Rahul Science Academy

IIT JEE / NEET / CET Classes

Address: Balewadi High Street, Pune

Contact: 7020329384 / 7588305622

Email: share.me650@gmail.com

PHYSICS (01)

SYLLABUS : Fundamental of Vectors, Addition, Subtraction and Multiplication of Vectors, Lami's Theorem

Date : _____

1. A force of 5 N acts on a particle along a direction making an angle of 60° with vertical. Its vertical component will be

(a) 10 N (b) 3 N

(c) 4 N (d) 2.5 N

2. Which of the following statement is true

(a) When the coordinate axis are translated the component of a vector in a plane changes

(b) When the coordinate axis are rotated through some angle, components of the vector change but the vector's magnitude remains constant

(c) Sum of $\vec{a}$ and $\vec{b}$ is $\vec{R}$. If the magnitude of $\vec{a}$ alone is increased angle between $\vec{b}$ and $\vec{R}$ decreases

(d) The cross product of $3\hat{i}$ and $4\hat{j}$ is 12

3. The X and Y components of a force F acting at 30° to x-axis are respectively

(a) $\frac{F}{\sqrt{2}}, F$ (b) $\frac{F}{2}, \frac{\sqrt{3}}{2}F$

(c) $\frac{\sqrt{3}}{2}F, \frac{1}{2}F$ (d) $F, \frac{F}{\sqrt{2}}$

4. $0.4\hat{i} + 0.8\hat{j} + c\hat{k}$ represents a unit vector when c is

(a) -0.2 (b) $\sqrt{0.2}$

(c) $\sqrt{0.8}$ (d) 0

5. With respect to a rectangular cartesian coordinate system, three vectors are expressed as $\vec{a} = 4\hat{i} - \hat{j}$, $\vec{b} = -3\hat{i} + 2\hat{j}$ and $\vec{c} = -\hat{k}$ where $\hat{i}, \hat{j}, \hat{k}$ are unit vectors, along the X, Y and Z-axis respectively. The unit vectors $\hat{r}$ along the direction of sum of these vectors is

(a) $\hat{r} = \frac{1}{\sqrt{3}}(\hat{i} + \hat{j} - \hat{k})$ (b) $\hat{r} = \frac{1}{\sqrt{2}}(\hat{i} + \hat{j} - \hat{k})$

(c) $\hat{r} = \frac{1}{3}(\hat{i} - \hat{j} + \hat{k})$ (d) $\hat{r} = \frac{1}{\sqrt{2}}(\hat{i} + \hat{j} + \hat{k})$

6. Two vectors are given by $\vec{A} = \hat{i} + 2\hat{j} + 2\hat{k}$ and $\vec{B} = 3\hat{i} + 6\hat{j} + 2\hat{k}$. Another vector $\vec{C}$ has the same magnitude as $\vec{B}$ but has the same direction as $\vec{A}$. Then which of the following vectors represent $\vec{C}$

(a) $\frac{7}{3}(\hat{i} + 2\hat{j} + 2\hat{k})$ (b) $\frac{3}{7}(\hat{i} - 2\hat{j} + 2\hat{k})$

(c) $\frac{7}{9}(\hat{i} - 2\hat{j} + 2\hat{k})$ (d) $\frac{9}{7}(\hat{i} + 2\hat{j} + 2\hat{k})$

RESPONSE GRID	1. ⓐⓑⓒⓓ 2. ⓐⓑⓒⓓ 3. ⓐⓑⓒⓓ 4. ⓐⓑⓒⓓ 5. ⓐⓑⓒⓓ 6. ⓐⓑⓒⓓ

7. If $\vec{A} = 2\hat{i} + 4\hat{j} - 5\hat{k}$ the direction of cosines of the vector $\vec{A}$ are

(a) $\frac{2}{\sqrt{45}}, \frac{4}{\sqrt{45}}$ and $\frac{-5}{\sqrt{45}}$

(b) $\frac{1}{\sqrt{45}}, \frac{2}{\sqrt{45}}$ and $\frac{3}{\sqrt{45}}$

(c) $\frac{4}{\sqrt{45}}, 0$ and $\frac{4}{\sqrt{45}}$

(d) $\frac{3}{\sqrt{45}}, \frac{2}{\sqrt{45}}$ and $\frac{5}{\sqrt{45}}$

8. Two persons A and B are located in x-y plane at the points (0, 0) and (0, 10), respectively. (The distances are measured in *MKS* units). At a time $t = 0$, they start moving simultaneously with velocities $\vec{v}_A = 2\hat{j}\ ms^{-1}$ and $\vec{v}_B = 2\hat{i}\ ms^{-1}$, respectively. The time after which A and B are at their closest distance is

(a) 2.5 s (b) 4 s

(c) 1s (d) $\frac{10}{\sqrt{2}}$ s

9. Following forces start acting on a particle at rest at the origin of the co-ordinate system simultaneously

$\vec{F}_1 = -4\hat{i} - 5\hat{j} + 5\hat{k}$, $\vec{F}_2 = 5\hat{i} + 8\hat{j} + 6\hat{k}$,

$\vec{F}_3 = -3\hat{i} + 4\hat{j} - 7\hat{k}$ and $\vec{F}_4 = 2\hat{i} - 3\hat{j} - 2\hat{k}$ then the particle will move

(a) In $x - y$ plane (b) In $y - z$ plane

(c) In $x - z$ plane (d) Along x –axis

10. If $|\vec{A} - \vec{B}| = |\vec{A}| = |\vec{B}|$, the angle between $\vec{A}$ and $\vec{B}$ is

(a) 60° (b) 0°

(c) 120° (d) 90°

11. A certain vector in the x-y plane has an x-component of 12 m and a y-component of 8 m. It is then rotated in the x-y plane so that its x-component is halved. Then its new y-component is approximately

(a) 14 m (b) 13.11 m

(c) 10 m (d) 2.0 m

12. Three concurrent forces of the same magnitude are in equilibrium. What is the angle between the forces ? Also name the triangle formed by the forces as sides

(a) 60° equilateral triangle

(b) 120° equilateral triangle

(c) 120°, 30°, 30° an isosceles triangle

(d) 120° an obtuse angled triangle

13. Two forces, F_1 and F_2 are acting on a body. One force is double that of the other force and the resultant is equal to the greater force. Then the angle between the two forces is

(a) $\cos^{-1}(1/2)$ (b) $\cos^{-1}(-1/2)$

(c) $\cos^{-1}(-1/4)$ (d) $\cos^{-1}(1/4)$

14. At what angle must the two forces $(x + y)$ and $(x - y)$ act so that the resultant may be $\sqrt{(x^2 + y^2)}$

(a) $\cos^{-1}\left(-\frac{x^2 + y^2}{2(x^2 - y^2)}\right)$

(b) $\cos^{-1}\left(-\frac{2(x^2 - y^2)}{x^2 + y^2}\right)$

(c) $\cos^{-1}\left(-\frac{x^2 + y^2}{x^2 - y^2}\right)$

(d) $\cos^{-1}\left(-\frac{x^2 - y^2}{x^2 + y^2}\right)$

RESPONSE GRID					
	7. ⓐⓑⓒⓓ	**8.** ⓐⓑⓒⓓ	**9.** ⓐⓑⓒⓓ	**10.** ⓐⓑⓒⓓ	**11.** ⓐⓑⓒⓓ
	12. ⓐⓑⓒⓓ	**13.** ⓐⓑⓒⓓ	**14.** ⓐⓑⓒⓓ		

15. Two vectors $\vec{A}$ and $\vec{B}$ have equal magnitudes. If magnitude of $\vec{A}+\vec{B}$ is equal to n times the magnitude of $\vec{A}-\vec{B}$, then the angle between $\vec{A}$ and $\vec{B}$ is

(a) $\cos^{-1}\left(\frac{n-1}{n+1}\right)$ (b) $\cos^{-1}\left(\frac{n^2-1}{n^2+1}\right)$

(c) $\sin^{-1}\left(\frac{n-1}{n+1}\right)$ (d) $\sin^{-1}\left(\frac{n^2-1}{n^2+1}\right)$

16. A particle acted upon by constant forces $4\hat{i}+\hat{j}-3\hat{k}$ and $3\hat{i}+\hat{j}-\hat{k}$ is displaced from the point $\hat{i}+2\hat{j}-3\hat{k}$ to point $5\hat{i}+4\hat{j}-\hat{k}$. The total work done by the forces in SI unit is

(a) 20 (b) 24

(c) 50 (d) 30

17. $\vec{A}$ and $\vec{B}$ are two vectors given by $\vec{A}=2\hat{i}+3\hat{j}$ and $\vec{B}=\hat{i}+\hat{j}$. The magnitude of the component of $\vec{A}$ along $\vec{B}$ is

(a) $\frac{5}{\sqrt{2}}$ (b) $\frac{3}{\sqrt{2}}$

(c) $\frac{7}{\sqrt{2}}$ (d) $\frac{1}{\sqrt{2}}$

18. Which of the following is the unit vector perpendicular to $\vec{A}$ and $\vec{B}$

(a) $\frac{\hat{A}\times\hat{B}}{AB\sin\theta}$ (b) $\frac{\hat{A}\times\hat{B}}{AB\cos\theta}$

(c) $\frac{\vec{A}\times\vec{B}}{AB\sin\theta}$ (d) $\frac{\vec{A}\times\vec{B}}{AB\cos\theta}$

19. What is the unit vector perpendicular to the following vectors $2\hat{i}+2\hat{j}-\hat{k}$ and $6\hat{i}-3\hat{j}+2\hat{k}$

(a) $\frac{\hat{i}+10\hat{j}-18\hat{k}}{5\sqrt{17}}$ (b) $\frac{\hat{i}-10\hat{j}+18\hat{k}}{5\sqrt{17}}$

(c) $\frac{\hat{i}-10\hat{j}-18\hat{k}}{5\sqrt{17}}$ (d) $\frac{\hat{i}+10\hat{j}+18\hat{k}}{5\sqrt{17}}$

20. The area of the triangle formed by $2\hat{i}+\hat{j}-\hat{k}$ and $\hat{i}+\hat{j}+\hat{k}$ is

(a) 3 *sq. unit* (b) $2\sqrt{3}$ *sq. unit*

(c) $2\sqrt{14}$ *sq. unit* (d) $\frac{\sqrt{14}}{2}$ *sq. unit*

21. If $\vec{A}=2\hat{i}+3\hat{j}-\hat{k}$ and $\vec{B}=-\hat{i}+3\hat{j}+4\hat{k}$ then the unit vector perpendicular to both $\vec{A}$ and $\vec{B}$ will be

(a) $+\frac{1}{\sqrt{3}}(\hat{i}-\hat{j}-\hat{k})$ (b) $-\frac{1}{\sqrt{3}}(\hat{i}-\hat{j}-\hat{k})$

(c) Both (a) and (b) (d) None of these

22. For any two vectors $\vec{A}$ and $\vec{B}$, if $\vec{A}.\vec{B}=|\vec{A}\times\vec{B}|$, the magnitude of $\vec{C}=\vec{A}+\vec{B}$ is equal to

(a) $\sqrt{A^2+B^2}$

(b) $A+B$

(c) $\sqrt{A^2+B^2+\frac{AB}{\sqrt{2}}}$

(d) $\sqrt{A^2+B^2+\sqrt{2}\times AB}$

RESPONSE GRID					
	15. ⓐⓑⓒⓓ	**16.** ⓐⓑⓒⓓ	**17.** ⓐⓑⓒⓓ	**18.** ⓐⓑⓒⓓ	**19.** ⓐⓑⓒⓓ
	20. ⓐⓑⓒⓓ	**21.** ⓐⓑⓒⓓ	**22.** ⓐⓑⓒⓓ		

23. How many minimum number of non-zero vectors in different planes can be added to give zero resultant

(a) 2 (b) 3

(c) 4 (d) 5

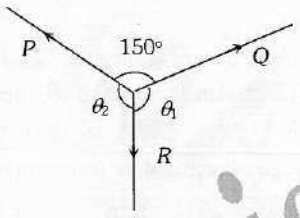
24. P, Q and R are three coplanar forces acting at a point and are in equilibrium. Given $P = 1.9318$ *kg-wt*, $\sin\theta_1 = 0.9659$, the value of R is (in *kg-wt*)

(a) 0.9659

(b) 2

(c) 1

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



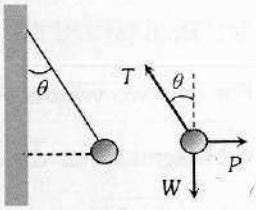
25. A metal sphere is hung by a string fixed to a wall. The sphere is pushed away from the wall by a stick. The forces acting on the sphere are shown in the second diagram. Which of the following statements is wrong

(a) $P = W\tan\theta$

(b) $\vec{T}+\vec{P}+\vec{W}=0$

(c) $T^2 = P^2 + W^2$

(d) $T = P + W$



NUMERICAL VALUE TYPE QUESTIONS

Questions from 26 to 30 are numerical value type according to the new pattern for JEE Main by NTA.

26. If a vector $\vec{P}$ make angles α, β, and γ respectively with the X, Y and Z axes. Then $\sin^2\alpha + \sin^2\beta + \sin^2\gamma =$

27. The maximum and minimum magnitudes of the resultant of two given vectors are 17 *units* and 7 *units* respectively. If these two vectors are at right angles to each other, the magnitude of their resultant is

28. Given that $\vec{A}+\vec{B}=\vec{C}$ and that $\vec{C}$ is $\perp$ to $\vec{A}$. Further if $|\vec{A}|=|\vec{C}|$, the angle between $\vec{A}$ and $\vec{B}$ is $n\pi/4$. Find the value of n.

29. Vector $\vec{A}$ has a magnitude of 5 units, lies in the xy-plane and points in a direction 120° from the direction of increasing x. Vector $\vec{B}$ has a magnitude of 9 units and points along the z-axis. The magnitude of cross product $\vec{A}\times\vec{B}$ is

30. The edges of parallelepiped are given by the vectors $(2\hat{i}+3\hat{j}+4\hat{k})$, $4\hat{j}$ and $(5\hat{j}+m\hat{k})$. What should be the value of m in order that the volume of the parallelepiped be 24?

RESPONSE GRID					
	23. ⓐⓑⓒⓓ	**24.** ⓐⓑⓒⓓ	**25.** ⓐⓑⓒⓓ	**26.** ○○	**27.** ○○
	28. ○○	**29.** ○○	**30.** ○○		

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PHYSICS (02)

SYLLABUS : SI Units, Fundamental and Derived Units, Dimensions of physical quantities

Date : _____

1. The unit of the coefficient of viscosity in S.I. system is

(a) $m/kg–s$ (b) $m–s/kg^2$

(c) $kg/m–s^2$ (d) $kg/m–s$

2. The unit of self-inductance is

(a) Weber ampere (b) Weber^{-1} ampere

(c) Ohm second (d) Farad

3. Erg-m^{-1} can be the unit of measure for

(a) Force (b) Momentum

(c) Power (d) Acceleration

4. If $x = at + bt^2$, where x is the distance travelled by the body in kilometers while t is the time in seconds, then the unit of b is

(a) km/s (b) km-s

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

5. The unit of L/R is (where L = inductance and R = resistance)

(a) *Sec* (b) *Sec*$^{-1}$

(c) *Volt* (d) *Ampere*

6. The unit of absolute permittivity is

(a) *Fm (farad/metre)*

(b) *Fm*$^{-1}$ *(farad/metre)*

(c) *Fm*$^{-2}$ *(farad/ metre*^{2}*)*

(d) *F (farad)*

RESPONSE GRID	1. ⓐⓑⓒⓓ 2. ⓐⓑⓒⓓ 3. ⓐⓑⓒⓓ 4. ⓐⓑⓒⓓ 5. ⓐⓑⓒⓓ 6. ⓐⓑⓒⓓ

7. The unit of permeability of vacuum (μ_0) is

(a) $\frac{N}{A}$ (b) $\frac{N}{A^2}$

(c) NA (d) $\frac{J}{A^2}$

8. $\frac{\text{watt}}{\text{kelvin}}$ is the unit of

(a) Stefan's constant

(b) Wien's constant

(c) Cooling's constant

(d) Thermal conductance

9. $\frac{h}{2\pi}$ is the dimension of

(a) Velocity

(b) Momentum

(c) Energy

(d) Angular momentum

10. The displacement of a particle moving along x-axis with respect to time t is $x = at + bt^2 - ct^3$. The dimensions of c are

(a) T^{-3} (b) LT^{-2}

(c) LT^{-3} (d) LT^3

11. If R and L represent respectively resistance and self-inductance, which of the following combinations has the dimensions of frequency

(a) $\frac{R}{L}$ (b) $\frac{L}{R}$

(c) $\sqrt{\frac{R}{L}}$ (d) $\sqrt{\frac{L}{R}}$

12. Dimensional formula for volume elasticity is

(a) $M^1L^{-2}T^{-2}$ (b) $M^1L^{-3}T^{-2}$

(c) $M^1L^2T^{-2}$ (d) $M^1L^{-1}T^{-2}$

13. Which of the following is dimensionally correct

(a) Pressure = Energy per unit area

(b) Pressure = Energy per unit volume

(c) Pressure = Force per unit volume

(d) Pressure = Momentum per unit volume per unit time

14. Dimensions of specific heat are

(a) $M^1L^2T^{-2}\theta^{-1}$ (b) $L^2T^{-2}\theta^{-1}$

(c) $L^2T^{-2}\theta^1$ (d) $M^1L^2\theta^1$

15. Which one of the following does not have the same dimensions

(a) Work and energy

(b) Angle and strain

(c) Relative density and refractive index

(d) Planck's constant and energy

16. Surface tension has the same dimensions as that of

(a) Coefficient of viscosity

(b) Impulse

(c) Momentum

(d) Spring constant

RESPONSE GRID					
	7. ⓐⓑⓒⓓ	**8.** ⓐⓑⓒⓓ	**9.** ⓐⓑⓒⓓ	**10.** ⓐⓑⓒⓓ	**11.** ⓐⓑⓒⓓ
	12. ⓐⓑⓒⓓ	**13.** ⓐⓑⓒⓓ	**14.** ⓐⓑⓒⓓ	**15.** ⓐⓑⓒⓓ	**16.** ⓐⓑⓒⓓ

17. Given that v is speed, r is the radius and g is the acceleration due to gravity. Which of the following is dimensionless

(a) v^2/rg (b) v^2r/g

(c) v^2g/r (d) v^2rg

18. If the acceleration due to gravity is $10ms^{-2}$ and the units of length and time are changed in kilometer and hour respectively, the numerical value of the acceleration is

(a) 360000 (b) 72,000

(c) 36,000 (d) 129600

19. From the dimensional consideration, which of the following equation is correct

(a) $T = 2\pi\sqrt{\frac{R^3}{GM}}$ (b) $T = 2\pi\sqrt{\frac{GM}{R^3}}$

(c) $T = 2\pi\sqrt{\frac{GM}{R^2}}$ (d) $T = 2\pi\sqrt{\frac{R^2}{GM}}$

20. The dimensions of $e^2/4\pi\varepsilon_0 hc$, where e, ε_0, h and c are electronic charge, electric permittivity, Planck's constant and velocity of light in vacuum respectively

(a) $[M^0L^0T^0]$ (b) $[M^1L^0T^0]$

(c) $[M^0L^1T^0]$ (d) $[M^0L^0T^1]$

21. If the velocity of light (c), gravitational constant (G) and Planck's constant (h) are chosen as fundamental units, then the dimensions of mass in new system is

(a) $c^{1/2}G^{1/2}h^{1/2}$ (b) $c^{1/2}G^{1/2}h^{-1/2}$

(c) $c^{1/2}G^{-1/2}h^{1/2}$ (d) $c^{-1/2}G^{1/2}h^{1/2}$

22. A dimensionally consistent relation for the volume V of a liquid of coefficient of viscosity η flowing per *second* through a tube of radius r and length l and having a pressure difference p across its end, is

(a) $V = \frac{\pi pr^4}{8\eta l}$ (b) $V = \frac{\pi\eta l}{8pr^4}$

(c) $V = \frac{8p\eta l}{\pi r^4}$ (d) $V = \frac{\pi p\eta}{8lr^4}$

23. The SI unit of energy is $J = kgm^2s^{-2}$; that of speed v is ms^{-1} and of acceleration a is ms^{-2} Which of the formulae for kinetic energy (K) given below can you rule out on the basis of dimensional arguments (m stands for the mass of the body)

(a) $K = m^{-2}v^3$ (b) $K = (1/2)\,mv^2$

(c) $K = ma$ (d) $K = (3/16)mv^{-2}$

RESPONSE GRID	17. ⓐⓑⓒⓓ 18. ⓐⓑⓒⓓ 19. ⓐⓑⓒⓓ 20. ⓐⓑⓒⓓ 21. ⓐⓑⓒⓓ 22. ⓐⓑⓒⓓ 23. ⓐⓑⓒⓓ

24. Let g be the acceleration due to gravity at earth's surface and K the rotational kinetic energy of the earth. Suppose the earth's radius decreases by 2%. Keeping mass to be constant, then

(a) g increases by 2% and K increases by 2%

(b) g increases by 4% and K increases by 4%

(c) g increases by 4% and K increases by 2%

(d) g increases by 2% and K increases by 4%

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

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

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

NUMERICAL VALUE TYPE QUESTIONS

Questions from 26 to 30 are numerical value type according to the new pattern for JEE Main by NTA.

26. Density of wood is $0.5\,gm/cc$ in the CGS system of units. The corresponding value in MKS units is $n\times10$, find the value of n.

27. Assuming the mass of Earth as $6.64\times10^{24}\,kg$ and the average mass of the atoms that make up Earth as $40u$ (atomic mass unit), the number of atoms in the Earth are approximately 10^m. Find the value of m.

28. A student determines a dimensionless quantity, $B = \frac{e^n}{2\varepsilon_0 hc}$. Find the value of n. (here, e = electric charge, ε_0 = electric permittivity of vacuum, h=Plank's constant and c = speed of light).

29. A particle of mass m is executing oscillation about origin on x-axis. Its potential energy is $U(x) = K|X|^n$. If the time period T is function of its mass, amplitude (a) and a physical quantity K. Find the value of n if $T \propto a^{\frac{1}{2}}$.

30. A gas bubble, oscillates with a time period T due to an explosion inside it. P, ρ, E denote pressure, density and total energy of the explosion, respectively. If energy of explosion, E is proportional to $T^a\rho^b P^c$. Find the value of $\frac{a^2c}{5b^2}$.

RESPONSE GRID					
	24. ⓐⓑⓒⓓ	**25.** ⓐⓑⓒⓓ	**26.** ○○	**27.** ○○	**28.** ○○
	29. ○○	**30.** ○○			