PHYSICS

BOOKS - RESNICK AND HALLIDAY PHYSICS (HINGLISH)

UNITS AND MEASUREMENT

Sample Problem

1. When the sun appears to be just on horizon, it is in fact below the horizon. This is because the light from the sun bends when it enters the earth's atmosphere. Let us assume that atmosphere is uniform and has index of refraction equal to μ. It extends upto a height $h(< < R =$ radius of earth) above the earth's surface. In absence of atmosphere how late would we see the sunrise compared to what we see now? Take time period of rotation of earth to be T. Calculate this time for following data $R = 6400km, \mu = 1.0003, h = 20km, T = 24hr.$

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2. The world's largest ball of string is about 2 m in radius. To the nearest order of magnitude, what is the total length L of the string in the ball?

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3. The mass of a box is $2.3kg$. Two marbles of masses $2.15g$ and $12.39g$ are added to it . Find the total mass of the box to the correct number of significant figures.

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4. The length of a rectangular sheet is $1.5 cm$ and breadth is $1.023 cm$. Find the area of the face of a rectangular sheet to the correct number of significant figures.

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5. The lengths of two rods are recorded as $l_1 = 25.2 \pm 0.1 cm$ and $l_2 = 16.8 \pm 0.1 cm$. Find the sum of the lengths of the two rods with the limits of error.

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6. The length and the width of a rectangular plate are $(16.30 \pm 0.05)m$ and $(13.80 \pm 0.05)m$, respectively. Calculate the area of the plate and also find the uncertainty in the area.

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7. The length of a cylinder is measured with a meter rod having least count $0.1 cm$. Its diameter is measured with Vernier calipers having least count $0.01 cm$. Given that length is $5.0 cm$ and radius is $2 cm$. Find the percentage error in the calculated value of the volume.

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8. Using a screw gauge, the diameter of a metal rod was measured. The observations are given as follows: 0.39 mm, 0.38 mm, 0.37 mm, 0.41 mm, 0.38 mm, 0.37 mm, 0.40 mm, 0.39 mm. Calculate (a) the most accurate value of the diameter (b) the relative error, and (c) the percentage error in the measurement of the diameter.

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9. Using the dimensional analysis, check whether the following equation is correct or not: $T = 2\pi\sqrt{R^3/GM}$.

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10. 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 find the expression of T.

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Problem

1. A gry is an old English measure for length, defined as 1/10 of a line, where line is another old English measure for length, defined as 1/12 inch. A common measure for length in the publishing business is a point, defined as 1/72 inch. What is an area of 0.75 gry^2 in points squared (points^2)?

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2. How many m/s are there in 1.0 mi/h?

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3. Spacing in this book was generally done in units of points and picas: 12 points = 1 pica, and 6 picas = 1 inch. If a figure was misplaced in the page proofs by 0.70 cm, what was the misplacement in (a) picas and (b) points?

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4. The height of a motion picture film's frame is 35.0 cm. If 24.0 frames go by in 1.0 s, calculate the total number of frames required to show a 2.0 h long motion picture.

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5. Assume the legal limit of speed is 70.0 mi/h. If driving day and night without stopping for 1.00 year, what is the maximum number of miles one can drive?

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6. A boy measures the thickness of a human hair by looking at it through a microscope of magnification 100x. After 25 observations, the boy finds that the average width of the hair in the field of view of the microscope is 3.8 mm. What is the estimate on the thickness of hair?

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7. A cubical object has an edge length of 1.00 cm. If a cubical box contained a mole of cubical objects, find its edge length (one mole = 6.02×10^{23} units).

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8. It is claimed that two cesium clocks, if allowed to run for 100 years, free from any disturbance, may differ by only about 0.02s.

What does this imply for the accuracy of the standard cesium clock in measuring a time interval of 1s ?

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9. Age of the universe is about 10^{10} years whereas the mankind has existed for 10^{6} years. How many seconds would the man have existed if age of universe were one day.

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10. A clock with a brass pendulum shaft keeps correct time at a certain temperature.

a. How closely must the temperature be controlled if the clock is not to gain or lose more that 1 s a day? Does the answer depend on the period of the pendulum?

b. Will an increase of temperature cause the clock to gain or lose? $(\alpha_{\text{brass}} = 2 \times 10^{-5} / {}^{\circ} C)$

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11. A lecture period (50 min) is close to 1 microcentury.

(a) How long is a microcentury in minutes? (b) Using percentage difference = $\frac{\text{actual - approximation}}{\text{actual}} 100,$

find the percentage difference from the approximation.

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12. Time standards are now based on atomic clocks. A promising second standard is based on pulsars, which are rotating neutron stars (highly compact stars consisting only of neutrons). Some rotate at a rate that is highly stable, sending out a radio beacon that sweeps briefly across Earth once with each rotation, like a lighthouse beacon. Pulsar PSR 1937 + 21 is an example, it rotates once every 1.557 806 448 872 75 ± 3 ms, where the trailing ± 3 indicates the uncertainty in the last decimal place (it does not mean ± 3 ms). (a) How many rotations does PSR 1937 + 21 make in 8.00 days? (b) How much time does the pulsar take to rotate exactly one million times and (c) what is the associated uncertainty?

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13. Two clocks A and B being tested against a standard clock located in the national laboratory At 10.00 AM by the standard clock, the readings of the two clocks are shown in following table

Day	Clock A	Clock B
I^{st}	$10:00:06$	$8:15:00$
II^{nd}	$10:01:13$	$8:15:0.1$
III^{rd}	$9:59:0.8$	$8:15:04$
IV^{th}	$10:02:15$	$8:14:58$
V^{th}	$9:58:10$	$8:15:02$

If you are doing an experiment that requires precision time interval measurements, which of the two clocks will you prefer ?

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14. Assuming the length of the day uniformly increases by 0.001 second per century. Calculate the net effect on the measure of time over 20 centuries.

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15. Gold, which has a density of $19.32g/cm^3$, is the most ductile metal and can be pressed into a thin leaf or drawn out into a longfiber. (a) If a sample of gold with a mass of 29.34 g is pressed into a leaf of $1.000 \mu m$ thickness, what is the area of the leaf? (b) If, instead, the gold is drawn out into a cylindrical fiber of radius $2.500 \mu m$, what is the length of the fiber?

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16. Estimate the averaage atomic mass density of a sodium atom, assuming its size ot be 2.5 Å. Compare it with density of sodium in its crystalline phase $\left(970 kg m^{-3}\right)$. Are the two denities of the same order of magnitude ? If so, why ?

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17. A grocer's balance shows the mass of an object as 2.500 kg. Two gold pieces of masses 21.15 g and 21.17 g are added to the box. What is (a) the total mass in the box and (b) the difference in the masses of the gold pieces to the correct number of significant figures?

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18. Einstein's mass - energy relation emerging out of his famous theory of relativity relates mass (m) to energy $(E) as E = mc^2$, where c is speed of light in vacuum. At the nuclear level, the magnitudes of energy are vary small. The energy at nuclear level is usually measured in MeV, where $1 MeV = 1.6 \times 10^{-13} J$, the masses are measured in unified mass unit (u) where $1u = 1.67 \times 10^{-27} kg$. (a) Show that the energy equivalent of 1u is 931.5 MeV. (b) A student writes the relation as 1 u = 931.5 MeV. The teacher points out that the relation is dimensionally incorrect. Write the correct relation.

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19. Water is poured into a container that has a small leak. The mass m of the water is given as a function of time t by $m = 500t^{0.8} - 3.00t + 20.00$, with $t \geq 0$, m in grams, and t in seconds. (a) At what time is the water mass greatest, and (b) what is that greatest mass? In kilograms per minute, what is the rate of mass change at (c) t = 3.00 s and (d) t = 5.00 s?

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20. A vertical container with base area measuring 14.0 cm by 17.0 cm is being filled with identical pieces of candy, each with a volume of $50.0 mm^3$ and a mass of 0.0200 g. Assume that the volume of the empty spaces between the candies is negligible. If the height of the candies in the container increases at the rate of 0.250 cm/s, at what rate (kilograms per minute) does the mass of the candies in the container increase?

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Practice Questions Single Correct Choice Type

1. The pitch of a screw gauge is 1 mm with 100 divisions on the circular scale. For a given wire, the linear scale reads 2 mm and 64th divisions on the circular scale coincides with the reference line. If the length of the wire is 3.5 cm, find the volume in cm^3?

A. $19.0cm^3$

B. $0.19cm^3$

C. $76.0cm^3$

D. $0.76cm^3$

Answer: B

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2. The formula $W = (F + 2Ma)v^n$, where W is the work done, F is the force, M is the mass, a is the acceleration and v is the velocity can be made dimensionally correct for

A. $n = 0$

B. $n = 1$

C. $n = -1$

D. no value of n

Answer: D

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3. To determine the young's modulus of a wire , the formula is $Y = \frac{F}{A} \cdot \frac{L}{\Delta l}$, where L = l ength ,A = area of cross - section of the wire , ΔL = change in the length of the wire when streched with a force F. Find the conversion factor to change it from CGS t o MKS system.

A. 1

B. 10

C. 0.1

D. 0.01

Answer: C

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4. In the measurement of a physical quantity $X = A^2 \frac{B}{C^{1/3}} D^3$ The percentage errors introduced in the measurement of the quantities A, B, C and D are 2%, 2%, 4% and 5% respectively. Then, the minimum amount of percentage error in the measurement of X is contributed by

A. A

B. B

C. C

D. D

Answer: C

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5. If frequency F, velocity V , and density D are considered fundamental units , the dimensional formula for momentum will be

A. DVF^2

B. DV^2F^{-1}

C. $D^2V^2F^2$

D. DV^4F^{-3}

Answer: D

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6. If pressure can be expressed as $P = \frac{b}{a}\sqrt{1 + \frac{k\theta t^3}{ma}}$ where k is the Boltzmann's constant, θ is the temperature, t is the time and a and b are constants, then dimensional formula of b is equal to the dimensional formula of

A. linear momentum

B. force

C. angular momentum

D. torque

Answer: A

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7. During a short interval of time the speed v in m/s of an automobile is given by $v = at^2 + bt^3$, where the time t is in seconds. The units of a and b are, respectively.

A. ms^2, ms^4

B. $s^{3}/m, s^{4}/m$

C. $m/s^{2}, m/s^{3}$

D. $m/s^{3}, m/s^{4}$

Answer: D

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8. You may not know integration , but using dimensional analysis you can check on some results . In the integral $\int \frac{dx}{(2ax - x^{2})^{1/2}} = a^{n} \sin^{-1}\left(\frac{x}{a} - 1\right)$, find the valiue of n .

A. 1

B. -1

C. 0

D. $\frac{1}{2}$

Answer: C

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9. The volume of liquid flowing per second is called the volume flow rate Q and has the dimensions of $[L]^3/[T]$. The flow rate of a liquid through a hypodermic needle during an injection can be estimated with the following equation:

$$Q = \frac{\pi R^n (P_2 - P_1)}{8\eta L}$$

The length and radius of the needle are L and R, respectively, both of which have the dimension [L]. The pressures at opposite ends of the needle are P_2 and P_1, both of which have the dimensions of $[M]/[L][T]^2$. The symbol η' represents the viscosity of the liquid and has the dimensions of $[M]/[L][T]$. The symbol π stands for pi and. like the number 8 and the exponent n, has no dimensions. Using dimensional analysis, determine the value of n in the expression for Q.

A. 1

B. 3

C. 2

D. 4

Answer: D

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10. 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. resistance

B. charge

C. voltage

D. current

Answer: D

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11. The main scale of Vernier calipers reads in millimeter. Its Vernier is divided into 10 divisions, which coincide with 9 divisions of the main scale. When there is nothing between its jaws, the fifth division of its Vernier scale coincides with a division on the main scale. Also, zero of the Vernier scale lies on the right side of the zero of the main scale. When a coin in tightly gripped by its jaws to measure the diameter, the zero of the Vernier scale is observed to be slightly left to the 3.4 cm and the third Vernier scale division coincides with a main scale division. The diameter of the coin is

A. 3.27 cm

B. 3.38 cm

C. 3.33 cm

D. 3.23 cm

Answer: B

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12. At the end of a year, a motor car company announces that sales of a pickup are down by 43% for the year. If sales continue to decrease by 43% in each succeeding year, how long will it take for sales to decrease to zero?

A. 1 year

B. 2 year

C. 3 year

D. More than 5 years

Answer: D

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13. A body travels uniformly a distance of (10.2 ± 0.4) m in a time interval $(6.0 \pm 0.2)s$. The speed of the particle is best expressed as (in m/s^{-1}).

A. 1.7 ± 0.12

B. 1.7 ± 0.01

C. 1.7 ± 0.07

D. 1.7 ± 0.00

Answer: A

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14. In two systems of relations among velocity , acceleration , and force are , respectively , $v_2 = \frac{\alpha^2}{\beta} v_1, a_2 = \alpha\beta a_1, \text{ and } F_2 = \frac{F_1}{\alpha\beta}$. If α and β are constants , then make relations among mass , length , and time in two systems.

A. $M_2 = \frac{\alpha}{\beta} M_1, L_2 = \frac{\alpha^2}{\beta^2} L_1, T_2 = \frac{\alpha^3 T_1}{\beta}$

B. $M_2 = \frac{1}{\alpha^2\beta^2} M_1, L_2 = \frac{\alpha^3}{\beta^3} L_1, T_2 = T_1 \frac{\alpha}{\beta^2}$

C. $M_2 = \frac{\alpha^3}{\beta^3} M_1, L_2 = \frac{\alpha^2}{\beta^2} L_1, T_2 = \frac{\alpha}{\beta} T_1$

D. $M_2 = \frac{\alpha^2}{\beta^2} M_1, L_2 = \frac{\alpha}{\beta^2} L_1, T_2 = \frac{\alpha^3}{\beta^3} T_1$

Answer: B

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15. Metric time is defined so that one day equals 10 hours, one hour equals 100 minutes, and one minute equals 100 seconds. One metric second equals how many normal seconds?

A. 0.60

B. 0.864

C. 1.00

D. 1.16

Answer: B

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16. The equation of the stationary wave is $y = 2a\sin(2\pi ct / \lambda)\cos(2\pi x / \lambda)$, which of the following statements is wrong?

A. The unit of ct is same as that of λ

B. The unit of x is same as that of λ

C. The unit of $2\pi c / \lambda$ is same as that of $2\pi x / \lambda t$

D. The unit of c / λ is same as that of x / λ

Answer: D

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17. A spring is hanging down from the ceiling, and an object of mass m is attached to the free end. The object is pulled down, thereby stretching the spring, and then released. The object

oscillates up and down, and the time T required for one complete up-and-down oscillation is given by the equation $T = 2\pi\sqrt{m / k}$, where k is known as the spring constant. What must be the dimension of k for this equation to be dimensionally correct?

A. $\frac{[M]}{[T]}$

B. $\frac{[T]}{[M]}$

C. $\frac{[M]}{[T]^2}$

D. $\frac{[T]}{[M]^2}$

Answer: C

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18. 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. $v_T \propto \eta r m g$

D. $v_T \propto \frac{mgr}{\eta}$

Answer: A

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19. The term $(1/2)\rho v^2$ occurs in Bernoulli's equation, with ρ being the density of a fluid and v its speed. The dimensions of this term are

A. $[M^{-1}L^5T^2]$

B. $[MLT^2]$

C. $[ML^{-1}T^{-2}]$

D. $[M^{-1}L^9T^{-2}]$

Answer: C

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20. The variables x, v, and a have the dimensions of $[L], [L]/[T]$, and $[L]/[T]^2$, respectively. These variables are related by an equation that has the form $v^n = 2ax$, where n is an integer constant (1, 2, 3, etc.) without dimensions. What must be the value of n, so that both sides of the equation have the same dimensions? Explain your reasoning.

A. 1

B. 3

C. 2

D. 4

Answer: C

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21. The SI standard of length is based on:

A. the distance from the north pole to the equator along a meridian passing through Paris

B. wavelength of light emitted by Hg^{198}

C. wavelength of light emitted by Kr^{86}

D. the speed of light

Answer: D

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22. With the usual notations the following equation $S_t = u + \frac{1}{2}a(2t - 1)$ is

A. only numerically correct

B. only dimensionally correct

C. both numerically and dimensionally correct

D. neither numerically nor dimensionally correct

Answer: C

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23. 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 find the expression of T.

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

Answer: A

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24. The relative density of material of a body is found by weighting it first in air and then in water . If the weight in air is $(5.00 \pm 0.05)N$ and the weight in water is $(4.00 \pm 0.05)N$. Find the relative density along with the maximum permissible percentage error.

A. $5.0 \pm 11\%$

B. $5.0 \pm 1\%$

C. $5.0 \pm 6\%$

D. $1.25 \pm 5\%$

Answer: A

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25. A physical quantity $P = B^2 l^2 / m$ where B is the magnetic induction, l is the length and m is the mass. The dimensions of P is

A. MLT^{-3}

B. $ML^2T^{-4}I^{-2}$

C. $M^2L^2T^{-4}I$

D. $MLT^{-2}I^{-2}$

Answer: B

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26. If each frame of a motion picture film is 35 cm high, and 24 frames go by in a second, estimate how many frames are needed to show a two hour long movie.

A. 1400

B. 25 000

C. 50 000

D. 170 000

Answer: D

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27. The famous Stefan's law of radiation states that the rate of emission of thermal radiation per unit by a black body is proportional to area and fourth power of its absolute temperature that is $Q = \sigma A T^4$ where A = area, T = temperature and σ is a universal constant. In the 'energy-length-time temperature' (E-L-T-K) system the dimension of σ is

A. $E^{2}T^{2}L^{-2}K^{-2}$

B. $E^{-1}T^{-2}L^{-2}K^{-1}$

C. $ET^{-1}L^{-3}K^{-4}$

D. $ET^{-1}L^{-2}K^{-4}$

Answer: D

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28. If the velocity of light c, Planck's constant h and time t are taken as basis of fundamental units, then the dimension of force will change to

A. $hc^{-1}t^{-2}$

B. $hc^{-1}t^{2}$

C. $hc^{-1}t^{-1}$

D. $h^{-1}c^{-1}t^{-2}$

Answer: A

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29. If the acceleration due to gravity is represented by unity in a system of unit and one second is the unit of time , the unit length is

A. the new unit of length is g meter

B. the new unit of length is 1 meter

C. the new unit of length is g^2 meter

D. the new unit of time is 1/g second

Answer: A

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30. The largest mass (m) that can be moved by a flowing river depends on velocity (v), density (ρ) of river water and acceleration due to gravity (g). The correct relation is

A. $m \propto \frac{\rho^2 v^4}{g^2}$

B. $m \propto \frac{\rho v^6}{g^2}$

C. $m \propto \frac{\rho v^4}{g^3}$

D. $m \propto \frac{\rho v^6}{g^3}$

Answer: D

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31. If velocity v acceleration A and force F are chosen as fundamental quantities, then the dimensional formula of angular momentum is terms of v,A and F would be

A. $FA^{-1}v$

B. Fv^3A^{-2}

C. Fv^2A^{-1}

D. $F^2v^2A^{-1}$

Answer: B

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Practice Questions More Than One Correct Choice Type

1. Which of the following pairs have different dimensions?

A. Frequency and angular velocity

B. Tension and surface tension

C. Density and energy density

D. Linear momentum and angular momentum

Answer: B::C::D

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2. L, C and R represent the physical quantities inductance, capacitance and resistance respectively. The combinations which have the dimensions of frequency are-

A. $1/RC$

B. R/L

C. $\sqrt{LC}$

D. C / L

Answer: A::B

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3. 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. $[\varepsilon_0] = M^{-1}L^3T^2I$

B. $[\varepsilon_0] = M^{-1}L^{-3}T^4I^2$

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

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

Answer: B::C

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4. The velocity, acceleration and force in two systems of units are related as under:

(i) $v' = \frac{\alpha^2}{\beta} v$

(ii) $a' = (\alpha\beta)a$

(iii) $F' = \left(\frac{1}{\alpha\beta}\right)F$

All the primed symbols belong to one system and unprimed ones belong to the other system. Here α and β are dimensionless constants. Which of the following is/are correct?

A. Length standards of the two systems are related by:

$$L' = \left(\frac{\alpha^3}{\beta^3}\right)L$$

B. Mass standards of the two systems are related by:

$$m' = \left(\frac{1}{\alpha^2\beta^2}\right)m$$

C. Time standards of the two systems are related by:

$$T' = \left(\frac{\alpha}{\beta^2}\right)T$$

D. Momentum standards of the two systems are related by:

$$P' = \left(\frac{1}{\beta^3}\right)P$$

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

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5. Using 1AU (mean earth-sun distance)=$1.5 \times 10^{11} m$ and parsec as distance at which 1AU subtends an angle of 1 sec of arc, find parsec in metres.

A. $4.85 \times 10^{-6} pc$

B. $5.85 \times 10^{-6} pc$

C. $4.85 \times 10^{-5} pc$

D. $3.85 \times 10^{-6} pc$

Answer: A

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6. Astronomical distances are so large compared to terrestrial ones that much larger units of length are used for easy comprehension of the relative distances of astronomical objects. An astronomical unit (AU) is equal to the average distance from Earth to the Sun, $1.50 \times 10^{8} km$. A parsec (pc) is the distance at which 1 AU would subtend an angle of 1 second of arc. A light year (ly) is the distance that light, traveling through a vacuum with a speed of 3.00×10^{5} km/s, would cover in 1 year.

Express a light - year and a parsec in kilometers.

A. $9.48 \times 10^{11} km, 4.08 \times 10^{13} km$

B. $9.48 \times 10^{12} km, 3.08 \times 10^{13} km$

C. $9.48 \times 10^{12} km, 3.08 \times 10^{14} km$

D. $8.48 \times 10^{12} km, 4.08 \times 10^{13} km$

Answer: B

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Practice Questions Matrix Match

1. Match Column I (Event) with Column II (order of the time interval for happening of the event) and select the correct combination from the options given below.

Column I	Column II
(i) Rotation period of Earth	$(p) 10^{5} s$
(ii) Revolution period of Earth	$(q) 10^{7} s$
(iii) Period of a light wave	$(r) 10^{-15} s$
(iv) Period of a sound wave	$(s) 10^{-3} s$

A. (i) $\rightarrow$ (p), (ii) $\rightarrow$ (q), (iii) $\rightarrow$ (r), (iv) $\rightarrow$ (s)

B. (i) $\rightarrow$ (q), (ii) $\rightarrow$ (p), (iii) $\rightarrow$ (s), (iv) $\rightarrow$ (r)

C. (i) $\rightarrow$ (p), (ii) $\rightarrow$ (q), (iv) $\rightarrow$ (s), (iv) $\rightarrow$ (r)

D. (i) $\rightarrow$ (q), (ii) $\rightarrow$ (p), (v) $\rightarrow$ (r), (iv) $\rightarrow$ (s)

Answer: A

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2. Match the physical quantities in Column I with the units given in Column II.

Column I	Column II
(a) GM_eM_s G – universal gravitational constant, M_e – mass of the Earth, M_s – mass of the Sun.	(p) (volt)(coulomb)(meter)
(b) $\frac{3RT}{M}$ R – universal gas constant, T – absolute temperature, M – molar mass.	(q) (kilogram)$(\text{meter})^3$ $(\text{second})^{-2}$

Column I	Column II
(c) $\frac{F^2}{q^2B^2}$ F – force, q – charge, B – magnetic field.	(r) $(\text{meter})^2(\text{second})^{-2}$
(d) $\frac{GM_e}{R_e}$ G – universal gravitational constant, M_e – mass of the Earth, R_e – radius of the Earth.	(s) (farad)$(\text{volt})^2(\text{kg})^{-1}$

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3. The physical quantities, their formulae and dimensions expressed in terms of fundamental quantities are given in

Column I, Column II and Column III, respectively.

Column I	Column II	Column III
(I) Angular momentum	(i) Force × Distance	(J) $[M^1L^2T^{-2}]$
(II) Stefan's constant	(ii) Moment of Inertia × Angular Velocity	(K) $[M^1L^1T^{-1}]$
(III) Planck's constant	(iii) $\dfrac{\text{Energy}}{\text{Frequency}}$	(L) $[M^1L^0T^{-3}K^{-4}]$
(IV) Torque	(iv) $\dfrac{\left(\dfrac{\text{Energy}}{\text{Area} \times \text{Time}}\right)}{(\text{Temperature})^4}$	(M) $[M^1L^2T^{-1}]$

Which of the options correctly represents the physical quantity that remains conserved in planetary motion?

A. (III) (i) (K)

B. (I) (ii) (M)

C. (II) (iv) (J)

D. (IV) (iii) (L)

Answer: B

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4. The physical quantities, their formulae and dimensions expressed in terms of fundamental quantities are given in Column I, Column II and Column III, respectively.

Column I	Column II	Column III
(I) Angular momentum	(i) Force × Distance	(J) $[M^1L^2T^{-2}]$
(II) Stefan's constant	(ii) Moment of Inertia × Angular Velocity	(K) $[M^1L^1T^{-1}]$
(III) Planck's constant	(iii) $\frac{\text{Energy}}{\text{Frequency}}$	(L) $[M^1L^0T^{-3}K^{-4}]$
(IV) Torque	(iv) $\frac{\left(\frac{\text{Energy}}{\text{Area} \times \text{Time}}\right)}{(\text{Temperature})^4}$	(M) $[M^1L^2T^{-1}]$

Which one of the following options correctly represents the physical quantity with the same dimensions as that of angular momentum?

A. (I) (ii) (J)

B. (IV) (iii) (L)

C. (III) (iii) (M)

D. (II) (iv) (M)

Answer: C

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5. The physical quantities, their formulae and dimensions expressed in terms of fundamental quantities are given in Column I, Column II and Column III, respectively.

Column I	Column II	Column III
(I) Angular momentum	(i) Force × Distance	(J) $[M^1L^2T^{-2}]$
(II) Stefan's constant	(ii) Moment of Inertia × Angular Velocity	(K) $[M^1L^1T^{-1}]$
(III) Planck's constant	(iii) $\frac{\text{Energy}}{\text{Frequency}}$	(L) $[M^1L^0T^{-3}K^{-4}]$
(IV) Torque	(iv) $\frac{\left(\frac{\text{Energy}}{\text{Area} \times \text{Time}}\right)}{(\text{Temperature})^4}$	(M) $[M^1L^2T^{-1}]$

Which one of the following options represents correct combination for relation between power radiated and temperature?

A. (IV) (i) (M)

B. (III) (iii) (K)

C. (I) (ii) (J)

D. (II) (iv) (L)

Answer: D

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6. Suppose two students trying to make a new measurement system so that they can use it like a code measurement system and others do not understand it Instead of taking 1 kg, 1 m and 1 second, as basic unit they took unit of mass as α kg, the unit of length as β m and unit of times as γ second. They called power in new system as "Aakash", then find The value of α "Aakash" in watt.

A. (II) (i) (J)

B. (IV) (ii) (M)

C. (I) (iv) (L)

D. (III) (iii) (K)

Answer: B

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7. Suppose two students trying to make a new measurement system so that they can use it like a code measurement system and others do not understand it Instead of taking 1 kg, 1 m and 1 second, as basic unit they took unit of mass as α kg, the unit of length as β m and unit of times as γ second. They called power in new system as "Aakash", then find The value of α "Aakash" in watt.

A. (I) (iv) (L)

B. (III) (ii)

C. (IV) (iii) (M)

D. (II) (i) (J)

Answer: A

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8. Suppose two students are trying to make a new measurement system so that they can use it like a code measurement. Instead of taking 1 kg, 1 m 1 s, as the basic unit they took unit of mass as α kg, the unit of length as β m and the unit of tme as γ s. They called the new system as ACME. Column I represents the units of the physical quantities, Column II represents the ACME units and Column III represents the CGS units of the physical quantities.

Column I	Column II	Column III
(I) 1 N in new system	(i) $[\alpha^{-1}\beta^{-2}\gamma^{2}]$	(J) $g\ cm^{2}s^{-3}$
(II) 1 J in new system	(ii) $[\alpha^{1}\beta^{2}\gamma^{-3}]$	(K) dyne cm^{-2}
(III) 1 Pa in new system	(iii) $[\alpha^{-1}\beta^{1}\gamma^{2}]$	(L) dyne
(IV) 1 W in new system	(iv) $[\alpha^{-1}\beta^{-1}\gamma^{2}]$	(M) erg

Which of the following represents the correct combination for a physical quantity known as rate of energy?

A. (III) (iii) (L)

B. (IV) (ii) (J)

C. (II) (i) (M)

D. (I) (iv) (K)

Answer: B

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9. If voltage $V = (100 \pm 5)$ V and current $I = (10 \pm 0.2)$ A, the percentage error in resistance R is

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10. 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.

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11. The time period of oscillation of a simple pendulum is given by $T = 2\pi \sqrt{l/g}$

The length of the pendulum is measured as $1 = 10 \pm 0.1$ cm and the time period as $T = 0.5 \pm 0.02 s$. Determine percentage error in te value of g.

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