PHYSICS

BOOKS - SUNIL BATRA 41 YEARS IITJEE PHYSICS (HINGLISH)

UNITS & MEASUREMENTS

Jee Main And Advanced

1. Planck's constant has dimension ..... .

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2. In the formula $X = 3YZ^2$, X and Z have dimensions of capacitance and magnetic induction respectively. The dimensions of Y in MKSQ system are ....., ...

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3. The equation of state for real gas is given by $\left(\left(p + \frac{a}{V^2}\right)(V - b) = RT\right.$. The dimension of the constant a is ..... .

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4. The dimension of $\left(\frac{1}{2}\right)\varepsilon_0 E^2$ (ε_0 : permittivity of free space, E electric field

A. (a) MLT^{-1}

B. (b) ML^2T^2

C. (c) $ML^{-1}T^{-2}$

D. (d) ML^2T^{-1}

Answer: C

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5. a quantity X is given by $\varepsilon_0 L\frac{\Delta V}{\Delta t}$ where $\in_0$ is the permittivity of the free space, L is a length, ΔV is a potential difference and Δt is a time interval. The dimensinal formula for X is the same as that of

A. (a) resistance

B. (b) charge

C. (c) voltage

D. (d) current

Answer: D

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6. A cube has a side of length $1.2 \times 10^{-2} m$. Calculate its volume.

A. (a) $1.7 \times 10^{-6} m^3$

B. (b) $1.73 \times 10^{-6} m^3$

C. (c) $1.70 \times 10^{-6} m^3$

D. (a) $1.732 \times 10^{-6} m^3$

Answer: A

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7. Pressure depends on distance as, $P = \frac{\alpha}{\beta}\exp\left(-\frac{\alpha z}{k\theta}\right)$, where α, β are constants, z is distance as , k is Boltzman's constant and θ is tempreature. The dimension of beta are

A. (a) $M^0L^0T^0$

B. (b) $M^{-1}L^{-1}T^{-1}$

C. (c) $M^0L^2T^0$

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

Answer: C

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8. A wire of length $l = \pm 0.06cm$ and radius $r = 0.5 \pm 0.005cm$ and mass $m = \pm 0.003gm$. Maximum

percentage error in density is

A. (a) 4

B. (b) 2

C. (c) 1

D. (d) 6.8

Answer: A

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9. Which of the following set have different dimensions?

A. (a) Pressure, Young's modulus, Stress

B. (b) EMF, Potential difference, Electirc potential

C. (c) Heat, Work done, Energy

D. (d) Dipole moment, Electric flux, Electric field

Answer: D

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10. In a screw gauge, the zero of mainscale coincides with fifth division of circular scale in figure (i). The circular division of screw gauge are 50. It moves $0.5mm$ on main scale In one rotation. The diameter of the ball in figure (ii) is

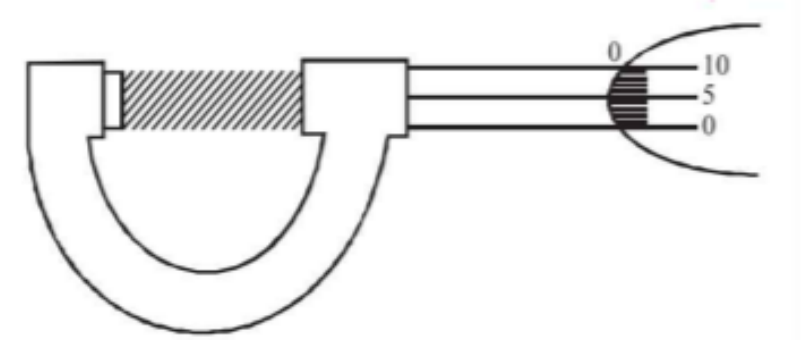
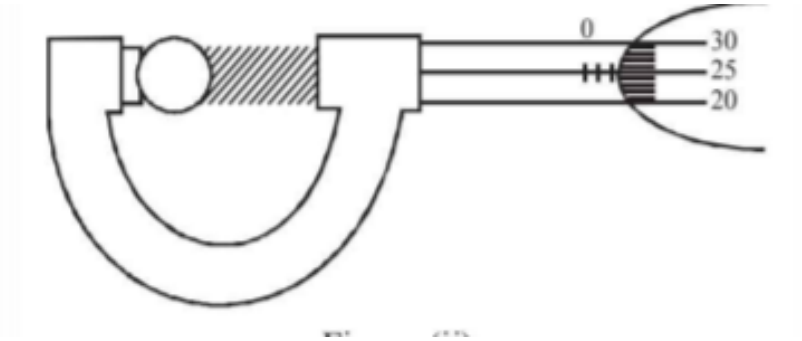


Figure (i)



A. (a) $2.25mm$

B. (b) $2.20mm$

C. (c) $1.20mm$

D. (d) $1.25mm$

Answer: C

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11. A student performs an experiment an for determination of $g\left(=\frac{4\pi^2 l}{T^2}\right)$. The error in length l is Δl and in time T is ΔT and n is number of times the reading is taken. The measurment of g is most accurate for

A. (a) $\Delta l = 5mm, \Delta = 0.2\,\text{sec}, n = 10$

B. (b) $\Delta l = 5mm, \Delta = 0.2\,\text{sec}, n = 20$

C. (c) $\Delta l = 5mm, \Delta = 0.1\,\text{sec}, n = 10$

D. (d) $\Delta l = 1mm, \Delta = 0.1\,\text{sec}, n = 50$

Answer: D

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12. A student performs an experiment to determine the Young's modulus of a wire, exactly$2m$ long, by Searle's method. In a partcular reading, the student measures the extension in the length of the wire to be $0.8mmwithanuncerta\int yof$+- 0.05mm $ataloadofexactly$1.0kg

, $thestudentalsomeasuresthediameterofthewire \rightarrow be$ 04mm$withanuncerta\int yof$+-0.01mm. $Take$g=9.8m//s^(2)` (exact). the Young's modulus obtained from the reading is

A. (a) $(2.0 \pm 0.3) \times 10^{11} N/m^2$

B. (b) $(2.0 \pm 0.2) \times 10^{11} N/m^2$

C. (c) $(2.0 \pm 0.1) \times 10^{11} N/m^2$

D. (d) $(2.0 \pm 0.05) \times 10^{11} N/m^2$

Answer: B

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13. A vernier calipers has $1mm$marks on the main scale. It has 20 equal divisions on the Verier scale which match with 16 main scale divisions. For this Vernier calipers, the least count is

A. (a) $0.02mm$

B. (b) $0.05mm$

C. (c) $0.1mm$

D. (d) $0.2mm$

Answer: D

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14. The density of a solid ball is to be determined in an experiment. The diameter of the ball is measured with a screw

gauge, whose pitch is $0.5mm$ and there are 50 divisions on the circular scale. The reading on the main scale is $2.5mm$ and that on circular scale is 20 divisions. if the measured mass of the ball has a relative error of 2%, the relative percentage error in the density is

A. (a) 0.9%

B. (b) 2.4%

C. (c) 3.1%

D. (d) 4.2%

Answer: C

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15. In the determination of Young's modulus $\left(Y = \frac{4MLg}{\pi / d^2}\right)$ by using Searle's method, a wire of length L= 2 m and diameter d = 0.5 mm is used. For a load M = 2.5 kg, an extension l = 0.25 mm in the length of the wire is observed. Quantities d and l are measured using a screw gauge and a micrometer, respectively. The have the same pitch of 0.5 mm. The number of divisions on their circular scale is 100. The contributions to the maximum probable error of the Y measurement

A. (a) due to the errors in the measurements of d and l are the same.

B. (b) due to the error in the measurement of d is twice that due to the error in the measurement of l.

C. (c) due to the error in the measurement of l is twice that due to the error in the measurement of d.

D. (d) due to the error in the measurement of d is four times that due to the error in the measurement of l.

Answer: A

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16. The diameter of a cylinder is measured using a Vernier callipers with no zero error. It is found that the zero of the Vernier scale lies between $5.10cm$ and $5.15cm$ of the main scale. The Vernier scale has 50 divisions equivalent to $2.45cm$. The 24^{th} division of the Vernier scale exactly coincides with one of the main scale divisions. the diameter of the cylinder is

A. (a) $5.112cm$

B. (b) $5.124cm$

C. (c) $5.136cm$

D. (d) $5.1148cm$

Answer: B

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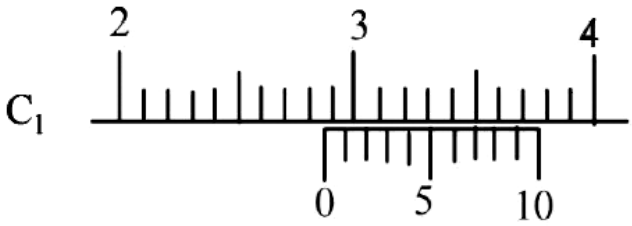
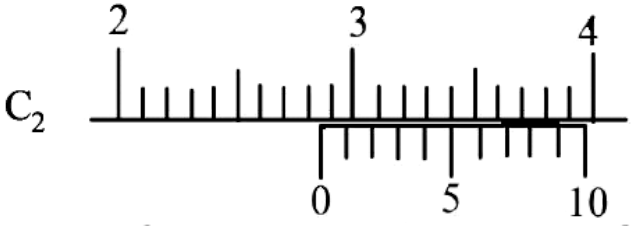
17. There are two Vernier calipers both of which have $1cm$ divided into 10 equal divisions on the main scale. The vernier scale of the calipers (c_1) has 10 equal divisions that correspond to 9 main scale divisions. The Vernier scale of the other calipers (C_2) has 10 equal divisions that correspond to 11 main scale divisions. the reading of the two calipers are shown in the figure. the measured values (in cm) by calipers C_1 and C_2 respectively,



are



A. (a) 2.85 and 2.82

B. (b) 2.87 and 2.83

C. (c) 2.87 and 2.86

D. (d) 2.87 and 2.87

Answer: B

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18. The dimension of the quantities in one (or more) of the following pairs are the same. Identify the pair (s)

A. (a) Torque and Work

B. (b) Angular momentum and work

C. (c) Energy and Young's modulus

D. (d) Light year and wavelength

Answer: A::D

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19. The pairs of physical quantities that have the same dimensions is (are):

A. (a) Reynolds number and coeffiecient of friction

B. (b) Curie and frequency of a light wave

C. (c) Latent heat and gravitational potential

D. (d) Planck's constant and torque

Answer: A::B::C

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20. The SI unit of inductance, the henry can be written as

A. (a) $weber / ampere$

B. (b) $vo < -\sec / amp$

C. (c) $joe / (ampere)^2$

D. (d) $ohm - \sec ond$

Answer: A::B::C::D

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21. Let $[\varepsilon_0]$ denote the dimensional formula of the permittivity of the vacuum, and $[\mu_0]$ that of the permeability of the vacuum. If $M = mass, L = \ \leq n > h, T = time$ and $I = e \leq ctriccurrent$,

A. (a) $[\varepsilon_0] = M^{-1}l^{-3}T^2I$

B. (b) $[\varepsilon_0] = M^{-1}l^{-3}T^4I^2$

C. (c) $[\mu_0] = MLT^{-2}I^{-2}$

D. (d) $[\mu_0] = ML^2T^{-1}I$

Answer: B::C

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22. A student uses a simple pendulum of exactly $1m$ length to determine g, the acceleration due ti gravity. He uses a stop watch with the least count of $1\sec$ for this and record $40\sec onds$ for 20 oscillations for this observation, which of the following statement $(s) is (are)$ true?

A. (a) Error ΔT in measuring T, the time period, is $0.05\sec onds$

B. (b) Error ΔT in measuring T, the time period, is $1\sec onds$

C. (c) Percentage error in the determination of g is $5\ \%$

D. (d) Percentage error in the determination of g is $2.5\ \%$

Answer: A::C

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23. Using the expression $2d \sin\theta = \lambda$, one calculates the values of d by measuring the corresponding angles θ in the range $0 \rightarrow 90 \circ$. The wavelength λ is exactly known and error in θ is constant for all values of θ. As θ increases from $0 \circ$

A. (a) The absolute error in d remains constant

B. (b) The absolute error in d increases

C. (c) The fractional error in d remains constant

D. (d) The fractional error in d decreases

Answer: D

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24. Planck's constant h, speed of light c and gravitational constant $G$are used to form a unit of length L and a unit of

mass M. Then the correct option (s) is (are)

A. (a) $M \propto \sqrt{c}$

B. (b) $M \propto \sqrt{G}$

C. (c) $L \propto \sqrt{h}$

D. (d) $L \propto \sqrt{g}$

Answer: A::C::D

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25. Consider a Vernier callipers in which each $1cm$ on the main scale is divided into 8 equal divisions and a screw gauge 5 divisions of the Vernier scale coincide with 4 divisions on the main scale and in the screw gauge, one complete rotation of the circular scale moves it by two divisions on the linder scale. Then:

A. (a) If the pitch of the screw gauge is twice the least count of the Vernier callipers, the least count of the screw gayge is $0.01mm$

B. (b) If the pitch of the screw gauge is twice the least count of the Vernier callipers, the least count of the screw gauge is $0.005mm$

C. (c) If the least count of the linear scale of the screw gauge is twice the least count of the Vernier callipers, the least count of the screw gauge is $0.01mm$

D. (d) If the least count of the linear scale of the screw gauge is twice the least count of the Vernier callipers, the least count of the screw gauge is $0.005mm$

Answer: B::C

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26. In terms of potential difference C, electric current$I$, permittivity ε_0, permeability μ_0 and speed of light c, the dimensionally correct equation (s) is (are)

A. (a) $\mu_0 I^2 = \varepsilon_0 V^2$

B. (b) $\mu_0 I = \mu_0 V$

C. (c) $I = \varepsilon_0 cV$

D. (d) $\mu_0 cI = \varepsilon_0 V$

Answer: A::C

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27. A length - scale (l) depends on the permittivity (ε) of a dielctric material. Boltzmann constant (k_B), the absolute tempreture (T), the number per unit volume (n) of certain charged particles, and the charge (q) carried by each of the partcles. which of the following expression (s) for I is (are) dimensionally correct?

A. (a) $l = \sqrt{\left(\frac{nq^2}{\varepsilon K_B T}\right)}$

B. (b) $l = \sqrt{\left(\frac{\varepsilon K_B T}{nq^2}\right)}$

C. (c) $l = \sqrt{\left(\frac{q^2}{\varepsilon n^{2/3} K_B T}\right)}$

D. (d) $l = \sqrt{\left(\frac{q^2}{\varepsilon n^{1/3} K_B T}\right)}$

Answer: B::D

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28. In an experiment to determine the acceleration due to gravity g, the formula used for the time period of a periodic motion is $T = 2\pi\sqrt{\left(7\frac{R-r}{5g}\right.}$. The values of R and r are measured to be $(60 \pm 1)mm$ and $(10 \pm 1)mm$, repectively. In five successive measurment, the time period is found to be $0.52s, 0.56s, 0.57s, 0.54s$ and $0.59s$. the least count of the watch used for the measurement of time period is $0.01s$. Which of the following satement (s) is (are) true?

A. (a) The error in the measurement of r is $10\ \%$

B. (b) The error in the measurement of T is $3.75\ \%$

C. (c) The error in the measurement of T is $2\ \%$

D. (d) The error in the determined value of g is $11\ \%$

Answer: A::B::D

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29. Give the MKS units for each of the following quatities.

(i) Young's modulus

(ii) Magnetic induction

(iii) Power of a lens

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30. A gas bubble , from an explosion under water , oscillates with a period T proportional in $P^a D^b E^c$, where p is the static pressure , d is the density of water and E is the total energy of the explosion . Find the value of$a$, b and$c$.

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31. Write the dimensions of the following in terms of mass, time, length and charge

(i) magnetic flux

(ii) rigidity modulus

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32. If n^{th} division of main scale coincides with $(n+1)^{th}$ divisions of vernier scale. Given one main scale division is equal to 'a' units. Find the least count of the vernier.

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33. A screw gauge having 100 equal division and a pitch of length $1mm$ is used to measue the diameter of a wire of length

$5.6cm$. The main scale reading is $1mm$ and 47^{th} circular division coincides with the scale. Find the curved surface area of wire in cm^2 to appropriate significant fihure.

$\left(use\pi = \frac{22}{7}\right.$

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34. In Searl's experiment, which is used to find Young's Modulus of elasticity, the diameter of experimental wire is $D = 0.05cm$ (measured by a scale of least count $0.001cm$) and length is $L = 110cm$ (measured by a scale of least count $0.1cm$). A weight of $50N$ causes an extension of $X = 0.125cm$ (measured by a micrometer of least count $0.001cm$). find the maximum possible error in the values of Young's modulus. Screw gauge and meter scale are free error.

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35. The side of a cube is measured by vernier callipers (10 divisions of a vernier scale coincide with 9 divisions of main scale, where 1 division of main scale is $1mm$). The main scale reads $10mm$ and first division of vernier scale coincides with the main scale. Mass of the cube is $2.736g$. find the density of the cube in appropriate significant figures.

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36. A dence collection of equal number of electrona and positive ions is called netural plasma. Certain solids contianing fixed positive ions surroundedby free electrons can be treated as neytral plasma. Let 'N' be the numbrer density of free electrons, each of mass 'm'. When the elctrons are subjected to an eletric field, they are displaced relatively away from the heavy positive

ions. if the electric field becomes zero, the electrons begin to oscillate about the positive ions with a natural angular frequency 'ω_P' which is called the plasma frequency. to sustain the oscillations, a time varying electric field needs to be applied that has an angular frequrncy ω, where a part of the energy is absorbed and a part of it is reflected. As ω approaches ω_p all the free electrons are set to resonance together and all the energy is reflected. this is the explaination of high reflectivity of metals.

(1) Taking the electronic charge as 'e' and the permittivity as 'ε_0'. use dimensional analysis to determine the correct expression for ω_p.

A. (a) $\sqrt{\frac{Ne}{m\varepsilon_0}}$

B. (b) $\sqrt{\frac{m\varepsilon_0}{Ne}}$

C. (c) $\sqrt{\frac{Ne^2}{m\varepsilon_0}}$

D. (d) $\sqrt{\frac{Ne^2}{m\varepsilon_0}}$

Answer: C

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37. A dence collection of equal number of electrona and positive ions is called netural plasma. Certain solids contianing fixed positive ions surroundedby free electrons can be treated as neytral plasma. Let 'N' be the numbrer density of free electrons, each of mass 'm'. When the elctrons are subjected to an eletric field, they are displaced relatively away from the heavy positive ions. if the electric field becomes zero, the electrons begin to oscillate about the positive ions with a natural angular frequency 'ω_P' which is called the plasma frequency. to sustain the oscillations, a time varying electric field needs to be applied that has an angular frequrncy ω, where a part of the energy is absorbed and a part of it is reflected. As ω approaches ω_p all the

free electrons are set to resonance together and all the energy is reflected. this is the explaination of high reflectivity of metals.

(2) Estimate the wavelength at which plasma reflection will occur for a metal having the density of electrons $N \approx 4 \times 10^{27} m^{-3}$. Taking $\varepsilon_0 = 10^{11}$ and mass $m \approx 10^{-30}$, where these quantities are in proper SI units.

A. (a) $800nm$

B. (b) $600nm$

C. (c) $300nm$

D. (d) $200nm$

Answer: B

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38. To find the distance d over which a signal can be seen clearly in foggy conditions, a railways-engineer uses dimensions and assumes that the distance depends on the mass density ρ of the fog, intensity (power/area) S of the light from the signal and its frequency f. the engineer finds that d is proportional to $S^{1/n}$. the value of n is

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39. During Searle's experiment, zero of the Vernier sacle lies between 3.20×10^{-2}, and $3.25 \times 10^{-2} m$ of the main scale. The 20^{th} division of the Vernier scale exactly coincides with one of the main scale divisions. When an additional load of $2kg$ is applied to the wire, the zero of the vernier scale still lies between 3.20×10^{-2}, and $3.25 \times 10^{-2} m$ of the main scale but now the 45^{th} division of Vernier scale coincide with one of the

main scale divisions. the length of the thin metallic wire is $2m$ and its cross-sectional ares is $8 \times 10^{-7} m^2$. the least count of the Vernier scale is $1.0 \times 10^{-5} m$. the maximum percentage error in the Young's modulus of the wire is

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40. The energy of a system as a function of time t is given as $E(t) = A^2 \exp(-\alpha t), \alpha = 0.2 s^{-1}$. The measurement of A has an error of 1.25%. If the error In the measurement of time is 1.50%, the percentage error in the value of $E(t)$ at t = 5 s` is

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41. Identify the pair whose dimensions are equal

A. (a) torque and Work

B. (b) stress and energy

C. (c) force and stress

D. (d) force and work

Answer: A

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42. Dimension of $\frac{1}{\mu_0 \varepsilon_0}$, where symbols have usual meaning, are

A. (a) $\left[L^{-1}T\right]$

B. (b) $\left[L^{-2}T^{2}\right]$

C. (c) $\left[L^{2}T^{-2}\right]$

D. (d) $\left[LT^{-1}\right]$

Answer: C

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43. The physical quantities not having same dimensions are

A. (a) torque and Work

B. momentum and planck's constant

C. (c) stress and young's modulus

D. (d) speed and $(\mu - (0)\varepsilon_0)^{-1/2}$

Answer: B

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44. Which one of the following represents the correct dimensions of the coefficient of viscosity?

A. (a) $ML^{-1}T^{-1}$

B. (b) MLT^{-1}

C. (c) $ML^{-1}T^{-2}$

D. (d) $ML^{-2}T^{-2}$

Answer: A

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45. Out of the following pair, which one NOT have identical dimensions is

A. (a) impulse and momentum

B. (b) angular momentum and planck's constant

C. (c) work and torque

D. (d) moment of intertia and moment of a force (towards north - west)

Answer: D

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46. The dimension of magnetic field in M, L, T and C (coulomb) is given as

A. (a) $MLT^{-1}C^{-1}$

B. (b) $MT^{2}C^{-2}$

C. (c) $MT^{-1}C^{-1}$

D. (d) $MT^{-2}C^{-1}$

Answer: C

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47. A body of mass $m = 3.513kg$ is moving along the x-axis with a speed of $5.00ms^{-1}$. The magnetude of its momentum is recorded as

A. (a) $17.6kgms^{-1}$

B. (b) $17.565kgms^{-1}$

C. (c) $17.56kgms^{-1}$

D. (d) $17.57kgms^{-1}$

Answer: A

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48. Two full turns of the circular scale of a screw gauge cover a distance of $1mm$ on its main scale. The total number of divisions on the circular scale is 50. Further, it is found that the screw gauge has a zero error of $-0.03mm$. While main scale reading of $3mm$ and the number of circular scale divisions in line with the main scale as 35. the dimeter of the wire is

A. (a) $3.32mm$

B. (b) $3.73mm$

C. (c) $3.67mm$

D. (d) $3.38mm$

Answer: D

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49. in an experiment the angles are required to be using an instrument, 29 divisions of the main scale exactly coincide with the 30 divisions of the vernier scale. If the sallest division of the main scale is half- a degree $(= 0.5^{\circ}$, then the least count of the instrument is :

A. (a) half minute

B. (b) one degree

C. (c) half degree

D. (d) one minute

Answer: D

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50. The respective number of signficant figures for the numbers $23.023, 0.0003$ and 2.1×10^{-3} are

A. (a) $5, 1, 2$

B. (b) $5, 1, 5$

C. (c) $5, 5, 2$

D. (d) $4, 4, 2$

Answer: A

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51. A screw gauge gives the following reading when used to mesure the diametre of a wire.

Main scale reading : $0mm$

Circular scale reading : $52 \div isions$

Given that $1mm$ on main scale corresponds to 100 divisions of the circular scale. the diameter of wire from the above data is :

A. (a) $0.052cm$

B. (b) $0.026cm$

C. (c) $0.005cm$

D. (d) $0.52cm$

Answer: A

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52. Resistance of a given wire is obtained by measuring the current flowing in it and the voltage difference applied across it. If the percentage errors in the measurment of the current and the voltage difference are 3% each, then error in the value of resistance of the wire iS :

A. (A) 6%

B. (b) zero

C. (c)1%

D. (d)3%

Answer: A

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53. A spectrometer gives the following reading when used to measure the angle of a prism.

Main scale reading : $58.5 degree$

Vernier scale reading : 09 divisions

Given that 1 division on main scale correspods to 0.5 degree. Total divisions on the vernier scale is 30 and match with 29

divisions of the main scale. the angle of the prism from the above data:

A. (a) $58.59 degree$

B. (b) $58.77 degree$

C. (c) $58.65 degree$

D. (d) $59 degree$

Answer: C

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54. Let $[\in_0]$ denote the dimensional formula of the permittivity of vacuum. If $M = mass, L = \leq n > h, T = time$ and $A = elctriccurrent$, then :

A. (a) $\in_0 = \left[M^{-1}L^{-3}T^2A\right]$

B. (b) $\in_0 = \left[M^1L^3T^5A^2\right]$

C. (c) $\in_0 = \left[M^1L^2T^1A^2\right]$

D. (d) $\in_0 = \left[M^1L^{-2}T^1A\right]$

Answer: B

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55. A student measured the length of a rod and wrote it as $3.50cm$. Which insturment did he use to measure it?

A. (a)A meter scale.

B. (b) A vervier calliper where the 10 divisions in vernier scale matches with 9 division in main scale and scale has 10 divisions in $1cm$.

C. (c) A screw gauge having 100 divisions in the circular scale and pitch as $1mm$.

D. (d) A screw gauge having 50 divisions in the circular scale and pitch as $1mm$.

Answer: B

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56. The period of oscillation of a simple pendulum is $T = 2\pi\sqrt{\frac{L}{g}}$. Meaured value of L is $20.0cm$ know to $1mm$ accuracy and time for 100 oscillation of the pendulum is found to be $90s$ using a wrist watch of $1s$ resolution. The accracy in the determinetion of g is :

A. (a) $1\ \%$

B. (b) $5\ \%$

C. (c) $2\ \%$

D. (d) $3\ \%$

Answer: D

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57. A student measures the time period of 100 ocillations of a simple pendulum four times. The data set is $90s$, 91 s, 95 s, and 92 s. $If the \min i\mu m \div ision \in themeasur \in gclockis1$ s`, then the reported men time should be:

A. (a) $92 \pm 1.8s$

B. (b) $92 \pm 3s$

C. (c) $92 \pm 2s$

D. (d) $92 \pm 5.0s$

Answer: A

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58. A screw gauge with a pitch of $0.5mm$ and a circular scale with 50 divisions is used to measure the thicknes of a thin sheet of Aluminium. Before starting the measurement, it is found that wen the jaws of the screw gauge are brought in cintact, the 45^{th} division coincide with the main scale line and the zero of the main scale is barely visible. what is the thickness of the sheet if the main scale readind is $0.5mm$ and the $25th$ division coincide with the main scale line?

A. (a) $0.70mm$

B. (b) $0.50mm$

C. (c) $0.75mm$

D. (d) $0.80mm$

Answer: D

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