PHYSICS

BOOKS - DISHA PUBLICATION PHYSICS (HINGLISH)

CHAPTERWISE NUMERIC /INTEGER ANSWER QUESTIONS

Chapter 1 Physical World Units And Measurements

1. The density of a material in SI units is 128 kg m^{-3}. In certain units in which the unit of length is 25 cm and the unit of mass is 50 g, the numerical value of density of the material is :

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2. the least count of the main scale of a screw gauge is 1 m. the minimum number of divisions on its circular scale required to measure $5\mu m$ diameter of a wire is :

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3. In the densilty measurement of a cube, the mass and edge length are measured as (10.00 ± 0.10) kg and (0.10 ± 0.01) m, respectively. The error in the measurement of density is.

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4. The area of a square is $5.29 cm^2$ The area of 7 such squares taking into account the significant figures is:

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5. A student has measured the length of a wire equal to 0.04580 m. this value of length has the number of significant figures equal to

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6. The period of revolution(T) of a planet moving round the sun in a circular orbit depends upon the radius (r) of the orbit, mass (M) of the sun

and the gravitation constant (G). Then T is proportioni of r^a. The value of a is

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7. Error in the measurement of radius of a sphre is 1%. Then maximum percentage error in the measurement of volume is

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8. Position of a body with acceletation a is given box $x = ka^m t^n$, where t is time and k is numeric constant. Find the value of m.

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9. 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 is LT^{-x}. The value of x is

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10. Subtract 0.2 J from 7.26 and express the result with correct number of significant figures

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11. Multiply 107.88 by 0.610 and express the result with correct number of significant figures.

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12. The velocity of water waves (v) may depend on 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 $v^2 = kg^x \lambda^x \rho^y$. The value of x is (Here k is a constant).

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13. 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.

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14. Let Q denote the charge on the plate of a capacitor of capacitance c. The dimensional formula for $\frac{Q^2}{C}$ is $\left[ML^xT^{-x}\right]$. Find the value of x.

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15. If the error in the measurement of the volume oif sphere is 6% then the error (in percent) in the measurement of its surface area will be:

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Chapter 2 Motion In A Straight Line

1. A particle starts from the origin at time t=0 and moves along the positive x-axis. The graph of velocity with respect to time is shown in figure. What is the position (in metre) of the particle at time t=5s?

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2. A car travels half the distance with a constant velocity of $40m/s$ and the remaining half with a constant velocity of $60m/s$. The average velocity of the car in m/s is

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3. The position of an object moving along x-axis is given by $a+bt^2$, where a=8.5 m and b= $2.5m/s^2$ and t is measured in seconds. The average velocity (in m/s) of the object between t=2s and t=4s is

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4. A car moves a distance of $200m$. It covers the first-half of the distance at speed $40km/h$ and the second-half of distance at speed vkm/h. The average speed is $48km/h$. Find the value of v.

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5. A bus travelling the first one third distance at a speed of 10 km/h, the next one third at 20 km/h and the last one third at 60 km/h. The average speed (in km /h) of the bus is

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6. The v-t graph for a particles is as shown below. The distance (in metre) travelled in the first four second is

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7. The v-t pot of a moving object is shown in the figure. The average velocity of the object during the first 10 seconds is

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8. A motor car moving with a uniform speed of 20 m/sec comes to stop on the application of brakes after travelling a distance of 10m, its deceleration is

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9. A body moves from rest with a constant acceleration of $5m/s^2$. Its instantaneous speed (in m/s) at the end of 10 sec is

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10. A bus starts moving with acceleration $2m/s^2$. A cyclist 96 m behind the bus starts moving simultaneously towards the bus a speed

of 20 m/s. After what minimum time will he be able to overtake the bus?

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11. The displacement x of a particle at the instant when its velocity is v is given by $v = \sqrt{3x + 16}$. Its initial velociyt is

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12. A body starts from rest, if the ration of the distance travelled by the body during the 4th and 3rd second is $\frac{x}{5}$. Find the valud of x.

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13. If a ball is thrown vertically upwards with a velocity of $40m/s$, then velocity of the ball after $2s$ will be $(g = 10m/s^2)$

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14. A stone falls from a ballon that id descending at a uniform rate of 12m/s. The displacement of the stone from the point of release after 10 sec is

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15. Water drops fall at regular intervals from a tap 5 m above the ground. The third drop is leaving the tap, the instant the first drop touches the ground. How far above the ground is the second drop at that instant. $(g = 10ms^{-2})$

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Chapter 3 Motion In Plane

1. A body is project at t= 0 with a velocity $10ms^{-1}$ at an angle of 60° with the horizontal .The readius of curvature of its trajectory at t=1s is R. Neglecting air resitance and taking acceleration due to gravity $g=10ms^{-2}$, the value of R is :

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2. A particle is moving along a circular path with a constant speed $10ms^{-1}$.What is the magnitude of the change in velocity of the particle ,when it moves through an angle of 60° around the center of the circle ?

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3. A particle moves from the point $\left(2.0\hat{i} + 4.0\hat{j}\right)$m at t=0, with an initial velocity ($5.0\hat{i} + 4.0\hat{j}\big)ms^{-1}$. It is acted upon by constant acceleration $\left(4.0\hat{i} + 4.0\hat{j}\right)ms^{-2}$. What is the distance (im metre) of the particle from the origin at time 2s?

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4. Ship A is sailing towards norht east with velocity $\vec{v} = 30\hat{i} + 50\hat{j}$ km/hr where $\hat{i}$ points east and $\hat{j}$, north Ship B is at a distance of 80 km east and 150 km north of Ship A and is sailing towards west at 10 km/hr. A will be at minimum distance from B in _______________hours.

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5. The position vector of a partcle $\overrightarrow{r}(t) = 15t^2\hat{i} + (4 - 20t^2)\hat{j}$. What is the magnitude of the acceleration (in m/s^2) at t=1?

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6. A palne is inclined at an angle $\alpha = 30^\circ$ with respect to the horizontal. A particle is projected with a speed $u = 2ms^{-1}$ from the base of the plane, as shown in figure. The distance (in metre) from the base, at which the particle hits

the plane is close to: (Take $g = 10ms^{-2}$)

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7. The angles between the two vectors $\overrightarrow{A} = 3\hat{i} + 4\hat{j} + 5\hat{k}$ and $\overrightarrow{B} = 3\hat{i} + 4\hat{j} - 5\hat{k}$ will be

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8. A vector is represented by $3\hat{i} + \hat{j} + 2\hat{k}$. Projection of this vector in XY plane is

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9. The resultant of two vectors $\vec{A}$ and $\vec{b}$ is perpendicular to the vector $\vec{A}$ and its magnitude is equal to half the magnitude of vector $\vec{B}$. The angle between $\vec{A}$ and $\vec{B}$ is

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10. A person aiming to reach the exactly opposite point on the bank of a stream is swimming with a speed of $0.5\frac{m}{s}$ at an angle of 120° with the direction of flow of water. The speed of water in the stream is

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11. The horizontal range of a projectile is $4\sqrt{3}$ times its maximum height. Its angle of projection will be

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12. An aircraft moving with a speed of 2.50 m/s is at a height of 6000 m., just overhead of an anti aircraft gun. If the muzzle velcoity is 500 m/s, the firing angle θ should be:

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13. A body is thrown horizontally from the top of a tower of height 5m. It touches the ground at a distance of 10 m from the foot of the tower. The initial velcotiy (in m/s) of the body is $(g = 10ms^{-2})$

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14. At the height 80m, an aeroplane is moving with the speed of 150 m/s. A bomb is dropped from it so as to hit a target. At what distance (in metre) from the target shoud the bomb be dropped (given $g = 10m/s^2$)

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15. Two bodies are thrown up at angles of 45° and 60° respectively, with the horizontal. If both bodies attain same vertical height, then the ratio of velocity with which these are thrown is $\sqrt{\frac{x}{2}}$. Find the value of x.

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Chapter 4 Laws Of Motion

1. A block of mass 10 kg is kept on a rough inclined plane as shown in the figure. A force of

3 N is applied on the block. The coefficient of static friction between the plane and the block is 0.6. What should be the minimum value of force P (in newton), such that the block does not move downward? (Take $g = 10ms^{-2}$)

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2. A mass of 10 kg is suspended vertically by a rope from the roof. When a horizontal force is applied on the rope at some point, the rope deviated at an angle of 45° at the roof point. If the suspended mass is at equilibrium, the magnitude of the force applied is (g $= 10ms^{-2}$)

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3. A bullet of mass 20 g is moving with initial speed of $1ms^{-1}$ just before it starts penetrting a mud wall of thickness 20 cm. If the wall offers a mean resistance of $2.5 \times 10^{-2}N$, the speed (in m/s) of the bullet after emerging from the other side of the wall is nearly equal to:

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4. Two blocks A and B masses $m_A = 1$ kg and $m_B = 3kg$ are kept on the table A and B is 0.2 and between B and the surface of the table is also 0.2. The maximum force F (in newton) that can be applied on B horizontally so that the block A does not slide over the black B is: (Take $g = 10m/s^2$)

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5. A block of mass 5 kg is (i) pushed in case (A) and (ii) pulled in case (B), by a force F=20N, making an angle of 30° will the horizontal as shown in the figures. The coefficient of friction between the block and floor is $\mu = 0.2$. The difference between the acceleration (in m/s^2) of the block in case (B) and case (A) will be: $(g = 10ms^{-2})$

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6. A body of mass 2 kg is moving with a velocity 8 m/s on a smooth surface. If it is to be brought to rest in 4 seconds, then the magnitude of force (in newton) to be applied in opposite direction of motion is

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7. A force of 100 dynes acts oin a mass of 5 gram for 10 sec. The velocity (in cm/s) of the mass will be

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8. A body of mass 0.05 kg is observed to fall with an acceleration of $9.5ms^{-2}$. The opposing force (in newton) of air on the bod is ($g = 9.8ms^{-2}$)

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9. A car having a mass of 1000 kg is moving at a speed of $30\text{metres}/\text{sec}$. Brakes are applied to bring the car to rest. If the frictional force between the tyres and the road surface is 5000 newtons, the car will come to rest in

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10. A ball of mass 150 g starts moving with an acceleration of $20m/s^2$. When hit by a force, which acts on it for 0.1 sec the impulsive force on the ball (in newton second) is

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11. A body of mass 5 kg explodes at rest into three fragments with masses in the ratio 1 : 1 : 3. The fragments with equal masses fly in mutually

perpendicular directions with speeds of 21 m/s. The velocity of the heaviest fragment will be -

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12. An elevator weighing 6000 kg is pulled upward by a cable with an acceleration of $5ms^{-2}$. Taking g to be $10ms^{-2}$, then the tension in the cable is

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13. A block A of mass 7 kg is placed ona frictionless table. A thread tied to it passes over a frictionless pulley and carries a body B of mass 3 kg at the other end.

The acceleration (in m/s^2) of the system is (given $g = 10ms^{-2}$)

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14. Three blocks of masses m_1, m_2 and m_3 are connected by massless strings as shown on a frictionless table. They are pulled with a force $T_3 = 40N$. If $m_1 = 10kg, m_2 = 6kg$ and $m_3 = 4kg$, the tension T_2 (in newton) will be

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15. A light string passes over a frictionless pulley. To one of its ends a mass of 6 kg is attached. To its other end a mass of 10 kg is attached . The tension (in newton) in the thread will be [Take $g = 9.8m/s^2$]

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Chapter 5 Work Energy And Power

1. Thre block A, B and C are lying on a smooth horizontal surface, as shwon in the figure. A and B have equal masses m while C has mass M. Block A is given an initial seed v towards B due to which it collides with B perfectly inelastically. The combined mass collides with C, also perfectly inelastically and $\frac{5}{6}$th of the initial kinetic energy is lost whole process. If the value of M/m is $\frac{4}{x}$. FInd the value of x.

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2. A force acts on a 2 kg object so that its position is given as a function of time as $x = 3t^2 + 5$. What is the work done by this force in first 5 seconds ?

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3. A piece of wood of mass 0.03 kg is dropped from the top of a building 100 m high. At the same time, a bullet of mass 0.02 kg is fired vertically upward with a velocity of 100 m/s from the ground the bullet gets embedded in the wooded piece after striking. find the height to which the combination rises above the building before it starts falling take $g = 10m/s^2$

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4. A particle which is experiencing a force given by $\vec{F} = 3\vec{i} - 12\vec{j}$, undergoes a displacement of $\vec{d} = 4\vec{i}$. If the particle had a kinetic energy of 3 J at the beginning of the displacement, what is its kinetic energy (in joule) at the end of the displacement?

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5. A body is of mass 1 kg falls freely from a height of 100 m. on a platform of mass 3 kg which is mounted on a spring having spring constant $k = 1.25 \times 10^6 N / m$.The body sticks to the platform and the spring's maximum compression is found to be x .Given that $g = 10 ms^{-2}$,the value of x will be calose to :

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6. An alpha-particle of mass m suffers 1-dimentinal eleastic collision with a nucleus at rest of unknown mass. It is scattered directly backwards losing 64% of its initial kinetic energy. The mass of the nucleus is :

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7. A particle moves in one dimension from rest under the influence of a force that varies with the distance travelled by the particle as shown in the figure.The kinetic energy (in Joule) of the particle after it has travelled 3 m is :

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8. A body of mass 2 kg makes an elastic collision with a second body at rest and continues to move in the original direction but with one fourth of its original speed. What is the mass (inkg) of the second body?

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9. A body of mass $3kg$ is under a constant force which causes a displacement s metre in it, given by the relation $s = \frac{1}{3}t^2$, where t is in seconds. Work done by the force in 2 seconds is

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10. A ball is dropped from a height of 100 m. At the surface of the earth, 20% of its energy is lost. To what height the ball will rise?

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11. A force of 5 N, making an angle θ with the horizontal, actig on an object displaces it by 0.4 m along the horizontal direction. If the object gains kinetic energy of 1J. The horizontal component of the force is

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12. A motor of 100 H.P. is moving with a constant velocity of 72 km/hour. The forward force exerted by the engine on the car is –

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13. Four smooth steel balls of equal mass at rest are free to move along a straight line without friction. The first ball is given a velocity of 0.4 m/s . It collides head on with the second elastically, the second one similarly with the third and so on. The velocity of the last ball is

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14. A shell of mass $20kg$ at rest explodes into two fragments whose masses are in the ratio $2:3$. The smaller fragment moves with a velocity of $6m/s$. The kinetic energy of the larger fragment is

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15. A ball drops from a celling of a room and after rebounding twice from the floor reaches a height equal to half that of the ceiling. If th coefficient of restitution is $\left(\frac{1}{2}\right)^{1/x}$. Find the value of x.

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Chapter 6 System Of Particles And Rotational Motion

1. A string is wound around a hollow cylinder of mass 5 kg and radius 0.5 m. If the string is now pulled with a horizontal force of 40 N, and the cylinder is rolling without slipping on a horizontal surface (see figure) then the angular acceleration (in rad/s^2) of the cylinder will be (Neglect the mass and thickness of the string),

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2. Let the moment of inertia of a hollow cylinder of length 30 cm (inner radius 10 cm and outer radius 20 cm), about its axis be I. the radius of a thin cylinder of the same about its axis is also I is :

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3. A particle of mass 20 g is released with an initial velocity 5m/s alogn the curve from the point A, as shown in the figure. The point A is at height h from point B. The particle slides along the frictionless surface. When the particle reaches point B, its angular momentum (in kgm^2/s)) about O will be (Take $g = 10m/s^2$)

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4. Moment of inertia of a body about a given axis is $1.5kgm^2$. Initially the body is at rest. In order to produce a rotational kinetic energy of 1200 J, the angular acceleration of $20rad/s^2$ must be applied about the axis for a duration of ________ (in sec).

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5. A solid sphere of mass M and radius R is divided into two unequal parts. The first parts has a mass of $\frac{7M}{8}$ and is converted into a uniform disc of radius 2R. The second part is converted into a uniform solid sphere. Let I_1 be the moment of inertia of the uniform disc about its axis and I_2 be the moment of inertia of the sphere made from remaining part about its axis. The ratio I_1 / I_2 is $\frac{140}{x}$. Find the value of x.

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6. A metal coin of mass 5 g and radius 1 cm is fixed to a thin stick AB of negligible massas shown in the figure. The system in initially at rest. The constant torque (in Nm) that will make the system rotate about AB at 25 rotations per second in 5s, is close to:

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7. If linear density of a rod of length 3m varies as $\lambda = 2 + x$, then the position of the centre of mass of the rod is $\frac{P}{7}m$. Find the value of P.

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8. Two bodies of masses 2 kg and 4 kg are moving with velocities 2 m/s and 10 m/s respectively along same direction. Then the velocity of their centre of mass will be

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9. A wheel is rotating at 900 r.p.m about its axis. When the power is cut off, it comes to rest in 1 minute. The angular retardatin in radian/s^2 is $\frac{\pi}{x}$. Find the value of x.

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10. A wheel has a speed of 1200 revolution per minute and is made to slow down at a rate of 4 radian/s^2. The number of revolutions it makes before coming to rest is

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11. A particle of mass 10 gram is rotaing in a plane in circular path of radius 1 m. Its angular momentum is 1 J-sec. The centripetal force (in newton) acting on the particle is

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12. A ring of mass 10 kg and diameter 0.4m is rotated about its axis. If it makes 2100 revolutions per minute, then its angular momentum (in kg m^2 / s) will be

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13. X and Y are two loops made from same wire. The radii of X and Y are r_1 and r_2 and their M.I are I_1 and I_2 . If $I_2 / I_1 = 4$ the value of $\frac{r_2}{r_1}$ is $(K)^{1/3}$. Find the value of K.

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14. A particle of mass $m = 5kg$ is moving with a uniform speed $v = 3\sqrt{2}$ in the XOY plane along the line $Y = X + 4$. The magnitude of the angular momentum of the particle about the origin is

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Chapter 7 Gravitation

1. The energy required to take a satelite to a height h above Earth surface (radius of Earth $= 6.4 \times 10^3$km) is E_1 and kinetic energy required for the satellite to be in a circular orbit at this height is E_2. The value of h (in km) for which E_1 and E_2 are equal is

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2. Two stars of masses $3 \times 10^{31} kg$ each, and at distance $2 \times 10^{11} m$ rotate in a plane about their common centre of mass O. A meteorite passes through O moving perpendicular to the star's rotation plane. In order to escape from the gravitational field of this double star, the minimum speed that meteorite should have at O is : (Take Gravitational constant $G = 6.67 \times 10^{-} 11 Nm^2 kg^{-} 2$)

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3. Two satellites, A and B, have masses m and 2m respectively. A is in a circular orbit of radius R, and B is in a circular orbit of radius 2R around the earth. The ratio of their kinetic energies T_A / T_B is $\frac{1}{x}$. Find the value of x.

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4. The value of acceleration due to gravity at Earth's surface is $9.8 ms^{-2}$. The altitude (in metre) above its surface at which the acceleration due to gravity decreases to $4.9ms^{-2}$, is close to :(Radius of earth $= 6.4 \times 10^6 m$)

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5. A spaceship orbits around a planet at a height of 20 km from its surface. Assuming that only gravitational field of the planet acts on the spaceship, what will be the number of complete revolutiions made by the spaceship in 24 hours around the planet? [Given : Mass of Planet $= 8 \times 10^{22}$kg, Radius of planet $= 2 \times 10^6$m, Gravitational constant

$G = 6.67 \times 10^{-11} Nm^2 / kg^2]$

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6. The eccentricity of the earth's orbit is 0.0167. The ratio of its maximum speed in its orbit to its minimum speed is

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7. A rocket is fired vertically from the surface of mars with a speed of 2 km/s. If 20% of its initial energy is lost due to martian atmosphere resistance how far (in km) will the rocket go from the surface of mars before returning to it? Mass of mars $= 6.4 \times 10^{23}$ kg, radius of mars =3395 km, $G = 6.67 \times 10^{-11} Nm^2 / kg^2$.

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8. Mass M is divided into two parts x M and (1-x)M. For a given separation, the value of x for which the gravitational attraction between the two pieces becomes maximum is

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9. If the distance between the earth and the Sun were half its present value, the number of days in a year would have been

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10. If the earth has no rotational motion, the weight of a person on the equation is W. Detrmine the speed with which the earth would have to rotate about its axis so that the person at the equator will weight $\frac{3}{4}$ W. Radius of the earth is 6400 km and g = 10 m/s^2.

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11. Radius of moon is 1/4 times that of earth and mass is 1/81 times that of earth. The point at which gravitational field times that of earth. The point at which gravitational field due to earth becomes equal and opposite to that of moon, is x R from centre of earth. Find the value of x, (Distance between centres of earth and moon is 60R, where R is radius of earth)

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12. The height (in km) of the orbit above the surface of the earth in which a satellite, if placed, will appear stationary is

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13. An artificial satellite moving in a circular orbit around the earth with a speed equal to half the magnitude of escape velocity from the earth's surface, will be at a height____________ km.

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14. The radius of the earth is reduced by 4%. The mass of the earth rermains unchanged. The escape veocity increases by K%. Find the value of K.

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15. Two satellites of masses m and 2m are revolving around a planet of mass M with different speeds in orbits of radii r and 2r respectively. The ratio of minimum and maximum forces on the planet due to satellites is $\frac{1}{x}$ Find the valueof x.

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Chapter 7 Mechanical Properties Of Solids

1. A composite wire of uniform diameter 3.0 mm consisting of a copper wire of length 2.2m and a steel wire of length 1.6m stretches under a load by 0.7 mm. Calculate the load, given that the Young's modulus for copper is $1.1 \times 10^{11} Pa$ and for steel is $2.0 \times 10^{11} Pa$.

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2. A steel wire having a radius of 2.0 mm, carrying a load of 4 kg, is hanging from a ceiling. Given that $g = 3.1 \pi m s^{-2}$, what will be the

tensile stress that would be developed the wire ?

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3. A boy has a catapult made of a rubber cord of length $42cm$ and diameter $6.0mm$. The boy stretches the cord by $20cm$ to catapult a stone of mass $20g$. The stone flies off with a speed of $20ms^{-1}$. Find Young's modulus for rubber. Ignore the change in the cross section of the cord in stretching.

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4. Young's moduli of two wires A and B are in the ratio 7 : 4. Wire A is 2 m long and has radius R. Wire B is 1.5 m long and has radius 2 mm. If the two wires stretch by the same length for a given load, then the value of R is close to:

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5. In an environment, brass and steel wires of lengh 1 m each with areas of cross section $1mm^2$ are used. The wires are connected in series ankd one end of the combined wie is connected toa rigid support and other endis subjected to elongation. The stress (in Nm^{-2}) requird to produce a net elongation of 0.2 mm is

[Given the Young's modulus for steel and brass are respectively $120 \times 10^9 N/m^2$ and $60 \times 10^9 N/m^2$)

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6. The elastic limit of brass is 379 MPa . What should be the minimum diameter of a brass rod if it is to support a 400 N load without exceeding its elastic limit ?

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7. A 2 m long rod of radius 1 cm which is fixed from one end is given a twist of 0.8 radians. The shear strain developed will be

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8. The compressibility of water is 4×10^{-5} per unit atmospheric pressure. The decrease in volume of 100 cubic centimetre of water under a pressure of 100 atmosphere will be

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9. A uniform cube is subjected to volume compression. If each side is decreased by 1 % then bulk strain is

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10. What is the bulk modulus (in Pa) of water for the given data: Initial volume =100 litre, pressure increase= 100 atmosphere, final volume =100.5 litre(1 atmosphere $= 1.013 \times 10^5$ Pa)

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11. The breaking stress of the material of a wire is $6 \times 10^6 Nm^{-2}$ Then density ρ of the material is $3 \times 10^3 kgm^{-3}$. If the wire is to break under its own weight, the length (in metre) of the wire made of that material should be (take $g = 10ms^{-2}$)

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12. When a certain weight is suspended from a long uniform wire, its length increases by $1cm$. If the same weight is suspended from another wire of the same material and length but having a diameter half of the first one, the increases in length will be

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13. A wire of length $50cm$ and cross sectional area of 1 sq. mm is extended by $1mm$. The required work will be $(Y = 2 \times 10^{10} Nm^{-2})$

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14. A rigid bar of mass 15 kg is supported symmetrically by three wires each 2 m long. Those at each end are of copper and middle one is of iron. Determine the ratio of their diameters if each is to have the same tension. Young's modulus of elasticity for copper and steel are

$110 \times 10^9 Nm^{-2}$ and $190 \times 10^9 Nm^{-2}$ respectively.

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15. The marina Trench is located in the pacific ocean, and at one place it is nearly eleven km beneath the surface of water. The water pressure at the bottom of the Trench is about $1.1 \times 10^8 Pa$. A steel ball of initial volume $0.32 m^3$ is dropped into the ocean and falls to the bottom of the Trench. what is the change in the volume of the ball when it reaches to the bottom? Bulk modulus for steel = $1.6 \times 10^{11} Nm^{-2}$.

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Chapter 9 Mechanical Properties Of Fluids

1. The top of a water tank is open to air and its water lavel is maintained. It is giving out $0.74 m^3$ water per minute through a circular opening of 2 cm radius in its wall. The depth of the centre of the opening from the level of water in the tank is close to :

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2. Water flows into a large tank with flat bottom at the rate of $10^{-4}m^3s^{-1}$. Water is also leaking out of a hole of area 1 cm^2 at its bottom. If the height of the water in the tank remains steady, then this height is :

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3. A long cylinderical vessel is half filled with a liquid. When the vessel is rotated about its own

vertical axis. The liquid rises up near the wall. If the radius of vessel is $5cm$ and its rotational speed is 2 rotatins per second, then the difference in the heights between the centre and the sides, in cm. will be :

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4. Water form a pipe is coming at a rate of 100 liters per minute. If the radius of the pipe is 5 cm, the Reynolds number for the flo0w is : (density of water $= 1000kg/m^3$, coefficient of viscosity of water =1mPas)

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5. An incompressible liquid flows through a horizontal tube shown in the following fig. Then the velocity v (in m/s) of fluid is

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6. A cubical block of side 0.5 m floats on water with 30% of its volume under water. What is the maximum weight that can be put on the block without fully submerging it under water?

[Take, density of water $= 10^3 kg/m^3$]

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7. A submarine experiences a pressure of $5.05 \times 10^6 Pa$ at a depth of d_1 in a sea When it goes futher to a depth of d_2. It experiences a pressure of $8.08 \times 10^6 Pa$. The $d_2 - d_1$ is approximately (density of water $= 10^3 kg/m^3$ and acceleration due to gravity $= 10 ms^{-2}$)

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8. Water from a tap emerges vertically downwards an intial speed of 1 m/s . The cross-sectional area of the tap is $10^{-4} m^2$. Assume that the pressure is contant throughout the stream of water and that the flow is steady . The cross-sectional area of the steam. 0.15 m below the tap is

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9. A solid sphere, of radius R acquires a terminal velocity v_1 when falling (due to gravity) through

a viscous fluid having a coefficient of viscosity h. The sphere is broken into 27 identical solid spheres. If each of these spheres acquires a terminal velocity, v_2, when falling through the same fluid, the ratio (v_1 / v_2) equal $\frac{9}{x}$. Find the value of x.

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10. A wooden block floating in a bucket of water has 4/5 of its volume submerged. When certain amount of an oil is poured into the bucket, it is found that the block is just under the oil surface with half of its volume under water and half in oil. The density of oil relative to that of water is:

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11. A long cylindrical drum is filled with water. Two small holes are made on the side of the drum as shown in the figure. The depth (inm) of the liquid in the drum if the ranges of water from the holes equal.

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12. A glass U-tube is such that the diameter of one limb is $3.0mm$ and that of the other is 6.0mm. The tube is inverted vertically with the open ends below the surface of water in a beaker. What is the difference between the height to which water rises in the two limbs? Surface tension of water is $0.07Nm^{-1}$. Assume that the angle of contact between water and glass is 0°.

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13. Two pistons of hydraulic press have diameters of 30.0 cm and 2.5 cm. What is the force (in kg-wt) exerted by larger piston, when 50.0 kg-wt is placed on the smaller piston?

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14. A wooden plank of length 1 m and uniform cross section is hinged at one end to the bottom of a tank as shown in Figure. The tank is filled with water up to a height of 0.5 m. The specific gravity of the plank is 0.5. Find the angle (in degree) that the plank makes the vertical in the equilibrium position (Exclude the case $\theta = 0$).

15. A cube of ice of edge 4 cm is placed in an empty cylindrical glass of inner diameter 6 cm. Assume that the ice melts uniformly from each side so that it always retains its cubical shape. Remembering that ice is lighter than water, find the length (in cm) of the edge of the ice at the instant it just leaves the contact with the bottom of the glass.

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Chapter 10 Thermal Properties Of Matter

1. Temperature difference of $120^\circ C$ is maintained between two ends of a uniform rod AB of length 2L. Another bent rod PQ,of same cross section as AB and length $\frac{3L}{2}$, is connected across AB. In steady state, temperature difference (in $^\circ C$) between P and

Q will be close to:

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2. A heat source at T = 10^3 K is connected to another heat reservoir at T = 10^2 K by a copper slab which is 1 m thick. Given that the thermal conductivity of copper is 0.1 $WK^{-1}m^{-1}$, the energy flux through it in steady state is :

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3. An unknown metal of mass 192 g heated to a temperature of $100^\circ C$ was immersed into a brass calorimeter of mass 128 g containing 240 g of water at a temperature of $8.4^\circ C$. Calculate the specific heat of the unknown metal if water temperature stabilizes at $21.5^\circ C$. (Specific heat of brass is $394 Jkg^{-1}K^{-1}$)

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4. Two kg of a monoatomic gas is at a pressure of $4 \times 10^4 N/m^2$. The density of the gas is

$8kg/m^3$. What is the order of energy of the gas due to its thermal motion ?

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5. $Iceat - 20^\circ C$ is added to 50 g of water at $40^2 C$ When the temperature of the mixture reaches $0^\circ C$ it is found that 20 g of ice is still unmelted .The amount of ice added to (Specific heat of water $= 4.2j/g/^\circ C$

Specific heat of Ice $= 2.1J/g/^\circ C$ M

Heat of fusion of water of $0^\circ C = 334J/g)$

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6. Two rods A and B of identical dimensions are at temperature $30^\circ C$. If A is heated upto $180^\circ C$ and B $T^\circ C$, then new lengths are the same . If the ratio of the coefficients of linear expansion of A and B is 4:3,then the value of T is

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7. A liquid A of mass 100 g at $100^\circ C$ is added to 50 g of a liquid B at temperature $75^\circ C$, the temperature of the mixture becomes $90^\circ C$.

Now if 100 g of liquid A is $100^{\circ}C$ is added to 50 g of liquid B at $50^{\circ}C$, temperature of the mixture will be

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8. A thermometer graduated accoding linear scale reads a value x_0 when in contact with boiling water, and $X_0 s/3$ when in contact with ice . What is the temperature of an object in $.^{\circ}C$, if this thermometer in the contact with the object reads $x_0/2$?

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9. A thermally insulated vessel contains $150g$ of water at $0^{\circ} C$. Then the air from the vessel is pumped out adiabatically. A fraction of water turms into ice and the rest evaporates at $0^{\circ} C$ itself. The mass of evaporated water will be closest to :

(Latent heat of vaporization of water $= 2.10 \times 10^{6} jkg^{-1}$ and Latent heat of Fusion of water $= 3.36 \times 10^{5} jkg^{-1}$)

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10. A cylinder with fixed capacity of 67.2 lit contains helium gas at STP. The amount of heat (in joule) needed to raise the temperature of the gas by $20^\circ C$ is

[Given that $R = 8.31 J\text{mol}^{-1} K^{-1}$]

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11. The coefficient of cubical expansion of mercury is $0.00018 / ^\circ C$ and that of brass $0.00006 / ^\circ C$. If a barometer having a brass scale were to read 74.5 cm at $30^\circ C$ find the true barometric height (in cm) at $0^{\circ} C$. Tlhe scale is supposed tobe correct at $15^{\circ} C$.

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12. A bar with a crack at its centre buckles as a result of temperature rise of $32^{\circ} C$. If the fixed distacne L_0 is 3.77 m and the coefficient of linear expansion of the bar is $25 \times 10^{6} / {}^{\circ} C$ find the rise (in metre) of the centre.

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13. In an experiement on the specific heat of a metal a 0.20 kg block of the metal at $150^\circ C$ is dropped in a copper calorimeter (of water equivalent 0.025 kg) containing $150 cm^3$ of water at $27^\circ C$. The final temperature is $40^\circ C$. Compute the specific heat (in $J kg^{-1} {}^\circ C^{-1}$) of the metal.

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14. The temperature of equal masses of three different liquids A,B and C are $12^\circ C, 19^\circ C$ and $28^\circ C$ respectively. The

temperature when A and B are mixed is $16^\circ C$ and when B and C are mixed it is $23^\circ C$. What should be the temperature when A and C are mixed?

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15. A bdoy initially at $80^\circ C$ ools to $64^\circ C$ in 5 minutes and to $52^\circ C$ in 10 minutes. What will be the temperature (in $^\circ C$) after 15 minutes?

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Chapter 11 Thermodynamics

1. A gas can be taken from A to B via two different process ACB and ADB.

When path ACB is used 60 J of heat flows into the system and 30 J of work is done by the system. If path ADB is used work done by the system is 10J. The heat (in joule) flow into the system in path ADB is:

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2. Two Camot engines A and B are operated in series. The first one, A , receives heat at $T_1(= 600K)$ and rejects to a reservoir at temperature T_2. The second engine B receives heat rejected by the first engine and, in turn, rejects to a heat reservoir at $T_3(= 400K)$. Calculate the temperature T_2 if the work outputs of the two engines are equal :

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3. For the given cyclic process CAB as shown for gas, the work done (in joule) is:

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4. A sample of an ideal gas is taken through the cyclic process abca as shown in the figure. The change in the internal energy of the gas along the path ca is -180 J, The gas absorbs 250 J of heat along the path ab and 60 J along the path bc. The work done (in joule) by the gas along the path abc is:

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5. $1.0m^3$ of water is converted into $1671m^3$ of steam at atmospheric pressure and $100^\circ C$ temperature. The latent heat of vaporisation of water is $2.3 \times 10^6 Jkg^{-1}$. If 2.0 kg of water be converted into steam at atmospheric pressure and $100^\circ C$ temperature, then how much will be the increases in its internal energy? Density of water $1.0 \times 10^3 kgm^{-3}$, atmospheric pressure = $1.01 \times 10^5 Nm^{-2}$.

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6. Air is contained in a piston cylinder arrangement as shown in fig. with a cross sectional area of $4cm^2$ and an initial volume of 20 cc. The air is initially at a pressure of 1 atm and temperature of $20^\circ C$. The piston is connected tio a spring whose spring constant is $k = 10^4$N/m, and the spring is initially underformed. How much heat (in joule) must be added to the air to increase the pressue to 3 atm. (For air $C_V = 718 J / kg^\circ C$,molecular massof ari 28.97)

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7. Consider the cyclic process ABCA, shown in fig. performed on a sample of 2.0 mole of an ideal gas. A total of 1200 J of heat is withdrawn from the sample in the process . Find the work done (in joule) by the gas during the part BC.

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8. A motor car tyre has a pressure of 2 atmosphere at room temperature of $27^{\circ} C$. If the tyre suddenly bursts, find the resulting temperature (in kelvin).

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9. A carnot engine whose heat sink is at $27^{\circ} C$ has an efficiency of 40%. By how many degrees should the temperature of source be changed to increase the efficiency by 10% of the original efficiency?

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10. Five moles of an ideal gas taken in a Carnot engine working between $100^{\circ}C$ and $30^{\circ}C$. The useful work done in one cycle is 420 joule. If the ratio of the volume of the gas at the end and beginning of the isothermal expansion is $\frac{115}{x}$.

Find the value of x.

(Take R=8.4J/mol.K)

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11. How much energy in watt hour may be required to convert $2kg$ of water into ice at $0^\circ C$, assuming that the refrigerator is ideal? Take room temp. $= 25^\circ C$, which is also the initial temp. of water and temp. of freezer is $-15^\circ C$.

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12. Helium gas goes through a cycle ABCDA (consisting of two isochoric and isobaric lines) as shown in figure. Find efficienty of this cycle.

(Assume the gas to be close to an ideal gas)

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13. Find the amount of work done to increase the temperature of one mole jof an ideal gas by $30^{\circ} C$, if it is expanding under condition $V \infty T^{2/3}$.

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14. A thin U-tube sealed at one end consist of three bends of length l=250 mm each, forming right angles. The vertical parts of the tube are filled with mercury to half the height.

All of mercury can be displaced from the tube by heating slowly the gas in the sealed end of the tube, which is separated from the atmospheric aire by mercury. Determine the work done (in joule) by the gas there by if the atmospheric pressure is $P_0 = 10^5$ Pa the densilty of mercury is $\rho_{\text{mer}} = 13.6 \times 10^3 kg/m^3$, and the cross sectional area of the tube is $S = 1cm^2$

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15. A carnot engine having a perfect gas aas the working substance is driven backwards and is used for freezing water already at $0^\circ C$. If the engine is driven by $500W$ electric motor with an efficiency of 60% how long will it take to freeze $15kg$ of water? The working temps of the engine are $15^\circ C$ and $0^\circ C$. The system involves no energy losses. Given latent heat of ice $= 333 \times 10^3 Jkg^{-1}$.

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Chapter 12 Kinetic Theory

1. A mixture of 2 moles of helium gas ($(a \rightarrow micmass) = 4a.m.u)$ and 1 mole of argon gas $((a \rightarrow micmass) = 40a.m.u)$ is kept at 300K in a container. The ratio of the rms speeds $\left(\frac{v_{rms}(helium)}{(v_{rms}(argon))}\right)$ is

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2. A mass M = 15 g of nitrogen is enclosed in a vessel at temperature T = 300 K. What amount of heat has to be transferred to the gas to increase the root-mean-square velocity of molecules 2 times ?

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3. Half mole of an ideal monoatomic gas is heated at constant pressure of 1 atm from

$20^{\circ} C$ to $90^{\circ} C$. Work done by gas is close to:

(Gas constant R = 8.31 J/mol-K)

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4. An ideal gas occupies a volume of $2m^3$ at a pressure of 3×10^6 p,a the energy of the gas is :

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5. An ideal gas is enclosed in a cylinder at pressure of 2 atm and temperature, 300 K.The men time between two successive collosions is 6×10^{-8} s. If the pressure to $500K$, the mean time between two successive collisions will be close to :

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6. 10^{22} particles each of mass $10^{-26} Kg$ are striking perpendicular on a wall of area $1m^2$ with speed $10^4 m/s$ in $1 \sec$. The pressure on the well if collision are perfectly elastic is : (A) $2N/m^2$ (B) $4N/m^2$ (C) $6N/m^2$ (D) $8N/m^2$

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7. The temperature, at which the root mean square velocity of hydrogen molecules equals their escape velocity from the earth, is closest to:

[Boltzmann constant $k_B = 1.38 \times 10^{-23} J / K$ Avogadro Number $N_A = 6.02 \times 10^{26} / Kg$ Radius of Earth : 6.4×10^6 m Gravitational acceleration on Earth $= 10 ms^{-2}$]

8. For a given gas at 1 atm pressure, rms speed of the molecules is 200 m/s at $127^{\circ} C$. At 2 atm pressure and at $227^{\circ} C$, the rms speed of the molecules will be:

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9. Two different masses m and 3m of an ideal gas are heated separately in a vessel of constant volume, the pressure P and absolute temperature T, graph for these two cases are shown in the figure as A and B. The ratio of slopes of curves B to A is

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10. An air bubble of volume $1.0 cm^3$ rises from the bottom of a lake 40 m deep at a temperature of $12^\circ C$. To what volume does it grow when it reaches the surface, which is at a temperature of $35^\circ C$. ? Given $1 atm = 1.01 \times 10^5 Pa$.

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11. Two moles of helium gas is mixed with three moles of hydrogen molecules (taken to be rigid). The molar specific heat of mixture at constant volume is ______ $(\text{in J//mol//K})?(\text{R} = 8.3\text{ J//mol K})$

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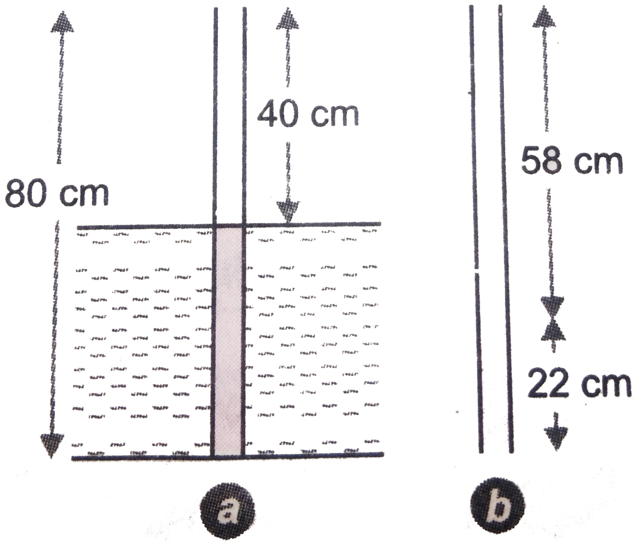
12. A narrow uniform glass tube 80 cm long and open at both ends is half immersed in mercury. Then the top of the tube is closed and it is taken out of mercury. A column of mercury 22 cm long then remains in the tube. What is the atmospheric pressure?



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13. A vessel of volume , $V = 5.0$ litre contains $1.4g$ of nitrogen at a temperature $T = 1800K$.

Find the pressure of the gas if 30% of its molecules are dissociated into atoms at this temperature.

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14. A gaseous mixture enclosed in a vessel consists of one gram mole of a gas A with $\gamma = \left(\frac{5}{3}\right)$ and some amount of gas B with $\gamma = \frac{7}{5}$ at a temperature T.

The gases A and B do not react with each other and are assumed to be ideal. Find the number of gram moles of the gas B if γ for the gaseous mixture is $\left(\frac{19}{13}\right)$.

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15. An oxygen cylinder of volume 30 litre has an initial gauge pressure of 15 atm and a temperature of $20^\circ C$. After some oxygen is withdrawn from the cylinder, the gauge pressure drops to 11 atm and its temperature drop to $17^\circ C$. Estimate the mass (inkg) of oxygen taken out of the cylinder,

$R = 8.3 J \text{mol}^{-1} K^{-1}$, molecule weight of oxygen =32.

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Chapter 13 Oscillations

1. A rod of mass 'M' and length '2L' is suspended at its middle by a wire. It exhibits torsional oscillations, if two masses each of 'm' are attached at distance $'L/2'$ from its centre on both sides, it reduces the oscillation frequency by 20%. The value of ratio m/M is close to :

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2. A simple pendulum of length 1 m is oscillating with an angular frequency $10 rad/s$. The suopport of the down with a small angular frequecy of $1 rad/s$ and an amplitude of $10^{-2} m$. The relative changes in the angular frequency of the pendulum is best given by.

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3. A damped harmonic oscillator has a frequency of 5 oscillations per second. The amplitude drops to half its value for every 10 oscillations. The time it will take to drop to $\frac{1}{1000}$ of the original amplitude is close to:

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4. Figure shows v-x graph of a particle executing simple harmonic oscillations. What is the velocity (in m/s) of the particle at x=3 m?

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5. Two simple pendulums of length 1m and 1.21 m are started oscillating from some position. Find the minimum time (in second) after which they again start from same position.

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6. A spring balance has a scale that reads from 0 to 50kg. The length of the scale is 20cm. A body suspended from this spring, when displaced and released, oscillates with period of 0.60s. What is the weight of the body?

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7. A pendulum is executing simple harmonic motion and its maximum kinetic energy is K_1. If the length of the pendulum is doubled and it perfoms simple harmonuc motion with the same amplitude as in the first case, its maximum kinetic energy is K_2 Then:

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8. Equation of motion for a particle performing damped harmonic oscillation is given as $x = e^{-1t} \cos(10\pi t + \phi)$. The time when amplitude will half of the initial is :

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9. Two light springs of force constants k_1 and k_2 and a block of mass m are in one line AB on a smooth horizontal table such that one end of each spring is fixed on rigid support and the other end is free as shown in figure. The distance CD between the free ends of springs is 60 cm. If the block moves along AB with a velocity 120 cm/s in between the springs, calculate the period (in second) of oscillation of block. ($k_1 = 1.8N/m, k_2 = 3.2N/m, m = 200g$)

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10. Two particles execute simple harmonic motion of the same amplitude and frequency along close parallel lines. They pass each other moving in opposite directions each time their displacement is half their amplitude. Their phase difference is

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11. A cubical body (side $0.1m$ and mass $0.002kg$) floats in water. It is pressed and then released so that it executes SHM. Find the time period. $(g = 10m/s^2)$

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12. Two particles execute SHM with same frequency and amplitude along the same straight line. They cross each other , at a point midway between the mean and the extreme position. Find the Phase difference between them.

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13. A block is kept on a horizontal table. The table is undergoing simple farmonic motion of frequency 3Hz in a horizontal plane. The coefficient of static friction between the block and the table surface is 0.72. find the maximum amplitude of the table at which the block does not slip on the surface $g = 10ms^{-1}$

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14. A mass (M) is suspended from a spring of negligible mass. The spring is pulled a little and then released so that the mass executes SHM of time period T. If the mass is increased by m, the time period becomes $\frac{5T}{3}$. Then the ratio of $\frac{m}{M}$ is .

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15. A pendulum has time period T in air when it is made to oscillate in water it acquired a time period $T = \sqrt{2}T$ The density of the pendulum bob is equal to (density) of water $= 1)$

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Chapter 14 Waves

1. A musician using and open flute of length 50 cm produces second harmonic sound waves. A person runs towards the musician from another end of a hall at a speed of 10 km/h. If the wave speed is 330 m/s, the frequency heard by the running person shall be close to :

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2. A closed organ pipe has fundamental frequency of 1.5 kHz. The number of overtones that can be distinctly heard by a person with this organ pipe will be : (Assume that the highest frequency a person can hear is 20,000 Hz)

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3. Equation of travelling wave on a stertched string of linear density $5g/m$ is y=00.3 sin (450 t - 9 x) where distance and time are measured in SI units. The tension in the string is

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4. A source of sound in moving along a circular orbit of radius 3 m with an angular velocity of 10 rad/s. A sound detector located far away from the source is executing linear simple harmonic motion along the lin BD with an amplitude BC=CD=6m. The frequency of oscillation of the detector $5/\pi$ per second. The source is at the point A when the detector is at the pont B. If the source emits a continuous sound wave of frequency 340 Hz, find the minimum frequencies (in Hz) recorded by the detector.

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5. Two cars A and B are moving away from each other in opposite directions. Both the cars are moving with a speed of $20ms^{-1}$ with respect to the ground. If an observer in car A detects a frequency 2000 Hz of the sound coming from car B, what is the natural frequency of the sound source in car B? (Speed of sound in air = $340ms^{-1}$)

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6. The amplitude of a wave disturbance propagating along positive X-axis is given by $= \frac{1}{1+x^2}$ at t=0 and $y = \frac{1}{1+(x-2)^2}$ at t=4 s where x and y are in metre. The shape of wave diturbance does not change with time. The velocity of the wave is

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7. A tuning fork of frequency 220Hz produces sound waves of wavelength 1.5m in air at NTP.

Calculate the increase in wavelength, when temperature of air in $27^\circ C$.

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8. A sample of oxygen at NTP has volume V and a sample of hydrogen at NTP has volume $4V$. Both the gases are mixed and the mixture is maintained at NTP if the speed of sound in hydrogen at NTP is $1270m/s$, that in the mixture will be

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9. A glass tube of $1.0m$ length is filled with water . The water can be drained out slowly at the bottom of the tube . If a vibrating tuning fork of frequency $500c/s$ is brought at the upper end of the tube and the velocity of sound is $330m/s$, then the total number of resonances obtained will be

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10. Pipe A has length twice the pipe B. Pipe A has both ends open and pipe B has one end open.

Which harmonics of pipe A have a frequency that matches a resonance frequency of pipe B.

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11. A string is clamped at both the ends and it is vibrating in its 4^{th} harmonic. The equation of the stationary wave is $Y = 0.3 \sin(0.157x)\cos(200\pi t)$. The length of the string is: (All quantities are in SI units.)

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12. A road runs between two parallel rows of buildings.A motorist moving just in the middle with a velocity of 30 km/h, sounds the horn. He hears an echo one second after sounding the horn. Find the distance (in metre) between the two rows of the buildings. The velocity of sound =330 m/s.

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13. One metre long wire is fixed between two rigid supports. The tension is the wire is 200 N and mass per unit length of the wire is $\mu = 2x$, where x is the distance from one end of the wire. Find the time (in second) the pulse takes to reach the other end of the wire.

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14. A train approaching a railway crossing at a speed of 120 km/h sounds a short whistle at frequency 640 Hz when it is 300 m away from the crossing. The speed of sound in air is 340 m/s. What will be the frequency (in Hz) heard by a person standing on a road perpendicular to the track through the crossing at a distance of 400 m from the crossing?

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15. A string of length 40 cm and weighing 10 g is attached to a spring at one end and to a fixed wall at the other end. The spring has a spring constant of $160 Nm^{-1}$ and is stretched by 1.0 cm. If a wave pulse is produced on the string near the wall, how much time will it take to reach the spring ?

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Chapter 15 Electric Charges And Fields

1. Two semicircular wires of radius 20 cm and 10 cm have a common centre at the origin O as shown in the figure. Assume that both the wires are uniformly charged and have an equal charge of 0.70 nC each. The magnitude of electric fiedl (in Vm^{-1}) at the common centre of curvature O of the system is

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2. Three point charges Q_1, Q_2, Q_3 in the order are placed equally spaced along a straight line. Q_2 andQ_3 are equal in magnitude but opposite in sign. If the net force on Q_3 is zero. The value of Q_1 is

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3. A uniformly charged conducting sphere of 4.4 m diameter has a surface change density of

$60\mu Cm^{-2}$. The charge on the sphere is

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4. When an electric dipole P $\vec{v}$ is placed in a uniform electric field $\vec{E}$ then at what angle between $\vec{P}$ and $\vec{E}$ the value of torque will be maxima

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5. An uniform electric field E exists along positive x-axis. The work done in moving a charge 0.5 C through a distance 2 m along a direction making an angle 60° with x-axis is 10 J. Then the magnitude of electric field is

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6. Two point charges $+3\mu C$ and $+8\mu C$ repel each other with a force of $40N$. If a charge of $-5\mu C$ is added to each of them, then the force between them will become

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7. Two similarly and equally charged identical metal spheres A and B repel each other with a force of $2 \times 10^{-5} N$. A third identical uncharged sphere C is touched with A and then placed at the midpoint between A and B. Find the net electric force on C.

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8. A sphere of radius R carries charge such that its volume charge density is proportional to the square of the distance from the centre. What is the ratio of the magnitude of the electric field at a distance 2 R from the centre to the magnitude of the electric field at a distance of $R/2$ from the centre?

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9. A negatively charged oil drop is prevented from falling under gravity by applying a vertical electric field of $100Vm^{-1}$. If the mass of the drop is $1.6 \times 10^3 g$ the number of electrons carried by the drop is $(g = 10ms^{-2})$

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10. An electric dipole is placed at an angle of 30° with an electric field intensity $2 \times 10^5 N/C$. It experiences a torque equal to $4Nm$. The charge on the dipole, if the dipole is length is $2cm$, is

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11. A point charge of charge q and mass m is placed at rest at point X at distance r from a short electric dipole. The initial acceleration of charge $a = \frac{k.\,q.\,p}{2mr^3}n$, where $k = \frac{1}{4\pi\varepsilon_0}$. Then n is

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12. A solid sphere of radius R has a charge Q distributed in its volume with a charge density $\rho = kr^a$, where k and a are constants and r is the distance from its centre. If the electric field at $r = \frac{R}{2}$ is $\frac{1}{8}$ times that $r = R$, find the value of a.

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13. A charge of $10 \mu C$ is placed at the centre of a hemisphere of radius R=10cm as shown.The electric flux through the hemisphere (in MKS units) is

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14. A point charge causes an electric flux of $-1.0 \times 10^3 Nm^2 / C$ to pass through a spherical Gaussian surface of 10.0 cm radius centred on the charge. (a) If the radius of the Gaussian surface were doubled, how much flux would pass through the surface ? (b) What is the is the value of the point charge ?

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15. An electric field of $1000 V / m$ is applied to an electric dipole at angle of 45°. The value of electric dipole moment is $10^{-29} C.m$ .What is the potential energy of the electric dipole ?

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Chapter 16 Electrostatic Potential And Capacitance

1. A parallel plate capicitaor with plates of area $1m^2$ each, are at a separation of 0.1m. If the electric field between the plates is 100 N/C, the magnitude of charge on each plate is : (Take $\varepsilon = 8.85 \times 10^{-12} \frac{C^2}{N - m^2}$)

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2. Voltage rating of a parallel plate capacitor is 500V. Its dielectric can withstand a maximum electric field of $10^6 V/m$. The plate area is $10^{-4} m^2$. What is the dielectric constant if the capacitance is 15pF? (given $\in_0 = 8.86 \times 10^{-12} C^2 / Nm^2$)

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3. A parallel plate capacitor of capacitance $1\mu F$ has a charge of $+2\mu C$ on one of the plates and a charge of $+4\mu C$ on the other. The potential difference developed across the capacitor is

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4. In Region of Electric field Given by $\overrightarrow{E} = (Ax - B)\hat{I}$. Where $A = 20$ unit and $B = 10$ unit. If Electric potential at $x = 1m$ is v_2. Then $v_1 - v_2$ is equal to

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5. A capacitor with capacitance $5\mu F$ is charged to $5\mu C$. If the plates are pulled apart to reduce the capacitance to $2\mu F$, how much work is done?

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6. The electric potential is $V = (x^2 - 2x)$. What is the electric field strength at x=1?

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7. The 1000 small droplets of water each of radius r and charge Q, make a big drop of spherical shape. The potential of big drop is how many times the potential of one small droplet

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8. A hollow metal sphere of radius $5cm$ is charged such that the potential on its surface is $10V$. The potential at a distance of $2cm$ from the centre of the sphere

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9. From a point charge, thre is a fixed point A at some distance. At A, there is an electric field of 500 V/m and potential differecne of 3000 V. Distance (in metre) between point charge and A will be

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10. A 20 μF capacitor is connected to 45 V battery through a circuit whose resistance is

2000 Ω. What is the final charge on the capacitor ?

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11. Calculate the area (in m^2) of the plates of a one farad parallel plate capacitor if separtion between plates is 1 mm and plates are in vacuum.

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Chapter 17 Current Electricity

1. A copper wire is stretched to make it 0.5% longer. The percentage change in its electrical resistance if its volume remains unchanged is :

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2. A uniform metallic wire has a resistance of 18 Ω and is bent into an equiolateral triangle. Then, the resistance between any two vertices of the triangle is :

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3. A 2 W carbon resistor is color coded with green, black, red and brown respectively. The maximum current which can be passed through this resistor is :

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4. The actual value of resistance R, shown in the figure is 30Ω. This is measured in an experiment as shown using the standard formula $R = \frac{V}{I}$, where V and I are the reading of the voltmeter and ammeter, respectively. If the measured value of R is 5% less, then the internal resistance (in Ω) of the voltmeter is :

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5. A current of 2 mA was passed through an unknown resistor which dissipated a power of 4.4 W. Dissipated power when an ideal power supply of 11 V is connected across it is

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6. The amount of charge Q passed in time t through a cross-section of a wire is $Q = 5t^2 + 3t + 1$. The value of current at time t=5 s is

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7. A current of 1 mA is flowing through a copper wire. How many electrons will pass a given point in one second $\left[e = 1.6 \times 10^{19}\right.$Coulomb]

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8. At what temperature will the resistance of a copper wire become three times its value at $0^\circ C$ (Temperature coefficient of resistance for copper $= 4 \times 10^3$ per C)

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9. In the circuit showin in fig the current in 4Ω resistance is 1.2 A. What is the potential difference (in volt) between B and C?

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10. A current of 30A is registered when the terminals of a dry cell of emf 1.5 V are connected through an ammeter. (Neglect the ammeter resistance). The amount of heat produced (in joule) in the battery in 20s is

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11. A 100 watt bulb working on 200 volt has resistance R and a 200 watt bulb working on 100 volt has resistance S.If the R/S is $\frac{8}{x}$. Find the value of x.

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12. The total power dissipated in watts in the circuit shown here is

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13. In a meter bridge the balancing length rom the left end (standard resistance of 1Ω is in the right gap) is found to be 20 cm . The value of the unkown resistance is

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Chapter 18 Moving Charges And Magnetism

1. A current loop, having two circular arcs joined by two radial lines is shown in the figure. It carries a currentoif 10A. The magnetic field (in

Tesla) at point O will be

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2. A particle having the same charge as of electron moves in a circular path of radius 0.5 cm under the influence of a magnetic field of 0.5 T. If an electric field of 100V/m makes it to move in a straight path, then the mass of the particle is (Given charge of electron $= 1.6 \times 10^{-19} C$)

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3. A galvanometer having a resistance of 20Ω and 30 divisions on both sides has figure of merit. 0.005 ampere /division. The resistance that should be connected in series such that it can be used as a voltmeter unto 15 V , is :

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4. The dipole moment of a circular loop carrying a current I, is m and the magnetic field at the centre of the loop is B_1 . When the dipole moment is doubled by keeping the current constant, the magnetic field at the centre of the loop is B_2 . The ratio $\frac{B_1}{B_2}$ is:

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5. In an experiment, electrons are accelerated, from rest, by applying a voltage of 500V. Calculate the radius of the path if a magnetic field 100mT is then applied. [Charge of the electron $= 1.6 \times 10^{-19} C$, Mass of the electron $= 9.1 \times 10^{-31}$ Kg]

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6. A galavanometer, whose resistance is 50 ohm has 25 divisions in it. When a current of 4×10^{-4} A passes through it,its needle (pointer) deflects by one division. To use this galvanometer as a volmeter of range $2.5V$, it is should be connected to a resistance of :

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7. A rectangular coil (Dimension $5cm \times 2.5cm$) with 100 turns, carrying a current of A in the origin and in the X-Z plane. A magnetic field of 1

T is applied along X-axis. If the coil is tilted through 45° about Z-axis, then the torque on the coil is :

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8. A moving coil galvanometer has resistance 50Ω and it indicates full deflection at 4 mA current. A voltmeter is made using this galvanometer and a $5k\Omega$ resistance. The maximum voltage, that can be measured using this voltmeter (in volts) will be ________.

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9. An electron accelerated by a potential difference $V = 1.0kV$ moves in a uniform magnetic field at an angle $\alpha = 30^\circ$ to the vector B whose modulus is $B = 29mT$. Find the pitch of the helical trajectory of the electron.

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10. A wire ABCD is bent in the form shown here in the figure. Segments AB and CD are of length

1 m each while the semicircular loop of radius 1m. A current of 5 A flows from A towards the end D and the whole wire is placed in a magnetic field is 0.5 T directed out of the page.The force (in newton) acting on the wire is

11. The resistance of a moving coil galvanometer is 50 ohm and the maximum current which can be passed through the galvanometer is 0.002 A. What resistance (in ohm) must be connected to it order to convert in into an ammeter of range 0-0.5A?

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12. Find the magnitude of the magnetic fieldat the center of an equilateral triangular loop of side length 1m which is carrying a current of 10A. (Take $\mu_0 = 4\pi \times 10^{-7} NA^{-2}$)

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13. A thin ring of 10 cm radius carries a uniformly distributed charge. The ring rotates at a constant angular speed of $40\pi \text{rad s}^{-1}$ about its axis, perpendicular to its plane. If the magnetic field at its centre is $3.8 \times 10^{-9} T$, then the charge carried by the ring is close to $(\mu_0 = 4\pi \times 10^{-7} N / A^2)$

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14. Find the magnetic field (in Tesla) at point P due to a straight line segment AB of length 6 cm carrying a current of 5A. $(\mu_0 = 4\pi \times 10^{-7} N - A^{-2})$

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15. A 200 turn solenoid having a length of 25 cm and a diameter of 10 cm carries a curret of 0.30 A. Calculate the magnetic of the magnetic field $\vec{B}$ (in mT) inside the solenoid.

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1. A bar magnet is demagnetized by inserting it inside a solenoid of length 0.2 m, 100 turns, and carrying a current of 5.2 A. The coercivity of the bar magnet is :

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2. A magnet of total magnetic moment $10^{-2}\hat{i}$ A-m^2 is placed in a time varying magnetic field, $B\hat{i}(\cos\omega t)$ where B = 1 Tesla and

ω = 0.125 rad/s. The work done for reversing the direction of the magnetic moment at t = 1 second, is :

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3. At some location on earth the horizontal component of earth's magnetic field is $18 \times 10^{-6} T$. At this location, magnetic needle of length 0.12m and pole strength 1.8 Am is supended from its mid-point using a thread, it makes 45° angle with horizontal in equilibrium.

To keep this needle horizontal, th evertical force that should be applied at one of its ends is

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4. A paramagnetic substance in the form of a cube with sides 1 cm has a magetic dipole moment of $20 \times 10^{-6} J/T$ was when a magnetic intensity of $60 \times 10^3 A/m$ is applied .Its magnetic susceptibility is :

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5. A paramagnetic material has $10^{28}a \rightarrow ms/m^3$. Its magnetic susceptibility at temperature $350K$ is 2.8×10^{-4}. Its susceptibility at $300K$ is :

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6. If the moment of a magnet is $0.4Am^{-1}$ and force seting on esch pote in a uniform magnetic field of induction $3.2 \times 10^{-5} \text{Wb/m}^2$ is $5.12 \times 10^{-5}N$, the dstance berween the poles of magnet is

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7. The magnetic field of earth at the equator is approximately $4 \times 10^{-5} T$. The radius of earth is $6.4 \times 10^{6} m$. Then the dipole moment (in $A-m^{2}$) of the earth will be nearly of the order of

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8. The angle of dip at a place is 37° and the vertical component of the earth's magnetic field

is $6 \times 10^{-5} T$. The earth's magnetic field at this place is $\left(\tan 37^{\circ} = \frac{3}{4}\right)$

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9. If relative permeability of iron is 2000,its absolute permeability is SI unit is

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10. The susceptibility of annealed iron at saturation is 5500. Find the absolute permeability (in SI unit) of annealed iron at saturation.

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11. A magnetising field of $2 \times 10^3 Am^{-1}$ produces a magnetic flux density of $8\pi T$ in an iron rod. The relative permeability of the rod will be

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12. Two tangent galvanometers having coils of the same radius are connected in series. A current flowing in them produces deflections of 60° and 45° respectively. The ratio of the number of turns in the coils is

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13. Two short magnets with their axes horizontal and perpendicular to the magnetic maridian are palced with their centres 40 cm east and 50 cm west of magnetic needle.If the needle remains undeflected, the ratio of their magnetic moments $M_1 : M_2$ is

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14. A certain amount of current when flowing in a properly set tangent galvanoment, produces a deflection of 45°. If the current be reduced by a factor of $\sqrt{3}$, the deflection would

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Chapter 20 Electromagnetic Induction

1. Two concentric coplanar circular loops made of wire with resistance per unit length $10^{-4}\Omega/m$, have diameters 0.2 m and 2m. A time varying potential difference (4+2.5t) volt is applied to the larger loop. Calculate the current in the smaller loop.

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2. In figure a 120- turn coil of radius 1.8 cm and resistance 5.3Ω is placed outside a solenoid. The current in the solenoid is 1.5 A and its reduces to zero at a steady rate in 25 ms. What current (inmA) appears in the coil? The number of turns per unit length of the solenoid is 220 turns/ cm and its diameter D=3.0 cm.

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3. The current in a coil of self inductance 2.0 henry is increasing according to $i = 2\sin t^2$ ampere. Find the amount of energy spent during the period when the current changes from 0 to 2 amp.

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4. The current in an RL circuits drops from 1.0 A to 10 mA in the 10 second following removal of the battery from the circuti. If L is 10 H, find the resistance R (in ohm) in the circuit.

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5. An airplane with a 20 wingspread is flying at 250m/s straight south parallel to the earth's surface. The earths magnetic field has a horizontal component of $2 \times 10^{-3} Wb/m^2$ and the dip angle is 60°. Calculate the induced e.m.f. between the plane tips.

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6. The self induced emf of a coil is 25 volts. When the current in it is changed at uniformed rate from 10 A to 25 A in 1s, the change in the energy of the inductances is

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7. A 10 m long horizontal wire extends from North east ro South East. It is falling with a speed of $5.0 ms^{-1}$, at right angles to the horizontal component of the earth's magnetic field, of $0.3 \times 10^{-4} Wb/m^2$. The value of the induced emf in wire is :

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8. A uniform magnetic field B exists in a direction perpendicular to the plane of a square frame made of copper wire. The wire has a diameter of 2 mm and a total length of 40cm. The magntic field changes with time at a steady rate $\frac{dB}{dt} = 0.02Ts^{-1}$. Find the current induced in the frame. Resistivity of copper $= 1.7X10^{-8}Wm.$

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9. A conducintg circular loop having a redius of 5.0cm, is placed perpendicular to a magnetic field of 0.50 T. It is removed from the field in 0.50 s. Find the average emf produced In the loop during this time.

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10. A coil of inductance $1H$ and resistance 10Ω is connected to a resistanceless battery of emf $50V$ at time $t = 0$. Calculate the ratio of rthe rate which magnetic energy is stored in the coil to the rate at which energy is supplied by the battery at $t = 0.1s$.

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11. A long solenoid having 200 turns per centimeter carries a current of $1.5A$. At the center of the solenoid a coil is placed of 100 turns of cross-sectional area $3.14 \times 10^{-4} m^2$ having its axis parallel to the field produced by the solenoid. When the direction of current in the solenoid is reversed within $0.05s$, the induced emf in the coil is

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12. A circular disc of radius $0.2m$ is placed in a uniform magnetic fied of induction $\frac{1}{\pi}\left(\frac{Wb}{m^2}\right)$ in such a way that its axis makes an angle of 60° with The magnetic flux linked with the disc is

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13. A plane loop, shaped as two squares of sides a=1m and b=0.4 m is introduced into a uniform magnetic field perpendicular to the pane of loop. The manetic field varies as $B = 10^{-3} \sin(100)T$. The amplitude of the current (in A) induced in the loop is its resistance per unit length is $r = 5m\Omega m^{-1}$ is

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14. A square metal loop of side 10 cm and resistance 1Ω is moved with a constant velocity partly inside a uniform magnetic field of $2Wbm^{-2}$, directed into the paper, as shown in the figure.

The loop is connected to a network of five resistors each of value 3Ω. If a steady curret of 1 mA flows in the loop , then the speed (in cm^{-1}) of the loop is

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15. If the rod is moving with a constant velocity of 12cm/s then the power (in watt) that must be supplied by an external force in maintaining the speed will be

(Given B=0.5 Tesla, l=15 cm, v=12 cm/s, Resistance of rod $R_{Ab} = 9.0 m\Omega$)

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Chapter 21 Alternating Current

1. A series AC circuit containing an inductor $(20 mH)$, a capacitor (120 μF) and a resistor (60Ω) is driven by an Ac source of 24 V/50Hz. The energy dissipated in the circuit in 60 s is :

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2. A power transmission line feeds input power at 2300 V a step down transformer with its primary windings having 4000 turns. The output power is delivered at 230 V by the transformer. If the current in the primary of the transformer is 5A and its efficiency is 90%, the output current would be :

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3. An alternating voltage v(t) = 220 sin 100 pt volt is applied to a purely resistive load of 50Ω . The time taken for the current to rise from half of the peak value to the peak value is :

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4. An inductor of inductance $100 mH$ is connected in series with a resistance, a variable capacitance and an AC source of frequency $2.0 kHz$. What should be the value of the capacitance so that maximum current may be drawn into the circuit?

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5. A 60 Hz AC voltage of 160 V impressed across an LR-circuit results in a current of 2A. If the power dissipation is 200 W, calculate the maximum value of the back emf (in volt) arising in the inductance.

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6. A 100 V AC source of frequency 500 Hz is connected to LCR circuit with L=8.1mH, $C = 12.5 \mu F$ and $R = 100 \Omega$, all connected in series. Find the potential (in volt) across the resistance.

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7. A coil has a resistance of 10Ω and an inductance of 0.4 henry. It is connected to an AC source of $6.5V$, $\frac{30}{\pi} Hz$. Find the average power consumed in the circuit.

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8. A circuit has a resistance of 12 ohm and an impendance of 15 ohm. The power factor of the circuit will be

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9. An AC generator of 220 V having internal resistance $r = 10\Omega$ and external resistance $R = 100\Omega$. What is the power developed in the external circuit?

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10. If $i_1 = 3\sin\omega t, i_2 = 4\cos\omega t,$ and $i_3 = i_0 \sin(\omega t + 53^\circ)$ find the value of i_0.

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11. Given LCR circuit has $L = 5H, C = 80\mu F, R = 40\Omega$ and variable frequency source of 200V. The source frequency (in Hz) which drives the circuit at resonance is

$\frac{x}{\pi}$.Find the value of

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12. An $L-C-R$ series circuit with 100Ω resistance is connected to an AC source of $200V$ and angular frequency $300rad/s$. When only the capacitance is removed, the current lags behind the voltage by 60°. When only the inductance is removed the current leads the voltage by 60°. Calculate the current and the power dissipated in the $L-C-R$ circuit

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13. A current of $4A$ flows in a coil when connected to a $12V DC$ source. If the same coil is connected to a $12V, 50rad/sAC$ source, a current of $2.4A$ flows in the circuit. Determine the inductance of the coil. Also, find the power developed in the circuit if a$2500\mu F$ capacitor is connected in series with the coil.

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14. A capacitor of capacitance $12.0\mu F$ is joined to an AC source of frequency 200 Hz.The rms current in the circuit is 2.00 A. Find the rms voltage (in volt) across the capacitor.

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15. An LCR circuit has $L = 10mL, R = 3\Omega$, and $C = 1\mu F$ connected in series to a source of $15 \cos \omega t$ volt. The current amplitude at a frequency that is 10% lower then the resonant frequency is

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Chapter 22 Electromagnetic Waves

1. A plane electromagnetic wave of frequency 50 MHz travels in free space along the positive x-direction. At a particular point in space and time $\vec{E} = 6.3\hat{j}$ V/m. The corresponding magnetic field $\vec{B}$, at that point is $x \times 10^{-8}\hat{k}T$. Find the value of x.

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2. If the magnetic field of a plane electromagnetic wave is given by (The speed of light = 3×10^8 m/s)

$$B = 100 \times 10^{-6} \sin\left[2\pi \times 2 \times 10^5 \left(t - \frac{x}{2}\right)\right]$$

then the maximum electric field associated with it is :

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3. A 27 mW laser beam has a cross-sectional maximum electric field in this electromagnetic wave is given by :

[Given permittivity of space $\in_0 = 9 \times 10^{12}$ SI units, Speed of light $c = 3 \times 10^8 m/s$]

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4. The mean intensity of radiation on the surface of the Sun is about $10^s W/m^2$. The rms value of the corresponding magnetic field is closed to :

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5. The magnetic field of a plane electromagnetic wave is given by: $\overrightarrow{B} = B_0 \hat{i} - [\cos(kz - \omega t)] + B_1 \hat{j} \cos(kz + \omega t)$ where $B_0 = 3 \times 10^{-5} T$ and $B_1 = 2 \times 10^{-6} T$. The rms value of the force experienced by a stationary charge $Q = 10^{-4} C$ at $z = 0$ is close to:

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6. A 50 W m^{-2} energy density of sunlight is incident normally on the surface of a solar panel. Some part of incident energy (25%) is reflected from the surface and the rest is absorbed. The force exerted on $1m^2$ surface area will be close to

$(c = 3 \times 10^8 ms^{-1})$

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7. A light beam traveling in the x-direction is described by th electric field $E_y = 300 \sin \omega \left(t - \frac{x}{c}\right)$. An electron is constarained to move along the y-direction with a speed of 2.0×10^7 m/s. Find the maximum electric force (in newton) on the electron.

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8. A laser beam has intensity $2.5 \times 10^{14} \frac{W}{m^2}$. Find the amptitude of electric field (in V/m) in the beam.

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9. Light is incident normally on a completely absorbing surface with an energy flux of $25 W cm^{-2}$ If the surface has an area of $25 cm^2$ the momentum transferred to the surface in 40 min time duration will be:

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10. In a wave $E_0 = 100 V m^{-1}$. Find the magnitude of Poynting's vector is watt m^{-2}.

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11. The magnetic field in a travelling electromagnetic wave has a peak value of 20 nT. The peak value of electric field strength (in volt m^{-1}) is

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12. A new system of unit is evolved in which the values of μ_0 and ε_0 aer 2 and 8 respectively. Then the speed of light in this system will be

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13. A plane electromagnetic wave of intensity of $10W/m^2$ strikes a small mmirror of area $20cm^2$, held perpendicular to the approcaching wave. The radiation froce on the mirror will be:

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14. Radiations of intensity $0.5W/m^2$ are striking a metal plate. The pressure on the plate is

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15. The electric field associated with an em wave in vacuum is given by $\vec{E} = 40\cos(kz - 6 \times 10^8 t)\hat{i}$, where E, z and t are in V.m^{-1}. meter and seconds respectively. The value of wave vector k is

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Chapter 23 Ray Optics And Optical Instruments

1. The eye can be regarded as a single refracting surface is equal to that of cornea (7.8 mm). This surface separates two media of refractive indices 1 and 1.34. Calculate the distance from the refracting surface at which a parallel beam of light will come to focus.

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2. A light wave is incident normally on a glass slab of reflected and the amplitude of the electrons field of the incident light is 30V/m, then the amplitude of the eletric field for the wave propogating in the glass medium will be :

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3. In figure, the optical fiber is l=2 m long and has a diameter of $d = 20 \mu m$. If a ray of light is incident on one end of the fiber at angle $\theta_1 = 40^\circ$, the number of reflections it makes before emerging from the other end :

(refractive index of fiber is 1.31 and $\sin 40^\circ = 0.64$)

4. A convex lens (of focal length 20 cm) and a concave mirror, having their principal axes align the same lines, are kept 80 cm apart from each other. The concave mirror is to the right of the convex lens. When an object is kept at a distance of 30 cm to the left of the convex lens, its image remains at the same position even if the concave mirror is removed. The maximum distance (in cm) of the object for which this concave mirror, by itself would produce a virtual image would be:

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5. A concave mirror used for face viewing has focal length of $0.4m$. The distance at which you hold the mirror from your face in order to see your image upright with a magnification of 5 is ______ (in m).

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6. A concave mirror has radius of curvature of 40 cm. It is at the bottom of a glass that has water filled up to 5 m. If a small particle is floating on the surface of water, its image as seen, from directly above the glass, is at a distance d from the surface of water. The value of d (in cm) is:

(Refractive index of water =1.33)

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7. A simple telescope, consisting of an objective of focal length $60cm$ and a single eye lens of focal length $5cm$ is focussed on a distant object is such a way that parallel rays comes out from the eye lens. If the object subtends an angle 2° at the objective, the angular width of the image.

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8. A ray of light falls on a glass plate of refractive index $\mu = 1.5$.

What is the angle of incidence of the ray if the angle between the reflected and refracted rays is 90°?

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9. A vessel having perfectly reflecting plane botton is filled with water $(\mu = 4/3)$ to depth d. A point source of light is placed at a height h above the surface of water. Find the distance of final image from water surface.

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10. A light ray is incident at an angle of 45° with the normal to a $\sqrt{2}$ cm thick plate$(\mu 2.0)$. Find the shift in the path of the light as it emerges out from the plate.

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11. The monochromatic beam of light is incident at 60° on one face of an equilateral prism of refractive index n and emerges from the opposite face making an angle $\theta(n)$ with the normal. For $n=\sqrt{3}$ the value of θ is 60° and $\frac{d\theta}{dn}=m$. The value of m is

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12. A prism ABC of angle 30° has its face AC silvered. A ray of light incident at an angle of 45° at the face AB retraces its path after refraction at face AB and reflection at face AC. The refractive index of the material of the prism is

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13. A glass sphere of radius 5 cm has a small bubble at a distance 2 cm from its centre.The bubble is viewed along a Diameter of the sphere from the side on which it lies.How far from the surface will it appear.Refractive index of glass is 1.5

2.5 cm behind the surface

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14. A converging beam of rays in incident on a diverging lens. Having passed through the lens the rays intersect at a point 15 cm from the lens. If the lens is removed the point where the rays meet will move 5 cm closer to the mounting that hold the lens. Find focal length (in cm) of the lens.

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15. The magnifying power of a microscope with an objective of $5mm$ focal length is 400. The length of its tube is $20cm$. Then the focal length of the eye $-$ piece is

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1. In a Young's double slit experiment, the slits are placed 0.320 mm apart. Light of wavelength $\lambda = 500$ nm is incident on the slits. The total number of bright fringes that are observed in the angular range $-30^\circ \leq \theta \leq 30^\circ$ is :

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2. In a Young's double slit experiment , the path difference at a certain point on the screen

,between two interfering waves is $\frac{1}{8}$th of wavelenght .The reatio of the intensity at this point to that at the center of abright fringe is close to :

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3. In a double-slit experiment, green light (5303Å) falls on a double slit having a separation of $19.44\mu m$ and a width of $4.05\mu m$. The number of bright fringes between the first and the second diffraction minima is:

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4. In an interference experiment the ratio of amplitudes of coherent waves is $\frac{a_1}{a_2} = \frac{1}{3}$ The ratio of maximum and minimum intensities of fringes is ....

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5. Calculate the limit of resolution of a telescope objective having a diameter of $200cm$, if it has detect light of wavelength $500nm$ coming from a star.

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6. A beam of light of wavelength 600 nm from a distant source falls on a single slit 1 mm wide and the resulting diffraction pattern is observed on a screen 2 m away. The distance between the first dark fringes on either side of the central bright fringe is

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7. If aperture diameter of the lens of a telescope is 1.25 m and wavelength of light used is 5000 Å its resolving power is

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8. A system of three polarizers P_1, P_2, P_3 is set up such that the pass axis of P_3 is crossed with respect to that of P_1. The pass axis of P_2 is incined at 60° to the pass axis of P_3. When a beam of unpolarized light of intensity I_0 is incident on P_1 the intensity of light transmitted by the three polarizes is I.The ratio (I_0 / I) equals (nearly):

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9. There are two sources kept at distance 2λ. A large screen is perpendicular to line joining the sources. Number of maximas on the screen in this case is ($\lambda =$ wavelength of light)

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10. A Young's double slit interference arrangement with slits S_1 and S_2 is immersed in water (refractive inded $= \frac{4}{3}$) as shown in the figure. The positions of maximum on the surface of water are given by $x^2 = p^2 m^2 \lambda^2 - d^2$, where λ is the wavelength of light in air (refractive index =1) , 2d is the separation betwen the slits and m is an integer. The value of p is

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11. Two waves of the same frequency have amplitudes 2 and 4. They interfare at a point where their phase difference is 60°. Find their resultant amplitude.

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12. If an interfernce pattern,at a point we observe the 16^{th} order maximum for $\lambda_1 = 6000\text{Å}$. what order will be visible here if the soruce is replaced by light of wavelength $\lambda_2 = 4800\text{Å}$

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13. Diameter of the objective lens of a telescope is 250 cm. for light of wavelength 600 nm. Coming from a distance object, the limit of resolution of the telescope is close to :

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14. A young's doubel slit arrangement produces interference fringes for sodium light $(\lambda = 5890\text{Å})$ that are 0.20° apart. What is the angular fringe separation(in degree) if the entire arrangement is is immersed in water? (refractive index of water is 4/3).

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15. A beam of plane polarised light falls normally on a polariser (cross sectional area $3 \times 10^{-4} m^2$) which rotates about the axis of the ray with an angular velocity of $31.4 rad / s$. Find the energy of light passing through polariser per revolution and the intensity of emergent beam, if flux of energy of the incident ray is $10^{-3} W$.

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Chapter 25 Dual Nature Of Radiation And Matter

1. Surface of certain metal is first illuminated with light of wavelength $\lambda_1 = 350$ nm and then, by light of wavelength $\lambda_2 = 540$ nm. It is found that the maximum speed of the photo electrons in the two cases differ by a factor of 2. The work function of the metal (in eV) is close to :

(Energy of photon $= \dfrac{1240}{\lambda(\text{in nm})} Ev$

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2. The magnetic field associated with a light wave is given, at the origin, by

$$B = B_0\left[\sin\left(3.14 \times 10^7\right)ct + \sin\left(6.28 \times 10^7\right)ct\right].$$

If this light falls on a silver plate having a work function fo 4.7 eV, what will be the maximum kinetic energy of the photo electrons?

$\left(c = 3 \times 10^8 ms^{-1}, h = 6.6 \times 10^{-34} J - s\right)$

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3. A metal plate of area $1 \times 10^{-4} m^2$ is illuminated by a radiation of intensity $16 mW / m^2$. The work function of the metal is 5eV. The energy of the incident photons is 10eV. The energy of the incident photons is 10eV and 10% of it produces photo electrons. The number of emitted photo electrons per second their maximum energy, respectively, will be : $\left[1 eV = 1.6 \times 10^{-19} J\right]$

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4. The stopping potential V_0 (in volt) as a function of frequeny (v) for a sodium emitter, is shown in the figure.

The work functio (in eV) of sodium, from the data plotted in the figure will be

(Given Plank's constant $(h) = 6.63 \times 10^{-34}$ Js, electron charge $e = 1.6 \times 10^{-19} C$)

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5. If the deBroglie wavelength of an electron is equal to 10^{-3} times the wavelength of a photon of frequency $6 \times 10^{-14} Hz$ then the speed (in m/s) of electron is equal to:

(Speed of light $= 3 \times 10^{8} m / s)$

Planck's constant $= 6.63 \times 10^{-34} J. s$

Mass of electron $= 9.1 \times 10^{-31} kg)$

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6. In a photoelectric experiment, the wavelength of the light incident on a metal is changed from

300 nm to 400 nm. Choose the closest value of change in the stopping potential from given options $\left(\frac{hc}{e} = 1240 nm. V\right)$

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7. A particle A of mass 'm' and charge 'q' is accelerated by a potential difference of 50 V. Another particle B of mass '4 m' and charge 'q' is accelerated by a potential difference of 2500 V. The ratio of de-Broglie wavelengths $\frac{\lambda_A}{\lambda_B}$ is close to :

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8. In a Frank-Hertz experiment,an electron of energy $5.6eV$ passes through mercury vapour and emerges with an energy $0.7eV$. The minimum wavelength of photons emitted by mercury atoms is close to :

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9. In the arrangement shown in figure y=1.0 nm, d=0.24 mm and D=1.2m. The work function of the material of the emitter is 2.2 eV. If stopping potential is 0.3 x, then value of x (in V) is

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10. The electric field of light wave is given as $\overrightarrow{E} = 10^{-3} \cos\left(\frac{2\pi x}{5 \times 10^{-7}} - 2\pi \times 6 \times 10^{14} t\right) \widehat{x} \frac{N}{C}$. This light falls on a metal plate of work function 2 eV. The stopping potential of the photo-electrons is:

Given, E (in eV) $= \frac{12375}{\lambda(\text{in}\text{Å})}$

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11. In a photoelectric effect experiment the threshold wavelength of light is 380 nm. If the wavelength of incident light is 260 nm, the maximum kinetic energy of emitted electrons will be ________eV

Given E (in eV) = $\frac{1237}{\lambda(\text{in mm})}$

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12. A 2 mW laser operates at a wavelength of 500 nm. The number of photons that will be emitted per second is: [Given Planck's constant $h = 6.6 \times 10^{-34} Js$, speed of light $c = 3.0 \times 10^8 m/s$]

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13. A monochromatic source of light operation at 200 W emits 4×10^{20} photons per second. Find the wavelength of the light $(\text{in} 10^{-7} m)$.

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14. Light of wavelength 1800 $\mathring{A}$ ejects photoelectrons from a plate of a metal whose work functions is 2 eV. If a uniform magnetic field of 5×10^{-5} tesla is applied parallel to plate, what would be the radius of the path followed by electrons ejected normally from the plate with maximum energy.

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15. A 100 W point source emits monochromatic light of wavelength $6000 A$

Q. Calculate the total number of photons emitted by the source per second.

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Chapter 26 Atoms

1. Taking the wavelength of first Balmer line in hydrogen spectrum ($n = 3$ to $n = 2$) as 660 nm, the wavelength of the 2^{nd} Balmer line ($n = 4$ to $n = 2$) will be:

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2. If He^{+} ion is in its first excited state then its ionization energy is

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3. In Li^{++}, electron in first Bohr orbit is excited to a level by a radiation of wavelength λ When the ion gets deexcited to the ground state in all possible ways (including intermediate emissions), a total of six spectral lines are observed. What is the value of λ (Given : $h = 6.63 \times 10^{-34} Js, c = 3 \times 10^{8} ms^{-1}$)

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4. An excited He^{+} ion emits two photons in succession, with wavelength 108.5 nm and 30.4 nm, in making a transition to ground state. The quantum number n, corresponding to its initial excited state is (for photon of wavelength λ, energy $E = \dfrac{1240eV}{\lambda(\text{in nm})}$

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5. Consider an electron in a hydrogen atom, revolving in its second excited state (having radius 4.65Å). The de-Broglie wavelength of the electron is

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6. The largest wavelength in the ultraviolet region of the hydrogen spectrum is 122 nm. The smallest wavelength in the infrared region of the hydrogen spectrum (to the nearest integer) is

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7. A hydrogen atom in its ground state is irradiated by light of wavelength 970Å Taking $hc/e = 1.237 \times 10^{-6}$eV m and the ground state energy of hydrogen atom as $-13.6eV$ the number of lines present in the emmission spectrum is

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8. The energy of an excited H-atom is $-3.4eV$. Calculate angular momentum of e^{-}

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9. An electron in hydrogen-like atom makes a transition from nth orbit or emits radiation corresponding to Lyman series. If de Broglie wavelength of electron in nth orbit is equal to the wavelength of rediation emitted , find the value of n . The atomic number of atomis 11.

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10. Some energy levels of a molecule are shown in the figure. The ratio of the wavelengths $r = \lambda_1 / \lambda_2$ is given by

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11. Ratio of the wavelength of first line of Lyman series and first line of Balmer series is

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12. As par Bohr model, the minimum energy (in eV) required to remove an electron from the ground state of doubly ionized Li atom $(Z = 3)$ is

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13. The ionisation energy of hydrogen atom is $13.6eV$. Following Bohr's theory, the energy corresponding to a transition between the 3rd and the 4th orbit is

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14. If the binding energy of the electron in a hydrogen atom is $13.6eV$, the energy required to remove the electron from the first excited state of Li^{++} is

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15. When an electron jumps from a level $n = 4$ to $n = 1$, the momentum of the recoiled hydrogen atom will be

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Chapter 27 Nuclei

1. Using a nuclear counter the count rate of emitted particles from a radioactive source is measured. At t=0 it was 1600 counts per second and t = 8 seconds it was 100 counts per second.

The count rate observed, as counts per seconds, at t=6, seconds is close to :

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2. The ratio of mass densities of nuclei of ^{40}Ca and ^{16}O is close to :

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3. The activity of a freshly prepared radioactive sample is 10^{10} disintergrations per second, whose mean life is $10^9 s$. The mass of an atom of this radioisotope is $10^{-25} kg$. The mass (in mg) of the radioactive samples is

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4. A radioactive element decays by $\beta - emission$. A detector records n beta particles in $2s$ and in next $2s$ it records $0.75n$ beta particles. Find mean life correct to nearest whole number. Given ln $|2| = 0.6931$, ln $|3| = 1.0986$.

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5. The half life of radon is 3.8 days. After how many days will only one twentieth of radon sample be left over?

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6. the count rate from a radioactive sample falls from 4.0×10^6per second to 1.0×10^6 per second in 20 hours.What will be the count rate 100 hours after the begnning ?

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7. In an ore containing Uranium, the ratio of U^{238} to Pb^{206} nuceli is 3. Calculate the age of the ore, assuming that alll the lead present in the ore is the final stable, product of U^{238}. Take the half-like of U^{238} to be 4.5×10^{9} years. In $(4/3) = 0.288$.

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8. In a nuclear reactor, U^{235} undergoes fission libertaing $200MeV$ of energy. The reactor has a 10% efficiency and produces $1000MW$ power. If the reactor is to function for 10 years, find the total mass of urnaium needed.

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9. A radioactive source, in the form of a metallic sphere of radius $10^{-2}m$ emits $\beta-$ particles at the rate of 5×10^{10} particles per second. The source is electrically insulated. How long will it take for its potential to be raised by $2V$, assuming that 40% of the emitted $\beta-$ particles escape the source.

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10. It is proposed to use the nuclear fusion reaction,

$._1^2H+_1^2H\rightarrow_2^4He$

in a nuclear reactor $200MW$ rating. If the energy from the above reaction is used with a 25 per cent efficiency in the reactor, how many grams of deuterium fuel will be needed per day?

(The masses of $._1^2 H$ and $._2^4 He$ are 2.0141 atomic mass units and 4.0026 atomic mass units respectively.)

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11. A $.^7 Li$ target is bombarded with a proton beam current of 10^{-4} A for 1 hour to produce $.^7 Be$ of activity 1.8×10^8 disintegrations per second.

Assuming that $.^7 Be$ radioactive nucleus is produced by bombarding 1000 protons, determine its half-life.

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12. The disintegration rate of a certain radioactive sample at any instant is 4750 disintegrations per minute. Five minutes later the rate becomes 2700 per minute. Calculate (a) decay constant and (b) half-life of the sample

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13. If the radius of a nucleus ^{256}X is 8 fermi, then the radius (in fermi) of ^{4}He nucleus will be

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14. The mass defect for the nucleus of helium is 0.0303 a.m.u. What is the binding energy per nucleon for helium in MeV ?

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15. The radius of germanium (Ge) nuclide is measured to be twice the radius of $._4^9 Be$. The number of nucleons in Ge are

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Chapter 28 Semiconductor Electronics Materials Devices And Simple Circuits

1. Mobility of electrons in a semiconductor is defined as the ratio of their drift velocity to the applied electric field. If, for an n-type semiconuctor, the density of electrons is $10^{19}m^{-3}$ and their mobility is $1.6m^2/(V.s)$ then the resistivity of te semiconductor (since it is an n-type semiconductor contribution of holes is ignored) is close to :

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2. Ge and Si diodes start conducting at 0.3 V and 0.7 V respectively. In the following figure if Ge diode connection are reversed, the value of V_0 (in volt) changes by: (assume that the Ge diode has large breakdown voltage)

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3. Copper, a monovalent, has molar mass 63.54 g/mol and density $8.96g/cm^3$. What is the number density n (in m^{-3}) of conduction electron in copper?

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4. An LED is constructed from a p-n junction based on a certain Ga-As-P semiconducting material whose energy is 1.9 eV. What is the wavelength of the emitted light?

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5. For the circuit shown below, the current (in mA) through the Zener diode is:

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6. A non transistor operates as a common emitter amplifier, with a power gain of 60 dB. The input circuit resistance is 100Ω and the output load resistance is $10k\Omega$. The common emitter current gain β is:

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7. In half - wave rectification, what is the output frequency, if the

input frequency is 50 Hz ? What is the output frequency of a full - wave rectifier

for the same input frequency ?

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8. A comon emitter amplifier circuit, built using an npn transistor, is shown in the figure its dc current gain is 250, $R_C = 1k\Omega$ and $V_{\text{CC}} = 10V$. What is the minimum base current (in μA) for V_{CE} to reach saturation?

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9. In a photodiode,the conductivity increases when the material is exposed to light.It is found that the conductivity changes only if the wavelength is less than 620nm.What is the band gap?

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10. When the base current in a transistor is changed from $30\mu A$to $80\mu A$,the collector current is changed form 1.0 mA to 3.5 mA. Find the current gainβ.

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11. In the given circuit the current (in mA) through Zener Diode is

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12. In an intrinsic semiconductor the energy gap E_g is 1.2 eV. Its hole mobility is much smaller than electron mobility and independent of temperature. What is the ratio between conductivity at 600 K and that at 300 K? Assume that the temerature dependence of intrinsic carrier concentration n_i is given by

$n_i = n_0 \exp\left(-\frac{E_g}{2k_B T}\right)$ where n_0 is a constant.

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13. The reverse breakdwon voltage of a Zener diode is 5.6 V in the given circuit.

The current I_2 (in mA) through the Zener is:

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14. The transfer characteristic curve of a transistor, having input and output resistance 100Ω and 100 $k\Omega$ respectively, is shown in the figure. The Voltage gain is

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15. The circuit shown below contains two ideal diodes, eac with a forwad resistance of 50Ω. If the battery voltage is 6V, the current through the 100Ω resistance (in Ampere) is:

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Chapter 29 Communication Systems

1. An audio signal of amplitude 0.1 V is used is used in amplitude modulation of a carrier wave of amplitude 0.2 V. Calculate the modulation index.

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2. A transmitting antenna at the top of a tower has a height $32m$ and the height of the receiving antenna is $50m$. What is the maximum distance between them for satisfactory communication in LOS mode? Given radius of earth $6.4 \times 10^6 m$.

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3. A telephonic communication service is working at carrier frequency of 10 GHz. Only 10% of it is utilized for transmission. How many telephonic channels can be transmitted simultaneously if each channel requires a bandwidth of 5 kHz ?

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4. For an amplitude modulated wave, the maximum amplitude is found to be 10 V while minimum amplitude is found to be 2 V. Determine the modulation index μ. What would be the value of μ if the minimum amplitude is zero?

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5. A radar has a power of $1kW$ and is operating at a frequency of $10GHz$. It is located on a mountain top of height $500m$. The maximum distance upto which it can detect object located on the surface of the earth (Radius of earth $6.4 \times 10^6 m$) is

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6. An audio signal consists of two distinct sound. One a human speech signal in the frequency band of $200Hz$ to $2700Hz$, while the other is a high frequency music signal in the frequency band of $10200Hz$ to $15200Hz$. The ratio of the AM signal together to the AM signal band width required to send just the human speech is:

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7. In a communication system operating at wavelength 800 nm, only one percent of source frequency is a available as signal bandwidth. The number of channels accomodated for transmitting TV signals of band width 6 MHz are (Take velocity of light $c = 3 \times 10^8 m/s, h = 6.6 \times 10^{-34} J - s$)

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8. A TV transmission tower has a height of 140 m and the height of the receiving antenna is 40 m. What is the maximum distance upto which signals can be broadcasted from this tower in LOS (Line of Sight) mode ? (Given : radius of earth = 6.4×10^6 m).

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9. The modulation frequency of an AM radio station is 250 kHz, which is 10% of the carrier wave. If another AM station approaches you for license what broadcast frequency will you allot ?

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10. A 100 V carrier wave is mode to vary betqeen 160 and 40 V by a modulating signal . What is the modulation index ?

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11. To double the covering range of a TV transimitter tower, its height should be made

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12. The wavelength of the carrier waves in a modern optical fiber communication network is close to :

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13. In a line of sight radio communication, a distance of about 50 is Kept between the transmitting and receiving entennas. If the height of the receiving antenna is $70m$, then the minimum height fof the transmitting antenna should be:

$\left(\text{Radius of the Earth} = 6.4 \times 10^6 m\right)$.

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14. A message signal of frequency 10 kHz and peak voltage of 10 volts is used to modulate a carrier of frequency 1 MHz and peak voltage of 20 volts. The side bands are 10 10 kHz and ______________kHz.

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15. A diode detector is used to detect an amplitudemodulated wave of 60% modulation by using a condenser of capacity 250 picofarad in parallel with a load resistance 100 kilo ohm. Find the maximum modulated frequency (in kHz) which could be detected by it.

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