PHYSICS

Class **I IIT-JEE Achiever (Integrated) 2012-2014**

Solution to CET Test 01 **Test date** **02-06-2012**

1. A comet is composed of
   (1) rocks (2) dust (3) ice (4) all of these
   Ans (4)

2. $x = At + \left(\frac{1}{2}\right)Bt^2$ is a dimensionally correct equation, where t is time and A is velocity. The dimensions of B are
   (1) $M^0L^1T^{-2}$ (2) $M^0L^0T^{-2}$ (3) $M^1L^1T^{-2}$ (4) $M^0L^2T^{-1}$
   Ans (1)
   When two quantities are added (or subtracted) they must have the same dimensions.
   Therefore, dimensionally, $[At] = [Bt^2]$ i.e., $LT^{-1}T^1 = [B]\ [T^2]$ or $[B] = \frac{L}{T^2} = [LT^{-2}] = [M^0L^1T^{-2}]$

3. The number of significant figures in 0.06900 is
   (1) 5 (2) 4 (3) 2 (4) 3
   Ans (4)

4. $m = \frac{m_0}{\sqrt{1-\frac{A^2}{c^2}}}$ is an equation, where m is the mass of a moving body, m_0 is its mass at rest and c is the speed of light. The dimensional formula for A is
   (1) $M^0L^2T^{-1}$ (2) $M^1L^1T^{-2}$ (3) $M^0L^1T^{-1}$ (4) $M^{-1}L^{-1}T^{-2}$
   Ans (3)
   When one quantity is subtracted from another quantity, they must have the same dimensions.
   Here (A^2/c^2) is subtracted from 1.
   Therefore dimensions of 1 = dimensions of $\left[\frac{A}{c^2}\right]$
   Dimensions of A^2 = Dimensions of c^2
   Dimensions of A = Dimensions of c
   Dimensions of A = $[M^0L^1T^{-1}]$

5. Chandrashekhar got noble prize for his study on
   (1) birth of stars (2) structure of stars
   (3) both (1) and (2) (4) none of these
   Ans (3)

6. The velocity *v* of waves produced in water depends on their wave length λ, the density of water *d*, and acceleration due to gravity *g*. These quantities are related as (where *k* is a dimensionless constant)
   (1) $v^2 = k\lambda^{-1}g^{-1}d^{-1}$ (2) $v^2 = k\lambda g$ (3) $v^2 = k\lambda dg$ (4) $v^2 = k\lambda^{-3}g^{-1}d^{-1}$

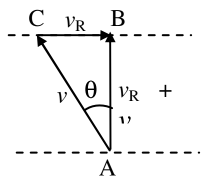
Ans (2)
$k\lambda g = L[LT^{-2}] = L^2T^{-2} \; = [LT^{-1}]^2 = v^2$

7. A physical quantity without a unit
(1) always possesses dimensions
(2) may possess dimensions
(3) never possesses dimensions
(4) does not exist
Ans (3)
For example, physical quantities such as refractive index, strain etc are pure ratios and hence have zero dimension and no unit.

8. The angle between $\vec{P} + \vec{Q}$ and $\vec{P} \times \vec{Q}$ is
(1) 0
(2) $\frac{\pi}{2}$
(3) π
(4) $\frac{\pi}{4}$
Ans (2)
The resultant $\vec{P}+\vec{Q}$ lies in the plane containing $\vec{P}$ and $\vec{Q}$. But $\vec{P} \times \vec{Q}$ acts in a direction perpendicular to the plane containing $\vec{P}$ and $\vec{Q}$.

9. A force $\vec{F} = 5\hat{i} + 6\hat{j} - 4\hat{k}$ acting on a body produces a displacement $\vec{s} = 6\hat{i} + 5\hat{k}$. Work done by the force is
(1) 18 units
(2) 11 units
(3) 15 units
(4) 10 units
Ans (4)
Work done $W = \vec{F}.\vec{s}$
$W = 5 \times 6\,(\hat{i}.\hat{i}) + 6 \times 0\,(\hat{j}.\hat{j}) - 4 \times 5\,(k.\,k)$
$W = 30 + 0 - 20 \quad (\because \hat{i}.\hat{i} = \hat{j}.\hat{j} = k.k = 1)$
$W = 10$ units

10. A river is flowing at 3 m s^{-1}. A man can swim in still water at a speed of 6 m s^{-1}. The angle with the bank at which the swimmer should start, so that he may cross the river along the shortest possible distance is
(1) 120° up stream
(2) 60° up stream
(3) 30° down stream
(4) 60° down stream
Ans (2)
The shortest distance between the banks is AB. In order to reach B, the swimmer has to swim upstream along AC. If v_R is the velocity of the stream and v is the velocity of the swimmer, then from the triangle ABC,



$\sin\theta = \frac{BC}{AC} = \frac{v_R}{v} = \frac{3}{6} \Rightarrow \theta = 30°$
The angle made with the bank
$\theta' = 90° - \theta = 60°$

11. N is the numerical value obtained in the measurement of a physical quantity and u is the unit used. The result is expressed as Nu. If the result is expressed in different units, then

(1) $N \propto$ size of u (2) $N \propto u^2$ (3) $N \propto \sqrt{u}$ (4) $N \propto \frac{1}{\text{size of u}}$

Ans (4)

$N \propto \frac{1}{\text{size of u}}$

Since, the size of a physical quantity is a number which is N times the size of the unit u, Nu = constant or $N \propto \frac{1}{u}$

For example, mass of an object is 100 g = 0.1 kg. Here, we see that with increase in the size of the unit (u) from gram to kilogram, the numerical value (N) decreases from 100 to 0.1.

Therefore, $N \propto \frac{1}{\text{size of u}}$

12. Of the following, the pair/s having the same dimensions is/are

(1) pressure, stress (2) impulse, change of momentum

(3) work, energy (4) all these

Ans (1), (2), (3)

Pressure = $\frac{F}{A}$, Stress = $\frac{F}{A}$

(1) Impulse = change of momentum

(2) Work done is a measure of energy spent.

Hence, the choice (1), (2) and (3) are all correct.

13. The distance travelled by a body in an interval of time t is given by $s = a + bt + ct^2$. The dimensions of b and c are respectively

(1) $[LT^{-1}]$ and $[LT^{-2}]$ (2) $[L]$ and $[L^2]$

(3) $[MLT^{-1}]$ and $[MLT^{-2}]$ (4) $[L]$ and $[L]$

Ans (1)

As the dimensions of s = [L], the dimensions of a, bt and ct^2 must also be equal to [L].

$\therefore$ [a] = [L], [bt] = [L] and $[ct^2]$ = [L]

$\Rightarrow$ [a] = [L], [b] = $[LT^{-1}]$ and [c] = $[LT^{-2}]$.

14. Which of the following time measuring devices is most precise?

(1) A wall clock (2) A stop watch (3) A digital watch (4) An atomic clock

Ans (4)

15. If the velocity v, time t and force F are chosen as fundamental quantities, then the dimensional formula of mass is

(1) Ftv^{-1} (2) Ftv^{-2} (3) Ftv (4) $Ft^{-1}v$

Ans (1)

$$Ftv^{-1} = [MLT^{-2}][T][LT^{-1}]^{-1}$$
$$= [MLT^{-2}][T][L^{-1}T^{1}] = [M].$$

16. The physical quantity which has the dimensional formula same as that of $\frac{\text{work}}{\text{mass}\times\text{length}}$ is

(1) force (2) power (3) pressure (4) acceleration

Ans (4)

$\frac{\text{work}}{\text{mass} \times \text{length}} = \frac{[ML^2T^{-2}]}{[M][L]} = [LT^{-2}]$ which is the dimensional formula for acceleration.

17. The number of significant figures in 11.118×10^{-6} V is

(1) 3 (2) 6 (3) 5 (4) 4

Ans (3)

The equation of the state for the adiabatic process is pV^{γ} = constant.

Using pV = nRT, we get

$T\,V^{\gamma-1}$ = constant

i.e., $T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}$

18. Heat generated in a circuit is given by $H = I^2$ Rt. If error in measuring current I, resistance R and time 't' are 2%, 1% and 3% respectively, then percentage error in calculating heat is

(1) 8% (2) 9% (3) 10% (4) 11%

Ans (1)

$H = I^2Rt$

$\frac{\Delta H}{H} = \frac{2\Delta I}{I} + \frac{4R}{R} + \frac{\Delta t}{t}$

$\frac{\Delta H}{H} = 2\times2\% + 1\% + 3\%$

$\frac{\Delta H}{H} = 8\%$

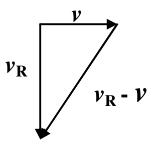
19. A vehicle with vertical screen glasses is moving at a constant speed. When the rain falls vertically, the rain drops strike

(1) front screen only (2) hind screen only

(3) both front and hind screens (4) neither the front nor the hind screens

Ans (1)

Let v_R be the velocity of the rain and v be the velocity of the vehicle. The relative velocity ($v_R - v$) of the rain is directed towards the front screen and away from the hind screen as shown in the diagram.



20. Three vectors satisfy the relation $\vec{A} \cdot \vec{B} = 0$ and $\vec{A} \cdot \vec{C} = 0$, then $\vec{A}$ is parallel to

(1) $\vec{C}$ (2) $\vec{B}$ (3) $\vec{B} \times \vec{C}$ (4) $\vec{B} \cdot \vec{C}$

Ans (3)

21. **Statement I:** Pressure can be subtracted from pressure gradient.

Statement II: Because both have the same dimensions.

(1) Statement I is correct (2) Statement (2) is correct

(3) Both statement is wrong (4) Statement (2) is wrong

Ans (3)

Both statements are wrong.

22. Which of the following is dimensionally correct?

(1) $T = \sqrt{\frac{L}{g^2}}$ (2) $T = \sqrt{\frac{L}{g}}$ (3) $T = 2M\sqrt{\frac{L}{g}}$ (4) $T = 2\pi\sqrt{\frac{L}{g^2}}$

Ans (2)

$T = \sqrt{\frac{L}{g}}$

23. The speed of light is $2.998 \times 10^8\ ms^{-1}$. The value expressed as three significant figures is

(1) $299.8 \times 10^8\ ms^{-1}$ (2) $2.99 \times 10^8\ ms^{-1}$ (3) $299 \times 10^8\ ms^{-1}$ (4) $3.00 \times 10^8\ ms^{-1}$

Ans (2)

2.99×10^8 m/s

24. The energy of a photon is given by E = hν, where 'h' is planck's constant and ν is the frequency of radiation. The dimensional formula of 'h' is

(1) $[ML^2T^{-2}]$ (2) $[ML^2T^{-1}]$ (3) $[M^2LT^{-2}]$ (4) $[ML^{-1}T^{-2}]$

Ans (2)

$h = \frac{E}{\gamma} = E \times \text{time}$

$\left(\gamma = \frac{1}{\text{Time}}\right) \quad \therefore\ h = M^1L^2T^{-2}T^1$

$h = ML^2T^{-1}$

25. $T = 2\pi L^{\frac{1}{2}} g^n$ is a physical equation, where T, L and g are period, length and acceleration due to gravity respectively. The equation becomes dimensionally correct, if n is equal to

(1) 1 (2) $\frac{1}{2}$ (3) – 1 (4) $-\frac{1}{2}$

Ans (4)

$g = L^1T^{-2}$

$T = 2\pi L^{\frac{1}{2}} \left[L^1T^{-2}\right]^{-\frac{1}{2}}$

$T = L^{\frac{1}{2}-\frac{1}{2}} \left(T^{-2}\right)^{-\frac{1}{2}}$

$T = 2\pi L^{\frac{1}{2}} g^h$

$T = T$

26. When a copper sphere is heated, maximum percentage change will be observed in

(1) radius (2) area (3) volume (4) none of these

Ans (3)

$v = \frac{4}{3}\pi R^3$

$\frac{\Delta v}{v} = 3\frac{\Delta R}{R}$

27. If $|\vec{P} \times \vec{Q}| = 0$, then the angle between $\vec{P}$ and $\vec{Q}$ is

(1) 90° (2) zero (3) 180° (4) 45°

Ans (2)

$\left|\vec{P} \times \vec{Q}\right| = PQ \sin \theta$.

$\left|\vec{P} \times \vec{Q}\right| = 0$ when $\sin \theta = 0$ or $\theta = 0$

28. The two vectors can yield a vector which is perpendicular to either of them, when they are

(1) multiplied (2) subtracted (3) added (4) divided

Ans (1)

The cross product of two vectors is a vector perpendicular to the plane containing the two vectors.

29. The angle between the two vectors $\vec{A} = 3\hat{i} + 4\hat{j} + 5\hat{k}$ and $\vec{B} = 3\hat{i} + 4\hat{j} - 5\hat{k}$ is

(1) 90° (2) 0 (3) 180° (4) 45°

Ans (1)

$\vec{A} \,.\, \vec{B} = AB \cos \theta$

$AB \cos \theta = 9\ (\hat{i}.\hat{i}) + 16\ (\hat{j}.\hat{j}) - 25\ (\hat{k}.\hat{k}) \qquad [\because \hat{i}.\hat{j} = \hat{j}.\hat{k} = \hat{k}.\hat{i} = 0]$

$= 9 + 16 - 25 \qquad [\because \hat{i}.\hat{i} = \hat{j}.\hat{j} = \hat{k}.\hat{k} = 1]$

$AB \cos \theta = 0 \Rightarrow \theta = 90°$

Alternatively

As you can see, $\hat{i}$ and $\hat{j}$ components are the same but the $\hat{k}$ components are opposite to each other. On visualizing the vectors, you can easily identify $\vec{A}$ and $\vec{B}$ to be perpendicular to each other.

30. The dot product of two vectors $\vec{A}$ and $\vec{B}$ is $\vec{A} \cdot \vec{B} = AB$. Then the angle between $\vec{A}$ and $\vec{B}$ is

(1) zero (2) 90° (3) 180° (4) 135°

Ans (1)

$\vec{A} \,.\, \vec{B} = AB \cos \theta$

When $\theta = 0$, $\cos \theta = 1$ and $\vec{A} \,.\, \vec{B} = AB$

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