PHYSICS WORK BOOK

CLASS - XI

State Council of Educational Research and Training
Govt. of Tripura

PHYSICS WORK BOOK

Class - XI

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রতন লাল নাথ
মন্ত্রী
শিক্ষা দপ্তর
ত্রিপুরা সরকার

বার্তা

শিক্ষার প্রকৃত বিকাশের জন্য, শিক্ষাকে যুগোপযোগী করে তোলার জন্য প্রয়োজন শিক্ষাসংক্রান্ত নিরন্তর গবেষণা। প্রয়োজন শিক্ষা সংশ্লিষ্ট সকলকে সময়ের সঙ্গে সঙ্গে প্রশিক্ষিত করা এবং প্রয়োজনীয় শিখন সামগ্রী, পাঠ্যক্রম ও পাঠ্যপুস্তকের বিকাশ সাধন করা। এস সি ই আর টি ত্রিপুরা রাজ্যের শিক্ষার বিকাশে এসব কাজ সুনামের সঙ্গে করে আসছে। শিক্ষার্থীর মানসিক, বৌদ্ধিক ও সামাজিক বিকাশের জন্য এস সি ই আর টি পাঠ্যক্রমকে আরো বিজ্ঞানসম্মত, নান্দনিক এবং কার্যকর করবার কাজ করে চলেছে। করা হচ্ছে সুনির্দিষ্ট পরিকল্পনার অধীনে।

এই পরিকল্পনার আওতায় পাঠ্যক্রম ও পাঠ্যপুস্তকের পাশাপাশি শিশুদের শিখন সক্ষমতা বৃদ্ধির জন্য তৈরি করা হয়েছে ওয়ার্ক বুক বা অনুশীলন পুস্তক। প্রসঙ্গত উল্লেখ্য, ছাত্র-ছাত্রীদের সমস্যার সমাধানকে সহজতর করার লক্ষ্যে এবং তাদের শিখনকে আরো সহজ ও সাবলীল করার জন্য রাজ্য সরকার একটি উদ্যোগ গ্রহণ করেছে, যার নাম ‘প্রয়াস’। এই প্রকল্পের অধীনে এস সি ই আর টি এবং জেলা শিক্ষা আধিকারিকরা বিশিষ্ট শিক্ষকদের সহায়তা গ্রহণের মাধ্যমে প্রথম থেকে দ্বাদশ শ্রেণির ছাত্র-ছাত্রীদের জন্য ওয়ার্ক বুকগুলো সুচারুভাবে তৈরি করেছেন। ষষ্ঠ থেকে অষ্টম শ্রেণি পর্যন্ত বিজ্ঞান, গণিত, ইংরেজি, বাংলা ও সমাজবিদ্যার ওয়ার্ক বুক তৈরি হয়েছে। নবম দশম শ্রেণির জন্য হয়েছে গণিত, বিজ্ঞান, সমাজবিদ্যা, ইংরেজি ও বাংলা। একাদশ দ্বাদশ শ্রেণির ছাত্র-ছাত্রীদের জন্য ইংরেজি, বাংলা, হিসাবশাস্ত্র, পদার্থবিদ্যা, রসায়নবিদ্যা, অর্থনীতি এবং গণিত ইত্যাদি বিষয়ের জন্য তৈরি হয়েছে ওয়ার্ক বুক। এইসব ওয়ার্ক বুকের সাহায্যে ছাত্র-ছাত্রীরা জ্ঞানমূলক বিভিন্ন কার্য সম্পাদন করতে পারবে এবং তাদের চিন্তা প্রক্রিয়ার যে স্বাভাবিক ছন্দ রয়েছে, তাকে ব্যবহার করে বিভিন্ন সমস্যার সমাধান করতে পারবে। বাংলা ও ইংরেজি উভয় ভাষায় লিখিত এইসব অনুশীলন পুস্তক ছাত্র-ছাত্রীদের মধ্যে বিনামূল্যে বিতরণ করা হবে।

এই উদ্যোগে সকল শিক্ষার্থী অতিশয় উপকৃত হবে। আমার বিশ্বাস, আমাদের সকলের সক্রিয় এবং নিরলস অংশগ্রহণের মাধ্যমে ত্রিপুরার শিক্ষাজগতে একটি নতুন দিগন্তের উন্মেষ ঘটবে। ব্যক্তিগত ভাবে আমি চাই যথাযথ জ্ঞানের সঙ্গে সঙ্গে শিক্ষার্থীর সামগ্রিক বিকাশ ঘটুক এবং তার আলো রাজ্যের প্রতিটি কোণে ছড়িয়ে পড়ুক।

(রতন লাল নাথ)

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CONTENT

Chapter-1

Physical World

Key Notes :-

- ⇨ Physics deals with the study of the basic laws of nature and their manifestation in different phenomena.
- ⇨ The basic laws of physics are universal and apply in widely different contexts and conditions.
- ⇨ The scope of physics is wide, covering a tremendous range of magnitude of physical quantities.
- ⇨ Physics and technology are related to each other. Some times technology gives rise to new physics; at other times physics generates new technology. Both have direct impact on society.
- ⇨ There are four fundamental forces in nature that govern the diverse phenomena of the macroscopic and the microscopic world.
- ⇨ The four fundamental forces are –
  - (i) Gravitational force
  - (ii) Electromagnetic force
  - (iii) Strong nuclear force
  - (iv) Weak nuclear force
- ⇨ Unification of different forces/domains in nature is a basic quest in physics.
- ⇨ The physical quantities that remain unchanged in a process are called conserved quantities.
- ⇨ Some of the general conservation laws in nature include the law of conservation of –
  - (a) Mass
  - (b) Energy
  - (c) Momentum
  - (d) Angular momentum
  - (e) Charge
  - (f) Parity etc.

⇨ Some conservation laws are true for one fundamental force but not for the other.

⇨ Conservation laws have a deep connection with symmetries of nature. Symmetries of space and time and other type of symmetries play a central role in modern theories of fundamental forces in nature.

Section-A

Multiple Choice Question : **(Mark-1)**

1. The physicist who discovered the law of gravitation was –

   a) Newton b) Faraday c) Chadwick d) Curie

   Ans:-..

2. In nature how many forces are there

   a) 2 b) 3 c) 4 d) 5

   Ans:-..

3. The word 'PHYSICS' was first used by –

   a) Aristotle b) Millikan c) Dirac d) Pauli

Ans:-..

4. Physics is –

   a) experimental science

   b) quantitative science

   c) the most basic science

   d) All the above

   Ans:-..

5. The theory of relativity was proposed by –

   a) Newton b) Bohr c) Einstein d) None

   Ans:-..

6. The classical physics is applicable to –
   a) microscopic world
   b) macroscopic world.
   c) both microscopic and macroscopic world
   d) cannot say

   Ans:-...

7. Electron was discovered by –
   a) Einstein b) Faraday c) Bohr d) J. J. Thomson

   Ans:-...

8. The conception of calculus was given by –
   a) Einstein b) Newton c) Bohr d) J. J. Thomson

Ans:-...

9. The laws of electromagnetic induction were discovered by –
   a) Faraday b) Curie c) Fermi d) Bohr

   Ans:-...

10 In science, a special particle which is responsible for the mass of other particles is –
   a) Electron b) Graviton c) Higgs - Boson d) Neutron

Ans:-...

Section-B

Very Short Answer Type Question : **(Mark-1)**

1. What is physics?

Ans:-...

2. What is a scientific law?

Ans:-...

3. What is Theory?

Ans:-..

4. What is Model?

Ans:-..

5. What is scientific method?

Ans:-..

6. What is classical physics?

Ans:-..

7. What is Modern physics?

Ans:-..

8. What are the five main branches of physics?

Ans:-..

9. What is the basic difference between science and technology?

Ans:-..

10. What are conservation laws?

Ans:-..

Section-C

Short Answer Type Question : **(Marks-2)**

1. What is the importance of mathematics in Physics?

Ans:-..

....

2. What is the drawback of classical physics?

Ans:-...

....

3. Discuss the basic forces of nature.

Ans:-...

....

4. Why physics is called the science of measurement?

Ans:-...

....

5. Discuss the relation between physics and chemistry.

Ans:-...

....

6. Discuss the relation between physics and Biology.

Ans:-...

....

7. How physics is related to society?

Ans:-...

....

Answer

Section-A

1. (a)	2. (c)	3. (a)	4. (d)	5. (c)	6. (b)
7. (d)	8. (b)	9. (a)	10. (c)		

Chapter-2

Units and Measurements

Key Notes :-

⇨ The unit of a physical quantity can be measured as the basic units raised to numeric indices. The indices denote the dimensions of the physical quantity.

⇨ **Unit** (i) Basic unit or fundamental unit
(ii) Derived unit

⇨ **System of units** (i) C.G.S. (cm, g and s)
(ii) F.P.S. (ft, lb and s)
(iii) M.K.S. (m, kg and s)
(iv) SI (m, kg, S, A, K, cd and mol)

⇨ When dimension of a physical quanity is One (1), the quantity is called dimension less physical quantity.

⇨ A dimensionless physical quantity can also have a unit.

⇨ The minimum length that can be measured by using a vernier scale or a screw gauge is the vernier constant or the least count respectively.

⇨ In a measurement, the number of digits in the measured value is said to be significant when, except the least digit, all other digits are correct.

⇨ **Principle of dimensional homogeneity :**

In any expression or equation involving physical quantities, each term in the expression or each term on the either side of the equation must have the same dimension.

⇨ Vernier constant of a vernier scale = 'c', length of the smallest division in the main scale = m

Reading on the main scale = a

Length of y division in vernier scale = length of x division in a main scale.

Length of a rod measured by that vernier scale = l

Reading in vernier scale = b

$(i)\ c = \frac{y-x}{y} \times m \qquad (ii)\ l = a + bc$

⇨ Least count of a screw gauge = c

Total number of divisions on circular scale = y

Reading on the linear scale = a

Pitch of the screw = x

Thickness of a lamina as measured by that screw gauge = d

Reading on the circular scale = b

$(i)\ c = \frac{x}{y} \qquad (ii)\ d = a + bc$

⇨ If n number of measured values of a physical quantity, are $x_1, x_2, x_3, ..., x_n$ then the average value or true value of the quantity,

$$\overline{x} = \frac{x_1 + x_2 + x_3 + ... + x_n}{n}$$

⇨ If the error in the average value of a physical quantity is $\in$, then the absolute value of the quantity, $x = \overline{x} \pm \in$

where, $\in = \frac{|x_1 - \overline{x}| + |x_2 - \overline{x}| + |x_3 - \overline{x}| + ... + |x_n - \overline{x}|}{n}$

⇨ Fractional error or relative error $= \frac{\in}{x}$

⇨ Percentage error $= \left(\frac{\in}{x} \times 100\right)\%$

Section-A

Multiple Choice Questions : **(Mark-1)**

Choose the correct answer :

1. Steradian is the unit of–

   (A) angle (B) solid angle

   (C) arc of a circle (D) circumference.

Ans:-..

2. Which is the dimensional formula of potential difference?

   (A) $ML^2T^{-3}A^{-1}$ (B) $MLT^{-3}A^{-1}$

   (C) $ML^3T^{-3}A$ (D) $ML^2T^{-3}A^{-2}$

Ans:-..

3. What is the number of significant figure in $(3.10 + 4.60) \times 10^7$?

   (A) 5 (B) 3 (C) 4 (D) 7

Ans:-...

4. Consider force (F), length (L) and time (T) to be fundamental physical quantities, find the dimension of mass.

   (A) $[FL^{-1}T^2]$ (B) $[FL^{-1}T^{-1}]$

   (C) $[FLT^{-2}]$ (D) $[F^{-1}L^{-1}T^2]$

Ans:-..

5. In which of the following pairs, the two physical quantities have different dimensions?

   (A) Planck's constant and angular momentum.

   (B) Impulse and linear momentum.

   (C) Moment of inertia and moment of force

   (C) Energy and torque.

Ans:-..

6. If percentage error in the measurment of radius of a sphere is 2%, calculate the percentage error in the measurement of volume of that sphere.

(A) 4% (B) 6% (C) 8% (D) 2%

Ans:-...

7. In a slide caliper $(m+1)$ number of vernier division is equal to m number of smallest main scale divisions. If d unit is the magnitude of the smallest main scale division, then the magnitude of the vernier constant is –

(A) d / (m+1) unit (B) $\frac{d}{m}$ unit

(C) md / (m+1) unit (D) (m+1)d / m unit

Ans:-...

8. The equation of state of a gas is given by $\left(p+\frac{a}{V^2}\right)(v-b)=RT$ where P, V, T are pressure, volume and temperature respectively and a, b are constants and 'R' molar gas constant. The dimension of 'a' and 'b' are

(A) $[ML^8T^2]$ and $[L^{3/2}]$ (B) $[ML^5T^{-2}]$ and $[L^3]$

(C) $[ML^5T^{-2}]$ and $[L^6]$ (D) $[ML^6T^{-2}]$ *and* $[L^{3/2}]$

Ans:-...

9. A screw gauge has 50 circular scale divisions and a pitch of $0.1cm$ when this is used to measure the thickness of a plate, the main scale reading is 0.2 cm and the circular scale reading is 35. What is the thickness of the plate?

(A) 0.23 (B) 0.26 (C) 0.27 (D) 0.72

Ans:-...

10. Time period of a pendulam (T), its length(l), mass of its bob (m) and acceleration due to gravity (g) are related as :

$T = km^x l^y g^z$ where

(A) $x=1,\ y=\frac{1}{2},\ z=\frac{1}{2}$ (B) $x=0,\ y=-\frac{1}{2},\ z=\frac{1}{2}$

(C) $x=1,\ y=-\frac{1}{2},\ z=\frac{1}{2}$ (D) $x=0,\ y=\frac{1}{2},\ z=-\frac{1}{2}$

Ans:-...

Section-B

Very Short Answer Type Questions : **(Mark-1)**

1. Write the number of basic units in SI.

Ans:-..

2. What is the dimension of a dimensionless physical quantity?

Ans:-..

3. How many significant figures in the Avogadro's Number 6.023×10^{23}?

Ans:-..

4. Relative density of lead is 11.3. What is its density in SI?

Ans:-..

5. If, $x = a + bt + ct^2$, where x is in metre and t is in second, what are dimension of b and c?

Ans:-..

Section-C

Short Answer Type Questions-I : **(Mark-2)**

1. What is the difference between angstrom (A^o) unit and astronomical unit (AU)?

Ans:-..

2. Does the measure of angle depend upon the unit of length? Explain.

Ans:-..

3. In the equation $p=\frac{a-t^2}{bx}$, what will be dimention of $\left(\frac{a}{b}\right)$? Where, $p=$ pressure, $x=$ distance and $t=$ time.

Ans:-..

4. From the equation $W=\frac{1}{2}Kx^2$, find out the dimension of K. Where $W=$ potential energy of the spring and $x=$ expansion in the spring.

Ans:-..

5. The radius of atom is of the order of $1\overset{0}{A}$ and radius of nucleus is of the order of 1 fermi. How many magnitudes higher is the volume of atom as compared to the volume of nucleus?

Ans:-..

Section-D

Short Answer Type Questions-II : (Mark-3)

1. Using the method of dimensional analysis, show that following equations are dimensionally correct–

   (*i*) $V=u+at$

   (*ii*) $S=ut+\frac{1}{2}at^2$

   (*iii*) $V^2=u^2+2as$

   (*iv*) $S_{nth}=u+\frac{1}{2}a(2n-1)$

   Where symbols are used in their usual meaning?

Ans:-..

2. What will be the conversion factor when you change a value expressed in newton to dyne.?

Ans:-..

3. A student measures the thickness of a human hair by looking at it through a microscope of magnification 100. He makes 20 observations and finds that the average width of the hair in the field of view of the microscope is 3.5 *mm*. What is the estimate on the thickness of hair?

Ans:-...

4. The escape speed (v) of a body depends upon radius (R) of the planet and acceleration due to gravity(g). Establish a relation among the above physical quantities.

Ans:-...

5. A physical quantity p is related to four observables a, b, c and d as follows.

$$p = \frac{a^3 b^2}{\sqrt{c \cdot d}}$$

The percentage error of measurment in a, b, c and d are 1%, 3%, 4%, and 2% respectively. What is the percentage error in the quantity p? If the value of p calculated by using the given relation turns out to be 3.763, to what value should the result be rounded off?

Ans:-...

ANSWER

Section-A :

1.B. 2.A. 3.B 4.A 5.C 6.B 7.A 8.B 9.C 10.D

Section-B :

1.7 2.1 3.4 4. 1.12×10^4 kgm^{-3} 5. $[LT^{-1}]$, $[LT^{-2}]$

Section-C :

1. See SCERT Text Book 2. See SCERT Text Book 3. $[ML^0T^{-2}]$

4. $[ML^0T^{-2}]$ 5. 10^{15}

Section-D :

1. See SCERT Text Book 2. 10^5 3. 0.035 *s*

4. $v = k\sqrt{gR}$ 5. $\pm 13\%$, 3.8

Chapter-3

Motion In A Straight Line

Key Notes :-

⇨ Speed, $v = l/t$, where $l =$ distance covered in time t

⇨ Average speed $= \dfrac{total\ distance}{total\ time}$

Or $v = \dfrac{l_1 + l_2 + l_3 + \ldots + l_n}{t_1 + t_2 + t_3 + \ldots + t_n}$

⇨ Instantaneous speed,

$$v_i = \underset{\Delta t \to 0}{Lt} \frac{\Delta l}{\Delta t} = \frac{dl}{dt}$$

⇨ Velocity, $v = \dfrac{s}{t}$, where, $S =$ displacement in time t.

⇨ Average Velocity $= \dfrac{total\ displacement}{total\ time}$

$$< v > = \frac{S_1 + S_2 + S_3 + \ldots + S_n}{t_1 + t_2 + t_3 + \ldots + t_n}$$

⇨ Instantaneous velocity, $v_i = \underset{\Delta t \to 0}{Lt} \dfrac{\Delta S}{\Delta t} = \dfrac{dS}{dt}$

⇨ For particles in motion

Initial velocity $= u$

The final velocity after time 't' $= v$

Acceleration $= a$

Displacement in time $t = s$

Distance covered in the n^{th} second $= S_n$

Acceleration due to gravity $= g$

Maximum height reached in time $t = h$.

⇨ Acceleration or average acceleration

$$= \frac{final\ velocity - Initial\ velocity}{time\ taken}$$

$$= \frac{change\ in\ velocity}{time\ taken}$$

Or $\quad < a > \ = \frac{v-u}{t}$

⇨ Instantaneous acceleration

$$a_i = \underset{\Delta t \to 0}{Lt} \frac{\Delta v}{\Delta t} = \frac{dv}{dt} = \frac{d^2 s}{dt^2}$$

⇨ For a paticle in motion with uniform acceleration 'a'

$(i)\ v = u + at \qquad (ii)\ S = ut + \frac{1}{2}at^2$

$(iii)\ v^2 = u^2 + 2as \qquad (iv)\ S_{nth} = u + \frac{1}{2}a(2n-1)$

⇨ Equation of vertical motion under gravity here downward direction taken as positive and upward direction taken as negative.

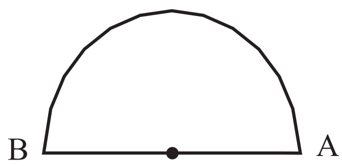
$(i)\ v = u \pm gt \qquad (ii)\ h = ut \pm \frac{1}{2}gt^2$

$(iii)\ v^2 = u^2 \pm 2gh$

Section-A

Multiple Choice Question : **(Mark-1)**

1. A particle moves from A to B as shown in the figure along the semi-circle of radius 1.0 m in 1s. Magnitude of the average velocity of the particle is –



a) 3.14 m/s b) 2.0 m/s c) 1.0 m/s d) zero

Ans:-...

2. A vehicle is moving with uniform speed of 36 km/h. The distance covered by it in 1s is

a) 18m b) 5m c) 10m d) 1m

Ans:-...

3. A person covers half of his path at a speed of 30 ms^{-1} and the remaining half at 40 ms^{-1}. His average speed is –

a) 35 ms^{-1} b) 60 ms^{-1} c) 34.3 ms^{-1} d) 50 ms^{-1}

Ans:-...

4. The displacement of a particle is given by $y = a + bt + ct^2 - dt^4$. The initial velocity and acceleration are respectively

a) $b, -4d$ b) $b, 2c$ c) $-b, -2c$ d) $2c, -4d$

Ans:-...

5. The displacement of a particle, starting from rest (at $t = 0$) is given by $S = 6t - t^2$. The time in second at which the particle obtain zero velocity again is –

a) 2 b) 4 c) 6 d) 3

Ans:-...

6. A body freely falling from the rest has a velocity v after it falls through a height of 'h'. The distance it has to fall down for its velocity becomes $2v$ is –

a) 4 h b) 6 h c) 8 h d) 10 h

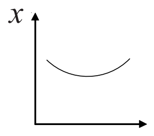
Ans:-...

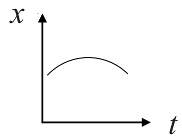
7. A body A is thrown up vertically from the ground with a velocity V_0 and another body B is simultaneously dropped from a height H. They meet at a height $\frac{H}{2}$, if V_0 is equal to –

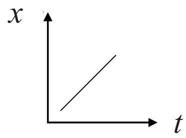
a) $\sqrt{2gH}$ b) $\sqrt{gH}$ c) $\frac{1}{2}\sqrt{gH}$ d) $\sqrt{\frac{2g}{H}}$

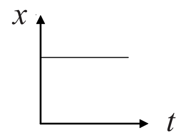
Ans:-..

8. *Position-time* graph from motion with zero acceleration is

a) 

b) 

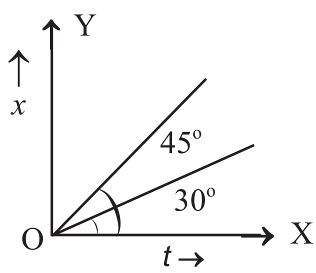
c) 

d) 

Ans:-..

9. The displacement time graph of two moving particles make angles of 30^0 and 45^0 with X-axis. The ratio of their velocities is –

a) $1:\sqrt{3}$ b) $1:1$ c) $1:2$ d) $\sqrt{3}:2$



Ans:-..

10. Equation of motion of a particle in two dimentional space is $x = 5t^2 + 2,\ \ y = 2t^2 + 5$. The path traced out is –

a) parabolic b) circular c) a straight line d) hyperbolic

Ans:-..

11. A bullet on penetrating 30 cm of its target losses its velocity by 50%. What additional distance will it penetrate before it comes to rest?

a) 30 cm b) 20 cm c) 10 cm d) 5 cm

Ans:-..

12. A particle moves along the X-axis and its displacement at any time is given by $x(t) = 2t^3 - 3t^2 + 4t$ in SI units. The velocity of the particle when its acceleration is zero is –

a) 2.5 ms^{-1} b) 3.5 ms^{-1} c) 4.5 ms^{-1} d) 8.5 ms^{-1}

Ans:-...

13. A stone falls freely under gravity. It covers distances h_1, h_2 and h_3 in the first 3*s*, the next 3*s* and the next 3s respectively. The relation between h_1, h_2 and h_3 is –

a) $h_2 = 3h_1$ and $h_3 = 3h_2$ b) $h_1 = h_2 = h_3$ c) $h_1 = 2h_2 = h_3$ d) $h_1 = \frac{h_2}{3} = \frac{h_3}{5}$

Ans:-...

14. The velocity of a particle moving along a straight line is described by the equation $v = 12 - 3t^2$ where v is in ms^{-1} and t is in 's' the retardation of the praticle when velocity becomes zero, is

(a) 24 ms^{-2} (b) zero (c) 6 ms^{-2} (d) 12 ms^{-2}

Ans:-...

15. A body freely falling from the rest has velocity *v* after it falls through a height of *h*. The distance it has to fall down for its velocity becomes 2*v* is –

a) 4 *h* b) 6 *h* c) 8 *h* d) 10 *h*

Ans:-...

Section-B

Very Short Answer Type Question : **(Mark-1)**

1. Can retardation be called a negative acceleration?

Ans:-...

2. Motion of an artifical satellite arround the earth is the example of which type of motion?

Ans:-...

3. What does slope of *position-time* graph represent?

Ans:-...

4. Does a particle with uniform speed in a curved path posses any acceleration?

Ans:-...

5. Area under *v-t* graph = ?

Ans:-..

Section-C

Short Answer Type Question : **(Marks-2)**

1. What is meant by a frame of reference? Does the magnitude of a physical quantity depend on the choice of frame of reference?

Ans:-..

....

2. Can the directions of velocity and acceleration be different? Explain your answer.

Ans:- ....

....

3. Distinguish between average speed and instantaneous speed.

Ans:-..

....

4. What kind of motion is described by the equation $S = S_0 + ut + \frac{1}{2}at^2$.

Ans:- ....

....

5. When the speed of a car is doubled, the distance required to stop it becomes 4 times – Why?

Ans:-..

....

6. State whether the displacement can be more than the total distance covered by a particle.

Ans:-..

....

7. The displacement of a particle during its motion is equal to half of the product of its instantaneous velocity and time. Show that the particle moves with a constant acceleration.

Ans:-..

....

8. State the nature of the graphs represents motions of a body with uniform velocity, with uniform acceleration and with uniform retardation respectively in a *displacement – time* graph.

Ans:-..

....

9. How can you represent

(*i*) motion with uniform velocity

(*ii*) motion with uniform acceleration and

(*iii*) motion with uniform retardation in a velocity - time graph?

Ans:-..

....

10. Draw the velocity time graph of a body moving with uniform acceleration, increasing acceleration and decreasing acceleration.

Ans:- ....

....

Section-D

Short Answer Type Question : **(Marks-3)**

1. Write down the differences between distance and displacement.

Ans:-..

....

2. Define rest and motion. "*Rest and motion are relative term*" – explain.

Ans:-..

....

3. Define the folliwng:-

Speed, uniform speed, non-uniform speed, average speed, instantneous speed.

Ans:-..

....

4. Write down the differences between speed and velocity.

Ans:-..

....

5. What are the differences between acceleration and retardation?

Ans:-..

....

6. Why in the unit of acceleration the per second comes two times? Why Retardation is called negative acceleration?

Ans:-..

....

7. A motor car covers $\frac{1}{3}$ part of total distance with velocity $V_1 = 10\, km/h$ and second $\frac{1}{3}$ part with velocity $V_2 = 20\, km/h$ and rest $\frac{1}{3}$ part with velocity $V_3 = 60\, km/h$. What is the average speed of the car?

Ans:-..

....

8. A train 600 m long crosses a bridge of 1200 m in 10s. Find the average speed of the train when it just crosses the bridge.

Ans:-..

....

9. On penetrating 1cm of a wooden block a bullet loses half of its velocity. How far would it penetrate before it comes to rest?

Ans:-..

....

10. The position *x* of a particle varies with *t* as $x = at^2 - bt^3$. Calculate the acceleration after 3.

Ans:-..

....

11. Establish the following equations of motion using calculus and graphically:

$(i)\ v = u + at$ $\qquad (ii)\ S = ut + \frac{1}{2}at^2$

$(iii)\ v^2 = u^2 + 2as$ $\qquad (iv)\ S_{n^{th}} = u + \frac{1}{2}a(2n-1)$

Ans:-..

....

12. An object, moving with a constant acceleration '*a*' covers a distance '*x*' in time *t* and distance *y* in the next time interval t'. Prove that, $a = \dfrac{2\left(\frac{y}{t'} - \frac{x}{t}\right)}{(t + t')}$

Ans:-..

....

13. A particle covers 25cm and 33cm in 5th and 7th seconds respectively. What is the velocity of the particle of its 8 second after the initiation of journey?

Ans:-..

....

14. A stone is dropped from a height of 19.6 m what is the time taken by the stone to travel the last metre of the path?

Ans:-..

....

15. A body is thrown vertically upwards. After attaining half of its maximum height its velocity becomes 14 m/s.

(*i*) How high will the body rises?

(*ii*) What will be the velocity of the body 1s and 3s after the projection? (iii) What is the average velocity of the body in the 1st half second?

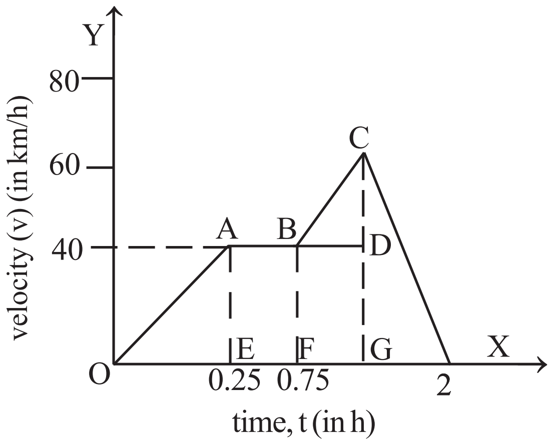
Ans:-..

....

16. A train moves from one station to the next in 2 *h*. The velocity of the train changes with time, as shown in fig.

(*i*) Find the value of the maximum acceleration in its path.

(*ii*) Distance covered between 0.75 *h* and 1*h*.



Ans:-...

....

Answer

Section-A :

1.(b)	2.(c)	3.(c)	4.(b)	5.(d)	6.(a)
7.(b)	8.(d)	9.(a)	10. (c)	11.(c)	12 (a)
13. (d)	14.(b)	15. (a)			

Section-B :

1. Yes 2. 2D 3. Velocity 4. Yes 5. Displacement

Section-C :

Follow the text Book

Section-D :

1-6 : Follow the Text Book

7. 18 km/h 8. 180 m/s 9. $\frac{1}{3}$ cm 10. $2(a-9b)$

11. Follow the Text Book 12. Do yourself

13. 37cm/s 14. 0.052 s

15. (i) 20 m, (ii) 10 ms^{-1} and -9.6 ms^{-1} (iii) 17.35ms^{-1}

16. (i) 160 km/h^2 (ii) 15 km.

Chapter-04

Motion In A Plane

Key Notes :-

⇨ **Geometrical representation of a vector:**

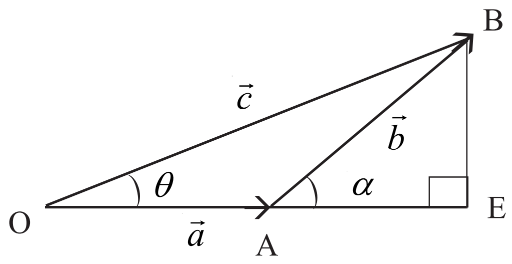
(*i*) A vector is represented by a line segment with an arrow head.

(*ii*) Magnitude of the vector is indicated by the length of the line segment

(iii) Direction of the vector is shown by an arrow head.

⇨ **Triangle law of vector addition:**

If two sides of a triangle taken in order, represent the magnitude and directions of two vectors, the third side, taken in the opposite order, represents the magnitude and direction of the resultant of the two vectors.



Resultant of $\vec{a}$ and $\vec{b}$, when the angle between them is α, is $\vec{c}$ such that

$$|\vec{c}| = \sqrt{a^2 + b^2 + 2ab\cos\alpha}$$

The angle between $\vec{a}$ and $\vec{c}$ is θ, then $\tan\theta = \dfrac{b\sin\alpha}{a + b\cos\alpha}$.

The equation gives the direction of the resultant.

(*i*) When, $\alpha = 0^0$, $c = (a+b) = c_{max}$

(*ii*) When, $\alpha = \pi$, $c = (a - b) = c_{min}$

(*iii*) When, $\alpha = \dfrac{\pi}{2}$, $c = \sqrt{a^2 + b^2}$ and $\theta = \tan^{-1}\left(\dfrac{b}{a}\right)$

⇨ **Parallelogram law of vector addition:**

If two adjacent sides of a parallelogram represent the magnitudes and direction of two vectors, then the diagonal, drawn through the intersection of the two sides of the parallelogram, represents the magnitude and direction of the resultant of the two vectors. In this case the point of intersection is the initial point of the two vectors and their resultant.

⇨ **Polygon law of vector addition:**

If the magnitudes and directions of a number of vectors are represented by the sides of a polygon, taken in order, then the last side, taken in opposite order, represents the magnitude and direction of the resultant of the vectors.

⇨ **Resolution of vectors:**

If any vector is splited into two or more vectors such that the original vector becomes the resultant of the splited parts or components of the vector, then this splitting is called resolution of vectors.

If two components of $\vec{R}$ are $\vec{a}$ and $\vec{b}$, angle between $\vec{R}$ and $\vec{a}$ is α, angle between $\vec{R}$ and $\vec{b}$ is β, then

$$a = \frac{R\sin\beta}{\sin(\alpha+\beta)} \text{ and } b = \frac{R\sin\alpha}{\sin(\alpha+\beta)}$$

When, $\alpha+\beta = \frac{\pi}{2}$ then, $a = R\cos\alpha$, $b = R\sin\alpha$

⇨ **Position vector:**

When the position of a point *w.r.t.* the origin is represented by a vector, then that vector is called the position vector.

Taking O as the origin of three-dimentional cartesian coordinate system, we get the position vector of A (x, y, z) as

$$\vec{r} = \overrightarrow{OA} = x\hat{i} + y\hat{j} + z\hat{k}$$

$$\therefore |\vec{r}| = \sqrt{x^2 + y^2 + z^2}$$

⇨ **Direction cosines:**

If $\vec{r}$ makes angles α, β, γ with x, y, z axes respectively, then the direction cosines of $\vec{r}$ are,

$$\cos\alpha = \frac{x}{r},\ \cos\beta = \frac{y}{r},\ \cos\gamma = \frac{z}{r}$$

⇨ **Product of Vector:**

Scalar product or dot product of two vectors is a scalar whereas vector product or cross product of two vectors is an another vector directed perpendicular to the plane containing the two vcectors.

If θ is the angle between $\vec{A}$ and $\vec{B}$, vector and scalar product of the vectors $\vec{A}$ and $\vec{B}$ are respectively. $\vec{A}\times\vec{B} = AB\sin\theta.\hat{n}$ and $\vec{A}\cdot\vec{B} = AB\cos\theta$ where $\hat{n}$ is the unit vector perpendicular to both $\vec{A}$ and $\vec{B}$ given by right hand screw rule perpendicular of cross product of vectors.

⇨ **Relative Velocity:**

Apparent velocity of a body, with respect to another body at rest or in motion on the earth's surface, is called its relative velocity.

If the velocities of the two particles are $\vec{v}_1$ and $\vec{v}_2$, then the relative velocity of the second particle *w.r.t.* the first is $\overrightarrow{v_{21}} = \overrightarrow{v_2} - \overrightarrow{v_1}$.

⇨ **Projectile:**

A body thrown in any direction from the earth's surface or from a point close to it is called a projectile.

If initial velocity of projectile and angle of projection of a projectile are 'u' and 'α' respectively, then

(i) Max^m height, $H = \dfrac{u^2\sin^2\alpha}{2g}$

(ii) Time of flight, $T = \dfrac{2u\sin\alpha}{g}$

(iii) Range of projectile, $R = \dfrac{u^2\sin 2\alpha}{g}$

(iv) Equation of the locus of porojectile, $y = x\tan\alpha - \dfrac{g}{2u^2\cos^2\alpha}x^2$

Section-A

Multiple Choice Question : **(Mark-1)**

1. What is the condition for $\vec{A}+\vec{B}=\vec{A}-\vec{B}$ to be valid?

    a) $\vec{A}=0$ b) $\vec{B}=0$ c) $\vec{A}=\vec{B}$ d) $\vec{A}=-\vec{B}$

Ans:-...

2. If the magnitude of the resultant of two vectors of same magnitude is equal to the magnitude of the either vectors then angle between the vectors is –

    a) 0^0 b) 60^0 c) 120^0 d) 90^0

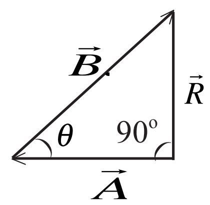
Ans:-...

3. $0.2\hat{i}+0.6\hat{j}+a\hat{k}$ is a unit vector. Value of 'a' should be

    a) $\sqrt{0.3}$ b) $\sqrt{0.4}$ c) $\sqrt{0.6}$ d) $\sqrt{0.8}$

Ans:-...

4. In the figure, $\vec{R}$ is the resultant of the vectors $\vec{A}$ and $\vec{B}$.



    If $R=\frac{B}{\sqrt{2}}$ then the angle θ is –

    a) 30^o b) 45^o

    c) 60^o d) 75^o

Ans:-...

5. If $P+Q=R$ and $|\vec{P}|=|\vec{Q}|=\sqrt{3}$ and $|\vec{R}|=3,$ then the angle between $\vec{P}$ and $\vec{Q}$ is –

    a) $\frac{\pi}{4}$ b) $\frac{\pi}{6}$ c) $\frac{\pi}{3}$ d) $\frac{\pi}{2}$

Ans:-...

6. Given $\vec{A} = 2\hat{i} + 3\hat{j}$ and $\vec{B} = \hat{i} + \hat{j}$ the component of the vector $\vec{A}$ along vector $\vec{B}$ is –

a) $\frac{1}{\sqrt{2}}$ b) $\frac{3}{\sqrt{2}}$ c) $\frac{5}{\sqrt{2}}$ d) $\frac{7}{\sqrt{2}}$

Ans:-...

7. In clockwise system –

a) $\hat{j} \times \hat{j} = 1$ b) $\hat{k} \,.\, \hat{j} = 1$ c) $\hat{j} \times \hat{k} = \hat{i}$ d) $\hat{i} \,.\, \hat{j} = 0$

Ans:-...

8. For any two vector $\vec{A}$ and $\vec{B}$, if $\vec{A} \cdot \vec{B} = \left|\vec{A} \times \vec{B}\right|$, the magnitude of $\vec{C} = \vec{A} + \vec{B}$ is equal to

a) $\sqrt{A^2 + B^2}$ b) $A + B$ c) $\sqrt{A^2 + B^2 + \frac{AB}{\sqrt{2}}}$ d) $\sqrt{A^2 + B^2 + \sqrt{2} \cdot AB}$

Ans:-...

9. Find the torque of a force $\vec{F} = -3\hat{i} + 2\hat{j} + \hat{k}$ acting at the point $\vec{r} = 8\hat{i} + 2\hat{j} + 3\hat{k}$

a) $14\hat{i} - 38\hat{j} + 16\hat{k}$ b) $4\hat{i} + 4\hat{j} + 6\hat{k}$ c) $-14\hat{i} + 38\hat{j} - 16\hat{k}$ d) $-4\hat{i} - 17\hat{j} + 22\hat{k}$

Ans:-...

10. A person can throw a stone to a maximum height of 'h' metre vertically, then the maximum distance through which it can be thrown horizontally by the same person is –

a) $\frac{h}{2}$ b) h c) $2h$ d) $3h$

Ans:-...

11. A body is projected from the ground with a velocity $\vec{v} = (3\hat{i} + 10\hat{j})\, m/s$ The maximum height attained and the range of the body respectively are $(g = 10 m/s^2)$ –

a) 5m and 6m b) 3m and 10m c) 6m and 5m d) 3m and 5m

Ans:-...

Section-B

Very Short Answer Type Question : **(Mark-1)**

1. Is any physical quantity having a magnitude and a direction, a vector quantity?

Ans:-...

2. Can the resultant of three co-planar vector be zero?

Ans:-...

3. What is free vector?

Ans:-...

4. What are the orthogonal unit-vectors?

Ans:-...

5. What is the position vector of the origin of a co-ordinate system?

Ans:-...

6. What is the value of the resultant of $(\vec{A}+\vec{B})$ and $(\vec{A}-\vec{B})$?

Ans:-...

7. Can commutative law be applied to vector subtraction?

Ans:-...

8. Can we apply associative law to vector subtraction?

Ans:-...

9. How many components can a vector be resolved into?

Ans:-...

10. What is the angle between $(\vec{A}+\vec{B})$ and $(\vec{A}-\vec{B})$

Ans:-...

11. Can the value of $\vec{A} \times \vec{A}$ be zero?

Ans:-..

12. What is the angle between vector $\vec{A}$ and $\vec{A} \times \vec{B}$?

Ans:-..

Section-C

Short Answer Type Question : **(Marks-2)**

1. Can the sum of three vectors i.e. their resultant be equal to zero? Explain.

Ans:-..

....

2. A boy throws a ball vertically upward from a vehicle moving with a constant acceleration. Where would the ball land?

Ans:-..

....

3. By adding three unit vectors is it possible to get a unit vector?

Ans:-..

....

4. How does the change of acceleration due to gravity affect the path of a projectile?

Ans:-..

....

5. Can four non-coplanar vectors produce equilibrium? Explain.

Ans:-..

....

6. Show that a stretched wire cannot remain horizontal when a weight is suspended from its mid-point.

Ans:-..

....

7. A particle is in uniform circular motion. At any point on its path, show the direction of the displacement vector, the velocity vector and the acceleration vector with the help of an illustration.

Ans:-..

....

8. If $\vec{A}$ is a constant vector, then show that $\frac{d\vec{A}}{dt}$ is perpendicular with $\vec{A}$.

Ans:-..

....

9. A water fountain on the ground sprinkles water all around it. If the speed of water coming out of the fountain is v, then what will be the total area around the fountain that gets wet?

Ans:-..

....

10. Define relative velocity.

Ans:-..

....

11. What is projectile? What is the nature of the path of a projectile?

Ans:-..

....

12. If the maximum horizontal range of a projectile is 87.6 m. Find its velocity of projection.

Ans:-..

....

13. Show that if the angle of projection of a projectile is $\left(\frac{\pi}{2}-\alpha\right)$ instead of α, the horizontal range remains the same for a particular velocity of projection.

Ans:-..

....

14. $\vec{A} = 2\hat{i} + 3\hat{j} + 4\hat{k}$ and $\vec{B} = \hat{i} - \hat{j} + \hat{k}$ are two vectors. Find $\vec{A} \times \vec{B}$.

Ans:-..

....

Section-D

Short Answer Type Question : **(Marks-3)**

1. Write down the differences between scalar quatity and vector quantity.

Ans:-..

....

2. Explain resolution of vectors in two components.

Ans:-..

....

3. Explain the polygon law of vector addition in terms of Triangle Law of vectors.

Ans:-..

....

4. Establish parallelogram law of vector addition using triangle law.

Ans:-...

....

5. Represent a vector using the coordinates in three dimention.

Ans:-...

....

6. What is direction cosine? In case of direction cosine prove that $l^2 + m^2 + n^2 = 1$.

Ans:-...

....

7. Derive the expression for relative velocity and its direction when two bodies are moving obliquly in a plane.

Ans:-...

....

8. Explain product of two vectors.

Ans:-...

....

9. Show that the locus of a projectile is parabolic.

Ans:-...

....

10. Velocity of a boat in still water in 5 *km*/*h*. It takes 15 *min* to cross a river along the width. The river is 1 *km* wide. Find the velocity of current.

Ans:-...

....

11. A body is projected with a velocity 20 m/s, making an angle of 45^{o} with the horizontal. Calculate –

(i) the time taken to reach the ground $(g = 10m/s^2)$.

(*ii*) the maximum height it attained and

(*iii*) its horizontal range.

Ans:-...

....

Section-E

LongAnswer Type Question : **(Marks-5)**

1. State the triangle law of vector addition. Hence derive the expression for resultant vector and its direction.

Ans:-...

....

....

2. State the parallelogram law of vector addition. Hence derive the expression for resultant vector and its direction.

Ans:-...

....

....

3. A projectile is projected with a velocity 'v' making an angle of θ with the horizontal, then calculate the following –

(*i*) Vertical range

(*ii*) Time of flight

(*iii*) Horizontal Range of projection

Ans:-...

....

....

4. (i) $\vec{R}$ is the resultant of two vectors $\vec{P}$ and $\vec{Q}$ When $\vec{Q}$ is reversed, the resultant is $\vec{S}$.
Prove that : $R^2 + S^2 = 2(P^2 + Q^2)$
(ii) When the angle between the forces P and Q is θ, magnitude of the resultant is $5\sqrt{P^2+Q^2}$.
When the angle between them changes to $(90^0 - \theta)$, magnitude of the resultant chagnes to $3\sqrt{P^2+Q^2}$. Prove that $\tan\theta = \frac{1}{3}$.

Ans:-..

....

5. (i) If $\vec{a} = 4\hat{i} + 6\hat{j} - 5\hat{k}$ then calculate its direction cosines.
(ii) The initial velocity of a projectile is $(\hat{i} + 2\hat{j})ms^{-1}$ Where $\hat{i}$ *and* $\hat{j}$ two unit vectors along two perpendicular axes. Calculate the locus of the projectile. Take $g = 10ms^{-2}$.

Ans:-..

....

Answer

Section-A:

1. (b)	2. (c)	3. (c)	4. (b)	5. (c)	6. (c)
7. (c)	8. (d)	9. (d)	10. (c)	11. (a)	

Section-B:

1. No.	2. Yes	3. Whose tail is not fixed		4. $\hat{i}, \hat{j}, \hat{k}$	5. zero
6. $2\vec{A}$	7. No	8. Yes	9. infinite	10. 90^0	11. Yes
12. 90^0					

Section-C:

9. $\frac{\pi v^4}{g^2}$ 12. $\frac{v^2}{g}$ 14. $7\hat{i} + 2\hat{j} - 5\hat{k}$

Section-D:

10. 3 km/h 11. 2.828 s, 10 m, 40 m

Section-E:

5. (i) $\frac{4}{\sqrt{77}}, \frac{6}{\sqrt{77}}, \frac{-5}{\sqrt{77}}$ (ii) $y = 2x - 5x^2$

Chapter-5

Laws of Motion

Key Notes :-

- Inertia of a body is the tendency of the body to oppose any change in its state of rest or motion. It is directly proportional to its mass.

- Linear momentum $\vec{p} = m\vec{v}$ and its S I unit is kg m/s.

- Force applied to any object is equal to its rate of change of linear momentum.

$$i.e,\ \vec{F} = \frac{\overrightarrow{dp}}{dt} = \frac{d}{dt}(m\vec{v})$$

$$(i)\ \vec{F} = m\frac{d\vec{v}}{dt} = m\vec{a} \qquad \text{(when mass ‘}m\text{’ is constant)}$$

$$(ii)\ \vec{F} = \vec{v}\frac{dm}{dt} \qquad \text{(when velocity ‘}\vec{v}\text{’ is constant)}$$

- In absence of any external force the body moves along a straight line with uniform velocity or remains at rest.

- Every action has its equal and opposite reaction. Action and reaction always acts simultaneously on two different bodies.

- Impulse = Force × time duration = change of linear momentum *i.e*,

$$\vec{J} = \vec{F}dt = \vec{P}_2 - \vec{P}_1 = \Delta\ \vec{P}$$

- According to conservation of linear momentum.
Total momentum of a system before collision = Momentum after collision.

Mathematically, $m_1\vec{u}_1 + m_2\vec{u}_2 = m_1\vec{v}_1 + m_2\vec{v}_2$

- Recoil of gun is an application of law of conservation of linear momentum. If mass of gun be M, mass of bullet m, velocity of bullet $\vec{u}$ then recoil velocity of gun,

$$\vec{V} = -\frac{m\vec{u}}{M}$$

⇨ When a body moves with an acceleration $\vec{a}$ in the vertical direction, then apparent weight of the body,

$W' = m(\vec{g} - \vec{a})$, where $\vec{a}$ is positive in downward direction and negative in upward direction.

⇨ For equilibrium of a body under the action of several forces,

$$\vec{F}_1 + \vec{F}_2 + \vec{F}_3 + ... = 0$$

⇨ Thrust and acceleration on rocket on earth's surface,

$$\vec{F} = \frac{\Delta m}{\Delta t}\vec{V} - mg \quad \text{and} \quad \vec{a} = \frac{\Delta m}{\Delta t} \cdot \frac{\vec{v}}{m}\vec{V} - g$$

where $\Delta m =$ man of gas ejected out in time Δt with velocity $\vec{v}$.

⇨ Velocity of rocket $V_{rok} = V_0 + V_{rcl} \log_e \frac{m_0}{m}$

⇨ Friction is a self-adjusting force which comes into play at the surface of contact and opposes the motion or tendency of motion of one body over other.

⇨ Frictional force depends on nature of surface in contact and normal reaction on body by the surface.

⇨ Static friction goes on increasing with applied force till it becomes maximum, which is called limiting value of static friction.

⇨ When one body actually starts slide over other it is called kinetic friction.

⇨ When a body rolls over any surface then rolling friction acts on the body.

⇨ Coefficient of static firction (μ_s) and coefficient of kinetic friction (μ_k) dpends only on the nature of surface in contact between two bodies.

$$\mu_s = \frac{f_{Lt}}{R} \quad \text{and} \quad \mu_k = \frac{f_k}{R}$$

Here $f_{Lt} =$ Limiting values of static friction

$f_k =$ Kinetic friction

$R =$ Normal reaction.

⇨ Angle of friction (θ) is the angle between normal reaction and resultant of normal reaction and limiting value of static friction. Numerically, $\mu_s = \tan\theta$

⇨ Angle of repose (φ) is the maximum angle of inclined plane, at which the body placed on it, just at the point of sliding down. Numerically, $\mu_s = \tan\varphi$

Section-A

Multiple Choice Question : **(Mark-1)**

1. During paddling a bycicle what is the direction of frictional force on front and back wheel?
   a) Along backward direction in front wheel and along forward direction in back wheel.
   b) Along forward direction in front wheel and along backward direction in back wheel.
   c) Along backward direction in both front and back wheel.
   d) Along forward direction in both front and back wheel.

Ans:-...

2) On which conservation principle, the working of jet engine works ?
   a) Conservation of mass
   b) Conservation of energy
   c) Conservation of Linear momentum
   d) Conservation of angular momentum.

Ans:-...

3) A man is situated inside a lift which is desending with an acceleration equal to the gravitational acceleration (g) of earth. He will feel –
   a) Less weight b) More weight c) Weightless d) Same weight

Ans:-...

4) A wooden block of mass M and length L is floating on water. A man of mass 'm' is standing at one of its end. If he walks to the other end of the block find amount of displacement of block.
   a) $\frac{mL}{M}$ b) $\frac{ML}{M}$ c) $\frac{mL}{m+M}$ d) $\frac{ML}{m+M}$

Ans:-...

5) A simple pendulum is hung from the roof of a train which is moving with an acceleration 'a' horizontally. Find the angle generated by the pendulum with verticle –

a) $\tan^{-1}\left(\frac{g}{a}\right)$ b) $\tan^{-1}\left(\frac{a}{g}\right)$ c) 0^0 d) $\sin^{-1}\left(\frac{a}{g}\right)$

Ans:-...

6) What is the correct relation between coefficitent of static friction (μ_s), coefficient of kinetic friction (μ_k) and coefficient of rolling friction (μ_r) –

a) $\mu_s > \mu_k > \mu_r$ b) $\mu_s < \mu_k < \mu_r$ c) $\mu_s > \mu_k < \mu_r$ d) $\mu_s > \mu_k = \mu_r$

Ans:-...

7) An object of weight W_1 is hung by a chain of weight W_2 from the roof of a room. Find the force on chain by roof.

a) W_1 b) W_2 c) $W_1 + W_2$ d) $\frac{W_1 + W_2}{2}$

Ans:-...

8) By the application of force, $\vec{F} = 6\hat{i} - 8\hat{j} + 10\hat{k}$ an object accures acceleration $1\ m/s^2$. Then mass of the object is –

a) $10\sqrt{2}kg$ b) $2\sqrt{10}kg$ c) 10kg d) 20Kg

Ans:-...

9) A block of weight 'W' is at rest on an inclined plane. If ϕ be the angle of friction then the minimum force required to be applied on the block so that it moves upwards –

a) $W \sin\phi$ b) $W \cos\phi$ c) $W \tan\phi$ d) $W \cot\phi$

Ans:-...

10) A person has to walk with small foot steps on ice because –

a) More frictional force generates.

b) Less frictional force generates.

c) More normal reaction generates.

d) Less normal reaction generates.

Ans:-..

Section-B

Very Short Answer Type Question : **(Mark-1)**

1) Write the dimension of impulse.

Ans:-..

2) Define SI unit of force from Newton's second law.

Ans:-..

3) In tug-of-war both the teams are applying force T on thread. What will be tension in the thread?

Ans:-..

4) Give an example where force generates due to rate of change of mass not velocity.

Ans:-..

5) What type of physical quantity is impulse? Scalar or Vector.

Ans:-..

6) What is inertial frame of referance?

Ans:-..

7) What is the unit of coefficient of static friction?

Ans:-..

8) A block of mass 5 kg is placed at rest on a horizontal surface of coefficient of static friction 0.7. What is the amount of static friction on the block?

Ans:-..

9) What is limiting value of static friction?

Ans:-..

10) In which situation coefficient of static friction becomes more than 1.

Ans:-..

11) Write two advantages of friction.

Ans:-..

12) What is babbiting?

Ans:-..

Section-C

Short Answer Type Question : **(Mark-2)**

1) Explain recoil of gun during firing bullet.

Ans:-..

2) Establish Newtons first law from Newton's 2nd law of motion.

Ans:-..

3) It is easier to jump on a heap of sand than on a hard floor.

Ans:-..

4) What is impulse? Show that it is equal to change of momentum.

Ans:-..

5) A ball of man 50 gm falls from $40m$ height and after collision with ground ascends to a height of $10m$. If duration of contact between ball and ground be $0.1s$, find force on ball.

Ans:-..

6) Why small foot steps are required while walking on slippary surface?

Ans:-...

7) What is coefficient of static and kinetic friction. On which factors they depend?

Ans:-...

8) Why it is easier to pull a rolar than pushing it?

Ans:-...

9) State laws of static friction.

Ans:-...

10) A stone of mass 1 kg skidding on a horizontal surface with initial velocity 2 m/s. If it comes to rest after travelling for 10s find the magnitude of coefficient of friction of the surface.

Ans:-...

Section-D

Long Answer Type Question : **(Mark-3)**

1) Establish Newtons 3rd law from Newtons 2nd law.

Ans:-...

2) Establish Newtons third law from principle of conservation of linear momentum.

Ans:-...

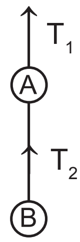
3) When a bullet from gun is shot to a glass pane it forms a hole, but if a stone is thrown to a glass pane it breakes into pieces – Explain.

Ans:-...

4) A bomb in rest explodes into three fragments of masses m, m and $2m$. The parts of equal mass moves parpendicular to each other with velocity 'v'. Find velocity of third piece.

Ans:-...

5) In the figure mass of object A is 15 kg and mass of object B is 11 kg and they are attached by a string. If the whole system is pulled upward by a string attached to A with acceleration 3 m/s^2 find tension T_1 and T_2.



Ans:-...

6) What is angle of repose. Establish its relation with limiting friction..

Ans:-...

7) Derive the expression of acceleration of a body skidding through rough inclined plane with its own weight.

Ans:-...

8) A wooden block is placed on a rough wooden slab. Now the inclination angle of the slab with horizontal is increasing slowly. When the angle becomes 30^0 the block tends to move. After very small increase of angle the block moves 4m in 4 sec. Find the value of coefficient of static and kinetic friction.

Ans:-...

9) A car is moving on a horizontal road with velocity 15m/s. If coefficient of kinetic friction between road and wheel be 0.5 then after applying brakes find the distance travelled by the car before coming to rest.

Ans:-...

Section-E

Large Answer Type Question : **(Mark-5)**

1) Derive the expression of apparent weight experienced by a person inside lift when lift –

a) Moves upward with an acceleration 'a'

b) Moves downward with an acceleration 'a'

c) Moves with uniform velocity or remains stationary

d) Starts falling freely.

Ans:-..

....

2) State and prove principle of conservation of linear momentum in case of one dimensional collision among two objects.

Ans:-..

....

3) Mass is the measure of inertia– explain. State Newton's 3rd Law and explain it with example.

Ans:-..

....

4) Define angle of friction and angle of repose. Show that they are numerically equal.

Ans:-..

....

5. When a body slides down from rest along a smooth inclined plane making an angle of 45^0 with the horizontal, it takes time 'T'. When the same body slides down from rest along a rough inclined plane making the same angle and through the same distance, it is seen to take time PT, where P is some number greater than 1. Calculate the co-efficient of friction between the body and the rough plane.

Ans:-..

....

....

....

Answer

Section-A

1. (a) 2. (c) 3. (c) 4. (c) 5. (b) 6. (a)

7. (c) 8. (a) 9. (a) 10. (c)

Chapter-6

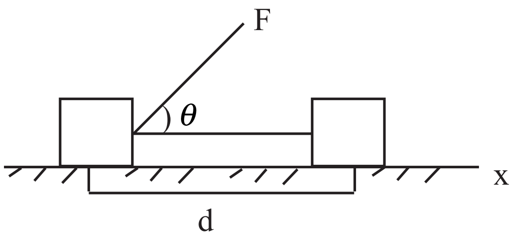
Work, Energy and Power

Key Notes :-

⇨ Work done by a constant force $\vec{F}$ through a displacement $\vec{d}$ is

$$w = \vec{F} \cdot \vec{d}$$

$$w = F\, d \cos \theta$$



⇨ Work done is zero when $\theta = 90^0$

⇨ Work done is positive when $\theta < 90^0$

⇨ Work done is negative when $\theta > 90^0$

⇨ SI unit of work is joule (J) and CGS unit of work is erg.

⇨ $1J = 10^7 erg$.

⇨ Work done is a scalar quantity.

⇨ Work done by a variable force,

$$w = \int_A^B \vec{F}.\overline{ds}$$

$=$ Area under force - displacement graph.

⇨ Energy of a body is defined as the capacity to do work.

⇨ Energy is a scalar quantity and has the same unit as of work.

⇨ Total mechanical energy $=$ Potential energy $+$ Kinetic energy.

⇨ Kinetic energy is the energy possessed by a body by virtue of its motion.

⇨ An object of mass 'm' moving with velocity v possess kinetic energy,

$$K.E. = \frac{1}{2} mv^2$$

⇨ According to work energy theorem, work done by a force is equal to the change in kinetic energy of the body.

$$W = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$$

⇨ Potential energy is the energy possessed by a body by virtue of its position or configuration

⇨ Gravitational potential energy is the energy possessed by virtue of its position above the surface of the earth.

Potential Energy,

$U = mg\,h$, $m \rightarrow$ mass of a body

$g \rightarrow$ acceleration due to gravity

$h \rightarrow$ height above the surface of earth.

⇨ If an elastic spring is stretched (or compressed) by a distance x from its equilibrium position, then elastic potential energy

$$U = \frac{1}{2}kx^2, \quad k \rightarrow \text{spring constant.}$$

⇨ Spring force is a conservative forces.

⇨ Kinetic energy and momentum are related by $E_k = \frac{1}{2}mv^2$

$$E_k = \frac{p^2}{2m}$$

$$P = \sqrt{2mE_k}$$

Where Ek = Kinetic energy of the body,

m= mass of the body,

v= velocity of the body,

p = linear momentum of the body.

⇨ For a freely falling body, mechanical energy is always constant.

⇨ According to Einstein, mass can be converted into energy and energy can be converted into mass. The equivalence between mass and energy is given by $E = mc^2$, $c \rightarrow$ velocity of light.

⇨ Power of a body is defined as the time rate of doing work.

⇨ Power, $P = \frac{dw}{dt} = \frac{\vec{F} \cdot \vec{ds}}{dt} = \vec{F} \cdot \vec{v}$

⇨ Power is a scalar quantity and its SI unit is watt.

⇨ Practical unit of power is horse power (*hp.*)

$1hp = 746W$

⇨ Commercial unit of electrical energy is Kilowatt hour (*kWh*)

$1\text{kWh} = 3.6 \times 10^6 J$

⇨ Collision is defined as an event in which two or more bodies strike each other physically or the path of motion of one body is influenced by the other.

⇨ A collision between two particles is said to be elastic if both the linear momentum and the kinetic energy of the system remain conserved. No deformation is produced in colliding bodies.

⇨ A collision is said to be inelastic if the linear momentum of the system remains conserved but its kinetic energy is not conserved.

⇨ A collision in which two bodies stick together after the collision is said to be perfectly inelastic collision.

⇨ Head on collision or one-dimensional collision is a collision in which the colliding bodies move along the same straight path before and after collision.

⇨ In one dimensional elastic collision, the relative velocity of approach before collision is equal to the relative velocity of separation after collision.

⇨ If two particles of mass m_1 and m_2 moving with velocities u_1 and u_2 collide head on then their final velocities after collision,

$$v_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)u_1 + \left(\frac{2m_2}{m_1 + m_2}\right)u_2$$

$$v_2 = \left(\frac{m_2 - m_1}{m_1 + m_2}\right)u_2 + \frac{2m_1}{(m_1 + m_2)}u_1$$

It the colliding bodies donot move along same straight line path before and after collisation, it is said to be oblique collision or two dimensional collision. In such a collision conservation of linear momentum is valid along X-axis as well as Y-axis.

⇨ Coefficient of restitution is defined as the ratio of relative velocity of separation after collision to the relative velocity of approach before collision. It is represented by 'e',

$$e = \frac{v_2 - v_1}{u_1 - u_2}$$

For perfectly elastic collison, e = 1

For perfectly inelastic collision, e = 0 otherwise, 'e' has value between 0 to 1.

Section-A

Very Short Answer Type Question : **(Mark-1)**

1. A body moves a distance of 10 m along a straight line under the action of a force of 5N. If the work done is 25J, the angle which the force makes with the direction of motion is –

   a) 30^0 b) 45^0 c) 60^0 d) 75^0

Ans:-...

2. A position dependent force, $F = (7 - 2x + 3x^2)N$ acts on a small body of mass 2 kg and displaces it from $x = 0$ to $x = 5$m. The work done in joule is –

   a) 135 b) 270 c) 35 d) 70

Ans:-...

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

   a) $\frac{19}{5}J$ b) $\frac{5}{19}J$ c) $\frac{3}{8}J$ d) $\frac{8}{3}J$

Ans:-...

4. A constant force $\vec{F}$ is applied on a body and the velocity becomes $\vec{V}$ The power can be represented by–

   a) $\vec{F} \times \vec{V}$ b) $\vec{V} \times \vec{F}$ c) $\vec{F} \cdot \vec{V}$ d) $\frac{1}{2}\vec{V} \cdot \vec{F}$

Ans:-...

5. A light and a heavy body have equal momentum. Which one has greater kinetic energy?

a) The light body

b) Both have equal kinetic energy

c) The heavy body

d) None of these

Ans:-...

6. Two bodies of masses 'm' and '4m' are moving with equal kinetic energies, the ratio of their linear momenta is –

a) 1:4 b) 4:1 c) 1:2 d) $1:\sqrt{2}$

Ans:-...

7. If momentum of a body increases by 50%, its kinetic energy will increase by –

a) 50% b) 100% c) 125% d) 150%

Ans:-...

8. A block of man 50 kg slides over a horizontal distance of 1 m. If the coefficient of friction between their surfarces is 0.2, then workdone against friction is

a) 34J b) 56J c) 72J d) 98J

Ans:-...

9. A body is moved along a straight line by a machine delivering consant power. The distance moved by the body in time '*t*' is proportional to:

a) $t^{1/2}$ b) $t^{3/4}$ c) $t^{3/2}$ d) t^2

Ans:-...

10. If $\vec{F} = (60\hat{i} + 15\hat{j} - 3\hat{k})N$

$\vec{v} = (2\hat{i} - 4\hat{j} + 5\hat{k})ms^{-1}$

then instantaneous power is –

a) 195W b) 45W c) 75W d) 100W

Ans:-...

Section-B

Very Short Answer Type Question : **(Mark-1)**

1. What is the S.I unit of workdone ?

Ans:-...

2. What is the elastic potential energy stored in a spring?

Ans:-...

3. Why is the work done by centripetal force zero?

Ans:-...

4. Does potential energy of a spring decrease/increase when it is compressed or stretched?

Ans:-...

5. Does Kinetic energy remain conserved in perfectly inelastic collission ?

Ans:-...

6. What should be the angle between the force and the displacement for maximum and minimum work?

Ans:-...

7. Give an example of negative work.

Ans:-...

8. The momentum of an object is doubled. How does its *K.E.* change?

Ans:-...

9. Give one example of non- conservative force ?

Ans:-...

10. What is the coefficient of restitution for perfectly elastic and inelastic collision?

Ans:-...

11. A spring is cut into two equal halves. How is the spring constant of each half affected ?

Ans:-..

12. When an air bubble rises in water, what happens to its potential energy ?

Ans:-..

Section-B

Very Short Answer Type Question : (Mark-2)

1. The displacement x of a particle moving in one dimension under the action of a constant force is related to time by the equation $t = \sqrt{x} + 3,$ where x is in metre and t in second. Calculate the work done by the force in the first 6 second.

Ans:-..

....

2. Two masses, one 'n' times as heavy as the other, have equal kinetic energies. What is the ratio of their momenta?

Ans:-..

....

3. What happens to the potential energy when –
a) two protons are brought close together
b) one proton and one electron are brought close together?

Ans:-..

....

4. Draw a graph showing variation of potential energy, kinetic energy and the total energy of a body freely falling on earth from a height '*h*'.

Ans:-..

....

5. Two springs *A* and *B* are identical but *A* is harder than $B(K_A > K_B)$. On which spring more work will be done if: (a) they are stretched through the same distance (b) they are stretched by same force.

Ans:-..

....

6. Draw a graph showing variation of potential energy, kinetic energy and the total energy of a body in an elastic spring with time.

Ans:-..

....

7. The length of a steel wire increases by 0.5cm when it is loaded with a weight of 5 kg. Calculate (i) force constant of the wire and (ii) work done in stretching the wire.

Ans:-..

....

8. A man weighing 60 Kg climbs up a staircase carrying a load of 20 *Kg* on his head. The staircase has 20 steps each of height 0.2m. If he takes 10s to climb, find his power.

Ans:-..

....

9. A body of mas m is accelerated to velocity 'v' in time 't'. Show that work done after time T is

$$\frac{1}{2}\frac{mV^2T^2}{t^2}$$

Ans:-..

....

10. A bullet of mas 20 gm moving with a velocity 600 m/s strikes a tree and goes out from the other side with a velocity of 400 m/s. Calculate the work done by the bullet in passing through the tree.

Ans:-..

....

11. A particle moves along the *X*-axis from $x = 0$ to $x = 2.0$m under the influence of a force given by F = (10 + 0.50x)N. Find the work done.

Ans:-..

....

12. If the kinetic energy of a body increases by 300% by what percentage will the linear momentum of the body increase?

Ans:-..

....

13. A body constrained to move along the *Z*-axis of a co-ordinate system is subject to a constant force $\vec{F} = -\hat{i} + 2\hat{j} + 3\hat{k}\ N$ where are unit vectors along the *X*, *Y* and *Z* axis of the system respectively. What is the work done by this force in moving the body a distance of 4*m* along the *Z*-axis. [*NCERT*]

Ans:-..

....

14. 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 40m above the ground, and the efficiency of the pump is 30%, how much electric power is consumed by the pump?

[*NCERT*]

Ans:-..

....

15. A particle of mass 0.5kg travels in a straight line with velocity $v = ax^{3/2}$ where $a = 5ms^{-2}$. What is the work done by the net force during its displacement from $x = 0$ to $x = 2m$. [*NCERT*]

Ans:-..

....

Section-D

Short Answer Type Question : **(Mark-3)**

1. Define kinetic energy. Derive an expression for the kinetic energy of a body moving with a uniform velocity.

Ans:-...

....

2. Define potential energy. Derive an expression for gravitational potential energy of a body of mass *m* raised to a height '*h*' above the earth's surface.

Ans:-...

....

3. State and prove work-energy theorem.

Ans:-...

....

4. Define power. Prove that $P = \vec{F} \cdot \vec{V}$, where the symbols have their usual meanings.

Ans:-...

....

5. Differentiate between elastic and inelastic collision. Give one example each.

Ans:-...

....

6. Show that in case of one-dimensional elastic collision of two bodies, the relative velocity of separation after the collision is equal to the relative velocity of approach before the collision.

Ans:-...

....

Section-E

Long Answer Type Question : **(Mark-5)**

1. Derive an expression for the potential energy of an elastic stretched spring. Draw the graph of equation $F_s = -Kx,$ where F_s is the spring force and x is the displacement of the block from equilibrium position. Using the graph show that $w_s = -\frac{1}{2}kx^2$ ($K=$ spring constant).

Ans:-...

....

2. State the law of conservation of mechanical energy. Show that the total mechanical energy of a body falling freely under gravity is conserved. Also show it graphically.

Ans:-...

....

3. In an elastic collision in one dimension. Calculate the velocities of bodies after collision. Discuss its special cases.

Ans:-...

....

4. Show that in perfectly elastic collision kinetic energy remains conserved.

Ans:-...

....

5. Prove that the value of kinetic energy losses when there is inelastic collision between two objects moving in a straight line. In that case the lost energy transforms to which energy?

Ans:-...

....

Answers

Section-A:

1. (c)	2. (a)	3.(d)	4. (b)	5. (c)	6. (c)
7. (c)	8. (a)	9. (c)	10. (b)	11. (21J)	

Chapter-7

System of Particles and Rotational Motion

Key Notes :-

⇨ Centre of mass: The centre of mass of a body or a system of particles is that point which moves as though all the mass were cocentrated there and all the external forces were applied to it.

If $\vec{r}_1$ and $\vec{r}_2$ are the position vectors of two particles of masses m_1 and m_2 then the position vector of their centre of mass is given by.

$$\vec{R}_{CM} = \frac{m_1\vec{r}_1 + m_2\vec{r}_2}{m_1 + m_2}$$

For system of *n*-particles,

$$\vec{R}_{CM} = \frac{m_1\vec{r}_1 + m_2\vec{r}_2 + \ldots m_n\vec{r}_n}{m_1 + m_2 \ldots m_n}$$

$$= \frac{\sum_{i=1}^{n} m_i\vec{r}_i}{M}$$

Where, $M = m_1 + m_2 + \ldots\ldots + m_n$

⇨ Velocity of centre of mass of a system of two particles is given by

$$\vec{V}_{CM} = \frac{m_1\vec{v}_1 + m_2\vec{v}_2}{m_1 + m_2}$$

⇨ Acceleration of centre of mass of a system of two particles is given by

$$\vec{a}_{cm} = \frac{m_1\vec{a}_1 + m_2\vec{a}_2}{m_1 + m_2}$$

⇨ A rigid body has a perfectly definite shape and size. The separation amongst the constituent particles of body do not change, whatever force applying on it.

⇨ Equations of rotational motion:

The equations of rotational motion can be written as

(*i*) $\omega=\omega_0+\alpha t$

(*ii*) $\theta=\omega_o t+\frac{1}{2}\alpha t^2$

(*iii*) $\omega^2-\omega_0^2 = 2\alpha\theta$

Where symbols have their usual meaning.

⇨ Torque is the moment of force. It is the turning effect of a force about the axis of rotation. It is measured as the product of the magnitude of the force and the perpendicular distance of the line of action of the force from the axis of rotation. Mathematically, $\tau=\vec{r}\times\vec{F}$

⇨ Principle of moments of rotational equilibrium: The algebric sum of moments about any point is zero. In rotational equilibrium, clock wise moment = anti clock wise moment

$$F_1\times d_1 = F_2\times d_2$$

Load × load arm = Effort × effort arm

⇨ For a small angle $d\theta$, workdone by the torque is, $dw=\tau\, d\theta$

⇨ Power in Rotational motion, $P=\frac{dw}{dt}$

$$P=\frac{\tau d\theta}{dt}$$

$$P=\tau\, w \quad \text{Where, } w=\frac{d\theta}{dt}$$

⇨ Angular momentum is the moment of linear momentum. It is measured as the product of linear momentum and perpendicular distance from the axis of rotation.

Mathematically, $\vec{L}=\vec{r}\times\vec{p}$

⇨ Geometrically, angular momentum of a particle is equal to twice the product of its mass and the areal velocity.

Mathematically, $\vec{L}=2m\frac{d\vec{A}}{dt}$

⇨ Relation between torque and angular momentum is given by $\vec{\tau}=\frac{d\vec{L}}{dt}$

⇨ Equilibrium of rigid bodies:

(i) Translational equilibrium : Net external force acting on the body must be zero.

$$\sum \vec{F}_i^{ext} = 0$$

(ii) Rotational equilibrium : Net external torque acting on the body about any point must be zero.

$$\sum \tau_i^{ext} = 0$$

⇨ Moment of inertia is the rotational analogue of mass in linear motion.

It is defined as the sum of the products of the masses of the particles and the square of their perpendicular distances from the axis. It is given by

$$I = m_1 r_1^2 + m_2 r_2^2 + ...m_n r_n^2$$

$$= \sum_{i=1}^{n} m_i r_i^2$$

Radius of gyration : If whole mass of the body is concentrated at a distance K from the axis of rotation then moment of inertia, $I = MK^2$

Where M is the total mass of the body and K is the radius of gyration.

Radius of gyration,

$$K = \sqrt{\frac{r_1^2 + r_2^2 + ...r_n^2}{n}}$$

⇨ Theorem of Parallel Axes:

According to this theorem the moment of inertia I of a body about any axis is equal to sum of its moment of inertia about a parallel axis through its centre of mass I_{CM} plus the product of the mass of the body and the square of the perpendicular distance between two parallel axes.

$$I = I_{CM} + Ma^2$$

Where M= Mass of the body

a = Perpendicular distance between the axes

⇨ Theorem of perpendicular Axes:

According to this theorem, the moment of inertia I of a planner body about a perpendicular axis is equal to the sum of moments of inertia of the body about two perpendicular axes concurrent with perpendicular axis and lying in the plane of the of body.

$$I_z = I_x + I_y$$

⇨ Rotational Kinetic energy of a body is $\frac{1}{2}Iw$

⇨ Total Kinetic energy of a rolling body is $\frac{1}{2}Mv^2 + \frac{1}{2}Iw$

⇨ Relation between moment of inertia and angular momentum: $\vec{L} = \mathrm{I}\mathrm{w}$

⇨ Law of conservation of angular momentum:
If no external torque acts on a system then the total angular momentum of the system remains conserved.
Mathematically,

$$\text{If} \quad \tau_{ext} = 0$$
$$L = constant$$
$$Iw = constant$$
$$I_1 w_1 = I_2 w_2$$

⇨ Relation between torque and moment of inertia: $\vec{\tau} = \mathrm{I}\vec{\alpha}$, where α= angular acceleration.

⇨ When a body rolls down along an inclined plane without slipping, the velocity on reaching the ground is

$$v = \sqrt{\frac{2gh}{1+\frac{K^2}{R^2}}}$$

Section-A

Very Short Answer Type Question -1: **(Mark-1)**

1. Two blocks of masses 10 Kg and 4 Kg are connected by a spring of negligible mass and placed on a frictionless horizontal surface. An impulse gives a velocity of 14m/s to the heavier block in the direction of the lighter block.
The velocity of the centre of mass is –
a) 30 m/s b) 20 m/s c) 10 m/s d) 5 m/s

Ans:-...

2. If force acts on a body, whose line of action does not pass through its centre of gravity, then the body will experience

a) angular acceleration
b) linear acceleration
c) both (a) and (b)
d) none of the above.

Ans:-...

3. Angular momentum is

a) moment of linear momentum
b) product of mass and angular velocity
c) product of *M.I.* and velocity
d) moment of angular momentum

Ans:-...

4. If there is change of angular momentum from J to 4 J in 4s, then the torque is –

a) $\frac{3}{4}$ J   b) 1J   c) $\frac{5}{4}$ J   d) $\frac{4}{3}$ J

Ans:-...

5. A particle performs uniform circular motion with an angular momentum *L*. If the frequency of the particles motion is doubled and kinetic energy halved, the angular momentum becomes –

a) 2L   b) 4L   c) $\frac{L}{2}$ d) $\frac{L}{4}$

Ans:-...

6. The radius of gyration of a body is independent of

a) mass of the body
b) distribution of mass
c) axis of rotation
d) none of the above

Ans:-...

7. A ring of radius *r* and mass *m* rotates about an axis passing through its centre and perpendicular to its plane with angular velocity *w*. Its *K.E.* is –

a) $mr\omega$, b) $\frac{1}{2}mr\omega^2$ c) $mr^2\omega^2$ d) $\frac{1}{2}mr^2\omega^2$

Ans:-..

8. A man is sitting with folded hands on a revolving table, suddenly he stretches his arms. Angular speed of the table would –

a) increase b) decrease c) remain the same d) none of the above

Ans:-..

9. When torque acting upon a system is zero, which of the following will be constant?

a) force b) linear momentum c) linear impulse d) none of the above

Ans:-..

10. One circular ring and one circular disc both have the same mass and radius. The ratio of their moments of inertia about the axis passing through their centres and perpendicular to their planes will be–

a) 1:1 b) 2:1 c) 1:2 d) 4:1

Ans:-..

11. Where does the centre of mass of uniform triangular lamina lie?

Ans:-..

12. What is the physical significance of moment of inertia ?

Ans:-..

13. About which axis would a uniform cube have a minimum rotational inertia?

Ans:-..

14. In a fly wheel, most of the mass is concentrated at the rim. Explain why ?

Ans:-..

15. A constant torque of 120N m rotates its points of action by an angle of 30^o. What is the work done by the torque ?

Ans:-..

16. State the condition for rotational equilibrium of a body.

Ans:-..

17. Which component of force does not contribute towards torque.

Ans:-..

18. It is difficult to open the door by pushing it or pulling it at the hinge. Why?

Ans:-..

19. Why a force is applied at right angles to the heavy door at the outer edge while closing or opening it?

Ans:-..

20. Which physical quantity is expressed as the rate of change of angular momentum?

Ans:-..

Section-B

Short Answer Type Question-2 **(Mark-2)**

1. Show that in the absence of any external force, the velocity of the centre of mass remains constant.

Ans:-...

....

2. Derive the relation between angular momentum and torque.

Ans:-...

....

3. State the factors on which moment of inertia of a body depends.

Ans:-..

....

4. Derive the relation between torque and angular acceleration produced in a rigid body.

Ans:-..

....

5. A solid cylinder of mass 20 Kg rotates about its axis with angular speed of 100 rad/s. The radius of cylinder is 0.25 m. What is the K.E. of rotation of cylinder.

Ans:-..

....

6. A constant torque is acting on a wheel. If starting from rest, the wheel makes n^{th} rotations in t seconds, show that the angular acceleration is given by

$$\alpha = \frac{4\pi n}{t^2}\ rad\ \mathrm{s}^{-2}$$

Ans:-..

....

7. The moments of inertia of two rotating bodies *A* and *B* are I_A and I_B $(I_A > I_B)$ and their angular momenta are equal. Which one has a greater kinetic energy?

Ans:-..

....

8. If earth were to shrink suddenly, what would happen to the length of the day?

Ans:-..

....

9. A particle performing uniform circular motion has angular momentum L. What will be the new angular momentum if its angular velocity is doubled and its kinetic energy halved?

Ans:-..

....

10. Two solid spheres of the same mass are made of metals of different densities. Which of them has larger moment of inertia about its diameter? Justify your answer.

Ans:-..

....

11. What is the moment of inertia of a rod of mass M, length l about an axis perpendicular to it through one end? Given the moment of inertia about the centre of mass is $\frac{1}{12}Ml^2$.

Ans:-..

....

12 Find the moment of inertia of a sphere about a tangent to the sphere, given that the moment of inertia of the sphere about any of its diameter to be $\frac{2}{5}MR^2$, where M is the mass of the sphere and R is the radius of the sphere. [*NCERT*]

Ans:-..

....

13. Given the moment of inertia of a disc of mass M and radius R about any of its diameter to be $\frac{1}{4}MR^2$. Find its moment of inertia about an axis normal to the disc and passing through point on its edge. [*NCERT*]

Ans:-..

....

14. A solid cylinder of mass 20*kg* rotates about its axis with angular speed 100 $rad\ s^{-1}$. The radius of the cylinder is 0.25*m*. What is kinetic energy associated with the rotation of the cylinder? What is the magnitude of angular momentum of the cylinder about its axis? [*NCERT*]

Ans:-..

....

15. A rope of negligible mass is wound round a hollow cylinder of mass 3 kg and radius 40 cm. What is angular acceleration of the cylinder if the rope is pulled with a force of 30*N* ? What is the linear acceleration of the rope? Assume that there is no slipping. [*NCERT*]

Ans:-..

....

16. Keeping angular momentum conserved in a system , moment of inertia is decreased. Will its roational kinetic energy be also conserved ? Explain.

Ans:-..

....

Section-C

Short Answer Type Question-3 : **(Mark-3)**

1. Derive an expression for the centre of mass of a two particle system.

Ans:-..

....

2. State and proof theorems of parallel and perpendicular axes.

Ans:-..

....

3. Derive an expression for the moment of inertia of a disc about –
   (a) its diameter
   (b) a tangent in its own plane.

Ans:-..

....

4. State and explain law of conservation of angular momentum.

Ans:-..

....

5. The angular speed of a motor wheel is increased from 800rpm to 2880 rpm in 16s (i) what is its angular acceleration, assuming the acceleration to be uniform ? (ii) How many revolutions does the engine make during this time ?

Ans:-..

....

Section-D

Long Answer Type Question : **(Mark-5)**

1. Define moment of inertia of a body. Derive an expression for the moment of inertia of a thin uniform circular ring about (a) its diameter (b) a tangent in its plane.

Ans:-..

....

2. Derive the following equations of rotational motion:
   (a) $\omega = \omega_0 + \alpha t$
   (b) $\theta = w_0 t + \frac{1}{2}\alpha\, t^2$

(c) $w^2 - w_0^2 = 2\alpha\theta$, where symbols have their usual meaning.

Ans:-..

....

3. (a) Obtain an expression for the kinetic energy of a body rolling without slipping.

(b) Three bodies a ring, a solid cylinder and a solid sphere roll down the same inclined plane without slipping. They start from rest. The radii of the bodies are identical. Which of the bodies reaches the ground with maximum velocity? [*NCERT*]

Ans:-..

....

Answer

Section-A

1. (c) 2. (c) 3. (a) 4. (a) 5. (d) 6. (a)

7. (d) 8. (b) 9. (d) 10. (b)

Chapter-8

Gravitation

Key Notes :-

⇨ If two masses 'm_1', and 'm_2', be 'r' distance apart then according to Newtons law of gravitation, force of attraction –

$$F = G\frac{m_1 m_2}{r^2}$$

Where $G =$ gravitational constant

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

⇨ If earth be a homogeneous sphere of mass 'M', radius 'R' and density 'ρ' then acceleration due to gravity on the surface of earth be,

$$g = \frac{GM}{R^2} = \frac{G}{R^2} \times \frac{4}{3}\pi R^3 \rho = \frac{4}{3}\pi R \rho G$$

⇨ Magnitude of gravitational acceleration at height 'h',

(*i*) $g' = g\left(\frac{R}{R+h}\right)^2$

(*ii*) For small height (h), $g' = g\left(1 - \frac{2h}{R}\right)$

⇨ Magnitude of gravitational acceleration at depth 'd',

$$g' = g\left(1 - \frac{d}{R}\right)$$

At centre of earth $d = R$ and $g' = 0$

$For\ R >> h$

$$(1-\frac{2h}{R}) = g\,(1-\frac{d}{R})$$

$\therefore d = 2h$

⇨ Magnitude of gravitational acceleration at lattitude 'ϕ' due to rotation of earth,

$$g' = g - R\omega^2 \cos^2\phi$$

At equator, $\phi = 0^0$ and $g' = g - R\omega^2$

At poles, $\phi = 90^0$ and $g' = g$

⇨ Gravitional potential Energy between two masses m_1 and m_2 separated by distance 'r' is –

$$E_P = -\frac{Gm_1m_2}{r}$$

⇨ Gravitational potential at distance 'r' from a point object of mass 'm' is –

$$V = \frac{-Gm}{r}$$

⇨ Gravitational field intensity at distance 'r' from a point object of mass 'm' is –

$$E = \frac{Gm}{r^2}$$

⇨ Orbital velocity of a satellite revolving around a planet of mass 'M', radius 'R', at height 'h' from its surface is

$$V_0 = \sqrt{\frac{GM}{R+h}} = \sqrt{\frac{gR^2}{R+h}}$$

When h is small, $V_0 = \sqrt{gR}$

⇨ Escape speed of an object from surface of a planet of mass 'M' and radius 'R' is,

$$V_e = \sqrt{\frac{2GM}{R}} = \sqrt{2gR} = \sqrt{2}\ V_0 \text{(When } h \text{ is very small)}$$

⇨ According to Kepler's third law if 'T' be the time period of revolution of any planet around its star in an orbit of avarage radius 'r' then,

$$T^2 \alpha\ r^3$$

⇨ Time period of Geostationary satellite = 24 hr, height of its orbit from earth's surface is almost 36000 km.

Section-A

Multiple Choice Question : **(Mark-1)**

1. What is the dimension of gravitational constant (G) –

   a) $[ML^3T^{-2}]$ b) $[M^{-1}L^{-3}T^2]$ c) $[ML^{-3}T^{-2}]$ d) $[M^{-1}L^3T^{-2}]$

Ans:-..

2. The escape speed of an object of mass 'm' from surface of any planet is proportional to –

   a) m^{-1} b) m^0 c) m d) m^2

Ans:-..

3) Kepler's second law is based on the conservation principle of –

   a) Energy b) Linear momentum c) Angular momentum d) Mass

Ans:-..

4) Inside surface of the earth which one is the correct equation for accelearation due to gravity (g) with distance from centre of earth (r).

   a) $g \, \alpha \, r$ b) $g \, \alpha \, \frac{1}{r}$ c) $g \, \alpha \, \frac{1}{r^2}$ d) g = Constant

Ans:-..

5) At which point on earth's surface value of gravitational acceleration is maximum –

   a) At pole b) At equator c) At 45^0 Altitude d) Constant everywhere

Ans:-..

6) When earth revolves round the sun which quantity among the four remains constant –

   a) Angular velocity b) Kinetic energy c) Potential energy d) Areal velocity

Ans:-..

7) Two masses 'm' and '$4m$' are placed at distance 'r'. If gravitational force of attraction on 'm' by '$4m$' be 'F' then force on '$4m$' by 'm' will be –

   a) F b) $4F$ c) $\frac{F}{4}$ d) $2F$

Ans:-..

8. What is the value of gravitational field intensity on the surface of earth –

a) g b) $2g$ c) $4g$ d) $\frac{g}{2}$

Ans:-..

9. If any object has weight 'W' on earth's surface, what will be its weight at a depth half of earth's radius–

a) W b) $\frac{W}{2}$ c) $2W$ d) $\frac{W}{4}$

Ans:-..

10. With what velocity any object coming from infinite distance will strike earth's surface (ignore air friction)

a) Infinity b) Zero c) $2\sqrt{gR}$ d) $\sqrt{2gR}$

Ans:-..

Section-B

Very Short Answer Type Question–1 : (Mark-1)

1. Gravitational force of attraction between two bodies is $4N$. If distance between them is doubled what will be the new force of attraction between them?

Ans:-..

2) What is the ratio of force of attraction between two bodies kept in air and in same distance apart in water.

Ans:-..

3) Write S.I. unit of gravitational potential.

Ans:-..

4) A satellite is revolving around earth with kinetic energy of 500 J. What will be its total mechanical energy?

Ans:-..

5) Draw the graph which shows variation of gravitational acceleration with distance starting from centre of earth.

Ans:-..

6) Two satellites of masses m and $2m$ are revolving around earth in same orbit. Find ratio of their speed.

Ans:-..

7) If T be time period of revolution of a planet around sun in an orbit of radius r, what will be the geometrical shape of 'T' vs. '$r^{3/2}$' graph.

Ans:-..

8) Among Delhi and Simla where will you find your weight comperatively less and why?

Ans:-..

9) What is escape speed ?

Ans:-..

10) What is the time period of a Geo-stationary satellite?

Ans:-..

Section-C

Short Answer Type Question–2 **(Mark-2)**

1) Why Newton's law of gravitation is called universal law.

Ans:-...

2) Establish relation between gravitational acceleration (g) and universal gravitational constant (G).

Ans:-..

3) At what height from earth's surface the value of acceleration due to gravity becomes 1% of its value on the earth surface ?

Ans:-..

4) Establish relation between gravitational acceleration at earth's surface and mean density of earth.

Ans:-..

5) Show that orbital velocity of a satellite does not depend on its mass.

Ans:-..

6) Mass and radius of earth is respectively 80 times and 4 times greater than that of moon. If value of gravitational acceleration on earth's surface be 10 m/s^2 find gravitational acceleration on moon's surface.

Ans:-..

7) Write applications of geostationary satellite.

Ans:-..

8) Explain weightlessness of an astronaut in satellite.

Ans:-..

9) Why moon has no atmosphere?

Ans:-..

10) If distance between sun and earth suddenly becomes half of its present value, how many days will be there in a year?

Ans:-...

Section-D

Long Answer Type Question–1 : **(Mark-3)**

1) Explain variation of gravitational acceleration due to height from earths surface. ($h<<R$)

Ans:-...

2) Show that value of gravitational acceleration at the centre of earth is zero.

Ans:-...

3) If value of gravitational acceleration at height 'h' from earth's surface and at depth 'd' be equal then establish relation between h and d. Where both h and d is negligible with respect to radius of earth.

Ans:-...

4) Establish mathematical form of kepler's third law.

Ans:-...

5) Three point objects of equal mass 'm' are placed at the vertices of an equilateral triangle of side 'a'. If they rotate under the influence of mutual gravitational force then find linear velocity of each mass.

Ans:-...

6) Show that orbital velocity of any satellite revolving very close to earth's surface is $\frac{1}{\sqrt{2}}$ times of escape speed of earth.

Ans:-...

7) If an object be thrown with velocity $\frac{1}{\sqrt{2}}$ times of escape speed on earth then find the maximum height attained by the object.

Ans:-...

8) Establish expression of gravitational potential due to a point mass.

Ans:-...

9) A wire of mass 'm' and length 'l' is bent in the form of a semicircle. Find gravitational field intensity at the centre of the semi circle.

Ans:-...

10) An uniform rod of length 'l' and mass 'm' is placed along X-axis. Find gravitational potential at a distance 'l' along its axis from its one end.

Ans:-...

Section-E

Large Answer Type Question–2 **(Mark-5)**

1. Establish expression of gravitational acceleration on earth's surface due to its rotation. From it show that rotation of earth has no effect on gravitational acceleration at earth's poles.

Ans:-...

....

2) What is escape speed? Establish expression of escape speed for any planet.

Ans:-...

....

3) What is geostationary satellite? Write its proparties. Find height of geostationary satellite from earth's surface.

Ans:-...

....

4) Establish expression of total mechanical energy of a satellite revolving around earth. Also find relation

among magnitude of kinetic energy, potential energy and total mechanical energy of satellite.

Ans:-..

....

Answer

Section-A

1. (d) 2. (b) 3. (c) 4. (a) 5. (a) 6. (d)

7. (a) 8. (a) 9. (b) 10. (d)

Section-B

1. 1 N 2. 1:1 3. J kg^{-1} 4. – 500 J 6. 1:1

7. straight line 8. Simla, due to height 10. 24 hr.

Chapter-9

Mechanical Properties of Solid

Key Notes :-

⇨ Stress $= \frac{Force}{Area} = \frac{F}{A}$

⇨ Strain $= \frac{Change\ in\ dimension}{Original\ dimension}$

$= \frac{\Delta L}{L}$ or $\frac{\Delta V}{V}$ or θ

⇨ Hookes Law: Within elastic limit, stress $\propto$ strain

⇨ Young's modulus $= \frac{Longitudinal\ Stress}{Longitudinal\ Strain} = \frac{F \cdot L}{A \cdot \Delta L}$

⇨ Bulk modulus $= \frac{Volume\ Stress}{Volume\ Strain} = \frac{F \cdot V}{A \cdot \Delta V} = \frac{P.V}{\Delta V}$

⇨ Rigidity modules $= \frac{Tangential\ Stress}{Tangential\ Strain} = \frac{F}{A \cdot \theta}$

⇨ Compressibility $= \frac{1}{Bulk\ Modulus} = \frac{\Delta V}{V \cdot P}$

⇨ Poisson's ratio $= \frac{Lateral\ Strain}{Longitudinal\ Strain} = \frac{\Delta D.L}{D \cdot \Delta L}$

⇨ Theoreitical range of Poisson's ratio is between -1 and 0.5 . Practical range of poisson's ratio is between 0 and 0.5

⇨ Energy density of stretched string $= \frac{1}{2} \times stress \times strain$

⇨ Spring constant (k) $= \frac{Elastic\ Force}{Deformation} = \frac{F}{x}$

Section-A

Multiple Choice Question : **(Mark-1)**

1. What is the dimension of stress?

   a) $[ML^{-1}T^{-1}]$ b) $[M^{-1}LT^{-1}]$ c) $[M^{-1}L^{-1}T]$ d) $[MLT^{-1}]$

Ans:-..

2. Which type of substance has Young's modulus –

   a) Solid b) Liquid c) Gas d) All

Ans:-..

3. In which type of substance value of rigidity modulus is zero –

   a) Solid only

   b) Liquid only

   c) Gas only

   d) Liquid and gas both

Ans:-..

4. If a spring of spring constant 'k' is cut into three equal pieces what will be value of spring constant of each part?

   a) k b) $2k$ c) $3k$ d) $\frac{k}{3}$

Ans:-..

5. Which substance among the following is the best elastic?

   a) Iron b) Steel c) Rubber d) Cotton

Ans:-..

6) Value of poisson's ratio of material of a wire is 0.5. If by stretching cross-section of the wire is reduced by 4%, what will be the percentage change in its length?

a) 1% b) 2% c) 2.5% d) 4%

Ans:-..

7. Among the following numbers which one cannot be the value of poisson's ratio?

a) 0.1 b) 0.2 c) 0.5 d) 0.7

Ans:-..

8. Value of Young's modules of perfectly rigid substance –

a) 10^{12} N/m^2 b) 10^{12} N/m^2 c) Infinity d) Zero

Ans:-..

9. Which one is the correct relation between bulk modulus (k) and compressibility (β)?

a) $K\beta = 1$ b) $K\alpha\frac{1}{\beta}$ c) $K = \beta$ d) $2K = \beta$

Ans:-..

10. On which factor Young's modulus of a wire depends –

a) Length
b) Radius
c) Cross sectional area
d) Nature of material.

Ans:-..

Section-B

Very Short Answer Type Question–1 : (Mark-1)

1. 'Young's modulus of steel is $2\times10^{11}\,N/m^2$' – What do you understand from the statement?

Ans:-..

2 x 1011 N/m^2

2. Write unit of compressibility?

Ans:-..

3. What is elastic limit?

Ans:-..

4. What is the general name of the ratio of stress and strain?

Ans:-..

5. How value of elastic modulus of a material varies with temparature?

Ans:-..

6. A wire can tolerate maximum weight of 20 kg. If the wire is bisected in two parts of equal length what will be the maximum tolerable weight by cach part?

Ans:-..

7. If a wire is snapped by stretching it, how will its temperature change?

Ans:-..

8. How will volume of a solid changes due to the application of shearing stress?

Ans:-..

Section-C

Short Answer Type Question : **(Mark-2)**

1. Define spring constant and write its unit.

Ans:-..

2. Define Poisson's ratio. Write its theoretical and practical range.

Ans:-..

3. Steel is better elastic material than rubber – explain.

Ans:-...

4. What is thermal stress.

Ans:-...

5. A matelic rod has diameter 25 cm. Due to application of longitudinal force its length increses by 0.04% and diameter decreased by 3×10^{-4} cm. Find value of Poission's ratio of the material.

Ans:-...

6. A vertical cylindrical rod has breaking stress 10^6 N/m^2 If density of the material of the cylinder be 2×10^4 kg/m^3 find maximum height of the rod.

Ans:-...

Section-D

Long Answer Type Question–2 : (Mark-3)

1. Define – stress, strain and breaking weight.

Ans:-...

2. Find expression of elongation of a wire hang from a celling for its own weight.

Ans:-...

3. A wire of steel of length 2 m and cross sectional area 2mm^2 is hung from roof of a house. If a 4 kg object is attached to its free ends find length extension of the wire. ($Y = 2 \times 10^{12}$ dyn/cm^2)

Ans:-...

4. A wire has length 10 m and cross sectional area 2 mm^2 . If a 2 kg body is hung from its free end its longitudinal strain becomes 0.001%. Find length extension and stress of the wire.

Ans:-...

5. A wire of length 4 m and cross-sectional area 1 m^2 requires 0.08 J of work to elongate its length by 1 mm. Find Youngs modulus of the material of wire.

Ans:-..

Section-E

Large Answer Type Question : **(Mark-5)**

1. State Hooke's law of elasticity and write the unit of elastic modulus. Define Young's modulus, Bulk modulus and rigidity Modulus.

Ans:-..

....

2. What is elastic potential energy. Show that in case of a stretched wire energy density $= \frac{1}{2} \times stress \times strain$

Ans:-..

....

3. What is shearing stress? If due to external force longitudinal strain in a wire be 'e' and its possion's ratio be σ then show that magnitude of its volume strain $= e(1-2\sigma)$

Ans:-..

....

Answer

Section-A

1. (a)	2. (a)	3. (d)	4. (c)	5. (d)	6. (d)
7. (d)	8. (c)	9. (a)	10. (d)		

Chapter-10

Mechanical Properties of Fluids

Key Notes :-

⇨ Density $= \frac{Mass}{Volume}$

⇨ Relative density or specific gravity $= \frac{Density\ of\ a\ substance}{Density\ of\ water\ at\ 4^0 C}$

⇨ Hydrostatic pressure at a depth 'h' below the surface of liquid of density ρ is $P = h\rho g$.

⇨ Equation of equilibrium of two non miscible liquids in U-tube,

$$\frac{h_1}{h_2} = \frac{\rho_2}{\rho_1}$$

⇨ When a body floats in liquid, weight of body = weight of displaced liquid.

⇨ When a body submarges in liquid, volume of body = Volume of displaced liquid.

⇨ According to Archimedes principle, when a body submarges fully or partially in fluid then apparent weight loss of body = weight of displaced fluid.

⇨ Fraction of body of density σ immersed in liquid of density ρ is $\frac{v}{V} = \frac{\sigma}{\rho}$, where $(\sigma < \rho)$

⇨ Surface tension $T = \frac{F}{l}$, F = Tangential force, l = length of the line.

⇨ Surface energy is the workdone in extending open surface of liquid by unity. It is numarically equal to surface tension.

⇨ Excess pressure inside liquid drop or air bubble inside liquid, $\Delta P = \frac{2T}{R}$

⇨ Excess pressure inside soap bubble $\Delta P = \frac{4T}{R}$

⇨ Surface tension of liquid decreases with rise in temperature.

⇨ Workdone = Surface tension $\times$ Increase in area

⇨ Viscous force $F = \eta A \frac{dv}{dx}$

⇨ According to stokes law viscous force on a sphere of radius r is, $F = 6\pi\eta rv$

⇨ Terminal velocity, $V = \frac{2r^2(\rho - \sigma)g}{9\eta}$

⇨ Critical velocity $V_c = R\frac{\eta}{\rho l}$ where R = Raynold's number.

If $R < 2000$, flow of liquid is streamline

If, $R > 3000$, flow of liquid is turbulent

⇨ Equation of continuty '$\alpha\ v =$ constant'.

⇨ Height of liquid in capillary tube, $h = \frac{2T\cos\theta}{r\rho g}$

⇨ Bernoulli's equation, $\frac{P}{\rho g} + h + \frac{v^2}{2g} =$ Constant.

⇨ Velocity of efflux that is Torricelli's law, $V = \sqrt{2gh}$

Section-A

Multiple Choice Question : **(Mark-1)**

1. The working of hydraulic press is based on –
   a) Archimedes principle
   b) Energy conservation principle
   c) Principle of multiplication of thrust

d) None of the above

Ans:-...

2. $\frac{1}{11}$ th fraction of an ice piece is floating on pure water. Density of ice is –

a) 1 g/cc b) 0.91g/cc c) 0.89g/cc d) 0.8g/cc

Ans:-...

3. What is the dimension of pressure?

a) MLT^{-2} b) $ML^{-1}T^{-2}$ c) $ML^{-1}T^{-1}$ d) $ML^{-1}T^{-3}$

Ans:-...

4. A small hole is made at depth '*h*' from open surface of a liquid kept in a container. Velocity of efflux of liquid is –

a) $\sqrt{gh}$ b) $2\sqrt{gh}$ c) $\sqrt{2gh}$ d) gh

Ans:-...

5. In absence of gravity which property of fluid will be absent?

a) visocity b) surface tension c) pressure d) buoyancy

Ans:-...

6. Surface tension acts along –

a) tengentially to the open surface of liquid

b) parpendicular to the open surface of liquid

c) at any angle of the open surface of liquid

d) all of the above.

Ans:-...

7. At critical temperature surface tension of liquid is –

a) infinite b) positive c) negative d) zero

Ans:-...

8. Ratio of radius of two soap bubbles is 1:3. The ratio of excess pressure inside them is –

a) 1:3 b) 3:1 c) 9:1, d) 1:1

Ans:-..

9. When oil is poured on sea water, intensity of wave decreases due to –

a) decrease of surface tension of water.

b) increase of surface tension of water.

c) decrease of bucyancey in water.

d) increase of bucyancy in water.

Ans:-..

10. Surface tension of a liquid does not depend on –

a) nature of liquid

b) temperature

c) nature of solute in liquid

d) atmospheric pressure

Ans:-..

11. Bernoulli's theorem depends on conservation principle of –

a) mass b) momentum c) energy d) electric charge.

Ans:-..

12. Ratio of terminal velocity of two rain drops are 4:9. The ratio of their radii is –

a) 4:9 b) 2:3 c) 3:2 d) 9:4

Ans:-..

13. The dimension of Reynold's no. is –

a) $ML^{-1}T^{-2}$ b) $M^0L^0T^{-2}$ c) $M^0L^0T^0$ d) $ML^{-2}T^{-2}$

Ans:-..

14. Which formula is used to derive the rate of liquid flow ?

a) bernoulli's law b) stokes law c) poiseulli's law d) newton's law

Ans:-..

15. Two liquid layers at perpendicular separation 0.1 *cm* has relative velocity 8 *cm/s.* Then gradient of velocity will be–

a) 40 s^{-1} b) 60 s^{-1} c) 80 s^{-1} d) 20 s^{-1}

Ans:-...

Section-B

Very Short Answer Type Question–1 : (Mark-1)

1. What type of physical quantity is pressure? Scalar or vector?

Ans:-...

2. Weather Archimedes principle is applicable inside a freely falling lift? Answer in yes or no.

Ans:-...

3. State Pascal's law.

Ans:-...

4. Write S.I unit of specific gravity.

Ans:-...

5. What is the apparent weight of a 5 kg object of density 8050 kg/m^{-3} that floats on water?

Ans:-...

6. What is capillarity?

Ans:-...

7. Write dimension of surface tension.

Ans:-...

8. What is angle of contact?

Ans:-...

9. If radius of a capillary tube is made half of present value how will the height of liquid column change inside capillary tube?

Ans:-...

10. What happens to the value of surface tension of a liquid when temperature increases?

Ans:-...

11. ‘Coefficient of viscosity of liquid is 12 poise’– What do you mean by the statement’?

Ans:-...

12. Write the dimension of ‘Coefficient of viscosity’.

Ans:-...

13. What is terminal velocity?

Ans:-...

14. A rain drop can never attain terminal velocity if it falls freely towards the surface of earth through vacuum – why?

Ans:-...

15. Three containers contains equal amount of water, honey and pitch separately and they are steared equally. Which liquid will sattle first and why?

Ans:-...

Section-C

Short Answer Type Question–2 : (Mark-2)

1. Show that open surface of a stationary liquid always remains horizontal.

Ans:-...

2. Explain – whether Pascal's law is applicable in gas or not.

Ans:-...

3. A container contains some water and an oil drop moving up through water from bottom of the container with acceleration $\frac{g}{3}$. Find density of oil drop.

Ans:-...

4. State the factors on which surface tension of a liquid depends.

Ans:-...

5. When a piece of camphor is put on surface of water, why it moves randomly?

Ans:-...

6. Diameter of a soap bubble is 2 cm. If its diameter increases to 4 cm, find the work done required. Surface tension of soap solution $= 3\times10^{-2}$ Nm^{-1}.

Ans:-...

7. State Bernoulli's theorem with mathematical expression.

Ans:-...

8. Define coefficient of viscosity.

Ans:-...

9. Why it is not wise to close the doors & windows of a house during heavy storm?

Ans:-...

10. Establish equation of continuty.

Ans:-...

Section-D

Long Answer Type Question–1 : **(Mark-3)**

1. Derive expression of excess pressure inside soap bubble.

Ans:-..

2. Show that surface tension and surface energy are numerically equal.

Ans:-..

3. Eight liquid droplets of radius $2mm$ coalesce to form a single large drop. If surface tension of the liquid be 5 dyn/cm, find the work done required.

Ans:-..

4. Derive expression of liquid pressure inside stationary liquid.

Ans:-..

5. Using Archimedes principle derive mathematical expression of density of a solid which sinks in the liquid.

Ans:-..

6. A solid object has volume $36cm^3$ and it can float on water with $\frac{1}{4}$ of its volume outside water. Find mass and density of the solid.

Ans:-..

7. Define streamline flow, turbulent flow and critical velocity.

Ans:-..

8. Describe working of a sprayer.

Ans:-..

9. State Stoke's law. Derive it dimentionally.

Ans:-...

10. Total area of two wings of an aeroplane is 2.5 m^2. Velocity of wind above and below the wings are 70 m/s and 63 m/s respectively. If density of air be 1.3 kg/m^3 find net upward force on aeroplane.

Ans:-...

Section-E

Long Answer Type Question–2 : (Mark-5)

1. What is angle of contact? Derive expression of liquid rise through a capillary tube.

Ans:-...

....

2. What is Buoyancy? Show that in case of a fully submerged body, buoyant force is equal to the weight of liquid of same volume to that of the body.

Ans:-...

....

3. Establish principle of multiplication of thrust. Show that energy remains conserved here.

Ans:-...

....

4. What is terminal velocity? Establish its expression using stokes law.

Ans:-...

....

5. Establish condition of equilibrium of two non-miscible liquid in a U-tube. State and prove Torricelli's theorem.

Ans:-..

....

Answer

Section-A

1. (c)	2. (d)	3. (b)	4. (c)	5. (d)	6. (a)
7. (d)	8. (b)	9. (a)	10. (d)	11. (c)	12. (b)
13. (c)	14. (c)	15. (c)			

Chapter-11

Thermal Properties of Matter

Key Notes :-

⇨ For any thermometer, $\frac{Thermometer\ reading - Lower\ fixed\ point}{Upper\ fixed\ point - Lower\ fixed\ point} = Constant$

⇨ Relation between Celsius scale and Farrenheit scale is, $\frac{c}{5} = \frac{F-32}{9}$

⇨ Relation between Celsius and Kelvin scale, $C + 273 = K$.

⇨ Linear expassion coefficient of solid, $\alpha = \frac{l_2 - l_1}{l_1(\theta_2 - \theta_1)}$

⇨ Surface expansion coefficient of solid, $\beta = \frac{S_2 - S_1}{S_1(\theta_2 - \theta_1)}$

⇨ Volume expansion coefficient of solid, $\gamma = \frac{V_2 - V_1}{V_1(\theta_2 - \theta_1)}$

⇨ Relation between three expansion coefficient of solid is, $\alpha = \frac{\beta}{2} = \frac{\gamma}{3}$

⇨ Real expansion coefficient of liquid, $\gamma = \frac{V_2 - V_1}{V_1(\theta_2 - \theta_1)}$

⇨ Apparent expansion coefficient of liquid, $\gamma' = \frac{V_2 - V_1'}{V_1'(\theta_2 - \theta_1)}$

⇨ Relation between two expansion coefficent of liquid, $\gamma = \gamma' + \gamma_s$

⇨ Boyle's law, $PV =$ constant (when *T* is constant)

⇨ Charle's law, $\frac{V}{T} =$ constant and $V_t = V_0\left(1+\frac{t}{273}\right)$ (When *P* is constant)

⇨ Pressure law, $\frac{P}{T} =$ constant and $P_t = P_0\left(1+\frac{t}{273}\right)$ (When *V* is constant)

⇨ Absolute zero temperature = OK= –273°C

⇨ Volume coefficient of gas, $\gamma_p = \frac{V_t - V_0}{V_0\left(t-t_0\right)}$

⇨ Pressure coefficient of gas, $\gamma_V = \frac{P_t - P_0}{P_0\left(t-t_0\right)}$

⇨ Absorbed or released heat by a body during change in temperature, $H = ms\Delta\theta$

⇨ Principle of calorimetry, Absorbed heat = Released heat. or Heat lost = Heat gained

⇨ Heat capacity or water equivalent of a body = *ms* (in *C.G.S*)

⇨ Heat released or absorved by a body during its state change $H = mL$.

⇨ Rate of heat conduction through a solid, $\frac{Q}{T} = \frac{kA(\theta_2 - \theta_1)}{x}$

⇨ Thermal resistance $R_{th} = \frac{x}{kA}$ and thermal resistivity $\rho_{th} = \frac{t}{k}$

⇨ Kirchhoff's law, $\frac{e_\lambda}{a_\lambda} = E_\lambda$

⇨ Stefan Boltzmann's law, $E = \sigma(T^4 - T_0^4)$

Where, $\sigma =$ Boltzmann constant, *T* = Absolute temparature of body,

T_0 = Absolute temparature of surrounding.

⇨ Newton's law of cooling : For small temparature difference between object and surrounding

rate of change of temperature, $\frac{dT}{dt}\alpha(T - T_0)$

⇨ Wien's displacement law, $\lambda_m T =$ Constant.

Section-A

Multiple Choice Question : **(Mark-1)**

1. Two bodies will be in thermal equilibrium when their –
   a) Heat is equal
   b) Kinetic energy is equal
   c) Potential energy is equal
   d) Temperature is equal

Ans:-..

2. Upper fixed point of Kelvin scale is –
   a) 100 K b) 212 K c) 273 K d) 373 K

Ans:-..

3. At normal pressure a thermometer reads temperature of ice as 5^{o} and temperature of steam as 99^{o}. If this thermometer reads temperature of a body as 52^{0} find temperature of that body in Fahrenheit scale?
   a) $109^{o}F$ b) $130^{o}F$ c) $100^{o}F$ d) $122^{o}F$

Ans:-..

4. If by applying heat length of each arm of a solid cube is increased by 2%, find parcentage change of its volume?
   a) 1% b) 2% c) 4% d) 6%

Ans:-..

5. Two rods of different length have lengths l_1 and l_2 and coefficient of their linear expansion are α_1 and α_2 respectively. Then for any certain temperature difference their length expansion will be equal if –
   a) $l_1 l_2 = \alpha_2 l_1$ b) $\alpha_1 l_1 = 2\alpha_2 l_2$ c) $\alpha_1 l_1 = \alpha_2 l_2$ d) $2\alpha_1 l_1 = \alpha_2 l_2$

Ans:-..

6. A matel disc has a hole at its centre. With increase of temperature –
   a) Area of hole will decrease.
   b) Area of hole will remain same.
   c) Area of hole will increase.
   d) Area of both hole and disc will remain same.

Ans:-..

7. If temperature of some water is increased from 0^0C to 10^0C then volume of water –

a) Decrease

b) Initially decrease and then increase

c) Initially increase and then decrease

d) Increase

Ans:-..

8. (i) 'Unit of linear expansion coefficient is K^{-1}' (ii) 'Unit of volume expansion coefficient is K^{-1}' – Among these two statements –

a) (i) and (ii) both are correct

b) (i) and (ii) both are wrong

c) (i) is correct and (ii) is worng

d) (i) is wrong and (ii) is correct

Ans:-..

9. A liquid of some amount having volume expansion coefficient x is kept in a container of linear expansion coefficient $\frac{x}{3}$. With increase in temperature the liquid level will –

a) decrease

b) increase

c) remain same

d) initially decrease then increase.

Ans:-..

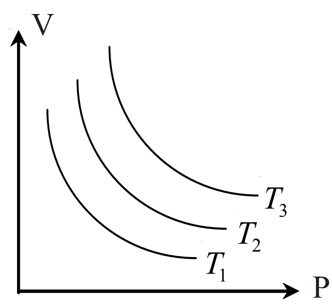
10. P-V diagram of Boyle's law is shown here. Which temperature relation is correct?

a) $T_2 < T_1 < T_3$

b) $T_1 < T_2 < T_3$

c) $T_3 < T_1 < T_2$

d) $T_3 < T_2 < T_1$



Ans:-..

11. A body of mass $10g$ has heat capacity $8cal\,^0C^{-1}$. Specific heat of the material is –

a) 0.8 b) 1.25 c) 0.4 d) 0.1

Ans:-..

12. $50g$ of water at 50^0C is mixed with $50g$ of ice at 0^0C. Final temperature of the mixture will be –

a) 0^0C b) 4^0C c) 25^0C d) 50^0C

Ans:-..

13. The process of heat transmission where no medium is required –

a) conduction
b) convection
c) radiation
d) such process does't exist.

Ans:-..

14. Which law is used to measure temperature on the surface of a star?

a) Plank's law
b) Newton's law
c) Wien's displacement law
d) Kirchhoff's law.

Ans:-..

15. A spherical black body at $500k$ temperature radiates energy at a rate of $200W$. If its radius reduced to half and temperature becomes double then rate of energy emission will be –

a) 500 W b) 600 W c) 800 W d) 900 W

Ans:-..

Section-B

Very Short Answer Type Question **(Mark-1)**

1. In which thermometer scale negative value of temperature is impossible?

Ans:-..

2. What is the S.I. unit of linear expansion coefficient of solid?

Ans:-..

3. With increase of temperature how the time period of pendulum watch changes?

Ans:-..

4. Write relation among real expansion coefficient, apparent expansion coefficient of liquid and volume expansion coefficient of solid.

Ans:-..

5. At what temperature water has maximum density?

Ans:-..

6. What is the value of pressure expansion coefficient of a gas?

Ans:-..

7. What is absolute zero temperature?

Ans:-..

8. On which factor/factors specific heat of any material depends?

Ans:-..

9. Define C.G.S. unit of heat.

Ans:-..

10. Name one apparatus where boiling point of water is increased by increasing pressure.

Ans:-...

11. 'Latent heat of fusion of ice is 80 *cal*/*g*' – What do you mean by the statement?

Ans:-...

12. What is the absorptive power of black body?

Ans:-...

13. Write dimension of thermal conductivity?

Ans:-...

14. What is the velocity of radiant heat in vacuum?

Ans:-...

15. Among red and blue star which one will have higher temperature?

Ans:-...

Section-C

Short Answer Type Question : (Mark-2)

1. Find the temperature at which Celsius and Fahrenheit scale shows same reading?

Ans:-...

2. Why between two rail tracks there remain small gap between the junction of two plastisof rail?

Ans:-...

3. At $15^{o}C$ temperature length of a steel rod is 60 cm . If temperature becomes $90^{o}C$ its length increases by 0.054 cm. Find linear expansion coefficient of steel.

Ans:-...

4. What is anomalous expansion of water. Draw volume vs temperature curve of water within the temperature range $0^{o}C$ to $10^{o}C$.

Ans:-...

5. State Charl's law. Find value of absolute zero temperature from Charle's law.

Ans:-...

6. Write the disadvantage of using water as calorimeter liquid.

Ans:-...

7. Ratio of mass and specific heat of two liquids are 3:4 and 2:3 respectively. If their initial temperature be $60^{o}C$ and $30^{o}C$ find final temperature after mixing?

Ans:-...

8. If two pieces of ice pressed by hand and then released, the two pieces join together – Explain the reason.

Ans:-...

9. Write properties of radiant heat?

Ans:-...

10. What is emissive power and absorptive power ?

Ans:-...

Section-D

Short Answer Type Question : **(Mark-3)**

1. What is compensated pendulum. Establish condition for being compensated.

Ans:-...

2. Establish relation between three types of expansion coefficient of solid.

Ans:-...

3. How marine creatures can survive in frozen lake.

Ans:-..

4. State Boyle's law? Draw its volume vs pressure and density vs pressure curve?

Ans:-..

5. Define specific heat, thermal capacity and water equivalent with their S.I. unit.

Ans:-..

6. A container has water equivalent $60g$ and $600g$ of water at 30^0C is kept in it. If heat is supplied to the container at a rate of 100 Cal S^{-1}, find time required by the water to reach at its boiling point.

Ans:-..

7. What is latent heat? If a piece of ice at -10^oC in standard pressure is given heat at constant rate till its temperature becomes 10^oC, draw its temperature vs time graph and explain different parts of the graph.

Ans:-..

8. Find amount of heat required to convert $50g$ of ice at $-10^0 C$ to steam at 100^0C. Given specific heat of ice = 0.5Cal.$g^{-1}\,^oC^{-1}$ latest heat of fusion of ice = 80 Cal g^{-1} and latent heat of vapourisation of water = 540 Cal g^{-1}.

Ans:-..

9. What is coefficient of thermal conductivity? Write its unit and dimension.

Ans:-..

10. Length of a metal rod is $31.41cm$ and its diameter 4 cm. Its one end is in contact with steam of 100^oC and other end connected with ice at 0^oC. If thermal conductivity of matel be 0.9 C.G.S unit then find amount of ice that will melt in 1 minute.

Ans:-..

Section-E

Large Answer Type Question : **(Mark-5)**

1. What is real and apparent expansion coefficient of liquid. Establish relation between them.

Ans:-..

....

2. What is volume and pressure coefficient of gas. Show mathematically that they are numerically equal.

Ans:-..

....

3. Write principle of calorimetry. Write conditions of calorimetry. State some advantages of high specific heat of water.

Ans:-..

....

4. State the factors on which rate of evaporation of any liquid depends. Write effect of pressure on melting point of a solid.

Ans:-..

....

5. State Newton's law of cooling. Establish it from Stefan-Boltzmann's law.

Ans:-..

....

Answer

Section-A

1. (d)	2. (d)	3. (d)	4. (d)	5. (c)	6. (c)
7. (b)	8. (a)	9. (c)	10. (b)	11. (a)	12. (a)
13. (c)	14. (c)	15. (c)			

Chapter-12

Thermodynamics

Key Notes :-

⇨ Assembly of an extremely large number of partions having certain value of pressre volume and temperature is called a thermodynamic system. Such system exhanges energy and mass with its surrroundings.

There are two types of thermodynamic variables (*i*) extensive variables such as mass, volume, internal energy, entropy etc. (*ii*) intensive variables such as pressure, tempature, density, specific heat, coefficient of expansion, modulus of elasticity etc.

⇨ **Joule's law:**

If some amount of work (*W*) is entirely converted into heat (*H*), the workdone and the heat produced are proportional to each other.

$$\therefore\ W \propto H \Rightarrow W = JH$$

Where, J = constant = mechanical equivalent of heat $= 4.2 J / cal = 4.2 \times 10^7\ erg/cal$.

⇨ **The first law of thermodynamics:**

When a system absorbs some amount of heat from the surrouding –

(*i*) a part of it increses the internal energy of the system and (*ii*) the remaining part is converted into some external work done by the system.

∴ heat taken by the system from the surroundings = change in internal evergy + external workdone

$$\Rightarrow\ dQ = dU + dW$$

$$dQ = dU + Pdv$$

⇨ **Relation between the two specific heat of gas:**

For an ideal gas, the difference between the molar specific heats is, $C_p - C_v = R$ where,

$C_p =$ molar specific heat at constant pressure

$C_v =$ molar specific heat at constant volume

$R =$ Universal gas constant $= 8.315 J.mol^{-1}.k^{-1}$

⇨ If $1g$ of gas is taken instead of $1mol$, then $C_p - C_v = \frac{R}{M}$, where M = molecular weight of gas.

⇨ The ratio between the two specific heats of gas is :

$$\gamma = \frac{C_p}{C_v}, \text{ As } C_p > C_v, \ \gamma > 1.$$

⇨ **Isothermal process:-** A process in which the temperature of a system remains constant but change in pressure and volume is called an isothermal process. The changes in volume and pressure in an isothermal process are called isothermal changes.

In isothermal process relation between pressure (p) and volume (v) is, $PV =$ Constant

In isothermal process the work done (w) can be expressed as,

$$W = RT \ln \frac{V_f}{V_i} = RT \ln \frac{P_i}{P_f}$$

⇨ **Adiabatic process:-** A process in which the pressure, volume and temperature of a system changes but there is no heat exchanged between a system and its surroundings is called an adiabatic process. The changes in volume pressure and temperature in an adiabatic process are called adiabatic changes.

In an adiabatic process of an ideal gas, P.

V and T are related as $PV^{\gamma} =$ Constant, $TV^{\gamma-1} =$ Cosntant, $T^{\gamma}P^{1-\gamma}$ Constant.

In adiabatic process workdone is given by, $W = C_v(T_i - T_f) = \frac{R}{\gamma - 1}(T_i - T_f)$

⇨ **Reversible and irreversible process:**

A reversible process is one that can be reversed and the heat exchange and the work done in each infinitesimal step in the reverse process are exactly equal and opposite to those in the forward process.

A process that does not satisfies these conditions is an irreversible process.

⇨ **The second law of thermodynamics:**

⇨ **Clausius statement:**

No self-acting machine can transfer heat from a lower to a higher temperature.

⇨ **Kelvin-Plank statement:**

No self acting machine can convert some amount of heat entirely into work.

⇨ **Principles of increase in entropy or general form of second law of thermody namies :**

Every process in nature occurs in such a direction that the total entropy of the universe increases. This is known as the principle of increase in entropy. It is the most general statement of the second law of thermodynamics.

⇨ **Heat engine:**

Heat engine is a mechanical device which converts heat into work.

The efficiency of heat engine is defined as the fraction of total heat taken from the source which is converted into work and it can be expressed as, $\eta = 1 - \frac{Q_2}{Q_1} = 1 - \frac{T_2}{T_1}$

Where, $Q_1 =$ heat taken by the engine from the source at temperature T_1.

$Q_2 =$ heat reject by the engine to its surroundings (sink) at temperature T_2.

⇨ **Refrigerator:**

A mechanical device which transfer heat from a colder to a hotter place is called a reftigerator.

The coefficient of performance of a refrigerator, $e = \frac{Q_2}{Q_1 - Q_2} = \frac{T_2}{T_1 - T_2}$

Where, $Q_2 =$ heat received by the refrigerator from the colder body at temperature T_2.

$Q_1 =$ heat delivered by the refrigerator to the surrounding at higher temperature T_1.

⇨ An ideal heat engine and an ideal refrigerator does not exist in nature.

⇨ **Carnot Cycle:**

A cycle enclosed by four reversible processes, two isothermal and two adiabatics, is called a carnot cycle.

⇨ **Carnot engine:**

A clockwise Carnot cycle acts as a heat engine. Which is enclosed by two reversible isothermal and two reversible adiabatic processess. This is called a Carnot's engine.

Efficiency of a Carnot engine using an ideal gas, $\eta = 1 - \frac{T_2}{T_1}$

Where, T_1 = temperature of the source.

and T_2 = temperature of the sink.

In case of a Carnot refrigerator, work done and heat exchange are equal and opposite to the corresponding quantities of a carnot engine. So, in this case the co-efficient of performance of a carnot refrigerator:

$$e = \frac{T_2}{T_1 - T_2}$$

⇨ **Carnot's theorem:**

Carnot showed that :

(*i*) all irreversible engines working between the same two temperaute have the same efficiency

and

(*ii*) no engine working between two given temperature can be more efficient than a reversible engine working between the same two temperature. This is Carnot's theorem.

Section-A

Multiple Choice Question : **(Mark-1)**

1. The internal energy of a substance actually means –

a) the kinetic energy of the substance

b) the kinetic energy of the molecules of the substance

c) the sum of its kinetic and potential energy

d) the sum of kinetic and potential energy of the molecules of the substance.

Ans:-..

2. Water falls from a height of 40 m in a waterfall. If 75% of its energy is converted to heat and absorbed by the water, what will be the rise in temperature of the water – ?

a) $0.035^{\circ}C$ b) $0.07^{\circ}C$ c) $0.35^{\circ}C$ d) $0.7^{\circ}C$

Ans:-..

3. If the internal energy 'U' and the work 'W' are expressed in unit of J and the heat Q is expressed in unit of cal, then 1st law of thermodynomics will be [here J = Joule's equivalent]

a) $dQ = dU + \frac{dW}{J}$ b) $dQ = dU + JdW$ c) $JdQ = dU + dW$ d) $\frac{dQ}{J} = dU + dW$

Ans:-..

4. $C_v = \frac{5}{2}R,$ for $1mol$ of any diatomic ideal gas. The value of the ratio of two specific heat $\left[\frac{C_p}{C_v} = \gamma\right]$ of the gas is –

a) $\frac{4}{3}$ b) $\frac{5}{3}$ c) $\frac{7}{3}$ d) $\frac{7}{5}$

Ans:-..

5. Workdone becomes zero –

a) at constant pressure.

b) at constant volume

c) in adiabatic process

d) in isothermal process.

Ans:-..

6. The change in internal energy of an ideal gas becomes zero –

a) at constant volume.

b) at constant pressure

c) in isothermal process

d) in adiabatic process.

Ans:-..

7. The process in which changes in pressure volume and temperature occur simultaneously is –

a) isochoric b) isobaric c) isothermal d) adiabatic

Ans:-..

8. In an adiabatic expansion, the change in internal energy of 10 *mol* of a gas is 100 *J*. The amount of work done by the gas will be –

a) – 100J b) 100J c) 1000J d) – 100J

Ans:-..

9. "*Heat cannot transmit from a body at lower temperature to a body at higher temperature on its own*" – This statement is derived from which law ?

a) First law of thermodynamics

b) Second law of thermodynamics

c) Law of conservation of momentum

d) Law of conservation of mass

Ans:-..

10. A system can go from state *A* to state *B* in two different process I and II. If the change in internal energy in the two cases are ΔU_1 and ΔU_2 respectively, then –

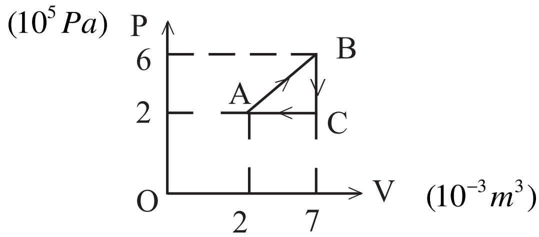
a) $\Delta U_1 < \Delta U_2$ b) $\Delta U_1 = \Delta U_2$ c) $\Delta U_1 > \Delta U_2$ d) none of these

Ans:-..

11. A gas is taken through the cycle $A \rightarrow B \rightarrow C \rightarrow A$ as shown in the figure. What is the net workdone by the gas?

a) 1000 *J* b) 0

c) 2000 *J* d) 200 *J*



Ans:-..

Section-B

Very Short Answer Type Question : **(Mark-1)**

1. How is the workdone related with the heat produced when work is completely converted into heat?

   Ans:-..

2. What is the value of mechanical equivalent of heat in SI?

   Ans:-..

3. Is pressure intensive or extensive variable?

   Ans:-..

4. Is rusting of iron a reversible process?

   Ans:-..

5. In a process, if dU, dW and dQ are change in internal evergy, workdone and heat absorbed respectively for a system, what is the relation between dU, dQ and dW?

   Ans:-..

6. A bicycle pump becomes hot when air is pumped into the tube. Why?

   Ans:-..

7. What is the change in internal energy in an isothermal process?

   Ans:-..

8. In case of one mole of an ideal gas, write down the value of $(C_p – C_v)$.

   Ans:-..

9. What is the relation between P and V in adiabatic process?

   Ans:-..

10. What is the value of the efficiency of an ideal heat engine?

Ans:-...

Section-C

Short Answer Type Question : **(Marks-2)**

1. When ice melts, then change in internal energy is greater than the heat supplied – why ?

   Ans:-...

   ....

2. State and explain Joule's law.

   Ans:-...

   ....

3. Define mechanical equivalent of heat. Write its value.

   Ans:-...

   ....

4. Define intensive and extensive variable.

   Ans:-...

   ....

5. Why there are two specific heats in case of gas?

   Ans:-...

   ....

6. Define isothermal process and adiabatic process?

Ans:-...

....

7. An isothermal process is essentially a very slow process. Explain.

Ans:-...

....

8. Find out the amount of work done to convert 100 g ice at $0^{o}C$ to water at $100^{o}C$ (Latent heat of fusion of ice $= 80\ cal/g$ and $J = 4.2\ J/cal$)

Ans:-...

....

9. What will be the time required to heat a 20 L bucket full of water from $20^{o}C$ to $40^{o}C$ using a 1500 W immersion heater?

Ans:-...

....

10. When will be value of the molar specific heat C_p and C_v of an ideal gas having $\gamma = 1.67$. Given, $R = 2cal.mol^{-1}.^{0}C^{-1}$.

Ans:-...

....

Section-D

Short Answer Type Question-2 : **(Marks-3)**

1. Prove that $C_p - C_v = R$.

Ans:-...

....

2. Write down the differences between isothermal and adiabatic process.

Ans:-..

....

3. Explain the importance of the ratio of two specific heats of gas.

Ans:-..

....

4. Derive the expression for workdone in case of isothermal porocess.

Ans:-..

....

5. Derive the expression for workdone in case of adiabatic process.

Ans:-..

....

6. What is entropy? Explain the second law of thermodynomics.

Ans:-..

....

7. Write down the differences between reversible and irreversible process.

Ans:-..

....

8. Show that the indicator diagram for an adiabatic process is steeper than that for an isothermal process.

Ans:-..

....

9. Deduce an the expression for the efficiency of a Carnot engine. On what factors does it depend?

Ans:-...

....

10. How is a heat engine different from a refrigerator?

Ans:-...

....

Answer

Section-A:

1. (d) 2. (b) 3. (c) 4. (d) 5. (b) 6. (c)

7. (d) 8. (a) 9. (b) 10. (b) 11. (a)

Section-B:

1. Proportional 2. One (1) 3. Intensive 4. No 5. $dQ=dU+dW$

6. Adiabatic compression 7. zero 8. R 9. $PV^{\gamma} = \text{Constant}$

10. 1 or 100%

Section-C:

8. 75600 J 9. 18 min 40 Sec 10. 2.98 cal mol^{-10} C^{-1} and 4.98 cal mol^{-10} C^{-1}

Chapter-13

Kinetic Theory of Gas

Key Notes :

⇨ **Brownian motion:**

The random and perpetual motion of very small particles present as impurities in a liquid or gas is known as Brownian motion.

⇨ **R.M.S. Velocity:**

Let N be the number of molecules of a gas in a closed container and of constant volume $C_1, C_2, C_3, \ldots C_n$ be the magnitude of velocities of the N molecules respectively.

So, mean velocity of the molecules,

$$\bar{C} = \frac{C_1 + C_2 + C_3 + \ldots + C_n}{N}$$

Mean square velocity of the molecules

$$\bar{C}^2 = \frac{C_1^2 + C_2^2 + C_3^2 + \ldots + C_n^2}{N}$$

Root mean square velocity or *rms* velocity of molecules, (C_{rms})

$$C_{rms} = \sqrt{\bar{C}^2} = \sqrt{\frac{C_1^2 + C_2^2 + C_3^2 + \ldots + C_n^2}{N}}$$

⇨ **Free path:**

The straight line path describe by a molecule between two successive collisions is called a free path.

⇨ **Mean free path:**

The mean value of length of different free path of different molecules of a gas is called the mean free path.

➯ **Pressure of gas:**

The pressure of gas in a container depends on :

(i) the mass of the molecules,

(ii) the number of molecules in unit volume and

(iii) the average velocity of the molecules.

$$\therefore P = \frac{1}{3}\rho C_{rms}^2 = \frac{1}{3}mnC_{rms}^2$$

Where, $m =$ mass of a molecule, $n =$ numbers of molecules in unit volume and $\rho = mn =$ density

$C_{rms} = rms$ velocity of gas molecules.

➯ **Temperature and energy:**

Temperature is a property of a gas which is proportional to the total kinetic energy of the gas molecules.

$$\therefore E = \frac{3}{2}PV \Rightarrow P = \frac{2E}{3V}$$

$\therefore$ In unit volume, $P = \frac{2}{3}E$

Again, $P = \frac{1}{3}\rho C_{rms}^2 = \frac{1}{3}\left(\frac{M}{V}\right)C_{rms}^2$

$$\Rightarrow C_{rms} = \sqrt{\frac{3RT}{M}}$$

$$\therefore C_{ms} \propto \sqrt{T}$$

➯ **Absolute zero Temperature:**

It is the temperature at which the internal energy of the gases becomes zero *i.e.* the molecular motion stops entirely.

➯ **Most probable velocity:**

The velocity which is possessed by the highest number of gas molecules in a container is called the most probable velocity.

If C_m = most probable velocity, then

$$C_m : \bar{C} : C = 1 : \frac{2}{\sqrt{\pi}} : \sqrt{\frac{3}{2}}$$

⇨ **Ideal gas:**

Gases obeying the Boyle's and Charle's law perfectly are called ideal or perfect gases.

The equation of state for $1 mol$ of ideal gas is $PV = RT$.

⇨ **Real gas:**

Generally, there is no ideal gas, all are real gas. Real gases behave as ideal gas at–

(*i*) high pressure and

(*ii*) low Temperature.

For real gases, volume and pressure corrections lead to the Vander Waals' equation of state:

$$\left(p+\frac{a}{V^2}\right)(V-b)=RT$$

Where *a* and *b* are constants.

⇨ **Degrees of freedom:**

The minimum number of independent co-ordinates necessary to specify the instantaneous position of a moving body, is called the degrees of freedom of the body.

Relation between degrees of freedom (*f*) and the ratio of two specific heat (γ) is :

$$\gamma = 1+\frac{2}{f}$$

⇨ **Principle of equipartition of energy:**

The average molecular kinetic energy of any substance is equally shared among the degrees of freedom.

$\therefore$ The average kinetic energy $=\frac{3}{2}kT$

Where, $k =$ Boltzmann constant $= 1.38\times10^{-23} J/K$

T = Absolute Temperature.

If there are *N* molecules in a gas then total energy,

$$E=\frac{3}{2}NkT$$

For $1 mol$ of gas, $N = N_0 =$ Avogadro No.

$$\therefore E=\frac{3}{2}N_0kT=\frac{3}{2}RT.$$

Section-A

Multiple Choice Question : **(Mark-1)**

1. If the volume of a body is V_1 and total volume of the molecules of the body is V_2 then –

   a) $V_1 < V_2$ b) $V_1 = V_2$ c) $V_1 > V_2$ d) none of these

   Ans:-...

2. The pressure and density of hydrogen gas, kept in a vessel, are $1.013 \times 10^6 \, dyn/cm^2$ and 0.089 *g/L*, respectively. The *rms* speed of the gas molecules will be –

   a) 18.5 *km/s* b) 185 *m/s* c) 1.85 *km/s* d) 18.5 *m/s*

   Ans:-...

3. There is a mixture of hydrogen and oxygen gases in a vessel. The root mean square speed of the oxygen molecules is –

   a) 6 times that of hydrogen molecules

   b) 16 times that of hydrogen molecules

   c) $\frac{1}{4}$ times of hydrogen molecules

   d) $\frac{1}{16}$ times that of hydrogen molecules

   Ans:-...

4. If k is Boltzmann constant and T is Temperature, the average kinetic energy of each molecules of a gas will be –

   a) $\frac{\sqrt{2}}{3} kT$ b) $\sqrt{\frac{2}{3}} kT$ c) $\frac{3}{2} kT$ d) $\sqrt{\frac{3}{2}} kT$

   Ans:-...

5. The *rms* speed of oxygen molecules at 47°C will be equal to the *rms* speed of hydrogen molecules at–

a) 60 k b) –83 k c) 3 k d) 20 k

Ans:-...

6. The pressure, volume and temperature of two samples of a gas are P, V, T and $2P$, $\frac{V}{4}$, 2T, respectively. The ratio of the number of molecules in the two samples is –

a) 2:1 b) 4:1 c) 8:1 d) 16:1

Ans:-...

7. The *rms* speed of gas molecules at 0^0C will be reduced to half at –

a) 0°C b) –273°C c) 32°C d) –204°C

Ans:-...

8. A container of $5L$ contains 10^{26} number of molecules of a gas. If the mass and *rms* speed of each molecule are $2.4\times10^{-25}\,g$ and $3.5\times10^{4}\,cm/s$, respectively, the pressure of the gas will be –

a) 2×10^6 dyn / cm^2 b) 10^4 dyn / cm^2 c) 3×10^6 dyn / cm^2

d) 5×10^6 dyn / cm^2

Ans:-...

9. Air is filled in two heat insulated vessel 1 and 2 having pressure, volume and Temperature, P_1, V_1, T_1 and P_2, V_2, T_2 respectively. If the intermediate valve between the two vessels is opened, the temperature of air at equilibrium will be –

a) $\frac{T_1+T_2}{T_1}$ b) $\frac{T_1+T_2}{2}$ c) $\frac{T_1T_2(P_1V_1+P_2V_2)}{P_1V_1T_1+P_2V_2T_2}$ d) $\frac{T_1T_2(P_1V_1+P_2V_2)}{P_1V_1T_2+P_2V_2T_1}$

Ans:-...

10. A vessel contains a mixture of one mole of oxygen and two moles of nitrogen at $300K$. The ratio of the average rotational kinetic energy per O_2 molecule to per N_2 molecules is –

a) 1:1 b) 1:2 c) 2:1 d) 2:3

Ans:-...

Section-B

Very Short Answer Type Question : **(Mark-1)**

1. Gas molecules collide with each other and with the walls of the container. What is the type of these collision?

   Ans:-..
2. What do you call the straight line path described by a gas molecule between two succeessive collisions?

   Ans:-..
3. What is the ratio of the rms speeds of O_3 and O_2 at certain temperature?

   Ans:-..
4. The velocity of three gas molecules are 4 cm/s, 8 cm/s, and 12 cm/s respectively. Calculate their *rms* speed.

   Ans:-..
5. Hydrogen and oxygen gases are kept in two vessels at the same temperature and pressure. What is the ratio of the *rms* speed of their molecules?

   Ans:-..
6. Under which conditions do real gases behaves like as ideal gas?

   Ans:-..
7. At which temperature does the kinetic energy of gas molecules becomes zero?

Ans:-..

Section-C

Short Answer Type Question : **(Marks-2)**

1. What is the difference between real gas and ideal gas?

   Ans:-...

   ....

2. 1 cm^3 of hydrogen gas and 4 cm^3 of oxygen gas are both at STP. Which one of them will contain higher number of molecules?

   Ans:-...

   ....

3. Why does moon have no atmosphere?

   Ans:-...

   ....

4. Explain the relation between pressure and volume of a gas confined in a closed vessel at a constant temperature, according to kinetic theory of gas.

   Ans:-...

   ....

5. Determine the rms speed of oxygen gas molecules at 27°C, Given $R = 8.3\times10^7 erg\ mol^{-1}\ K^{-1}$ atomic weight of oxygen = 16.

   Ans:-...

   ....

6. Explain the relation between pressure and temperature of a gas confined in a closed vessel, according to kinetic theory of gas.

   Ans:-...

   ....

7. What is equipartion of energy ?

Ans:-..

....

8. What do you mean by most probable velocity?

Ans:-..

....

Section-D

Short Answer Type Question - 2 : **(Marks-3)**

1. Write the characteristics of Brownian motion

Ans:-..

....

2. Write the assumptions of kinetic theory of gases.

Ans:-..

....

3. According to kinetic theory of gas derive the expression of pressure of gas.

Or

Derive the relation $P = \frac{1}{3}\rho C^2_{rms}$ using the assumption of kinetic theory of gases. Where symblols are used in their usual meaning.

Ans:-..

....

4. Using the concept of kinetic heory of gas establish the relation between kinetic energy and temperature of gas. Hence define absolute zero from kinetic interpretation of temperature.

Ans:-..

....

5. From the kinetic theory of gas establish the following –

(*i*) Boyle's law

(*ii*) Charle's law

(*iii*) Pressure law

(*iv*) Avogadro's law

(*v*) Dalton's law of partial pressure

(*vi*) Graham's law of diffusion and

(*vi*) Ideal gas equation

Ans:-...

....

....

....

....

....

....

....

6. What do you mean by degrees of freedom. Using the principle of equipartition of energy find the ratio of two specific heat of diatomic gas.

Ans:-..

....

7. Explain the relation between degrees of freedom and ratio of two specific heat of gas for linear and nonlinear triatomic gases and polyatomic gases.

Ans:-..

....

Answer

Section-A:

1. (c)	2. (c)	3. (c)	4. (c)	5. (d)	6. (b)
7. (d)	8. (a)	9. (d)	10. (a)		

Section-B:

1. Perfectly elastic 2. Free path 3. $\sqrt{2}:\sqrt{3}$ 4. 8.64 cm/s 5. 4:1

6. At low pressure and high temperature

7. At absolute zero temperature

Section-C:

5. 4.83 cm/s × 10^4 cm/s

Chapter-14

Oscillations

Key Notes :-

⇨ **Periodic Motion:**

A motion which repeats itself after regular interval of time is called periodic motion.

⇨ **Oscillatory Motion:**

A body is said to possess oscillatory motion if it moves back and forth repeatedly about a mean fixed position in a regular interval of time.

⇨ **harmonic Oscillation:**

Harmonic oscillation is that oscillation which can be expressed in terms of single harmonic function (sine function or cosine function) and acceleration is always proportional to the displacement and directed towards the mean position.

⇨ **Non-harmonic Oscillation:**

Non-harmonic oscillation is that oscillation which cannot be experessed in terms of single harmonic function.

⇨ **Periodic functions:**

Periodic functions are those mathematical functions which are used to represent periodic motion. A function f(t) is said to be periodic if,

$$f(t) = f(t+T) = f(t+2T) \text{ .... and so on.}$$

⇨ **Mathematical equation of Simple Harmonic Motion:**

Periodic motion in which the body moves to and fro about a fixed point (equilibrium position) in such a way that it is acted upon by a restoring force (F) proportional to its displecement (x) from its mean position. That is–

$$F \propto x$$

$$F = -k\,x$$

Where k is a positive constant known as force constant or spring factor.

⇨ **Differential Equation for SHM:**

$$\frac{d^2x}{dt^2} + \omega^2 x = 0 \quad \text{where} \quad \omega^2 = \frac{k}{m}$$

⇨ **Relation between SHM and uniform circular motion:**

Simple harmonic motion is the projection of a reference particle in its uniform circular motion on a diameter of a circle.

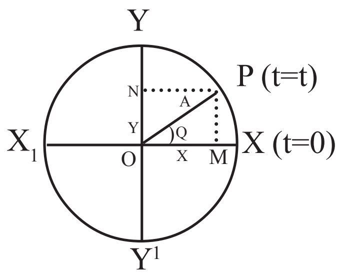
⇨ **Displacement in SHM:**

At any instant 't' displacement of a particle executing SHM with amplitude A and angular velocity ω is given by,

$x(t) = A\cos(\omega t + \phi_0)$ ϕ_0 = initial phase or epoch

If, $\phi_0 = 0$

$x(t) = A\cos\omega t$



Q = WT

When time is measured from the mean position,

$y(t) = A\sin wt$

When time is measured from the extreme position,

$x(t) = A\cos wt$

⇨ **Velocity in SHM:**

At any instant t velocity of a particle executing SHM with amplitude A and angular velocity ω is given by,

$V = \omega A\sin(wt + \varphi_0)$ {if $x = A\cos(\omega t + \varphi_0)$}

$V = \omega\sqrt{A^2 - x^2}$

⇨ **Acceleration in SHM:**

At any instant acceleration of a particle excuting SHM with amplitude A and angular velocity ω is given by

$$a = \frac{dv}{dt}$$

$a = -\omega^2 A\cos(\omega t + \varnothing_0)$

$a = -\omega^2 x$

⇨ **Phase relationship between displacement, velocity and acceleration:**

In SHM velocity leads displacement by a phase $\frac{\pi}{2}$ rad and acceleration leads displacement by π rad.

⇨ **Energy in SHM:**

When a body executes SHM, its energy changes between kinetic and potential but the total energy is always constant.

At any displecement x,

Potential energy, $u = \frac{1}{2} m\omega^2 x^2$

$$u = \frac{1}{2} kx^2$$

Kinetic energy, $K.E. = \frac{1}{2} mw^2 (A^2 - x^2)$

$$K.E. = \frac{1}{2} K(A^2 - x^2)$$

Total energy, $E = U + K.E.$

$$E = \frac{1}{2} mw^2 A^2$$

$$E = \frac{1}{2} KA^2$$

⇨ **Oscillations due to a spring:**

Oscillations due to a spring is simple harmonic. Time period of the oscillation of a mass 'm' in attached at the free end of a spring of force constand k is given by, $T = 2\pi\sqrt{\frac{m}{k}}$

⇨ **Simple Pendulum:**

An ideal simple pendulum consists of a bob suspended by a weightless, inextensible string from a rigid support about which it is free to oscillate. When the bob is displaced from mean position, it executes SHM.

Time period of a simple pendulum is given by, $T = 2\pi\sqrt{\frac{l}{g}}$

Where, l = effective length of the pendulum and g = acceleration due to graisty.

⇨ **Undamped oscillations:**

The oscillations whose amplitude remains cosntant with time are called undamped oscillation.

Damped oscillations:

The oscillation whose amplitude goes on decreasing exponentially with time are called damped oscillation.

Damping force is given by, $F_d = -bv$

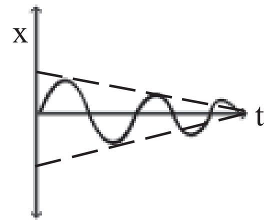
where v is the velocity of the oscillator and b is a damping constant.

Displacement of the damping oscillator at any instant is given by,

$$x(t) = Ae^{-bt/2m} \cos(\omega' t + \phi)$$

where ω' is the angular frequency of the damping oscillator.

$$\omega' = \sqrt{\frac{k}{m} - \frac{b^2}{4m^2}}$$



Total energy of the damping oscillator is given by,

$$E = \frac{1}{2} KA^2 e^{-bt/m}$$

Free oscillations:

If a body on being displaced from its equilibrium position, starts oscillating with its own natural frequency. Such oscillations are called free oscillations. The natural frequency is given by,

$$\upsilon_o = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$

Forced oscillations:

When a body oscillates under the influence of an external periodic force of frequency other than the natural frequency of the body then such oscillations are called forced oscillations.

Resonance:

Resonance is the phenomenon of setting a body into oscillations under the influence of some external periodic force whose frequency is exactly equal to the natural frequency of the given body and the amptitude of such oscillations become very large.

Section-A

Very Short Answer Type Question : **(Mark-1)**

1. A simple harmonic motion is repersented by Y (t) = 17 sin (20t + 0.5) cm. The amplitude of the SHM is–

   a) A = 30 cm b) A = 17 cm c) A = 20 cm d) A = 5 cm

   Ans:-..

2. A spring 50 mm long is stretched by the application of a force. If 20 N force is required to stretch the spring through 1 mm, then work done in stretching the spring through 50 mm is –

   a) 84 J b) 48 J c) 24 J d) 25 J

   Ans:-..

3. Which of the following relationships between the acceleration 'a' and the displacement 'x' of a particle involve simple harmonic motion?

   a) $a = 0.7x$ b) $a = -200x^2$ c) $a = -10x$ d) $a = 100x^3$

   Ans:-..

4. A particle in SHM is described by the displacement function $x(t) = A\cos(wt + \theta)$. If the initial $(t = 0)$ position of the particle is $1cm$ and its inital velocity is π cm / s what is its amplitude? The angular frequency of the particle is $\pi\, rads^{-1}$

   a) 1 cm b) $\sqrt{2}cm$ c) 3 cm d) 2.5 cm

   Ans:-..

5. The phase difference between the instantaneous velocity and instantaneous acceleration of a particle executing simple harmionic motion is –

   a) 0.5π b) π c) 0.707π d) 0.61π

   Ans:-..

6. A particle executes simple harmonic motion with an angular velocity of 2.5 rad/s and maximum acceleration of $6.5\ ms^{-2}$ respectively. The amplitude of oscillations is –

   a) 0.28 m b) 0.36 m c) 0.707 m d) 1.04 m

   Ans:-..

7. For a particle executing simple harmonic motion, which of the following statements is not correct?

a) total energy of the particle always remains the same.

b) restoring force is always directed towards a fixed point.

c) restoring force is maximum at the extreme positions

d) acceleration of the particle is maximum at the equilibrium position.

Ans:-..

8. A linear harmonic oscillator of force constant 2×10^6 N / m and amplitude 0.01 m has a total mechanical energy of 160 J. Its maximum potential energy is –

a) 160 J b) zero c) 100 J d) 140 J

Ans:-..

9. A simple pendulum performs simple harmonic motion about $x = 0$ with an amplitude 'a' and time period T. The speed of the pendulum at $x = \frac{a}{2}$ will be –

a) $\frac{\pi a\sqrt{3}}{T}$ b) $\frac{\pi a\sqrt{3}}{2T}$ c) $\frac{\pi a}{T}$ d) $\frac{3\pi^2 a}{T}$

Ans:-..

10. If a simple pendulum oscillates with an amplitude of 60 mm and time period of 2s, then its maximum velocity is –

a) 0.10 ms^{-1} b) 0.18 ms^{-1} c) 0.24 ms^{-1} d) 0.32 ms^{-1}

Ans:-..

11. What provides the restoring force for simple harmonic oscillation in a simple pendulum?

Ans:-..

12. What provides restoring force for simple harmonic oscillation in a spring?

Ans:-..

13. What is the phase difference between velocity and acceleration in SHM?

Ans:-...

14. At what points the velocity and acceleration are zero in SHM?

Ans:-...

15. At what points is the energy entirely kinetic and potential in SHM?

Ans:-...

16. How would the time period of spring mass system change when it is made to oscillate horizontally instead of vertically?

Ans:-...

17. The amplitude of a harmonic oscillator is doubled. How does its energy change?

Ans:-...

18. What is the length of a second's pendulum?

Ans:-...

19. What happens to the time period of a simple pendulum if it's length is doubled?

Ans:-...

20. At what points along the path of a simple pendulum is the tension in the string
(*i*) maximum and
(*ii*) minimum.

Ans:-...

21. Show graphical repesentation of damped oscillations.

Ans:-...

22. Show graphical representation of undamped oscillations.

Ans:-...

Section-B

Short Answer Type Question : **(Marks-2)**

1. A spring having a force constant K is divided into three equal parts. What would be the force constant for each individual part?

   Ans:-..

   ....

2. Two simple harmonic motions are represented by the equations:

   $y_1 = 0.1\sin\left(1000\pi t - \frac{\pi}{3}\right)$ and $y_2 = 0.1\cos\pi t$.

   What is the phase difference of the velocity of the particle 1 with respect to the velocity of particle 2?

   Ans:-..

   ....

3. Two springs of force constant K_1 and K_2 are joined in series and then in parallel. What are the force constants of the combination in each case ?

   Ans:-..

   ....

4. A body describes simple harmonic motion with an amplitude of 5 cm and a period of 0.2s. Find the acceleration and velocity of the body when the displacement is (a) 5 cm, b) 3 cm. [*NCERT*]

   Ans:-..

   ....

5. The maximum velocity of a particle, executing simple harmonic motion with an amplitude of 7 mm, is 4.4 ms^{-1}. What is the period of oscillation.

   Ans:-..

   ....

6. Can we use a pendulum watch in an artificial satellite? Justify.

Ans:-...

....

7. Will a pendulum clock lose or gain time when taken to the top of a mountain? Justify.

Ans:-...

....

8. The acceleration due to gravity an the surface of the moon is $1.7 ms^{-2}$. What is the time period of a simple pendulum on the moon if its time period on the earth is 3.5s? [*NCERT*]

Ans:-...

....

9. The length of a simple pendulum executing SHM is increased by 21%. What is the percentage increase in the time period of the pendulum of increased length.

Ans:-...

....

10. Why are army troops not allowed to march in steps while crossing a bridge?

Ans:-...

....

11. The shortest distance travelled by a particle (performing SHM) from mean position in 2s is equal to $\frac{\sqrt{3}}{2}$ of its amplitude. Find its time period.

Ans:-...

....

12. Velocity an displacement of a body executing SHM are out of phase by $\frac{\pi}{2}$. Justify.

Ans:-...

....

13. The length of a second's pendulum on the surface of earth is 1m. What will be the length of a second's pendulum on the surface of moon?

Ans:-..

....

14. A body oscillates with SHM according to the equation $x(t) = 5\cos\left(2\pi t + \frac{\pi}{4}\right)$, where t is in seconds and x in metres calculate (a) Displacement at $t = 0$, b) Time period (c) Initial phase.

Ans:-..

....

15. A mass attached to a spring is free to oscillate, with angular velocity ω, in a horizonal plane. Without friction or damping. It is pulled to a distance. x_0 and pushed towards the centre with a velocity v_0 at time $t = 0$. Determine the amplitude of the resulting oscillations in terms of the parameters ω, x_0 and v_0. [*NCERT*]

Ans:-..

....

Section-C

Short Answer Type Question : **(Marks-3)**

1. Write down the differential equation for SHM. Give it's solution. Hence obtain expression for the time period of SHM.

Ans:-..

....

2. Derive an expression for the instantaneous velocity and instantaneay acceleration of a paticle executing SHM.

Ans:-..

....

3. What is SHM? Show that the acceleration of a particle in SHM is proportional to its displacement.

Ans:-...

....

4. Show that the horizontal oscillations of a massless loaded spring is simple harmonic. Deduce an expression for its time period.

Ans:-...

....

5. Show that motion executed by the bob of the pendulum is SHM. Derive an expression for its time period.

Ans:-...

....

6. Show that for a particle in linear SHM, the average kinetic energy over a period of oscillation equals the average potential energy over the same period. [*NCERT*]

Ans:-...

....

Section-D

Long Answer Type Question : **(Marks-5)**

1. Show that simple harmonic motion may be regarded as the projection of uniform circular motion along a diameter of the circle. Hence derive an expression for the displacement of a particle in SHM.

Ans:-...

....

2. Derive expressions for the kinetic and potential energies of a harmonic oscillator. Hence show that total energy is conserved in SHM.

Ans:-..

....

3. Find the total energy of the particle executing SHM. How many times in one vibration, kinetic and potential energy become maximum? Show graphically

(*i*) variation of potential energy and kinetic energy with displacement in SHM

(*ii*) Variation of potential energy and kinetic energy with time in SHM.

Ans:-..

....

4. Show graphically variation of displacement, velocity and acceleration with time for a particle executing SHM. Discuss their phase relationship.

Ans:-..

....

Answer

Section-A:

1. (b)	2. (d)	3. (c)	4. (b)	5. (a)	6. (d)
7. (d)	8. (c)	9. (a)	10. (b)		

11. Gravity 12. Elasticity 13. $\frac{\pi}{2}$

Chapter-15

Waves

Key Notes :-

⇨ **Waves:**

Wave is a form of disturbance which travels through a medium due to the repeated periodic motion of the particles of the medium about their mean position without any actual transfer of matter.

Waves are mainly of three types –

(a) Mechanical waves

(b) Electromagnetic waves

(c) Matter waves.

⇨ **(a) Mechanical Waves:**

This type of wave can be produced or propagated only in a material medium. For example, waves on water surface, waves on strings, sound waves etc.

For propagation of mechanical waves, medium must satisfy three conditions:-

(i) The medium must posses elasticity

(ii) The medium must have property of inertia

(iii) The frictional resistance must not be very large so that oscillatory movement gets damped

⇨ **(b) Electromagnetic Waves:**

Waves which may not require meterial medium for their production and propagation. Such waves can pass through vaccum and medium too. These waves travel in the form of oscillating electric and magnetic fields. Examples – Visible light, Ultra-violet light, radio waves, micro waves etc.

⇨ **(c) Matter waves:**

These waves are associated with moving particles of matter like electrons, protons, neutrons etc. Such waves are also called de-Broglie Waves.

⇨ **Types of mechancial waves:**

⇨ **Transverse Waves:**

In transverse waves, particles of the medium vibrate about their mean positions at right angles to the direction of propogation of the wave. Transverse waves travels in the form of crests and troughs. These waves can propagate in those media which have a shear modulus of elasticity for example solids.

Examples – Waves in the stretched strings of musical instruments, repples produced on the surface of water etc.

⇨ **Longitudinal Waves**:

In longitudinal waves, particles of the medium vibrate about their mean positions along the direction of propagation of the waves. These waves travels in the form of compression and rarefactions. These waves can propagate in those media having a bulk medulus of elasticity hence possible in all media.

Examples – Sound wave

⇨ **Amplitude:**

Amplitude of a wave is the maximum displacement of the particles of the medium from their mean position.

⇨ **Frequency:**

It is the number of waves produced per unit time. It time period of a wave is T then frequency,

$\upsilon = \frac{1}{T}$. S.I. unit of frequency is hertz (Hz).

⇨ **Time period:**

The time taken by the wave source to complete one vibration or cycle.

⇨ **Wavelength:**

It is the distance travelled by the wave during the time any particle of the medium completes one vibration or cycle about its mean position. The intermediate distance between two points of same phase is called wave length.

⇨ **Wave Velocity:**

The distance covered by a wave in one second is called wave velocity.

Wave velocity,

$$V = \frac{\lambda}{T}$$

$$V = \upsilon\lambda$$

Again, $V = \frac{\lambda}{T} = \frac{\omega}{K}$, where, $K = \frac{2\pi}{\lambda}$

⇨ **Speed of transverse waves:**

(*i*) Speed of transverse waves in a stretched string is given by,

$v = \sqrt{\frac{T}{\mu}}$ where, T is the tension in the string and μ is mass per unit length.

(*ii*) Speed of transverse wave in a solid is given by,

$v = \sqrt{\frac{\eta}{\rho}}$ where, η = modules of rigidity, ρ = density

⇨ **Speed of longitudenal waves:**

(*i*) Speed of longitudinal waves in a long rod is given by

$v = \sqrt{\frac{\gamma}{\rho}}$ where, γ = Young's modules, ρ = density

(*ii*) Speed of longitudinal waves in a liquid is given by,

$v = \sqrt{\frac{K}{\rho}}$ where, K = Bulk modulus, ρ = density

(*iii*) Speed of longitudinal waves in a gaseous medium is given by,

$v = \sqrt{\frac{K}{\rho}}$ where, K = Bulk modulus, ρ = density

⇨ **Newton's Formula for speed of sound:**

Newton assumed that the propagation of sound waves in a gas takes place under isothermal conditions. So, Newton's formula for the speed of sound is

$$v = \sqrt{\frac{K_{iso}}{\rho}} = \sqrt{\frac{P}{\rho}}$$

$= 280 \text{ ms}^{-1}$ at STP.

Experimental value for speed of sound in air is 331 ms^{-1} at STP

⇨ **Laplace Correction:**

According to Laplace, the propagation of sound wave in a gas takes place under adiabatic conditions. So, Laplace formula for the speed of sound in air is

$$v = \sqrt{\frac{K_{adia}}{\rho}} = \sqrt{\frac{\delta P}{\rho}}$$

$$= 331.2 \text{ ms}^{-1} \text{ at STP.}$$

This result agrees with the experimental value.

⇨ **Factors Affecting speed of sound in a Gas:**

(*i*) Speed of sound in a gas is inversely proportional to the square root of density of the gas.

(*ii*) Speed of sound in a gas is independent of pressure provided the temperature remains constant.

(*iii*) Speed of sound in a gas is directly proportional to the square root of its absolute temperature.

(*iv*) Speed of sound in moist air is greater than the Speed of sound in dry air.

⇨ **Progressive wave:**

A wave that moves from one point of medium to another is called a progressive wave.

⇨ **Progressive Wave Equation:**

A plane progressive harmonic wave travelling along positive X-direction is given by,

(*a*) $y = A\sin(wt - Kx)$

(*b*) $y = A\sin 2\pi\left(\frac{t}{T} - \frac{x}{\lambda}\right)$

(*c*) $y = A\sin\frac{2\pi}{\lambda}(vt - x)$

where sysmbols have their usual meanings.

If the wave is travelling along negative X-direction,

(*a*) $y = A \sin (vt + Kx)$

(*b*) $y = A\sin 2\pi\left(\frac{t}{T} + \frac{x}{\lambda}\right)$

(*c*) $y = A\sin\frac{2\pi}{\lambda}(vt + x)$

⇨ **Principle of Superposition of Waves:**

This principle enable us to find the resultant of any number of waves meeting at a point. If

$\vec{y}_1, \vec{y}_2, \vec{y}_3 ... \vec{y}_n$ are displacements at a point due to n waves, the resultant displacement $\vec{y} = \vec{y}_1 + \vec{y}_2 + ... \vec{y}_n$.

⇨ **Reflection of a wave:**

When a wave is reflected from a rigid or closed bounday, it is reflected back with a phase difference of π radians but when a wave is reflected from an open boundary there is no phase change.

⇨ **Standing Waves or Stationary Waves:**

When two pregressive waves of same amplitude and frequency, travelling in opposite directions along a straight line superimpose, the resultant wave does not travel in either direction and is called stationary or standing wave.

⇨ **Nodes:**

Nodes are the points, where amplitude of vibration is zero.

⇨ **Antinodes:**

Antinodes are the points, where amplitude of vibration is maximum.

⇨ **Analytical treatment of stationary waves:**

$y_1 = A \sin(\omega t - kx)$ (incident wave)

on reflection from an open boundary,

$y_2 = A \sin(\omega t + kx)$

On superposition,

$y = y_1 + y_2$

$y = y_1 = A \sin(\omega t - kx) + A \sin(\omega t + kx)$

$y = 2A \cos kx \sin \omega t$

Position of nodes –

$$x = \frac{\lambda}{4}, \frac{3\lambda}{4}, \frac{5\lambda}{4} ...$$

Position of Antinodes –

$$x = 0, \frac{\lambda}{2}, \frac{3\lambda}{4} ...$$

On reflection from a rigid boundary,

$y_2 = -A \sin(\omega t + kx)$

On superposition –

$y = -2A \sin kx\, \omega t$

Position of nodes –

$$x = 0, \frac{\lambda}{2}, \frac{3\lambda}{2} \ldots$$

Position of Antinodes –

$$x = \frac{\lambda}{4}, \frac{3\lambda}{4}, \frac{5\lambda}{4} \ldots$$

Separation between two successive nodes or antinodes $= \frac{\lambda}{2}$

Separation between a node and nearest antinode $= \frac{\lambda}{4}$

⇨ **Modes of Vibrations of strings**

Fundamental mode –

$$\lambda_1 = 2L$$

$$\upsilon_1 = \frac{l}{\lambda_1} = \frac{1}{2L}\sqrt{\frac{T}{m}}$$

Second mode –

$$\lambda_2 = L$$

$\upsilon_2 = 2\upsilon_1$ (Second harmonic or first overtone)

Third mode –

$$\lambda_3 = \frac{2L}{3}$$

$\upsilon_3 = 3\upsilon_1$ (Third harmonic or second overtone)

n^{th} mode –

$$\upsilon_n = \frac{n}{2L}\sqrt{\frac{T}{m}}$$

$\upsilon_n = n\upsilon_1$ (n^{th} harmonic or $(n–1)^{th}$ overtone)

⇨ **Modes of vibrations of closed organ pipes:**

Fundamental mode –

$$\lambda_1 = 4L$$

$$\upsilon_1 = \frac{v}{\lambda_1} =$$

Second mode – $\frac{v}{4T}$

$$\lambda_2 = \frac{4L}{3}$$

$\upsilon_2 = 3\upsilon_1$ (Second harmonic or first overtone)

Third mode –

$$\lambda_3 = \frac{4L}{5}$$

$\upsilon_3 = 5\upsilon_1$ (Fifth harmonic or second overtone)

n^{th} mode –

$$\lambda_n = \frac{4L}{(2n-1)}$$

$\upsilon_n = (2n-1)\upsilon$ {$(2n–1)^{th}$ harmonic or $(n–1)^{th}$ overtone}

Here $\upsilon_1 : \upsilon_2 : \upsilon_3 ... = 1 : 3 : 5 ...$ (only odd harmonics)

⇨ **Modes of vibrations of open organ pipe:**

Fundamental mode –

$$\lambda_1 = 2L$$

$$\upsilon_1 = \frac{v}{2L}$$

Second mode –

$$\lambda_2 = L$$

$\upsilon_2 = \frac{v}{L}$ (Second harmonic or first overtone)

Third mode –

$$\lambda_3 = \frac{2L}{3}$$

$\upsilon_3 = 3\upsilon_1$ (Third harmonic or second overtone)

n^{th} mode –

$$\lambda_n = \frac{2L}{n}$$

$\upsilon_n = n\upsilon_1$ (n^{th} harmonic or $(n-1)^{th}$ overtone)

Here $\upsilon_1 : \upsilon_2 : \upsilon_3 ... = 1:2:3...$ (Both odd and even harmonics).

➩ **Beats:**

When two waves of nearly equal frequencies travelling along the same line and in the same direction superimpose on each other, there is a regular rise and fall in the intensity of sound. This phenomenon is called beats.

One rise and one fall in the intensity of sound constitutes one beat and the number of beats per second is called beat frequency.

Beat frequency,

$$\upsilon_b = (\upsilon_1 - \upsilon_2) \qquad (\upsilon_1 > \upsilon_2)$$

➩ **Doppler's Effect:**

When there is a relative motion between the source of sound and the observer, there is an apparent change in the frequency of sound as heard by the observer. This phenomenon is called Doppler's Effect. Apparent frequency is given by,

$$\upsilon' = \frac{v'}{\lambda'} \quad \text{where, } v' = v \pm v_0 \quad \lambda' = \frac{v \pm v_s}{\upsilon}$$

$$\upsilon^1 = \left(\frac{v \pm v_0}{v \pm v_1}\right)$$

where, $v =$ speed of sound

$v_0 =$ velocity of observer

$v_s =$ velocity of source

$\upsilon =$ Frequency of source

(*i*) When the source moves towards the stationary observer,

$$\upsilon^1 = \left(\frac{v}{v - v_s}\right)\upsilon \qquad (\upsilon^1 > \upsilon)$$

(*ii*) When the source moves away from the stationary observer

$$\upsilon^1 = \left(\frac{v}{v+v_s}\right)\upsilon \qquad (\upsilon^1 < \upsilon)$$

(*iii*) When the observer moves towards the stationary source,

$$\upsilon^1 = \left(\frac{v+v_0}{v}\right)\upsilon \qquad (\upsilon^1 > \upsilon)$$

(*iv*) When the observer moves away from the stationary source,

$$\upsilon^1 = \left(\frac{v-v_0}{v}\right)\upsilon$$

(*v*) When both source and observer move towards each other,

$$\upsilon^1 = \left(\frac{v+v_0}{v-v_s}\right)\upsilon \qquad (\upsilon^1 > \upsilon)$$

(*vi*) When both source and observer move away from each other,

$$\upsilon^1 = \left(\frac{v-v_0}{v+v_s}\right)\upsilon \qquad (\upsilon^1 < \upsilon)$$

(*vii*) When source moves towards observer and observer away from the source,

$$\upsilon^1 = \left(\frac{v-v_0}{v-v_s}\right)\upsilon$$

(*viii*) When source moves away from the observer and observer towards the source

$$\upsilon^1 = \left(\frac{v+v_0}{v+v_s}\right)\upsilon$$

Section-A

Very Short Answer Type Question : (Mark-1)

1. The waves produced by a motorboat in water are –

   a) Transverse

   b) Longitudinal

c) Longitudinal and transverse

d) Stationary

Ans:-..

2. A boat at anchor is rocked by waves, whose crests are 100 m apart and speed is 25 ms^{-1}. The boat bounces up once in every –

a) 2.500s b) 25s c) 4s d) 0.25s

Ans:-..

3. The speed of sound at the same temperature in two monoatomic gases of densities ρ_1 and ρ_2 are v_1 and v_2 respectively. If $\frac{\rho_1}{\rho_2} = 4,$ then the value of $\frac{v_1}{v_2}$ is –

a) $\frac{1}{4}$ b) $\frac{1}{2}$ c) 2 d) 4

Ans:-..

4. If equation of a sound wave is $y = 0.0015\sin(62.8x + 314t)$ then its wavelength will be –

a) 0.1 unit b) 0.2 unit c) 0.3 unit d) 2 unit

Ans:-..

5. A tuning fork makes 256 vibrations per second in air. When the speed of sound is $330ms^{-1}$, then wavelength of the tone emitted is –

a) 0.56 m b) 0.11 m c) 0.89 m d) 1.29 m

Ans:-..

6. A wave is expressed by the equation $y = 0.5\sin\pi(0.01x + 3t)$, where x, y are in metres and t in seconds. The speed of propagation will be –

a) 150 ms^{-1} b) 300 ms^{-1} c) 350 ms^{-1} d) 250 ms^{-1}

Ans:-..

7. The speed of sound in air at N.T.P. is 300 ms^{-1}. If air pressure becomes four times, then the speed of

sound will be –

a) 150 ms^{-1} b) 300 ms^{-1} c) 800 ms^{-1} d) 1200 ms^{-1}

Ans:-..

8. Length of a string tied to two rigid supports is 40 cm. Maximum wavelength of a stationary wave produced on it is –

a) 20 cm b) 80 cm d) 40 cm d) 120 cm

Ans:-..

9. A tube closed at one end containing air produces fundamental note of frequency 512 Hz. If the tube is open at both the ends, the fundamental frequency will be –

a) 256 Hz b) 768 Hz c) 1,024 Hz d) 1,280 Hz

Ans:-..

10. The first overtone of a stretched wire of given length is 340 Hz. The first harmonic is –

a) 320 Hz b) 170 Hz c) 480 Hz d) 640 Hz

Ans:-..

11. Doppler's effect in sound is produced when the source and the observer are –

a) Moving b) In relative motion c) Stationary d) In resonance

Ans:-..

12. A source emits a sound of frequency of 400 Hz, but the listener hear its to be 390 Hz.

The –

a) the listener is moving towards the source

b) the source is moving towards the listener

c) the listener is moving away from the source

d) the listener has a defective ear

Ans:-..

13. When a source of sound is in motion towards a stationary observer, the effect observed is –

a) Increase in speed of sound

b) Decrease in speed of sound

c) Increase in frequency of sound

d) Increase in speed as well as frequency of sound

Ans:-...

14. Two waves are propagating with same amplitude and nearly same frequency in opposite direction, they result in –

a) beats b) stationary wave c) resonance d) wave packet

Ans:-...

15. Two waves are approaching each other, $y = a\sin 200\pi t, y_2 = a\sin 208\pi t.$ The number of beats heard per second is –

a) 8 b) 4 c) 6 d) zero

Ans:-...

16. Which type of waves do not require a material medium for their propagation?

Ans:-...

17. What is the phase angle between particle velocity and wave velocity in :

(*i*) transverse wave

(*ii*) longitudinal wave?

Ans:-...

18. What is the phase difference between two successive crests in a transverse wave?

Ans:-...

19. What is the distance between a compression and its nearest rarefaction in a longitudinal wave?

Ans:-...

20. In which gas, hydrogen or oxygen, will sound have greater speed ?

Ans:-...

21. At the same temperature and pressure, the densities of two diatomic gases are d_1 and d_2. What is the ratio of the speeds of sound in these gases?

Ans:-...

22. On what factors does the speed of transverse waves set up in a string depend?

Ans:-..

23. If tension of a wire is increased to four times, how is the wave speed changed?

Ans:-..

24. Does sound travel faster on a wet hot day or a dry cold day? Why?

Ans:-..

25. What is the distance between two consecutive nodes and antinodes?

Ans:-..

26. What is the distance between a node and the nearest antinode?

Ans:-..

27. Which harmonics are absent in a closed organ pipe?

Ans:-..

28. Why are stationary waves called so?

Ans:-..

29. Under what condition does a sudden phase reversal of waves on reflection take place?

Ans:-..

30. In an open organ pipe, third harmonic is 450 Hz. What will be the frequency of fifth harmonic.

Ans:-..

Section-B

Short Answer Type Question – 1 : **(Mark-2)**

1. Give four characteristics of wave motion.

Ans:-..

....

2. Mention the important properties which a medium must possess for the propagation of mechanical waves.

Ans:-..

....

3. Distinguish between transverse and longitudinal waves.

Ans:-..

....

4. Derive a relation between wave velocity, frequency and wavelength.

Ans:-..

....

5. What is the effect of

(i) frequency and

(ii) amplitude, on the speed of sound in air?

Ans:-..

....

6. State and illustrate the principle of superposition of waves.

Ans:-..

....

7. Give four characteristics of stationary waves.

Ans:-..

....

8. Differentiate between progressive waves and stationary waves.

Ans:-..

....

9. What is beat frequency? What is the essential condition for the formation of beats?

Ans:-..

....

10. Explain two practical applications of beats.

Ans:-..

....

11. A string of mass 2.50 *kg* is under a tension of 200 N. The length of the stretched string is 20.0 m. If the transverse jerk is struck at one end of the string, how long does the disturbance take to reach the other end? [*NCERT*]

Ans:-..

....

12. A hospital uses an ultrasonic scanner to locate tumours in a tissue in which the speed of sound is 1.7 Kms^{-1} ? The operating frequency of the scaner is 4.2 MHz. [*NCERT*]

Ans:-..

....

13. A transverse harmonic wave on a string is described by $y(x,t) = 3.0\sin\left(36t + 0.018x + \frac{\pi}{4}\right)$, where x, y are in *cm* and *t* in *s*. The positive direction of *x* is from left to right.

(i) Is this a travelling or a stationary wave? If it is travelling what are the speed and direction of its propagation?

(ii) What are its amplitude and frequency?

(iii) What is the initial phase at the origin?

(iv) What is the least distance between two successive crests in the wave? [*NCERT*]

Ans:-..

....

14. 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? [*NCERT*]

Ans:-..

....

15. A pipe 20 cm long is closed at one end. Which harmonic mode of the pipe is resonantly excited by a 430 Hz source? Will this same source be in resonance with the pipe if both ends are open? (speed of sound = 340 ms^{-1}).

[*NCERT*]

Ans:-..

....

16. Tube A has both ends open, while B has one end closed. Otherwise the two tubes are identical. What is the ratio of fundamental frequency of the tubes A and B?

Ans:-..

....

17. A whistle producing sound waves of frequencies 9500 Hz and above is approaching a stationary person with speed $v_s\,ms^{-1}$. The speed of sound in air is 300 $ms^{-1.}$ · If the person can hear frequencies upto a maximum of 10,000 Hz, What is the maximum valve of v_s upto which he can hear the whistle.

Ans:-..

....

18. Find the temperature at which the speed of sound in oxygen will be the same as that in nitrogen at $20°C$ Given that molar masses of oxygen and nitrogen are 32 and 28 respectively. Both gases are assumed to be ideal.

Ans:-..

....

19. An open pipe is suddenly closed at one end with the result that the frequency of the third harmonic of the closed pipe is found to be higher by 1000 Hz than the fundamental frequency of the open pipe. What is the fundamental frequency of open pipe?

Ans:-..

....

20. Calculate the speed of sound in a gas in which two waves of wavelengths 1.00 m and 1.01 m produce 10 beats in 3 seconds.

Ans:-..

....

Section-C

Short Answer Type Question : **(Mark-3)**

1. The speed of longitudinal waves in a medium of density ρ is given by –

$V=\sqrt{\frac{\gamma P}{\rho}}$ use this formula to explain why the speed of sound in air –

a) is independent of pressure

b) increases with temperature

c) increases with humidiy

Ans:-...

....

2. What is a plane progressive harmonic wave? Establish displacement relation for a harmonic wave travelling along the positive direction of X-axis.

Ans:-...

....

3. What are stationary waves? State the necessary condition for the formation of stationary waves.

Ans:-...

....

4. Show that in closed organ pipe only odd harmincs are present.

Ans:-...

....

5. Show that in open organ pipe, all harmonics are present.

Ans:-...

....

6. What is Doppler effect in sound? Obtain an expression for the apparent frequency of sound when the source is moving towards the stationary observer with a uniform velocity.

Ans:-...

....

7. Derive an expression for the apparent frequency of the sound when the observer moves towards a stationary source of sound with a uniform velocity.

Ans:-...

....

8. Explain Doppler effect in sound. Obtain an expression for apparent frequency of sound when source and listener are approaching each other.

Ans:-...

....

9. Explain the formation of beats by graphical method.

Ans:-...

....

10. What are beats? Prove that the number of beats produced per second by the two sound sources is equal to the difference between their frequencies.

Ans:-...

....

Section-D

Long Answer Type Question : **(Mark-5)**

1. Derive Newton's formula for speed of sound in an ideal gas. Why and what correction was applied by Laplace in this formula? Also deduce modified formula for speed of sound?

Ans:-...

....

2. Obtain an expression for a stationary wave formed by two sinusoidal waves travelling along the same path in opposite directions and obtain the positions of nodes and antinodes.

Ans:-...

....

3. Discuss the formation of standing waves in a string fixed at both ends and also discuss different modes of vibrations.

Ans:-...

....

4. Prove analytically that in the case of an open organ pipe of length L, the frequencies of vibrating air column are given by,

$\upsilon = n\left(\frac{v}{2L}\right)$. Also discuss various modes of vibration.

Ans:-...

....

5. Prove analytically that in the case of a closed organ pipe of length L, the frequencies of the vibrating air column are given by,

$\upsilon = (2n+1)\left(\frac{v}{4L}\right)$, where

n is an integer. Also discuss various modes of Vibration.

Ans:-...

....

6. What are beats? Explain their formation mathematically. Prove that the beat frequency is equal to the difference in frequencies of the two superposing waves.

Ans:-...

....

Answer

Section-A:

1. (c)	2. (c)	3. (b)	4. (a)	5. (d)	6. (b)
7. (b)	8. (b)	9. (c)	10. (b)	11. (b)	12. (c)
13. (c)	14. (b)	15. (b)			

16. Electromagnetic waves

17. (i) For transverse wave, angle is 90^o.

(ii) For longitudinal wave, angle is 0^o or 180^o

18. 2π radian

19. $\frac{\pi}{2}$

20. $\because$ $v \alpha \frac{1}{\rho}$, $\therefore$ speed of sound will be greater in hydrogen gas.

21. $\frac{v_1}{v_2} = \sqrt{\frac{d_2}{d_1}}$

22. (i) Tension (T)

(ii) Linear mass density (μ)

23. $\because$ $v \alpha \sqrt{T}$, $\therefore$ speed of wave becomes double.

24. Sound travels faster on a hot day due to high temperature and lesser density of wet air.

25. $\frac{\lambda}{2}$

26. $\frac{\lambda}{4}$

27. All even harmonics are absent.

28. See Text Book

29. See Test Book

30. Third harminic,

$3\upsilon = 450$ Hz

$\upsilon = 140$ Hz

Fifth harmonic, $= 5\ \upsilon\ = 750$ Hz

NOTE

NOTE

NOTE