Holiday Homework
Class XI Physics

Q1: Define the term 'Dimension' .
Q2: What are dimensional constants?

Q3: What are dimensional variables?

Q4: What are dimensionless quantities?

Q5: Define the principle of homogeneity of dimensions.

Q6. Find dimensions of the following physical quantities.

Power, force, coefficient of elasticity, coefficient of viscosity, torque, strain, stress, pressure, permittivity, gravitational acceleration, universal gravitational constant, universal gas constant

Q7 Prove that slope of x- t graph is equal to velocity for uniform motion.

Q8 Prove that slope of v-t graph is equal to acceleration for uniformly accelerated motion.

Q9 A book with many printing errors contains four different formulas for the displacement y of a particle undergoing a certain periodic motion:

(a) $y = a \sin 2\pi t/T$
(b) $y = a \sin vt$
(c) $y = (a/T) \sin t/a$
(d) $y = (a\ 2) (\sin 2\pi t / T + \cos 2\pi t / T)$

(a = maximum displacement of the particle, v = speed of the particle. T = time-period
of motion).
Rule out the wrong formulas on dimensional grounds.

Q10: The dimensions of torque, energy and work are equal. Comment.

Q11: Check the following equation for calculating displacement is dimensionally correct or not
(a) $x = x_0 + ut + (1/2) at^2$
where, x is displacement at given time t
x_0 is the displacement at t = 0

u is the velocity at t = 0
a represents the acceleration.

(b) $P = (\rho gh)^{1/2}$
where P is the pressure,
ρ is the density
g is gravitational acceleration
h is the height.

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Q.13: Hooke's law states that the force, F, in a spring extended by a length x is given by F = −kx.
According to Newton's second law F = ma, where m is the mass and a is the acceleration.
Calculate the dimension of the spring constant k.

Q.14: Compute the dimensional formula of electrical resistance (R).

Q.15: A calorie is a unit of heat or energy and it equals about 4.2 J where 1J = 1 kg m^2 s^{-2}. Suppose we employ a system of units in which the unit of mass equals α kg, the unit of length equals β m, the unit of time is γ s. Show that a calorie has a magnitude 4.2 α^{-1} β^{-2} γ^2 in terms of the new units.

Q.16: The kinetic energy K of a rotating body depends on its moment of inertia I and its angular speed ω. Considering the relation to be E = k $I^a w^b$ where k is dimensionless constant.
Find a and b. Moment of Inertia of a sphere about its diameter is $(2/5)Mr^2$

Q.17: What are the limitations of Dimensional Analysis?

Q.18: Convert 1 Newton into dyne using method of dimensions.

Q.19: The centripetal force (F) acting on a particle (moving uniformly in a circle)
depends on the mass (m) of the particle, its velocity (v) and radius (r) of the circle. Derive dimensionally formula for force (F).

Q.20: If the velocity of light c, gravitational constant G and planks constant h be chosen as fundamental units, find new unit of mass, length and time respectively.
(Take c = 3 x 10^{10} cm/sec, G = 6.67 x 10^8 dyn $cm^2/gram^2$ and h = 6.6 x 10^{-27} erg sec)

Q 21: A student while doing an experiment finds that the velocity of an object varies with time and it can be expressed as equation:

$$v = Xt^2 + Yt + Z .$$

If units of v and t are expressed in terms of SI units, determine the units of constants X, Y and Z in the given equation.

Q.22: Express Capacitance (C) in terms of dimensions of fundamental quantities i.e. Mass (M), Length(L), Time(T) and Ampere(A). Given work is the product of charge and electric potential and electric potential is work done per unit charge.

Q.23: If Force (F), velocity (V) and acceleration (a) are taken as the fundamental units instead of mass, length and time, express pressure and impulse in terms of F, V and a

Q 24: convert 5 joule into ergs.

Q25: convert 10 Pascal into CGS system.

Q 26: convert 5 watt into a system where fundamental unit of mass is 10 kg fundamental unit of length is 10 m and fundamental unit of time is 5 seconds.

Q27: prove that $g= GM/R^2$

Q28: Derive an expression for wavelength if it depends upon planck constant h mass of the body m and velocity of the body v.

Q29:Show that area under velocity time graph is equals to displacement for uniform motion.

Q30: show that area under velocity time graph is equals to displacement for uniformly accelerated motion.

Q31. Derive equations of motion by calculus method.

$v= u+at$

$S=ut + (1/2)\ at^2$

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

$S_{nth}= u+a(2n-1)/2$

Do Multiple choice questions given below .

1. Units

1. A physical quantity is measured and its value is found to be nu where $n=$ numerical value and $u=$ unit. Then which of the following relations is true

(a) $n \propto u^2$ (b) $n \propto u$

(c) $n \propto \sqrt{u}$ (d) $n \propto \frac{1}{u}$

2. Which of the following is the smallest unit?

(a) Millimetre (b) Angstrom

(c) Fermi (d) Metre

3. If $x = at + bt^2$, where x is the distance travelled by the body in kilometre while t is the time in second, then the units of b is

(a) km/s (b) kms

(c) km/s^2 (d) kms^2

4. Which is not a unit of electric field

(a) NC^{-1} (b) Vm^{-1}

(c) JC^{-1} (d) $JC^{-1}m^{-1}$

5. The correct value of 0°C on the Kelvin scale is

(a) 273.15K (b) 272.85K

(c) 273K (d) 273.2K

6. A new unit of length is so chosen that the speed of light in vacuum is unity. Calculate the distance (in this new unit) between sun and the earth if light takes 8 min and 20 seconds to reach earth from sun

(a) 300 (b) 400

(c) 500 (d) 600

7. *Joule-second* is the unit of

(a) Work (b) Momentum

(c) Pressure (d) Angular momentum

8. What is the SI unit of permeability?

(a) Henry per metre

(b) Tesla metre per ampere

(c) Weber per ampere metre

(d) All the above units are correct

9. Unit of magnetic moment is

(a) Ampere–$metre^2$ (b) Ampere–metre

(c) Weber–$metre^2$ (d) Weber/metre

10. Curie is a unit of

(a) Energy of γ-rays (b) Half life

(c) Radioactivity (d) Intensity of γ-rays

11. The unit of Stefan's constant σ is

(a) $Wm^{-2}K^{-1}$ (b) Wm^2K^{-4}

(c) $Wm^{-2}K^{-4}$ (d) $Wm^{-2}K^4$

12. The surface tension of a liquid is 70 *dyne/* cm . In MKS system its value is

(a) 70 N/m (b) 7×10^{-2} N/m

(c) 7×10^3 N/m (d) 7×10^2 N/m

13. The SI unit of universal gas constant (R) is

(a) Watt $K^{-1}mol^{-1}$ (b) Newton $K^{-1}mol^{-1}$

(c) Joule K^{-1} mol^{-1} (d) Erg K^{-1} mol^{-1}

14. The number of significant figures in 0.06900 is

(a) 5 (b) 4

(c) 2 (d) 3

2. Dimensions

1. The dimension of $\frac{1}{2}\varepsilon_0 E^2$, where ε_0 is permittivity of free space and E is electric field, is

(a) $[MLT^1]$ (b) $[ML^2T^{-2}]$

(c) $[ML^{-1}T^{-2}]$ (d) $[ML^2T^{-1}]$

2. If E, M, L and G denote energy, mass, angular momentum and gravitational constant respectively, then the quantity (EL^2/M^5G^2) has the dimensions of

(a) Angle (b) Length

(c) Mass (d) Time

3. The density of a material in CGS system of units is $4\,g/cm^3$. In a system of units in which unit of length is 10 cm and unit of mass is 100 g , the value of density of material will be

(a) 400 (b) 0.04

(c) 0.4 (d) 40

The position of a particle at time t is given by the relation $x(t)=\left(\frac{v_0}{\alpha}\right)(1-e^{-\alpha t})$, where v_0 is a constant and $\alpha>0$. The dimensions of v_0 and α are respectively

(a) $[M^0L^1T^{-1}]$ and $[T^{-1}]$ (b) $[M^0L^1T^0]$ and $[T^{-1}]$

(c) $[M^0L^1T^{-1}]$ and $[LT^{-2}]$ (d) $[M^0L^1T^{-1}]$ and $[T]$

A physical quantity x depends on quantities y and z as follows: $x=Ay+B\tan Cz$, where A, B and C are constants. Which of the following do not have the same dimensions?

(a) x and B (b) C and z^{-1}

(c) y and B/A (d) x and A

The frequency of vibration of string is given by $v=\frac{p}{2l}\left[\frac{F}{m}\right]^{1/2}$. Here p is number of segments in the string and l is the length. The dimensional formula for m will be

(a) $[M^0LT^{-1}]$ (b) $[ML^0T^{-1}]$

(c) $[ML^{-1}T^0]$ (d) $[M^0L^0T^0]$

The Vander Waal's equation of state for real gases is given as $\left(P+\frac{a}{V^2}\right)(V-b)=nRT$ which of the following terms has dimensions different from that of energy

(a) PV (b) $\frac{a}{V^2}$

(c) $\frac{ab}{V^2}$ (d) bP

Frequency is the function of density (ρ), length (a) and surface tension (T). Then its value is

(a) $k\rho^{1/2}a^{3/2}/\sqrt{T}$ (b) $k\rho^{3/2}a^{3/2}/\sqrt{T}$

(c) $k\rho^{1/2}a^{3/2}/T^{3/4}$ (d) None of these

The velocity of a freely falling body changes as g^ph^q where g is acceleration due to gravity and h is the height. The values of p and q are

(a) $1,\frac{1}{2}$ (b) $\frac{1}{2},\frac{1}{2}$

(c) $\frac{1}{2},1$ (d) $1,1$

If P represents radiation pressure, c represents speed of light and Q represents radiation energy striking a unit area per second, then non-zero integers x, y and z such that $P^xQ^yc^z$ is dimensionless, are

(a) $x=1, y=1, z=-1$ (b) $x=1, y=-1, z=1$

(c) $x=-1, y=1, z=1$ (d) $x=1, y=1, z=1$

11. The frequency of vibration f of a mass m suspended from a spring of spring constant K is given by a relation of this type, $f=Cm^xK^y$; where C is a dimensionless quantity. The value of x and y are

(a) $x=\frac{1}{2}, y=\frac{1}{2}$ (b) $x=-\frac{1}{2}, y=-\frac{1}{2}$

(c) $x=\frac{1}{2}, y=-\frac{1}{2}$ (d) $x=-\frac{1}{2}, y=\frac{1}{2}$

12. The velocity of water waves v may depend upon their wavelength λ, the density of water ρ and the acceleration due to gravity g. The method of dimensions gives the relation between these quantities as

(a) $v^2\propto \lambda g^{-1}\rho^{-1}$ (b) $v^2\propto g\lambda\rho$

(c) $v^2\propto g\lambda$ (d) $v^2\propto g^{-1}\lambda^{-3}$

13. If mass is measure in units of α kg, length in βm and time in γs then calorie would be

(a) $4.2\alpha\beta^2\gamma^{-2}$ (b) $4.2\alpha^{-1}\beta^2\gamma^2$

(c) $4.2\alpha^{-1}\beta^{-2}\gamma^2$ (d) $4.2\alpha^{-2}\beta^{-1}\gamma^{-2}$

14. A small steel ball of radius r is allowed to fall under gravity through a column of a viscous liquid of coefficient of viscosity η. After some time, the velocity of the ball attains a constant value known as terminal velocity v_T. The terminal velocity depends on (*i*) the mass of the ball m, (*ii*) η, (*iii*) r and (*iv*) acceleration due to gravity g. Which of the following relations is dimensionally correct?

(a) $v_T\propto\frac{mg}{\eta r}$ (b) $v_T\propto\frac{\eta r}{mg}$

(c) $v_T\propto\eta rmg$ (d) $v_T\propto\frac{mgr}{\eta}$

15. In a system of units if force (F), acceleration (a)and time (T) are taken as fundamental units then the dimensional formula of energy is

(a) FA^2T (b) FAT^2

(c) F^2AT (d) FAT

16. If the speed of light (c), acceleration due to gravity (g) and pressure (p) are taken as the fundamental quantities, then the dimension of gravitational constant is

(a) $c^2g^0p^{-2}$ (b) $c^0g^2p^{-1}$

(c) cg^3p^{-2} (d) $c^{-1}g^0p^{-1}$

17. If the time period (T) of vibration of a liquid drop depends on surface tension (S), radius (r) of the drop and density (ρ) of the liquid, then the expression of T is

(a) $T=k\sqrt{\rho r^3/S}$ (b) $T=k\sqrt{\rho^{1/2}r^3/S}$

(c) $T=k\sqrt{\rho r^3/S^{1/2}}$ (d) None of these

1. Distance and Displacement

1. A man goes 10*m* towards north, then 20*m* towards east then displacement is

(a) 22.5 m (b) 25 m

(c) 25.5 m (d) 30 m

2. Uniform Motion

1. The numerical ratio of displacement to the distance covered is always

(a) Less than one

(b) Equal to one

(c) Equal to or less than one

(d) Equal to or greater than one

2. Which of the following is a one dimensional motion?

(a) Landing of an aircraft

(b) Earth revolving around the sun

(c) Motion of wheels of moving train

(d) Train running on a straight track

3. A 150 m long train is moving with a uniform velocity of 45 km/h. The time taken by the train to cross a bridge of length 850*m* is

(a) 56 sec (b) 68 sec

(c) 80 sec (d) 92 sec

4. A particle is constrained to move on a straight line path. It returns to the starting point after 10 sec. The total distance covered by the particle during this time is 30 m. Which of the following statements about the motion of the particle is false

(a) Displacement of the particle is zero

(b) Average speed of the particle is 3 m/s

(c) Displacement of the particle is 30 m

(d) Both (a) and (b)

5. A person travels along a straight road for the first half time with a velocity v_1 and the next half time with a velocity v_2. The mean velocity v_{avg} of the man is

(a) $\frac{2}{v}=\frac{1}{v_1}+\frac{1}{v_2}$ (b) $v=\frac{v_1+v_2}{2}$

(c) $v=\sqrt{v_1v_2}$ (d) $v=\sqrt{\frac{v_1}{v_2}}$

3. Non-uniform Motion

1. A particle starts its motion from rest under the action of a constant force. If the distance covered in first 10 seconds is S_1 and that covered in the first 20 seconds is S_2, then

(a) $S_2=2S_1$ (b) $S_2=3S_1$

(c) $S_2=4S_1$ (d) $S_2=S_1$

2. A particle moves in a straight line with a constant acceleration. It changes its velocity from 10 ms^{-1} to 20 ms^{-1} while passing through a distance 135 *m* in *t* second. The value of *t* is

(a) 12 (b) 9

(c) 10 (d) 1.8

3. Two boys are standing at the ends *A* and *B* of a ground where $AB=a$. The boy at *B* starts running in a direction perpendicular to *AB* with velocity v_1. The boy at *A* starts running simultaneously with velocity v and catches the other boy in a time *t*, where *t* is

(a) $a/\sqrt{v^2+v_1^2}$ (b) $\sqrt{a^2/(v^2-v_1^2)}$

(c) $a/(v-v_1)$ (d) $a/(v+v_1)$

4. The initial velocity of a particle is u (at $t=0$) and the acceleration f is given by at. Which of the following relation is valid?

(a) $v=u+at^2$ (b) $v=u+a\frac{t^2}{2}$

(c) $v=u+at$ (d) $v=u$

5. What determines the nature of the path followed by the particle

(a) Speed (b) Velocity

(c) Acceleration (d) Both (b) and (c)

6. If a car at rest accelerates uniformly to a speed of 144 km/h in 20 s. Then it covers a distance of

(a) 20 m (b) 400 m

(c) 1440 m (d) 2880 m

7. If a train travelling at 72 kmph is to be brought to rest in a distance of 200 meters, then its retardation should be

(a) 20 ms^{-2} (b) 10 ms^{-2}

(c) 2 ms^{-2} (d) 1 ms^{-2}

The average velocity of a body moving with uniform acceleration travelling a distance of 3.06 m is 0.34 ms^{-1}. If the change in velocity of the body is 0.18 ms^{-1} during this time, its uniform acceleration is

(a) 0.01 ms^{-2} (b) 0.02 ms^{-2}

(c) 0.03 ms^{-2} (d) 0.04 ms^{-2}

9. The position of a particle moving along the x-axis at certain times is given below:

t (s)	0	1	2	3
x (m)	–2	0	6	16

Which of the following describes the motion correctly?

(a) Uniform, accelerated

(b) Uniform, decelerated

(c) Non-uniform, accelerated

(d) There is not enough data for generalization

10. Consider the acceleration, velocity and displacement of a tennis ball as it falls to the ground and bounces back. Directions of which of these changes in the process

(a) Velocity only

(b) Displacement and velocity

(c) Acceleration, velocity and displacement

(d) Displacement and acceleration

11. A body travels for 15 *sec* starting from rest with constant acceleration. If it travels distances S_1, S_2 and S_3 in the first five seconds, second five seconds and next five seconds respectively the relation between S_1, S_2 and S_3 is

(a) $S_1 = S_2 = S_3$ (b) $5S_1 = 3S_2 = S_3$

(c) $S_1 = \frac{1}{3}S_2 = \frac{1}{5}S_3$ (d) $S_1 = \frac{1}{5}S_2 = \frac{1}{3}S_3$

12. The distance travelled by a particle starting from rest and moving with an acceleration $\frac{4}{3}ms^{-2}$, in the third second is

(a) $\frac{10}{3}$m (b) $\frac{19}{3}$m

(c) 6 m (d) 4 m

13. If a ball is thrown vertically upwards with speed u, the distance covered during the last t seconds of its ascent is

(a) $\frac{1}{2}gt^2$ (b) $ut - \frac{1}{2}gt^2$

(c) $(u - gt)t$ (d) ut

14. A body starts from rest. What is the ratio of the distance travelled by the body during the 4th and 3rd second?

(a) $\frac{7}{5}$ (b) $\frac{5}{7}$

(c) $\frac{7}{3}$ (d) $\frac{3}{7}$

15. If a body starts from rest and travels 120 cm in the 6^{th} second, then what is the acceleration

(a) 0.20 m/s^2 (b) 0.027 m/s^2

(c) 0.218 m/s^2 (d) 0.03 m/s^2

16. A body starting from rest, accelerates at a constant rate a m/s^2 for some time after which it decelerates at a constant rate b m/s^2 to come to rest finally. If the total time elapsed is t sec, the maximum velocity attained by the body is given by

(a) $\frac{ab}{a+b}t$ m/s (b) $\frac{ab}{a-b}t$ m/s

(c) $\frac{2ab}{a+b}t$ m/s (d) $\frac{2ab}{a-b}t$ m/s

17. A bus begins to move with an acceleration of $1ms^{-2}$. A man who is 48m behind the bus starts running at $10ms^{-1}$ to catch the bus. The man will be able to catch the bus after

(a) 6 s (b) 5 s

(c) 3 s (d) 7 s

(e) 8 s

18. A man throws balls with the same speed vertically upwards one after the other at an interval of 2 seconds. What should be the speed of the throw so that more than two balls are in the sky at any time (Given $g = 9.8 m/s^2$)

(a) At least 0.8 m/s

(b) Any speed less than 19.6 m/s

(c) Only with speed 19.6 m/s

(d) More than 19.6 m/s

19. At a metro station, a girl walks up a stationary escalator in time t_1. If she remains stationary on the escalator, then the escalator take her up in time t_2. The time taken by her to walk up on the moving escalator will be

(a) $(t_1 + t_2)/2$ (b) $t_1 t_2/(t_2 - t_1)$

(c) $t_1 t_2/(t_2 + t_1)$ (d) $t_1 - t_2$

20. A particle moves along a straight line OX. At a time t (in seconds) the distance x (in meters) of the particle from O is given by $x = 40 + 12t - t^3$

How long would the particle travel before coming to rest

(a) 24 m (b) 40 m

(c) 56 m (d) 16 m

1. Units

1	c	**2**	c	**3**	c	**4**	d	**5**	a
6	a	**7**	b	**8**	b	**9**	d	**10**	d
11	a	**12**	b						

2. Dimensions

1	a	**2**	c	**3**	b	**4**	b	**5**	b
6	a	**7**	a	**8**	a	**9**	c	**10**	d
11	b	**12**	c	**13**	d	**14**	c	**15**	d
16	c	**17**	d	**18**	a	**19**	a	**20**	c

1. Distance and Displacement

1	a

2. Uniform Motion

1	c	2	d	3	c	4	c	5	b

3. Non-uniform Motion

1	c	2	b	3	b	4	b	5	d
6	b	7	d	8	b	9	c	10	b
11	b	12	a	13	a	14	a	15	c
16	a	17	e	18	d	19	c	20	d