t^2 + 3t + 7$
what is the velocity of the particle when it's acceleration is zero ?
(A) $-9\ ms^{-1}$ (B) $-12\ ms^{-1}$ (C) $3\ ms^{-1}$ (D) $42\ ms^{-1}$

Q.12 If the angle between the unit vectors $\hat{a}$ and $\hat{b}$ is 60°, then $|\hat{a} - \hat{b}|$ is
(A) 0 (B) 1 (C) 2 (D) 4

Q.13 In a book, the answer for a particular question is expressed as
$$b = \frac{ma}{k}\left[\sqrt{1+\frac{2kl}{ma}}\right]$$
here m represents mass, a represents accelerations , *l* represents length. The unit of b should be
(A) m/s (B) m/s^2 (C) meter (D) / sec.

Q.14 The resultant of two forces, one double the other in magnitude is perpendicular to the smaller of the two forces. The angle between the two forces is
(A) 150° (B) 90° (C) 60° (D) 120°

Q.15 Which of the following can be a set of fundamental quantities
(A) length, velocity, time (B) momentum, mass, velocity
(C) force, mass, velocity (D) momentum, time, frequency

Q.16 If 1 unit of mass = 4 kg; 1 unit of length = $\frac{1}{4}$ m and 1 unit of time = 5 sec, then 1 Joule = *x* units of energy in this system where *x* =
(A) 100 units (B) 0.01 units (C) 200 units (D) 0.02 units

Q.17 A man moves towards 3 m north then 4 m towards east and finally 5m towards south west. His approximate displacement from origin is
(A) $5\sqrt{2}$ m (B) 0 m (C) 12 m (D) 5 m (E) 1 m

Q.18 Kinetic energy (K) depends upon momentum (p) and mass (m) of a body as $K \alpha p^a m^b$
(A) a =1; b =1 (B) a =2; b = –1 (C) a =2; b=1 (D) a =1; b =2

Q.19 Use the approximation $(1 + x)^n \approx 1 + nx$, $|x| << 1$, to find approximate value for
(a) $\sqrt{99}$ (b) $\frac{1}{1.01}$ (c) $124^{1/3}$

Q.20 A particle is in a uni-directional potential field where the potential energy (U) of a particle depends on the x-cordinate given by $U_x = k(1 - \cos ax)$ & k and 'a' are constants. Find the physical dimensions of 'a' & k.

Q.21 An enclosed ideal gas A has its pressure P as a function of its volume V as $P = P_0 - \alpha V^2$, where P_0 & α are constants . Find the physical dimensions of α .

Q.22 Use the small angle approximations to find approximate values for (a) sin 8° and (b) tan 5°

Q.23 When two forces of magnitude P and Q are perpendicular to each other, their resultant is of magnitude R. When they are at an angle of 180° to each other their resultant is of magnitude $\frac{R}{\sqrt{2}}$. Find the ratio of P and Q.

Q.24 A particle moves along the space curve $\vec{r} = (t^2 + t)\hat{i} + (3t - 2)\hat{j} + (2t^3 - 4t^2)\hat{k}$. (t in sec, r in m) Find at time t = 2 the (a) velocity, (b) acceleration, (c) speed or magnitude of velocity and (d) magnitude of acceleration .

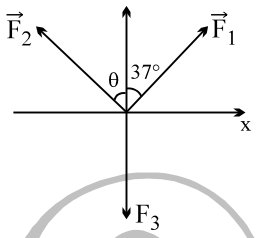
Q.25 The time period (T) of a spring mass system depends upon mass (m) & spring constant (k) & length of the spring (l) [$k = \frac{\text{Force}}{\text{length}}$]. Find the relation among, (T), (m), (l) & (k) using dimensional method.

Q.26 A body acted upon by 3 given forces is under equilibrium.

(a) If $|\vec{F}_1| = 10$ Nt., $|\vec{F}_2| = 6$ Nt.

Find the values of $|\vec{F}_3|$ & angle (θ).

(b) Express $\vec{F}_2$ in unit vector form.

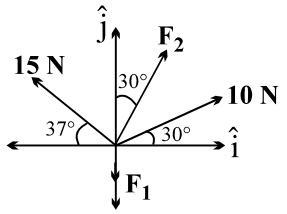


Q.27 A particle is acted upon by the forces $\vec{F}_1 = 2\hat{i} + a\hat{j} - 3\hat{k}$, $\vec{F}_2 = 5\hat{i} + c\hat{j} - b\hat{k}$, $\vec{F}_3 = b\hat{i} + 5\hat{j} - 7\hat{k}$, $\vec{F}_4 = c\hat{i} + 6\hat{j} - a\hat{k}$, . Find the values of the constants a, b, c in order that the particle will be in equilibrium.

Q.28 A satellite is orbiting around a planet. Its orbital velocity (v_0) is found to depend upon
(a) Radius of orbit (R)
(b) Mass of planet (M)
(c) Universal gravitation constant (G)
Using dimensional analysis find an expression relating orbital velocity (v_0) to the above physical quantities.

Q.29 If the four forces as shown are in equilibrium

Express $\vec{F}_1$ & $\vec{F}_2$ in unit vector form .



Q.30 The equation of state for a real gas at high temperature is given by $P = \frac{nRT}{V-b} - \frac{a}{T^{1/2}V(V+b)}$ where n, P, V & T are number of moles, pressure, volume & temperature respectively & R is the universal gas constant . Find the dimensions of constant 'a' in the above equation.

Q.31 The distance moved by a particle in time t from centre of a ring under the influence of its gravity is given by $x = a\sin\omega t$ where a & ω are constants. If ω is found to depend on the radius of the ring (r), its mass (m) and universal gravitational constant (G), find using dimensional analysis an expression for ω in terms of r, m and G.

Q.32 If the velocity of light c, Gravitational constant G & Plank's constant h be chosen as fundamental units, find the dimension of mass, length & time in the new system.

Q.33 A plane body has perpendicular axes OX and OY marked on it and is acted on by following forces
5P in the direction OY
4P in the direction OX
10P in the direction OA where A is the point (3a, 4a)
15P in the direction AB where B is the point (– a, a)
Express each force in the unit vector form & calculate the magnitude & direction of sum of the vector of these forces.

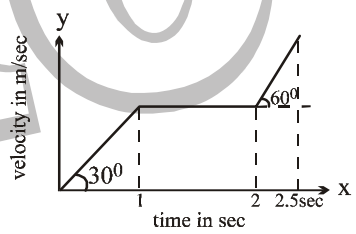
Q.34 Two vectors have magnitudes 3 unit and 4 unit respectively. What should be the angle between them if the magnitude of the resultant is (a) 1 unit, (b) 5 unit and (c) 7 unit.

Q.35 A vector $\vec{A}$ of length 10 units makes an angle of 60° with a vector $\vec{B}$ of length 6 units. Find the magnitude of the vector difference $\vec{A} - \vec{B}$ & the angle it makes with vector $\vec{A}$.

Q.36 At time t the position vector of a particle of mass m = 3kg is given by $\vec{r} = 6t\,\hat{i} - t^3\hat{j} + \cos t\,\hat{k}$. Find the resultant force $\vec{F}(t)$, magnitude of its acceleration when $t = \frac{\pi}{2}$ & speed when $t = \pi$.

Q.37 Given that the position vector of a particle moving in x-y plane is given by $\vec{r} = (t^2 - 4)\,\hat{i} + (t - 4)\,\hat{j}$. Find
(a) Equation of trajectory of the particle
(b) Time when it crosses x-axis and y-axis

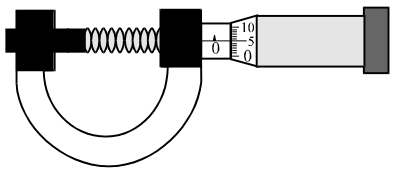
Q.38 The velocity time graph of a body moving in a straight line is shown. Find its
(a) instantaneous velocity at t = 1.5 sec.
(b) average acceleration from t = 1.5 sec. to t = 2.5 sec.
(c) draw its acceleration time graph from t = 0 to t = 2.5 sec

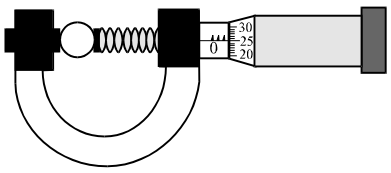


Q.39 The curvilinear motion of a particle is defined by $v_x = 50 - 16t$ and $y = 100 - 4t^2$, where v_x is in metres per second, y is in metres and t is in seconds. It is also known that x=0 when t=0. Determine the velocity (**v**) and acceleration(**a**) when the position y=0 is reached.

Q.40 The force acting on a body moving in a straight line is given by $F = (3t^2 - 4t + 1)$ Newton where t is in sec. If mass of the body is 1kg and initially it was at rest at origin. Find
(a) displacement between time t = 0 and t = 2 sec.
(b) distance travelled between time t = 0 and t = 2 sec.

Q.41 The circular divisions of shown screw gauge are 50. It moves 0.5 mm on main scale in one rotation. The diameter of the ball is





(A) 2.25 mm (B) 2.20 mm
(C) 1.20 mm (D) 1.25 mm **[JEE 2006]**

ANSWER KEY

EXERCISE

Q.1	D	Q.2	A	Q.3	D	Q.4	A	Q.5	A
Q.6	D	Q.7	C	Q.8	A	Q.9	B	Q.10	C
Q.11	A	Q.12	B	Q.13	C	Q.14	D	Q.15	C
Q.16	A	Q.17	B	Q.18	B	Q.19	(a) 9.95, (b) 0.99, (c) 4.986		

Q.20 L^{-1}, ML^2T^{-2} Q.21 $ML^{-7}T^{-2}$ Q.22 0.14, 0.09

Q.23 $2 \pm \sqrt{3}$

Q.24 (a) 5i + 3j + 8k, (b) 2i + 16k, (c) $7\sqrt{2}$, (d) $2\sqrt{65}$

Q.25 $T = a\sqrt{\frac{m}{k}}$ Q.26 (a) $|\vec{F}_3| = 8$ N, $\theta = 90°$ (b) $\vec{F}_2 = -6\hat{i}$

Q.27 $a = -7, b = -3, c = -4$ Q.28 $v_0 = k\sqrt{\frac{GM}{R}}$

Q.29 $\vec{F}_1 = -(12\sqrt{3}-1)\hat{j}$ & $\vec{F}_2 = (12-5\sqrt{3})\hat{i} + (12\sqrt{3}-15)\hat{j}$

Q.30 $ML^5T^{-2}K^{1/2}$ Q.31 $\omega = K\sqrt{\frac{Gm}{r^3}}$

Q.32 $[M] = [h^{1/2} \cdot c^{1/2} \cdot G^{-1/2}]$; $[L] = [h^{1/2} \cdot c^{-3/2} \cdot G^{1/2}]$; $[T] = [h^{1/2} \cdot c^{-5/2} \cdot G^{1/2}]$

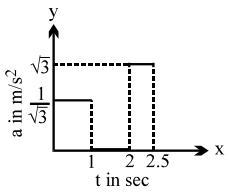
Q.33 $5P\hat{j}, 4P\hat{i}, 6P\hat{i} + 8P\hat{j}, -12P\hat{i} - 9P\hat{j}, \sqrt{20}, \tan^{-1}[-2]$ with the +ve x axis

Q.34 (a) 180°, (b) 90°, (c) 0 Q.35 $2\sqrt{19}$; $\cos^{-1}\frac{7}{2\sqrt{19}}$

Q.36 $-18t\hat{j} - 3\cos t\,\hat{k}$; 3π; $3\sqrt{4+\pi^4}$

Q.37 (a) $y^2 + 8y + 12 = x$; (b) crosses x axis when t = 4 sec. , crosses y axis when $t = \pm 2$ sec.

Q.38 (a) $\frac{1}{\sqrt{3}}$ m/s , (b) $\frac{\sqrt{3}}{2}$ m/s^2 , (c)



Q.39 $\vec{v} = -30\hat{i} - 40\hat{j}$, $\vec{a} = -16\hat{i} - 8\hat{j}$ Q.40 (a) $\frac{2}{3}$ m , (b) t = 0, 1

Q.41 C