UNIT 1

Q1.If heat dissipated in a resistance can be determined from the relation:

$H = I^2Rt$ joule , If the maximum error in the measurement of current, resistance and time are 2% ,1% , and 1% respectively, What would be the maximum error in the dissipated heat?

Q2. Name any three physical quantities having the same dimensions and also give their dimensions.

Q3. In Vander Wall's equation $(P + a/V^2)(V – b) = RT$, Determine the dimensions of a and b.

Q4. Give the limitations of dimensional analysis.

Q5. If $X= a+ bt^2$, where X is in meter and t is in second . find the unit of a and b?

Q6. What is meant by significant figures ? State the rules for counting the number of significant figures in a measured quantity?

Q7. Show that the maximum error in the quotient of two quantities is equal to the sum of their individual relative errors.

Q8. Deduce the dimensional formulae for the following physical quantities.

A) Gravitational constant.

B) Power

C) coefficient of viscosity

D) Surface tension.

Q9. Name the four basic forces in nature. Arrange them in the order of their increasing strengths.

Q10. Convert 1 Newton force in to Dyne.

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Q11. If E,M,J and G respectively denote energy, mass, angular momentum and gravitational constant, Calculate the dimensions of EJ^2/M^5G^2

Q12. The frequency ν of vibration of stretched string depends on its length L its mass per unit length m and the tension T in the string obtain dimensionally an expression for frequency ν.

Q13. What is meant by significant figures .State the rules for counting the number of significant figures in a measured quantity?

Q14. A physical quantity X is given by $X = A^2B^3/C\sqrt{D}$, If the percentage errors of measurement in A,B,C and D are 4%,2%,3% and 1% respectively, then calculate the % error in X.

Q15. If two resistors of resistance $R_1=(4 \pm 0.5)\Omega$ and $R_2=(16 \pm 0.5)\Omega$ are connected (1) In series and (2) Parallel . Find the equivalent resistance in each case with limits of % error.

Q16. The length of a rod measured in an experiment was found to be 2.48m, 2.46, 2.50m and 2.48m and 2.49m, Find the average length , the absolute error in each observation and % error.

Q17. A famous relation in physics relates moving mass m to the rest mass m_0 of a particle in terms of its speed v and the speed of the light c. A boy recalls the relation almost correctly but forgets where to put the constant c. He writes:

$$m = m_o / (1 - v^2)^{1/2}$$

Guess where to put the missing c.

Q18. A calorie is a unit of heat energy and it equals about4.2 J, where 1 J = 4.2 kgm^2s^{-2}. Suppose we employ a system of units in which the unit of mass equals α kg, the unit of length equals β m, the units of time is ϒ sec. show that a calorie has a magnitude $4.2\ \alpha^{-1}\ \beta^{-2}\ \Upsilon^2$ in terms of the new units.

Q19. In the formula $X = 3YZ^2$, X and Z have dimensions of capacitance and magnetic induction respectively, what are the dimensions of Y in MKS system?

Q20. In an experiment, on the measurement of g using a simple pendulum the time period was measured with an accuracy of 0.2 % while the length was measured with accuracy of 0.5%. Calculate the percentage error in the value of g.

Q21. Explain:

(i) Absolute error (iii) Mean absolute error

(ii) Relative error (iv) percentage error

(v) Random error

Q22. Convert:

(i) Gravitational constant (G) = $6.67 \times 10^{-11}\ Nm^2\ kg^{-2}$ to $cm^3\ g^{-1}\ s^{-2}$ (ii) The escape velocity v of a body depends on, the acceleration due to gravity 'g' of the planet and the radius R of the planet, Establish dimensionally for relation for the escape velocity.

Q23. Name the four basic forces in nature. Write a brief note of each, hence compare their strengths and ranges.

UNIT 2

Q1. Derive an equation for the distance travelled by an uniform acceleration body in n^{th} second of its motion.

Q2. The velocity of a moving particle is given by $V=6+18t+9t^2$(x in meter, t in seconds) what is it's acceleration at t=2s

Q3.what is relative velocity in one dimension, if V_A and V_B are the velocities of the body A and B respectively then prove that $V_{AB}=V_A-V_B$?

Q4. Show that when the horizontal range is maximum, height attained by the body is one fourth the maximum range in the projectile motion.

Q6. State the parallelogram law of vector addition. Derive an expression for magnitude and direction of resultant of the two vectors.

Q7. A gunman always keeps his gun slightly tilted above the line of sight while shooting. Why,

Q8. Derive the relation between linear velocity and angular velocity.

Q9. What do you mean by rectangular components of a vector? Explain how a vector can be resolved into two rectangular components in a plane .

Q10. The greatest height to which a man can a stone is h, what will be the longest distance upto which he can throw the stone ?

Q11. If 'R' is the horizontal range for Θ inclination and H is the height reached by the projectile, show that R(max.) is given by

$$R_{max} = 4H$$

Q12. A body is projected at an angle Θ with the horizontal. Derive an expression for its horizontal range. Show that there are two angles Θ_1 and Θ_2 projections for the same horizontal range. Such that $(\Theta_1 + \Theta_2) = 90^{0.}$

Q13. Prove that there are two values of time for which a projectile is at the same height . Also show that the sum of these two times is equal to the time of flight.

Q14: Draw position –time graphs of two objects , A and B moving along straight line, when their relative velocity is zero.

Q15. Two vectors **A** and **B** are inclined to each other at an angle Θ. Using triangle law of vector addition, find the magnitude and direction of their resultant.

Q16. Define centripetal acceleration. Derive an expression for the centripetal acceleration of a particle moving with constant speed v along a circular path of radius r.

Q17. When the angle between two vectors of equal magnitudes is 2π/3, prove that the magnitude of the resultant is equal to either.

Q18. A ball thrown vertically upwards with a speed of 19.6 m/s from the top of a tower returns to the earth in 6s. find the height of the tower. (g = 9.8 m/sec^2)

Q19. Find the value of λ so that the vector $\vec{\boldsymbol{A}} = 2\hat{\imath} + \lambda\,\hat{\jmath} + \hat{k}$ and $\vec{\boldsymbol{B}} = 4\hat{\imath} - 2\hat{\jmath} - 2\hat{k}$ are perpendicular to each.

Q10. Show that a given gun will shoot three times as high when elevated at angle of 60^0 as when fired at angle of 30^0 but will carry the same distance on a horizontal plane.

Q19. Draw velocity- time graph of uniformly accelerated motion in one dimension. From the velocity – time graph of uniform accelerated motion, deduce the equations of motion in distance and time.

Q20. (a) With the help of a simple case of an object moving with a constant velocity show that the area under velocity – time curve represents over a given time interval.

(a) A car moving with a speed of 126 km/h is brought to a stop within a distance of 200m. calculate the retardation of the car and the time required to stop it.

Q21. Establish the following vector inequalities :

(i) $|\vec{\boldsymbol{a}} + \vec{\boldsymbol{b}}| \leq |\vec{\boldsymbol{a}}| + |\vec{\boldsymbol{b}}|$

(ii) $|\vec{\boldsymbol{a}} - \vec{\boldsymbol{b}}| \leq |\vec{\boldsymbol{a}}| + |\vec{\boldsymbol{b}}|$

When does the equality sign apply.

Q22. What is a projectile ? show that its path is parabolic. Also find the expression for :

(i) Maximum height attained and

(ii) Time of flight

Q23. Define centripetal acceleration. Derive an expression for the centripetal acceleration of a body moving with uniform speed v along a circular path of radius r. explain how it acts along the radius towards the centre of the circular path.

UNIT3 AND UNIT 4

1. Is net force needed to keep a body moving with uniform velocity?

2. Is Newton's 2^{nd} law (F = ma) always valid. Give an example in support of your answer?

3. Action and reaction forces do not balance each other. Why?

4. Can a body remain in state of rest if more than one force is acting upon it?

5. Is the centripetal force acting on a body performing uniform circular motion always constant?

6. The string is holding the maximum possible weight that it could withstand. What will happen to the string if the body suspended by it starts moving on a horizontal circular path and the string starts generating a cone?

7. What is the reaction force of the weight of a book placed on the table?

8. What is the maximum acceleration of a vehicle on the horizontal road? Given that coefficient of static friction between the road and the tyres of the vehicle is μ.

9. Why guns are provided with the shoulder support?

10. While paddling a bicycle what are the types of friction acting on rear wheels and in which direction?

11. Explain why the water doesn't fall even at the top of the circle when the bucket full of water is upside down rotating in a vertical circle?

12. The displacement of a particle of mass 1kg is described by $s = 2t + 3t^2$. Find

the force acting on particle?

13. A particle of mass 0.3 kg is subjected to a force of F = -kx with k = 15 Nm^{-1}. What will be its initial acceleration if it is released from a point 10 cm away from the origin?

14. Three forces F_1, F_2 and F_3 are acting on the particle of mass m which is stationary. If F_1 is removed, what will be the acceleration of particle?

15. A spring balance is attached to the ceiling of a lift. When the lift is at rest spring balance reads 50 kg of a body hanging on it. What will be the reading of the balance if the lift moves :-

(i) Vertically downward with an acceleration of 5 ms^{-2}

(ii) Vertically upward with an acceleration of 5 ms^{-2}

(iii) Vertically upward with a constant velocity.

Take g = 10m/s^2

16. Is larger surface area break on a bicycle wheel more effective than small surface area brake? Explain?

17. Calculate the impulse necessary to stop a 1500 kg car moving at a speed of 25ms^{-1}? (–37500 N-s)

18.Give the magnitude and directions of the net force acting on a rain drop falling freely with a constant speed of 5 m/s?

19. A block of mass .5kg rests on a smooth horizontal table. What steady force is required to give the block a velocity of 2 m/s in 4 s?

10. Calculate the force required to move a train of 200 quintal up on an incline plane of 1 in 50 with an acceleration of 2 ms^{-2}. The force of friction per quintal is 0.5 N?

20. A bullet of mass 0.02 kg is moving with a speed of 10m^{-1}s. It penetrates 10 cm of a wooden block before coming to rest. If the thickness of the target is reduced to 6 cm only find the KE of the bullet when it comes out? (**Ans :** 0.4 J)

21. A man pulls a lawn roller with a force of F. If he applies the force at some angle with the ground. Find the minimum force required to pull the roller if coefficient of static friction between the ground and the roller is μ?

22. A ball bounces to 80% of its original height. Calculate the change in momentum?

23. A pendulum bob of mass 0.1 kg is suspended by a string of 1 m long. The bob is displaced so that the string becomes horizontal and released. Find its kinetic energy when the string makes an angle of (i) 0°, (ii) 30°, (iii) 60° with the vertical?

24. The velocity of a particle moving along a circle of radius R depends on the distance covered s as F = 2αs where α is constant. Find the force acting on the particle as a function of s?

25. A block is projected horizontally on rough horizontal floor with initial velocity u. The coefficient of kinetic friction between the block and the floor is μ. Find the distance travelled by the body before coming to rest?

26. A locomotive of mass m starts moving so that its velocity v changes according to $v = \sqrt{(\alpha\ s)}$, where α is constant and s is distance covered. Find the force acting on the body after time t?

27. Derive an expression for the centripetal force?

28. Find the maximum value of angle of friction and prove that it is equal to the angle of repose?

29. State and prove Lami's theorem?

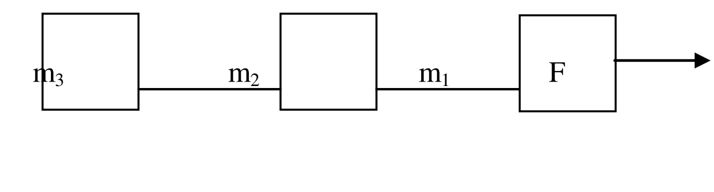
30. Find the maximum and minimum velocity of a vehicle of mass m on a banked road of banking angle θ, if coefficient of static friction of the wheels of vehicle with the road is μ?

31. Find the maximum and minimum force applied parallel up the incline on a block of mass m placed on it if angle of inclination is θ and coefficient of static friction with the block is μ so that the block remains at rest?

32. Prove that in case of vertical circular motion circular motion of a body tied to a string velocities at topmost and lowermost point be √(rg) and √(5rg) respectively and tensions in the strings be 0 and 6mg respectively?

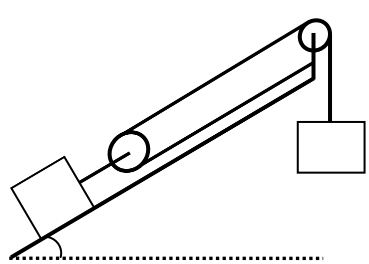
33. Find the maximum horizontal velocity that must be imparted to a body placed on the top of a smooth sphere of radius r so that it may not loose contact? If the same body is imparted half the velocity obtained in the first part then find the angular displacement of the body over the smooth sphere when it just loses contact with it?

34 Find the acceleration of the blocks and the tension in the strings?



Some Intellectual Stuff

1. Find the acceleration of the blocks m_1 and m_2. All the surfaces are smooth and string and pulley are light? Also find the net force on the clamped pulley?



2. A body of mass m explodes into three fragments of with masses in the ratio 2:2:6. If the two similar masses move of perpendicular to each other with the speed of 10m/s each, find the velocity of the third particle and its direction relative to the two other bodies?

3. A mass of 5 kg is suspended by a rope of length 2m from the ceiling. A horizontal force of 50 N is applied at the mid point P of the rope? Calculate the angle that the rope makes with the vertical and the tension in the part of the rope between the point of suspension and point P?. Neglect the mass of the rope. ($g = 10ms^{-2}$)

4. A body moving inside a smooth vertical circular track is imparted a velocity of $\sqrt{(4rg)}$ at the lowermost point. Find its position where it just loses contact with the track?

UNIT 5.

1. A bob is pulled sideway so that string becomes parallel to horizontal and released. Length of the pendulum is 2 m. If due to air resistance loss of energy is 10% what is the speed with which the bob arrives the lowest point?

2. Find the work done if a particle moves from position $r_1 = (4i + 3j + 6k)$m to a position $r_2 = (14i = 13j = 16k)$ under the effect of force, $F = (4i + 4j - 4k)$N?

3. 20 J work is required to stretch a spring through 0.1 m. Find the force constant of the spring. If the spring is stretched further through 0.1m calculate work done?

4. A pump on the ground floor of a building can pump up water to fill a tank of volume $30m^3$ in 15 min. If the tank is 40 m above the ground, how much electric power is consumed by the pump? The efficiency of the pump is 30%.

5. Spring of a weighing machine is compressed by 1cm when a sand bag of mass 0.1 kg is dropped on it from a height 0.25m. From what height should the sand bag be dropped to cause a compression of 4cm?
6. Show that in an elastic one dimensional collision the velocity of approach before collision is equal to velocity of separation after collision?

7. A spring is stretched by distance x by applying a force F. What will be the new force required to stretch the spring by 3x? Calculate the work done in increasing the extension?

8. Write the characteristics of the force during the elongation of a spring. Derive the relation for the P.E. stored when it is elongated by length. Draw the graphs to show the variation of potential energy and force with elongation?

9. How does a perfectly inelastic collision differ from perfectly elastic collision? Two particles of mass m_1 and m_2 having velocities u_1 and u_2 respectively make a head on collision. Derive the relation for their final velocities?

10. In lifting a 10 kg weight to a height of 2m, 250 Joule of energy is spent. Calculate the acceleration with which it was raised?($g=10m/s^2$)

11. An electrical water pump of 80% efficiency is used to lift water up to a height of 10m.Find mass of water which it could lift in 1hrour if the marked power was 500 watt?

12. A cycle is moving up the incline rising 1 in 100 with a const. velocity of 5m/sec. Find the instantaneous power developed by the cycle?

13. Find % change in K.E of body when its momentum is increased by 50%.

14. A light string passing over a light frictionless pulley is holding masses m and 2m at its either end. Find the velocity attained by the masses after 2 seconds.

15. Derive an expression for the centripetal force experienced by a body performing uniform circular motion.

16. Find the elevation of the outer tracks with respect to inner. So that the train could safely pass through the turn of radius 1km with a speed of 36km/hr. Separation between the tracks is 1.5m?

17. A block of mass m is placed over a smooth wedge of inclination θ. With what horizontal acceleration the wedge should be moved so that the block must remain stationery over it?

18. Involving friction prove that pulling is easier than pushing if both are done at the same angle.

19. In vertical circular motion if velocity at the lowermost point is $\sqrt{(6rg)}$ where find the tension in the string where speed is minimum. Given that mass of the block attached to it is m?

20. A bullet of mass m moving with velocity u penetrates a wooden block of mass M suspended through a string from rigid support and comes to rest inside it. If length of the string is L find the angular deflection of the string.

UNIT 6

1. Define centre of mass. Obtain an expression for perpendicular of centre of mass of two particle system and generalise it for particle system.

2. Find expression for linear acceleration of a cylinder rolling down on a inclined plane.
A ring, a disc and a sphere all of them have same radius and same mass roll down on inclined plane from the same heights. Which of these reaches the bottom (i) earliest (ii) latest ?

3. (i) Name the physical quantity corresponding to inertia in rotational motion. How is it calculated? Give its units.
(ii)Find expression for kinetic energy of a body.

4. State and prove the law of conservation of angular momentum. Give one illustration to explain it.

5. State parallel and perpendicular axis theorem.

Define an expression for moment of inertia of a disc R, mass M about an axis along its diameter.

6. A uniform disc of radius R is put over another uniform disc of radius 2R of the same thickness and density. The peripheries of the two discs touch each other. Locate the centre of mass of the system.

7 Two blocks of masses 10 kg and 20 kg are placed on the x-axis. The first mass is moved on the axis by a distance of 2 cm. By what distance should the second mass be moved to keep the position of centre of mass unchanged ?

8. A simple of length l is pulled aside to make an angle θ with the vertical. Find the magnitude of the torque of the weight w of the bob about the point of suspension. When is the torque zero ?

9. A square plate of mass 120 g and edge 5.0 cm rotates about one of edges. If it has a uniform angular acceleration of 0.2 rad/s^2, what torque acts on the plate ?

10. A wheel of moment of inertia 0.10 kg-m^2 is rotating about a shaft at an angular speed of 160 rev/minute. A second wheel is set into rotation at 300 rev/minute and is coupled to the same shaft so that both the wheels finally rotate with a common angular speed of 200 rev/minute. Find the moment of inertia of the second wheel.

UNIT 7

Q1.Explain how knowledge of g helps us to find (i)mass of earth and(ii)mean density of earth?

Q2.Obtain the expression for orbital velocity, time period, and altitude of a satellite.

Q3.What do you understand by 'Escape velocity'? Derive an expression for it in terms of parameters of given planet.

Q4.What do you understand by gravitational field, Intensity of gravitational field. Prove that gravitational intensity at a point is equal to the acceleration due to gravity at that point.

Q5.A mass M is broken into two parts of masses$m_1 and\ m_2$. How are $m_1\ and\ m_2$ related so that force of gravitational attraction between the two parts is maximum.

Q6.Two particles of equal mass move in a circle of radius r under the action of their mutual gravitational attraction. Find the speed of each particle if its mass is m.

Q7.The magnitude of gravitational field at distances $r_1\ and\ r_2$ from the centre of a uniform sphere of radius R and mass M are $I_1 and\ I_2$ respectively. Find the ratio of (I_1/I_2) if $r_1 > R\ and\ r_2 < R.$

Q8.Two bodies of masses $m_1 and\ m_2$ are initially at rest at infinite distance apart. They are then allowed to move towards each other under mutual gravitational attraction. Find their relative velocity of approach at a separation distance r between them.

Q9.Since the moon is gravitationally attracted to the earth, why does it not simply crash on earth?

Q10.What are the conditions under which a rocket fired from earth, launches an artificial satellite of earth?

Q11.State Kepler's laws of planetary motion. Prove second Kepler's law using concept of conservation of angular motion.

Q12.State universal law of gravitation. What is the significance of this law. Find the expression for acceleration due to gravity.

Q13.Explain the variation of acceleration due to gravity with (I)altitude (ii)depth

Q14.Define gravitational potential energy. Derive the expression for gravitational potential energy. What is the maximum value of gravitational potential energy?

Q15.What is escape speed? Derive the expressions for it. Calculate escape speed for the Earth.

UNIT 8.

Q.1 Steel is more elastic than rubber. Explain.

Q.2. A wire stretches by a certain amount under a load. If the load and radius are both increased to four times, find the stretch caused in the wire.

Q. 3. Calculate the percentage increase in the length of a wire of diameter 2mm stretched by a force of 1kg F. Young's modulus of the material of wire is 15 X $10^{10}Nm^{-2}$.

Q. 4. The pressure of a medium is changed from 1.01 X 10^5 pa to 1.165 X 10^5 pa and changed in volume is 10% keeping temperature constant. Find the bulk modulus of the medium.

Q.5. 27 identical drops of water are falling down vertically in air each with a terminal velocity of 0.15m/s. If they combine to form a single bigger drop, what will be its terminal velocity?

Q.6. Water flows through a horizontal pipe line of varying cross section at the rate of $0.2m^3s^{-1}$. Calculate the velocity of water at a point where the area of cross section of the pipe is $0.02m^2$.

Q. 7. A cylinder of height 20m is completely filled with water. Find the efflux water (in m s-1) through a small hole on the side wall of the cylinder near its bottom. Given g = 10m/s.

**Q.8. At what common temperature would a block of wood and a block of metal appear equally cold or equally hot when touched?

Q.9. A piece of chalk immersed into water emits bubbles in all directions. Why?

Q. 10. Water at a pressure of 4×10^4 Nm-2 flows at $2ms^{-1}$ through a pipe of $0.02m^2$ cross sectional area which reduces to $0.01m^2$. What is the pressure in the smaller cross section of the pipe?

Q.11. What is surface tension and surface energy? Derive the relation between surface tension and surface energy.

Q.12. Derive equation of continuity for steady and irrotational flow of a perfectly mobile and incompressible fluid. What conclusion is drawn from it?

Q.13 What is Stoke's law? Derive the relation by the method of dimension.

Q.14. A piece of iron of mass 0.1 kg is kept inside a furnace, till it attains the temperature of the furnace. The hot piece of iron is dropped into a calorimeter containing 0.24 Kg of water at 20□. The mixture attains an equilibrium temperature of 60□. Find the temperature of the furnace. Given water equivalent of calorimeter = 0.01 kg and specific heat of iron = 470 J Kg^{-1} $K^{-1.}$

**Q.15. Calculate the energy spent in spraying a drop of mercury of 1 cm radius into 10^6 droplets all of same size. Surface tension of mercury is 35×10^{-3} Nm^{-1}.

Q.16. A liquid takes 10 minutes to cool from 70□ to 50□. How much time will it take to cool from 60□ to 40□ ? The temperature of the surrounding is 20□.

**Q17. A slab of stone of area $0.36m^2$ and thickness of 0.1m is exposed to the lower surface of steam at 100□. A block of ice at 0□ rest on the upper surface of the slab. In one hour 4.8 Kg of ice is melted. Calculate the thermal conductivity of stone.

Q. 18. Define capillarity and angle of contact. Derive an expression for the ascent of liquid inside a capillary tube where it is dipped in a liquid.

Q. 19. Show that there is always excess of pressure on the concave side of the meniscus of a liquid. Obtain the expression for the excess of pressure inside (i) a liquid drop (ii) liquid bubble.

Q. 20. State and prove the Bernoulli's principle. Give two practical application of it.

UNIT 9

Q1 Which Thermodynamical variable is defined by the first law of thermodynamics?

Q2 What is the amount of work done in the Cyclic process?

Q3 Out of the parameters- temperature, pressure,work and volume, which parameter does not Characterize the thermodynamics state of matter?

Q4 What is the nature of P-V diagram for isobaric and isochoric process?

Q5 On what factors does the efficiency of Carnot engine depends?

** Q6 Can we increase the temperature of gas without supplying heat to it?

Q7 Why does the gas get heated on compression?

Q8 Which thermodynamic variable is defined by Zeroth law of thermodynamics?

Q9 Can the whole of work be converted into heat?

. Q10 In a Carnot engine, temperature of the sink is increased. What will happen to its efficiency? 1

**Q11 If hot air rises , why is it cooler at the top of mountain than near the sea level ?

. Q12 What happen to the internal energy of a gas during (i) isothermal expansion (ii) adiabatic Expansion?

Q13.Air pressure in a car increases during driving. Explain Why?

Q14 The efficiency of a heat engine cannot be 100%. Explain why ?

Q15 In an effort to cool a kitchen during summer, the refrigerator door is left open and the kitchen door and windows are closed. Will it make the room cooler ?

Q16 Why cannot the Carnot's engine be realised in practice?

Q17 A slab of ice at 273K and at atmospheric pressure melt.(a) What is the nature of work done on The ice water system by the atmosphere?(b)What happen to the internal energy of the ice- Water system?

Q18 Why is the conversion of heat into work not possible without a sink at lower temperature?

Q19 Can water be boiled without heating ?

Q20 What are the limitations of the first law of thermodynamics ?

Q21 What is thermodynamic system ? Prove that work done by thermodynamic system is equal to the area under P-V diagram.

22 Prove that C_p - C_v = R , for an ideal gas .

Q23 What is isothermal process / State two essential conditions for such a process to takes place. Show analytically that the work by one mole of an ideal gas during volume expansion from V_1 V_2 at temperature T is given by $W = RT \log_e V_2/V_1$

Q24 Define an adiabatic process. State two essential conditions for such a process to takes place.Derive an expression for adiabatic process to takes place.

Q25Discuss the four steps of Carnot's cycle and show that the efficiency is given by ¶ = 1 - T_2/ T_1, Where T_1 and T_2 are the temperature of the source and sink respectively.

Q26 Describe the working of refrigerator as heat pump. Derive the expression of its coefficient of performance.If the door of a refrigerator is kept open for a long time ,will it make the room warm or cool ?

Q27 What is the need of introducing the second law of thermodynamics ? State the Kelvin –Planck and Claussius statement of second law of thermodynamics and show that both the statement are equivalent.

UNIT 10

1. Show that rms velocity of O_2 is $\sqrt{2}$ times that of SO_2. Atomic wt. of Sulphur is 32 and that of oxygen is 16.
2. Calculate the temperature at which rms velocity of SO_2 is the same as that of Oxygen at27□.
3. Calculate the total no. of degrees of freedom possessed by the molecules in 1cm^3 of H_2 gas at NTP
4. Derive Boyle's law on the basis of Kinetic Theory of Gases.
5. Derive Charles's law on the basis of Kinetic Theory of Gases.
6. State Dalton's law of partial pressures. Deduce it from Kinetic Theory of Gases.
7. Using the expression for pressure exerted by a gas, deduce Avogadro's law and Graham's law of diffusion.
8. State the number of degree of freedom possessed by a monoatomic molecule in space. Also give the expression for total energy possessed by it at a given temperature. Hence give the total energy of the atom at 300 K.
9. At what temperature is the root mean square speed of an atom in an argon gas cylinder equal to the rms speed of helium gas atom at$-$ 20□? Atomic mass of argon = 39.9 u and that of helium = 4.0 u.

10. From a certain apparatus the diffusion rate of Hydrogen has an average value of 28.7 $cm^3\ s^{-1}$; the diffusion of another gas under the same conditions is measured to have an average rate of $7.2 cm^3 s^{-1}$. Identify the gas.

11. Prove that the pressure exerted by a gas is $P = \frac{1}{3}\rho \overline{c}^2$ where ρ is the density and c is the root mean square velocity.

12.What are the basic assumptions of Kinetic Theory of Gases? On their basis derive an expression for the pressure exerted by an ideal gas.

UNIT 11 AND 12

1. At what points is the energy entirely kinetic and potential in S.H.M? What is the total distance travelled by a body executing S.H.M in a time equal to its time period, if its amplitude is A?
2. A simple pendulum consisting of an inextensible length ‘l’ and mass ‘m’ is oscillating in a stationary lift. The lift then accelerates upwards with a constant acceleration of 4.5 m/s^2. Write expression for the time period of simple pendulum in two cases. Does the time period increase, decrease or remain the same, when lift is accelerated upwards?
3. Does the function $y = \sin^2\omega t$ represent a periodic or a S.H.M? What is period of motion?
4. All trigonometric functions are periodic, but only sine or cosine functions are used to define SHM. Why?
5. A simple Harmonic Motion is represented by $\frac{d^2x}{dt^2} + \alpha x = 0$. What is its time period?
6. The Length of a simple pendulum executing SHM is increased by 2.1%. What is the percentage increase in the time period of the pendulum of increased length?
7. A simple Harmonic motion has an amplitude A and time period T. What is the time taken to travel from x = A to x = A/2.
8. An open organ pipe produces a note of frequency 5/2 Hz at 15^0C, calculate the length of pipe. Velocity of sound at 0^0C is 335 m/s.
9. An incident wave is represented by Y(x, t)=20sin(2x-4t).Write the expression for reflected wave

   (i) From a rigid boundary

   (ii) From an open boundary.

Explain why

(i) in a sound wave a displacement node is a pressure antinode and vice- versa

(ii) The shape of pulse gets- distorted during propagation in a dispersive medium.

GROUP B

1. The speed of longitudinal wave `V` in a given medium of density ρ is given by the formula, use this formula to explain why the speed of sound in air.
   (a) is independent at pressure
   (b) increases with temperature and
   (c) increases with humidity

2. Write any three characteristics of stationary waves.

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3. Show that the speed of sound in air increased by .61m/s for every 1^0 C rise of temperature.
4. Find the ratio of velocity of sound in hydrogen gas $\Upsilon = \frac{7}{5}$ to that in helium gas $\Upsilon = \frac{5}{3}$ at the same temperature. Given that molecular weight of hydrogen and helium are 2 and 4 respectively.
5. The equation of a plane progressive wave is, $y = 10Sin2\pi(t - 0.005x)$where y & x are in cm & t in second. Calculate the amplitude, frequency, wavelength & velocity of the wave.
6. Write displacement equation respecting the following condition obtained in SHM.

Amplitude = 0.01m

Frequency = 600Hz

Initial phase = $\frac{\pi}{6}$

The amplitude of oscillations of two similar pendulums similar in all respect are 2cm & 5cm respectively. Find the ratio of their energies of oscillations.

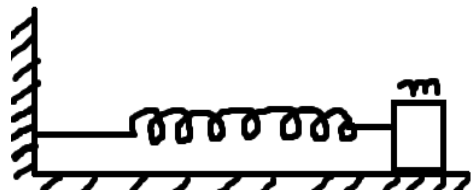
7. What is the condition to be satisfied by a mathematical relation between time and displacement to describe a periodic motion?

9. A spring of force constant 1200N/m is mounted horizontal table. A mass of 3Kg is attached to the free end of the spring, pulled sideways to a distance of 2.0cm and released.

(i) What is the frequency of oscillation of the mass?

(ii) What is the maximum acceleration of the mass?

(iii) What is the maximum speed of the mass?



10. Which of the following function of time represent, (a) simple harmonic (b) periodic but not SHM and (c) non periodic ?

(i) Sinωt- Cosωt (ii) $Sin^3\omega t$ (iii) $3Cos(\frac{\pi}{2} - 2\omega t)$(iv)exp$(-\omega^2 t^2)$

11. (a) A light wave is reflected from a mirror. The incident & reflected wave superimpose to form stationary waves. But no nodes & antinodes are seen, why?

(b) A standing wave is represented by y=2ASinKxCoswt.If one of the component wave is $y_1 = ASin(\omega t - Kx)$, what is the equation of the second component wave?

12. Discuss Newton's formula for velocity of sound in air. What correction was made to it by Laplace and why?

13. (a) What are beats? Prove that the number of beats per second is equal to the difference between the frequencies of the two superimposing wave.

(b) Draw fundamental nodes of vibration of stationary wave in (i) closed pipe, (ii) in an open pipe.

14. Discuss the formation of harmonics in a stretched string. Show that in case of a stretched string the first four harmonics are in the ratio 1:2:3:4.

15. Explain Doppler's effect of sound. Derive an expression for the apparent frequency where the source and observer are moving in the same direction with velocity Vs and Vo respectively, with source following the observer.

16. For a travelling harmonic wave, $y = 2Cos(10t - 0.008x + 0.35)$ where x & y are in cm and t in second. What is the phase difference between oscillatory motions at two points separated by a distance of (i) 4cm (ii) 0.5m (iii)$\frac{\lambda}{2}$ (iv) $\frac{3\lambda}{4}$?

17. i) A steel rod 100 cm long is clamped at its middle. The fundamental frequency of longitudinal vibrations of the rod is given to be 2.53 kHz. What is the speed of sound in steel?

(ii) A pipe 20 cm long is closed at one end. Which harmonic mode of the pipe is resonantly exited by a 430 Hz source? Will this same source be in resonance with the pipe if both ends are open? (Speed of sound = 340 m/s).

Hence source of frequency 430 Hz will not be in resonance with open organ pipe.

18.A train stands at a platform blowing a whistle of frequency 400 Hz in still air.

(i) What is the frequency of the whistle heard by a man running

(a)Towards the engine 10 m/s.

(b) Away from the engine at 10 m/s?

(ii) What is the speed of sound in each case?

(iii) What is the wavelength of sound received by the running man in each case?

Take speed of sound in still air = 340 m/s.

19What is a spring factor? Derive the expression for resultant spring constant when two springs having constants k_1 and $k_2$are connected in (i) parallel and (ii) in series.

20.Show that for a particle in linear S.H.M., the average kinetic energy over a period of oscillation is equal to the average potential energy over the same period. At what distance from the mean position is the kinetic energy in simple harmonic oscillator equal potential energy?