کامیابی کا تعویذ

NEW
Examination POLICY
Annual 2026

پنجاب کے تمام بورڈز کے لیے

(Complete Solved)

PHYSICS

Inter Part-I

* Most Imp. MCQs
* Most Imp. Short Questions
* Most Imp. Long Questions

صرف 2 ماہ تیاری کر کے پڑھائی میں کمزور طلباء وطالبات A+ گریڈ میں کامیابی حاصل کرسکتے ہیں۔

اب فیل ہونا بھول جائیں

According to ALP

A+ Challenge

(محمد قدیر رفیق)

القدیر جناح سائنس اکیڈمی ملیاں کلاں مرید کے روڈ شیخوپورہ

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PHYSICS-11

Multiple Choice Questions

No.	Question	(A)	(B)	(C)	(D)
1	Computer chips are made of:	**Silicon ✓**	Germanium	Iron	Cadmium
2	The branch of science which deals with the property of matter and energy is called:	Chemistry	Biology	Geology	**Physics ✓**
3	The branch of physics which deals with velocities approaching the velocity of light is called:	Quantum mechanics	**Relativistic mechanics ✓**	Classical mechanics	Wave mechanics
4	The products of chips developed from the basic ideas of physics are:	The radio networks	The television networks	**Computer networks ✓**	None of the above
5	Which of the following is a derived quantity?	length	mass	time	**force ✓**
6	Light year is a unit of:	Light	Time	Velocity	**Distance ✓**
7	The quantity 1 $(km)^2$ is equal to:	$1 \times 10^6 m^2$ ✓	$1 \times 10^5 m^2$	$1 \times 10^7 m^2$	$1 \times 10^4 m^2$
8	The percentage uncertainty in radius of a sphere is 2%. The total percentage uncertainty in the volume of sphere is:	2%	4%		8%
9	Zero error belongs to:	**Systematic error ✓**	Random error	Personal error	Collective error
10	The diameter of a steel ball is measured using a Vernier Callipers and its reading is shown in the figure. What is the diameter of the steel ball?	1.30 cm	1.39 cm	1.40 cm	**1.31cm ✓**
11	Significant figures in 0.04060 are:	2	**3 ✓**	4	5
12	Significant figures in 0.0010 are	four	**two ✓**	three	one
13	Significant figures in 0.000846 are:	six	four	**three ✓**	two
14	The quantity of 0.00467 has significant figures:	**3 ✓**	4	5	6
15	A precise measurement is the one which has:	Greater precision	**Less precision ✓**	Medium precision	More % error
16	Which of the following measurement is more precise?	3127 s	312.7 s	31.27 s	**3.127 s ✓**
17	Number of colours used in process of colour printing to produce the entire range of colours are:	7	6	5	**4 ✓**
18	The absolute uncertainty for vernier callipers of $L.C = 0.01$ cm is:	0.1 mm	0.01 m	0.001 cm	**0.001 mm ✓**
19	There are four readings of a micrometer to measure the diameter of a wire in mm are	0.02 mm	**0.01 mm ✓**	0.10 mm	0.20 mm

	1.21, 1.23, 1.25, 1.23. The mean of deviations is:				
20	The time taken by light from moon to earth is:	1 min 10 sec	**1 min 20 sec ✓**	1 min 30 sec	1 min 40 sec
21	The percentage of uncertainty for V and I is 2% and 6% respectively. Hence, total uncertainty to the value of $R = \frac{V}{I}$ is:	**8% ✓**	$\frac{1}{3}\%$	3%	4%
22	The dimension of the relation $\sqrt{\frac{F\times l}{m}}$ are equal to the dimension of:	Force	Momentum	Acceleration	**Velocity ✓**
23	The dimensions of frequency are:	[LT]	$[T^{-1}]$ ✓	[MLT]	$[LT^{-1}]$
24	Dimensions of viscosity are:	$[ML^{-1}T]$	$[ML^2T^{-1}]$	$[ML^{-1}T^{-1}]$ ✓	$[ML^{-1}T^{-2}]$
25	The dimensions of torque are:	$[ML^{-1}T]$	$[ML^2T^{-1}]$	$[ML^2T^2]$	$[ML^2T^{-2}]$ ✓
26	A scalar is a physical quantity which is completely specified by:	a number	a direction only	**a number with proper units ✓**	a number with direction
27	An example of scalar quantity:	**Speed ✓**	Displacement	Velocity	Acceleration
28	A typical rocket consumes fuel at a rate of (ejecting gas at speed of 4000 ms^{-1}:	10000 kg/s ✓	15000 kg/s	800 kg/s	660 kg/s
29	A typical rocket consumes about 10,000 kgs^{-1} of fuel and ejects the burnt gases at speeds of over:	2000 ms^{-1}	3000 ms^{-1}	4000 ms^{-1} ✓	5000 ms^{-1}
30	A typical rocket eject the burn gases at speeds of over:	400 m/sec	4000 m/sec ✓	8000 m/sec	10000 m/sec
31	A vector in space has components:	1	2	**3 ✓**	4
32	A force of 10 N makes an angle 30° with y-axis. Then magnitude of x-component is:	**5 N ✓**	8.66 N	10N	Zero
33	The resultant of two forces 3N and 4N acting at right angle to each other is:	**5 N ✓**	6 N	1 N	7 N
34	If magnitude of cross product and dot product of two vectors are equal. The angle between the vectors is:	0°	90°	180°	45° ✓
35	If two non-zero vectors a and b are parallel to each other, then:	$a.b = 0$	$a.b = ab$ ✓	$	a.b
36	The cross product of $\hat{\imath} \times \hat{\jmath}$ is equal to;	zero	one	-k	$\hat{k}$ ✓
37	A body having uniform acceleration of 10 ms^{-2} has a velocity of 100 ms^{-1}. In what time its velocity will be doubled?	8sec	**10sec ✓**	12sec	14sec
38	Mark the correct relation:	$a = \frac{v_f - v_i}{t}$	$a = \frac{v_f^2 - v_i^2}{2s}$	$a = \frac{2(S - v_i t)}{t^2}$	**all of them ✓**
39	The distance covered by a body with uniform acceleration "a" in time "t" starting from rest is:	$\frac{1}{2}at^2$ ✓	vt	$\frac{1}{2}$ vt	$\frac{1}{2}a^2t$
40	A bullet shot straight up, returns to its starting point in 10 sec. Its initial speed was:	9.8 ms^{-1}	24.5 ms^{-1}	49 ms^{-1} ✓	98 ms^{-1}

41	The distance covered by free falling body in 2 seconds is:	9.8 m	**19.6 m ✓**	4.9 m	49 m
42	The range of projectile is same for:	0°, 45°	30° 75°	15° 60°	**35°, 55° ✓**
43	Time of flight of a projectile is:	$\frac{v_i \sin\theta}{g}$	$\frac{v_i \sin\theta}{2g}$	$\frac{v_i^2 \sin\theta}{g}$	$\frac{2v_i \sin\theta}{g}$ ✓
44	The distance covered by a freely falling body in first 2 seconds, when its initial velocity was zero:	9.8 m	39.2 m	**19.6 m ✓**	4.9 m
45	The motion of the rocket in space is according to the law of conservation of:	energy	**linear momentum ✓**	mass	angular momentum
46	A force of 50N acts on a body for 10 seconds. What will be the change in momentum?	200 Ns	**500 Ns ✓**	800 Ns	5 Ns
47	The Sl unit of impulse is:	$kgms^1$	Ns	Newton	**both and ✓**
48	Time rate of change in momentum of a body is equal to:	**impulse ✓**	pressure	applied force	tension
49	When a massive body of mass m_1 collides with lighter stationary body of mass $m_2{}'$ the velocity of massive body after collision will be:	$v_1' = 2v_1$	$v_2' = v_1$	$v_1' = v_1$ ✓	$v_2' = 2v_2$
50	Elastic collision involves:	loss of energy	gain of energy	**no gain, no loss of energy ✓**	no relation between energy and elastic collision
51	100 radians are equal to:	57.3°	573°	5730° ✓	5.73°
52	When a body moves along a circular path, its velocity:	Remains the same	Becomes zero	**Changes continuously ✓**	Sometimes changes
53	The relation between linear velocity and angular velocity is:	(A) $\underline{v} = \underline{w} \times \underline{r}$	$\underline{v} = \underline{w} \times \underline{r}$ ✓	$\underline{w} = \underline{v} \times \underline{r}$	$\underline{w} = \underline{r} \times \underline{v}$
54	A body travelling in a circle at constant speed:	has constant velocity	**has an inward radial acceleration ✓**	is not accelerated	has an outward radial acceleration
55	If linear velocity and radius are both made to half of a body moving around a circle. Then its centripetal force becomes:	F_c	$\frac{F_c}{2}$ ✓	(0) $\frac{F_c}{4}$	$2F_c$
56	Which one of the following is not directed along the axis of rotation?	Angular acceleration	Angular momentum	**Centripetal acceleration ✓**	Angular displacement
57	The acceleration of a body undergoing uniform circular motion is constant in:	**Magnitude only ✓**	Direction only	Both	Neither
58	20 N centripetal force revolving a body along a circular path of radius 1 m, the work done by the centripetal force is:	20 Joule	40 Joule	10 Joule	**Zero Joule ✓**
59	Satellites are held in orbit by the gravitationa pull of:	Moon	Sun	**Earth ✓**	Star
60	Satellites are the objects that orbital around the:	Moon	Sun	**Earth ✓**	Star
61	The frequency of rotation of a spaceship about its own axis to create artificial gravity like that on earth is:	$f = 2\pi\sqrt{\frac{g}{R}}$	$f = \frac{1}{2\pi}\sqrt{\frac{g}{R}}$ ✓	$f = \frac{1}{2\pi}\sqrt{\frac{g}{R^2}}$	$f = \frac{1}{2\pi}\sqrt{\frac{R}{g}}$

62	A man inside the artificial satellite feels weightlessness because the force of attraction due to the Earth is:	zero at pole	balanced by the force of attraction due to the moon	**equal to the centripetal force ✓**	non-effective due to some particular design of the satellite
63	The mud flies the tyre of a moving bicycle in the direction of:	Towards the center	Radius	**Tangent to the tyre ✓**	Motion
64	Moment of inertia of 100 kg sphere having radius 50 cm will be:	$10\ kg\ m^2$ ✓	$5\ kg\ m^2$	$500\ kg\ m^2$	$2.5\ kg\ m^2$
65	Moment of inertia for a particle is given by:	m^2r^2	mr^2 ✓	m^2 r	mr^{-2}
66	The relation for moment of inertia of the thin ring is:	mr^2 ✓	$\frac{1}{2}mr^2$	$\frac{2}{5}mr^2$	$\frac{2}{3}mr^2$
67	Angular momentum of a rigid body is given by:	$I^2\omega$	(B) $I\omega^2$	$I^2\omega^2$	**Iw ✓**
68	The angular momentum L is given by:	$\vec{r}\times\vec{p}$ ✓	$\vec{L}\times\vec{r}$	$\vec{r}\times\vec{F}$	$\vec{F}\times\vec{p}$
69	In rotational motion, the torque is equal to rate of change of:	Angular velocity	Linear momentum	**Angular momentum ✓**	Angular acceleration
70	Angular momentum of a body under a centripetal force is:	Zero	Maximum	Minimum	**Constant ✓**
71	The rate of change of linear momentum of a body is equal to:	Moment of force	**The applied force ✓**	The applied torque	Impulse
72	When a torque acting on a system is zero, which of the following will be correct:	Linear momentum	Force	**Angular momentum ✓**	Linear impulse
73	The rate of change of angular momentum of a body is:	The applied force	The moment of inertia	**The applied torque ✓**	Impulsive force
74	Angular momentum is conserved under:	**Central force ✓**	Constant force	Variable force	Uniform force
75	If external torque on a body is zero, then which of these quantities is constant?	Force	Linear Momentum	Linear Velocity	**Angular Momentum ✓**
76	The dimensions of work are:	$[MLT^{-1}]$	$[MLT^{-2}]$	$[ML^2T^{-2}]$ ✓	[MLT]
77	If 50 kg crate is pushed through 2 m across the floor with a force of 50 N, the work done will be:	245 J	150 J	200 J	**100 J ✓**
78	When a body is lifted through a height 'h', the work done on the body appears in the form of	kinetic energy	**potential energy ✓**	force	work
79	The work done is said to be negative when force and displacement are:	parallel	**anti-parallel ✓**	perpendicular	none
80	Area under force-displacement graph gives:	Velocity	Power	**Work done ✓**	Acceleration
81	A field in which the work done in moving a body along closed path is zero is called:	electrical field	nuclear field	electromagnetic field	**conservative field ✓**
82	In Earth's gravitational field, work done is a closed path is:	Maximum	Positive	Negative	**Zero ✓**
83	Which one is a conservation force?	**Elastic spring force ✓**	Frictional force	Air resistance	Tension in the spring
84	An example of non-conservative force is:	elastic force	gravitational force	**frictional force ✓**	magnetic force

85	The dimension of power is:	MLT^{-1}	ML^2T^{-2}	ML^2T^{-1}	ML^2T^{-3} ✓
86	The Sl unit of product of pressure and volume is:	Watt	**Joule ✓**	Pascal	Nm
87	A dry battery can deliver 3000 J of energy to a 2 W small electric motor before the battery is exhausted. For how many minutes does the battery run?	1500 min	100 min	50 min	**25 min ✓**
88	Mass is highly concentrated form of:	Inertia	**Energy ✓**	Plasma	Charge
89	The escape velocity can be determined by relation:	$v_{esc} = gR$	$v_{esc} = 2gR$	$v_{esc} = \sqrt{2gR}$ ✓	$v_{esc} = \sqrt{\frac{gR}{M}}$
90	The value of escape velocity is:	$11.6 \times 10^3 ms^{-1}$	$11 \times 10^3 ms^{-1}$ ✓	$11.5 \times 10^3 ms^{-1}$	$12 \times 10^3 ms^{-1}$
91	The value of escape velocity is maximum for:	Moon	Mercury	Earth	**Jupiter ✓**
92	In work-energy principle work done on a body is equal to:	Kinetic energy	Potential energy	Internal energy	**Change in K.E ✓**
93	All the food we eat in one day has about the same energy as (if one litre petrol = 5×10^7):	5×10^7	$1.66 \times 10^7 J$ ✓	$10 \times 10^7 J$	0.33 J
94	According to work-energy principle in linear motion, the work done on body' uh to:	**change in K.E. ✓**	change in P.E.	zero	sum of K.E and P.E.
95	The K.E of bullet of mass 500gm moving at a speed of 200 ms^{-1}	250 J	125 J	2500 J	**10,000 J ✓**
96	Energy dissipated usually appears as:	**Heat energy ✓**	Nuclear Energy	P.E.	Chemical Energy
97	The substances in which the atoms do not form magnetic dipoles are called:	Diamagnetic	Paramagnetic	Ferromagnetic	**Crystal ✓**
98	Which of the following is polymer solid?	**Wool ✓**	Glass	Sodium chloride	Copper
99	The fundamental equation in fluid dynamics that relates pressure to fluid speed and height is:	Equation of continuity	**Bernoulli's equation ✓**	Stoke's equation	Mass energy equation
100	The term $\frac{1}{2}\rho v^2$ in Bernoulli's equation represents:	K.E of fluid	Pressure energy	**K.E per unit volume ✓**	P.E of fluid
101	Bernoulli theorem can be reduced to:	Torriceli's theorem but not venturi's relation	**Both Torriceli's theorem and venturi's relation ✓**	Venturi relation but not Torriclli's relation	This equation can not be reduced
102	The pressure will be low where the speed of fluid is:	**High ✓**	Low	Zero	Constant
103	A 10 meter high tank is full of water. A hole appears at its middle. The speed of efflux will be:	5 ms^{-1}	10 ms^{-1} ✓	100 ms^{-1}	5.11 ms^{-1}
104	The equation F=6πηrv is called:	Newton's law	**Stoke's law ✓**	Lenz's law	Faraday's law
105	Fluid dynamics is the study of the behavior of:	Fluid at rest	Liquids at rest	Liquids in motion	**Liquids and gases in motion ✓**

106	Sl unit of viscosity are:	$kg^{-1}ms^{-1}$	$kg^{-1}m^{-1}s$	$kgm^{-1}s^{-1}$ ✓	$kgms^{-1}$
107	Two fog droplets are in freely falling condition. The ratio of their radii is 2:3, the ratio of their terminal velocities will be:	2:3	4:6	**4:9 ✓**	9:4
108	The terminal velocity of spherical object is given by:	$v_t = \frac{2\rho g^2 r^2}{9\eta}$	$v_t = \frac{2\rho g r^2}{9\eta}$ ✓	$v_t = \frac{2\rho^2 g r^2}{9\eta}$	$v_t = \frac{2\rho^2 g^2 r^2}{9\eta}$
109	Which of the following is a defining characteristic of a superfluid?	**Zero viscosity ✓**	Infinite density	Zero temperature	Infinite thermal conductivity
110	Which of the following is a defining characteristic of a superfluid?	**Zero viscosity ✓**	Infinite density	Zero temperature	Infinite thermal conductivity
111	There are different crystal systems. The number of these crystal system is:	3	5	**7 ✓**	4
112	The ability of a body to return to its original shape is called:	Strain	Stress	**Elasticity ✓**	Plasticity
113	The Young's Modulus of Mercury is:	$70 \times 10^9 Nm^{-2}$	$15 \times 10^9 Nm^{-2}$	**Zero ✓**	$91 \times 10^9 Nm^{-2}$
114	Young's modulus of lead is:	$15 \times 10^9 Nm^{-2}$ ✓	$7.7 \times 10^9 Nm^{-2}$	$5.6 \times 10^9 Nm^{-2}$	$2.2 \times 10^9 Nm^{-2}$
115	Which one is not a ductile material?	Lead	**Steel ✓**	Copper	Wrought Iron
116	Out of the following which material is brittle?	Wrought iron	Copper	High steel carbon	**Tungsten ✓**
117	Glass and high steel carbon are example of:	Ductile substances	**Brittle substances ✓**	Soft substances	Hard substances
118	The velocity of rain drop attains constant value due to:	Air currents	Upthrust of air	Surface tension	**Viscous force exerted by air ✓**
119	Laminar flow occurs at:	High speed	**Low speed ✓**	Zero speed	Very high speed
120	The product of cross-sectional area of the pipe and the fluid velocity at any point along the pipe is:	Zero	Variable	**Flow rate ✓**	None of the above
121	If A, v, t denote Area of pipe, velocity of fluid and time of flow respectively, then rate of flow will be:	$\frac{Av}{t}$	**Av ✓**	$\frac{t}{Av}$	None of the above
122	The product of cross-sectional area of the pipe and fluid speed at any point along the pipe is:	Variable	Zero	**Constant ✓**	$x = 2\pi\sqrt{\frac{l}{g}}$
123	Boltzman constant, universal gas constant and Avogadro number are related as:	$K = \frac{R}{N_A}$ ✓	$K = \frac{N_A}{K}$	$R = \frac{K}{N_A}$	$R = \frac{N_A}{K}$
124	The K.E of molecules of an ideal gas at absolute zero will be:	**Zero ✓**	Infinite	Very high	Below zero
125	Charles's law can be written mathematically:	$V \propto T$ ✓	$V \propto \frac{1}{T}$	$P \propto \frac{1}{T}$	$P \propto T$
126	When temperature of source and sink of a heat engine becomes equal then the entropy change will be:	**Zero ✓**	Minimum	Maximum	Negative

127	When hot and cold water are mixed, the entropy:	Decreases	**Increases ✓**	Remains constant	Zero
128	When removed from the system entropy is:	Remain same	Positive	**Negative ✓**	Zero
129	A gas performs 10 J of work while expanding adiabatically. The change in its internal energy is:	**10 J ✓**	-10 J	100 J	-200 J
130	The sum of all the energies of molecules is known as:	Elastic potential energy	Kinetic energy	**Internal energy ✓**	Gravitational potential energy
131	If P = Pressure; V = Volume of a gas, then PΔV represents:	**Work ✓**	Density	Power	Temperature
132	What happens to internal energy of an object when its temperature:	decreases	remains constant	**increases ✓**	fluctuates
133	An adiabatic change is the one in which:	**No heat is added to or taken out of a system ✓**	No change of temperature takes place	Boyle's law is applicable	Pressure and volume remains constant
134	Which is an example of irreversible process?	**Explosion ✓**	Evaporation	Slow compression	Liquefaction
135	Which one of the following process is irreversible?	**Slow compressions of an elastic spring ✓**	Slow evaporation of a substance in an isolated vessel	Slow compression of a gas	A chemical explosion
136	An ideal reversible heat engine has:	**100% efficiency ✓**	Highest efficiency	An efficiency which depends on the nature of working substance	None of these
137	The efficiency of heat engine whose sink is at $17^{\circ}C$ and source at $200^{\circ}C$ is:	70%	100%	35%	**38% ✓**
138	Adevice which converts thermal energy into mechanical energy is called:	**heat engine ✓**	Carnot engine	refrigerator	turbine
139	When two objects are made in thermal contact having same temperature, then they are at:	**thermal Equilibrium ✓**	chemical Equilibrium	mechanical Equilibrium	physical Equilibrium
140	A heat engine operates between the temperature 1000 K and 400 K. Its efficiency is:	100%	70%	**60% ✓**	50%
141	If heat engine absorbs 400 J and rejects 200 J heat energy, its efficiency will be:	25%	**50% ✓**	70%	100%
142	An absolute scale of temperature was first produced by:	Carnot	Celsius	**Kelvin ✓**	Joule
143	A Carnot engine has an efficiency of 50% when its sink temperature is at $27^{\circ}C$. The temperature of source:	$273^{\circ}C$	$300^{\circ}C$	$327^{\circ}C$ ✓	$373^{\circ}C$
144	Area under p - V diagram of carnot engine represents:	Heat input	Heat output	Efficiency	**Work done ✓**
145	If temperature of sink increases, the efficiency of Carnot Engine:	**Decreases ✓**	Increases	Remains the same	First increases then decreases
146					
147	The waves which do not require any medium for their propagation are called:	Mechanical waves	Matter waves	**Electromagne tic waves ✓**	Longitudinal waves
148	The portion of a wave below the mean level is called:	crest	**trough ✓**	node	anti-node

149	What is difference between longitudinal and transverse wave?				
150	Doppler's effect can be used to calculate the:	Speed of light	Speed of electromagnetic	Speed of sound	**Speed of galaxies ✓**
151	The speed of stars and galaxies can be calculated by:	Compton effect	Stefan's law	**Doppler's effect ✓**	Pascal's Effect
152	Sonar is the name of technique used for detecting the objects:	In air	Under ground	**Under water ✓**	On earth
153	The distance between a compression and its adjacent rarefaction is:	**λ/2 ✓**	λ	2λ	4λ
154	Longitudinal waves of frequencies less than 20 Hz are known as:	**Infra sound ✓**	Ultra sound	Super sound	Audible sound
155	When two identical travelling waves are superposed, the velocity of the resultant wave:	Decreases	Increases	**Remain unchanged ✓**	Becomes zero
156	The distance between a node and the next antinode is:	λ	λ/2	**λ/4 ✓**	2λ
157	Diffraction is a special type of:	Reflection	Polarization	**Interference ✓**	Refraction
158	If the amplitude of the wave is tripled, then the amount of energy is increased by:	3 times	6 times	**9 times ✓**	12 times
159	In vibrating cord (or string), the points where the amplitude is minimum (i.e. zero) are called:	Antinodes	**Nodes ✓**	Crests	Troughs
160	Energy cannot flow away in the:	Transverse waves	**Stationary waves ✓**	Longitudinal waves	Sound waves
161	Stationary waves are set up in an open organpipe of length 2m. The wavelength of waves in first mode of vibration is:	**4 m ✓**	1m	8 m	3 m
162	In a stretched string, if speed of the wave is doubled, the tension in string will increase by:	2	**4 ✓**	6	8
163	The wave length of nth node of stationary waves in closed pipe is:	$\frac{2l}{n}$ ✓	$\frac{4l}{2n-1}$	$\frac{4l}{n}$	$\frac{4l}{2n+1}$
164	The amplitude of a vibrating body at resonance in vacuum is:	Minimum	Maximum	Zero	**Infinite ✓**
165	The typical frequency range of microwaves is:	10^3 Hz	$10^5 - 10^7 Hz$	$10^7 - 10^9 Hz$	**10^9 Hz ✓**
166	The bending of waves around an obstacle is called as:	refraction	reflection	**diffraction ✓**	interference
167	On loading the prong of a tuning fork with wax, the frequency of sound:	Increases	**Decreases ✓**	Remains same	First increases then decrease
168	When two notes of frequencies f_1 and f_2 are sounded together, beats are formed. If $f_1 > f_2$ what will be the beat frequency?	$f_1 + f_2$	$\frac{1}{2}(f_1 + f_2)$	$f_1 - f_2$ ✓	$\frac{1}{2}(f_1 - f_2)$
169	In order to produce beats, the two sound waves should have:	The same amplitude	Slightly different amplitude	The same frequency	**Slightly different frequencies ✓**

170	Sound waves cannot be:	Reflected	Refracted	**Polarized ✓**	Diffracted
171	The process of confining the beam of light to vibrate in one plane is called:	Interference	Diffraction	**Polarization ✓**	Total internal reflection
172	Which phenomenon of light proves that light waves are transverse in nature?	Refraction	Reflection	Diffraction	**Polarization ✓**
173	The phenomenon of polarization of light reveals that sun light is:	Longitudinal waves	**Transverse wave ✓**	Electromagnetic waves	Monochromatic wave
174	Transverse waves are distinguished from longitudinal waves by:	Refraction	Interference	**Polarization ✓**	Diffraction
175	Which one of the following can not be polarized?	Ultra Violet rays	Radio waves	T.V waves	**Sound waves ✓**
176	Intensity of light depends on:	Wavelength	Amplitude	Velocity	**Frequency ✓**
177	Which is no optically active?	Sugar	Tartaric acid	**Water ✓**	Sodium Chloride
178	Which of the followings cannot produce colours with white light?	Diffraction	Interference	**Polarization ✓**	Dispersion
179	For having more orders of spectra, the angle along the direction of normal to the grating is:	Diffraction	Polarization	**Interference ✓**	Reflection
180	Light is polarized by using:	sodium chloride	**optical fibre ✓**	dichroic substance	plane glass
181	The unwanted light that interferes with vision is termed as:	haze	**glare ✓**	contrast	flare
182	The angle between the light wave and the analyzer is called:	**polarization angle ✓**	refraction angle	reflection angle	azimuth angle
183	The key purpose of an analyzer in a polarization experiment is:	to polarize the light	to measure the intensity of light	to change the direction of light	**to filter out unwanted light ✓**
184	The intensity of light when it passes through a polarizer:	increases	**decreases ✓**	remains the same	becomes zero
185	The mathematical representation of Malus's law is:	$I=I_o cos^2\theta$ ✓	$I=I_o sin^2\theta$	$I=I_o tan^2\theta$	$I=I_o cot^2\theta$
186	The effect of increasing the angle between the light wave and the analyzer on the intensity of light is:	the intensity increases	**the intensity decreases ✓**	the intensity remains the same	the intensity becomes zero
187	Who predicted the existence of gravitational waves?	Galileo Galilei	**Albert Einstein ✓**	Issac Newton	Leonardo da Vinci
188	What are gravitational waves?	Electromagnetic waves	Mechanical Waves	**Ripples in the fabric of spacetime ✓**	Ocean waves
189	Which of the following is a primary source of gravitational waves?	**Binary black hole merger ✓**	Solar flares	Earthquake	Solar wind
190	Numerical value of permittivity of free space is:	$9\times10^{9}Nm^2C^{-2}$	$8.85\times10^{-12}Nm^2C^{-2}$	$8.85\times10^{-12}N^{-1}m^{-2}C^2$ ✓	$9\times10^{9}N^{-1}m^{-2}C^2$
191	A charged conductor has charge on its.	**Inner-surface ✓**	outer-surface	middle-surface	surrounding space

192	A battery has a charge of 40 C around a circuit at constant rate in 20 sec. The current will be:	**2 A ✓**	0.5 A	80 A	800 A
193	The number of electrons in one coulomb charge is equal to:	1.6×10^{-19} electrons	6.25×10^{-19} electrons	6.25×10^{18} **electrons ✓**	6.25×10^{19} electrons
194	The graphical representation Ohm's law is:	Hyperbola	Ellipse	Parabola	**Straight line ✓**
195	On increasing the length of wire, specific resistance of the wire:	Increases	**Decreases ✓**	Remains unchanged	First increase then decrease
196	The fractional change in resistance is minimum for if temperature change is same for all:	Platinum	Nichrome	Copper	**Constanton ✓**
197	Which one of the following bulbs has the least resistance?	100 watts	200 watts	500 watts	**1000 watts ✓**
198	The current through a conductor is 3.0 A when it is attached across a potential difference of 6.0 V. How much power is used?	0.5W	2.0W	9.0W	**18W ✓**
199	The maximum power (P_{out}) is delivered to a load resistance R, when the internal resistance of the source is:	$r = \infty$	$r = R$ ✓	$r = 0$	$r = \frac{R}{4}$
200	Which one of the following is used to determine internal resistance of a cell?	**Potentiometer ✓**	Wheatstone bridge	Ammeter	Voltmeter
201	Kirchhoff's first rule is the manifestation of the law of conservation of:	Mass	**Charge ✓**	Energy	Momentum
202	The algebraic sum of potential changes for a complete circuit is zero. It is the statement of:	Ohm's law	Gauss's law	Kirchhoff's first law	**Kirchhoff's second law ✓**
203	The relation of emfs of two cells $\frac{E_1}{E_2}$ is:	$\frac{I_2}{I_1}$	$\frac{I_1}{I_2}$ ✓	$\frac{1}{I_1 I_2}$	$I_1 \times I_2$
204	Potentiometer is used to:	Compare emf of two cells	Detect internal resistance of cells	Measure potential difference	**All of these ✓**
205	For computation of electric flux, the surface area should be:	Parallel	**Flat ✓**	Curved	Spherical
206	Electric flux does not depend upon:	Medium	**Shape of closed surface ✓**	Charge enclosed	Medium and charge enclosed
207	Electric flux is maximum, when angle between E and surface area is:	0° ✓	90°	180°	45°
208	The statement $\Phi_e = \frac{1}{\epsilon_o} Q$ was given by:	Faraday	Dersted	**Gauss ✓**	Coulomb
209	If charged body is moved against the electric field, it will gain:	P.E	(B) K.E	Mechanical energy	**Electrical potential energy ✓**
210	The potential at a point situated at a distance of 50 cm from a charge of 50 μC is:	9×10^{-4} volts	18×10^{-4} volts	9×10^{5} **volts ✓**	18×10^{4} volts

211	Electron volt is the unit of:	Potential	Potential difference	Electric current	**Electric energy ✓**
212	The amount of energy equal to $1.6 \times 10^{-19} J$ is called:	One volt	One milli volt	**One electron volt ✓**	One mega electron volt
213	The radius of curvature of the path of a charged particle in a uniform magnetic field is directly proportional to:	the particle's charge	**the particle's momentum ✓**	the particle's energy	the flux density of the field
214	is correct relation:	$1T = 10^4 G$	$1T = 10^{-4} G$ ✓	$1T = 10^{-2} G$	$1T = 10^2 G$
215	The magnetic force is simply a:	Reflecting force	**Deflecting force ✓**	Restoring force	Gravitational force
216	A charged particle enters in a strong magnetic field its K.E:	**Remain constant ✓**	Increases	Decreases	Increases then decreases
217	A current carrying conductor experiences maximum magnetic force in a uniform magnetic field when it is placed:	**Perpendicular to field ✓**	Parallel to field	At an angle of 60° to the field	At an angle of 180° to the field
218	A positive charge is moving towards an observer. The direction of magnetic induction will be:	Towards right	Clockwise	**Anti clockwise ✓**	Toward left
219	1 Tesla =	$NA^{-1}m^{-1}$ ✓	NAm^{-1}	$NA^{-1}m$	NA^2m^{-1}
220	The value of permeability of free space in Sl unit is:	(A) $4\pi \times 10^{-9} WbA^{-1}m^{-}$	$4\pi \times 10^{-7} WbA^{-1}m^{-1}$ ✓	$4\pi \times 10^{-10} WbA^{-1}$	$4\pi \times 10^{7} WbA^{-1}m$
221	Magnetic field strength is measured in terms of:	Wb	NmA^{-1} ✓	Wbm^{-2}	Js
222	The unit of flux density is:	$NA^{-1}m^{-1}$ ✓	NAm^{-1}	NmA^{-2}	N mA
223	The Sl unit of magnetic permeability is:	$WbA^{-1}m^{-1}$ ✓	WWm^{-2}	$WbmA^{-1}$	$WBAm^{-1}$
224	The Lorentz force on a charged particle moving in electric field E and magnetic field B is given by:	$F = F_E + F_B$ ✓	$F = F_E - F_B$	$F = \frac{F_B}{F_E}$	$F = F_E \times F_B$
225	Lorentz force is given by:	$q(\vec{E} - \vec{v} \times \vec{B})$	$q(\vec{E} + \vec{v} \times \vec{B})$ ✓	$q[\vec{E} \times (\vec{v} + \vec{B})]$	$q(\vec{v} + \vec{E} \times \vec{B})$
226	Work done by magnetic force is:	$Fd \cos \theta$	Positive	Negative	**Zero ✓**
227	The radius of curvature of the path of a charged particle in a uniform magnetic field is directly proportional to:	the particle's charge	**the particle's momentum ✓**	the particle's energy	the flux density of the field
228	Magnetic force on the charge q moving parallel to magnetic field with velocity vis:	gv B sine	qvB	**zero ✓**	ILB
229	If we make magnetic field stronger, the value of induced current is:	Decreased	**Increased ✓**	Vanishes	Remains constant
230	When a charge is projected perpendicular to a uniform magnetic field, then its path followed will be:	Straight line	**Circle ✓**	Ellipse	Helix
231	The motional emf is given by:	qvB	IBL	eBL	**VBL ✓**
232	The rod of unit length is moving at 30° through a magnetic field of 1T. If the	1 V	0.25 V	**0.5 V ✓**	0.6 V

	velocity of rod is 1 m/s, then induced emf in the rod will be given by:				
233	The Lenz's Law fulfils:	**Law of conservation of energy. ✓**	Law of conservation of charge.	Law of conservation of Momentum.	Kirchhoff's Law.
234	Lenz's Law deals with:	Magnitude of emf	Direction of emf	**Direction of induced current ✓**	Resistance
235	Electric current produces magnetic field was discovered by:	Faraday	Maxwell	**Oersted ✓**	Lenz
236	The direction of induced current is always so as to oppose the change which causes the current is:	Faraday's Law	**Lenz's Law ✓**	Ohm's Law	Kirchhoff's 1st rule
237	All motions are:	Absolute	Uniform	**Relative ✓**	Variable
238	Relativistic mechanic yields results different from classical mechanics for objects moving with:	low velocity	velocity equal to that of sound waves	velocity greater than sound waves	**velocity approaching that of light ✓**
239	If an observer is moving in the same direction as a sound wave, the velocity of the wave seems to be:	more	**less ✓**	constant	sum of the two velocities
240	Internal frame is a frame in which:	**1st law holds ✓**	2nd law holds	3rd law holds	Kelvin's law holds
241	No inertial frame of reference is prefferd over another inertial frame:	False	**True ✓**	True of static frames	True for dynamic frames
242	Using relativistic effects the location of an air craft after an hour flight can be predicated about:	20 m	**50 m ✓**	760 m	780 m
243	In 1905, the special theory of relativity was proposed by:	**Einstein ✓**	Bohr	Maxwell	De-Broglie
244	The velocity at which relativistic length of a body reduces to half of its original length is:	$\frac{1}{2}c$	$\frac{3}{2}c$	$\frac{1}{\sqrt{2}}c$	$\frac{\sqrt{3}}{2}c$ ✓
245	If an object moves with speed of light, its mass will be:	Zero	Maximum	**Infinity ✓**	Minimum
246	Earth orbital speed is:	10 km/s	20 km/s	30 km/s ✓	40 km/s
247	The velocity at which the mass of a body become double is:	$2.6 \times 10^8 m/s$ ✓	$1.6 \times 10^8 m/s$	$2.6 \times 10^7 m/s$	$3.6 \times 10^7 m/s$
248	1 kg mass will be equivalent to energy:	9×10^8; J	$9 \times 10^{12} J$	$9 \times 10^{16} J$ ✓	$9 \times 10^{19} J$
249	By modern system of NAVSTAR, the speed anywhere on the earth can be determined to accuracy about:	20 ms^{-1}	10 ms^{-1}	2 cms^{-1} ✓	2 ms^{-1}
250	The mass "m" of a moving object with speed 0.8c is:	0.66 mo	0.97 m_o	$1.67 m_0$ ✓	$1.08 m_o$
251	If an observer is moving in the same direction as a sound wave, the velocity of the wave seems to be:	more	**less ✓**	constant	sum of the two velocities

252	If the rest mass of a particle m, increases to m due to its high speed, then its kinetic energy is:	$\frac{1}{2}mc^2$	$\frac{1}{2}mv^2$	$(m-m_o)c^2$ ✓	$\frac{1}{2}(m-m_o)c^2$
253	The speed of beam light of a car. while moving with high speed as compared to its rest position is:	greater	less	**same ✓**	zero
254	A photon is a particle of light. What is its mass, when it moves with 0.9 c?	$9.1\times10^{-31}kg$	$1.67\times10^{-19}kg$	$1.67\times10^{-27}kg$	**Zero ✓**
255	0.1 kg mass will be equivalent to the energy:	$5\times10^{8}J$	$6\times10^{19}J$	$9\times10^{16}J$	$9\times10^{15}J$ ✓
256	The special theory of relativity based on:	One postulate	**Two postulates ✓**	Three postulate	Four postulates
257	Mass of proton is:	$1.67\times10^{-27}kg$ ✓	$1.6\times10^{-19}kg$	$1.67\times10^{-31}kg$	$9.1\times10^{-31}kg$
258	The charge number of 56, Ba is: 141	197	141	85	**56 ✓**
259	The number of neutrons present in a nucleus is given by:	$N=A+Z$	$N=A-Z$ ✓	$N=Z-A$	$N=A\times Z$
260	The minimum charge on any object cannot be less than:	$1.8\times10^{-19}C$	$3.2\times10^{-19}C$	$1.6\times10^{-19}C$ ✓	$9.1\times10^{-19}C$
261	The mass of a neutron is almost equal to mass of:	Electron	**Proton ✓**	Photon	Phonon
262	In a nucleus, a neutron changes into a proton, the atomic number changes by one, the mass number will:	decrease	increase	**remain the same ✓**	none of these
263	Which one of the following forces has negligible effect between the elementary particles?	Strong nuclear force	Weak force	**Gravitational force ✓**	Electromagnetic force
264	Which particles are produced by strong interaction?	Graviton	Leptons	**Hadrons ✓**	Mesons
265	A strong nuclear force exists between the nucleons of:	p-p	n-n	p-n	**all of these ✓**
266	Which one of the following pair of particles creates annihilation?	proton-proton	proton-neutron	**neutron-photon ✓**	electron-positron
267	The activity of radioactive sample:	Is constant	Increase with time	Decrease linearly with time	**Decreases exponentially with time ✓**
268	X-rays are similar in nature to:	**α rays ✓**	β rays	γ rays	Cathode rays
269	Which one of the following radiation/particles has the highest penetrating power?	a	β+	β	**γ ✓**
270	Which one belongs to lepton's group?	Electron	Muons	Neutrinos	**All of these ✓**
271	A pair of quark and anti-quark makes a:	**Meson ✓**	Hardon	Lepton	Baryon
272	Two down and one up quarks make:	Proton	**Neutron ✓**	Photon	Positron
273	Leptons are particles do not experience:	**Strong nuclear force ✓**	Weak nuclear force	Electric force	Magnetic force
274	The first discovered anti-particle is:	anti-proton	anti-neutrino	anti-photon	**anti-electron ✓**
275	Electrons are:	Hadrons	**Leptons ✓**	Quarks	Baryons
276	Which of the following are not hadrons?	**Muons ✓**	Mesons	Protons	Neutrons

277	Baryon with combination of up, up and up quark has charge:	le	**2e ✓**	-le	-2e
278	When a neutron changes into a proton, then we will observe:	**B-decay ✓**	B+ decay	Y-decay	α decay
279	The electroweak theory was introduced by:	Dirac	Einstein	Anderson	**Dr. Abdul Salam ✓**
280	The asymmetry of matter and anti-matter is due to imbalance number of:	hadron	lepton	**baryon ✓**	photons
281	The number of quarks that composed of a neutron is:	2	**3 ✓**	4	5
282	Which one of the following particle is responsible for the mass of the fundamental particle?	Quarks	Anti-quark	Lepton	**Higgs boson ✓**

Short Questions & Answers

Question NO.2

Q.NO.1 : How many significant figures should be retained in multiplying or dividing several numbers?
Answer : When multiplying or dividing numbers, the number of significant figures retained in the final result should not exceed the number of significant figures in the least accurate factor used in the calculation. This means the accuracy of the result is limited by the least precise measurement. For example, if you multiply a value with 3 significant figures by one with 2 significant figures, the answer must be rounded to 2 significant figures.

Q.NO.2 : How many significant figures should be retained in adding or subtracting numbers?
Answer : In addition or subtraction, the number of decimal places retained in the answer should correspond to the smallest number of decimal places in any of the quantities being added or subtracted. In this specific case, the total number of significant figures is less important; it is the position of the decimal (precision) that dictates the final answer.

Q.NO.3 : Kinetic energy of a body of mass $m$moving with speed $v$is given by $\frac{1}{2}mv^2$. What are the dimensions of kinetic energy?
Answer : To find the dimensions, we substitute the dimensions of mass and velocity into the formula. The dimension of mass $m$is $[M]$, and the dimension of velocity $v$is $[LT^{-1}]$.
Therefore, the dimensions of Kinetic Energy are:

$$\begin{aligned} K.E. &= [M] \times [LT^{-1}]^2 \\ &= [M][L^2T^{-2}] \\ &= [ML^2T^{-2}] \end{aligned}$$

Q.NO.4 : Write the dimensions of angular velocity.
Answer : Angular velocity ω is defined as the rate of change of angular displacement, $\omega = \frac{\Delta\theta}{\Delta t}$. The angular displacement $\theta$is measured in radians, which is a dimensionless quantity (a ratio of arc length to radius). Time has the dimension $[T]$. Thus, the dimensions of angular velocity are: $\left[\omega\right] = \frac{[1]}{[T]} = \left[T^{-1}\right]$

Q.NO.5 : State the right-hand rule for the vector product of two vectors.
Answer : To find the direction of a vector product $\vec{A} \times \vec{B}$, rotate the first vector $\vec{A}$ into the second vector $\vec{B}$through the smaller of the two possible angles. Curl the fingers of your right hand in the direction of this rotation while keeping the thumb erect. The direction of the product vector is strictly along the erect thumb, perpendicular to the plane containing both $\vec{A}$and $\vec{B}$.

Q.NO.6 : Define impulse and show how it is related to momentum.

Answer : Impulse is defined as the product of the average force F and the time interval t during which the force acts.

$$Impulse = F \times t.$$

According to Newton's second law, $F = \frac{mv_f - mv_i}{t}$

$$Impulse = \frac{(mv_f - mv_i)}{t} \times t = mv_f - mv_i$$

This shows that impulse is exactly equal to the change in linear momentum of the body.

Q.NO.7 : Differentiate between an elastic and an inelastic collision.

Answer : An **elastic collision** is a collision in which the total kinetic energy of the system is conserved; no kinetic energy is lost during the impact. In contrast, an **inelastic collision** is one where the total kinetic energy is not conserved. In inelastic collisions, a portion of the kinetic energy is transformed into other forms of energy, such as heat, sound, or deformation work.

Q.NO.8 : Show that the rate of change in momentum is equal to the force applied.

Answer : Consider a force F acting on a body of mass m for time t, changing its velocity from v_i to v_f. The acceleration is $a = \frac{v_f - v_i}{t}$. Using Newton's second law ($F = ma$): $F = m\left(\frac{v_f - v_i}{t}\right) = \frac{mv_f - mv_i}{t}$

Since $mv_f - mv_i$ represents the change in momentum, this equation proves that the time rate of change of momentum equals the applied force.

Q.NO.9 : State the law of conservation of linear momentum.

Answer : The law states that the total linear momentum of an isolated system remains constant over time. An isolated system is defined as one on which no external agency exerts any net force. If the system consists of interacting bodies, their mutual forces may change individual momenta, but the vector sum of all momenta remains unchanged.

Q.NO.10 : Show that the range of a projectile is maximum at an angle of $45°$.

Answer : The horizontal range R of a projectile is given by the formula $R = \frac{v_i^2}{g} \sin 2\theta$. For a fixed initial velocity v_i, the range is maximum when the factor $\sin 2\theta$ has its maximum value, which is 1. $\sin 2\theta = 1 \implies 2\theta = 90° \implies \theta = 45°$

Thus, the maximum range is achieved at a projection angle of $45°$.

Q.NO.11 : What is the effect of changing the position of a diver while diving in the pool?

Answer : When a diver leaves the diving board and curls their body by pulling arms and legs in, their moment of inertia (I) decreases significantly. According to the conservation of angular momentum ($L = I\omega$), a decrease in I must be accompanied by an increase in angular velocity ω. This allows the diver to spin rapidly. Before entering the water, they stretch out to increase I and slow down the spin.

Q.NO.12 : Mass is a measure of inertia in linear motion. What is its analogue in rotational motion?

Answer : The analogue of mass in rotational motion is the **Moment of Inertia** (I). Just as mass determines how difficult it is to change an object's linear velocity, the moment of inertia determines how difficult it is to change an object's angular velocity. It depends not only on the mass m but also on the distribution of that mass relative to the axis of rotation ($I = mr^2$).

Q.NO.13 : Why is it harder for a car to take a turn at higher speed than at lower speed?

Answer : To take a turn, a car requires a centripetal force given by $F_c = \frac{mv^2}{r}$. This force acts towards the center of the turn and is provided by the friction between the tyres and the road. Since F_c is proportional to the square of the speed (v^2), a higher speed requires a much larger frictional force. If the speed is too high, the available friction may be insufficient, causing the car to skid.

Q.NO.14 : When a moving car turns around a corner to the left, in what direction do the occupants tend to fall? Answer : The occupants tend to fall outward, to the **right**. This happens due to inertia. The passengers' bodies are in motion in a straight line and want to continue moving in that straight line. When the car turns left, the centripetal force acts on the car, but if the passengers are not securely strapped in, no sufficient force pulls them into the turn, so they continue straight, appearing to be thrown to the right relative to the car.

Q.NO.15 : How does an astronaut feel weightlessness while orbiting the Earth?
Answer : An astronaut feels weightlessness because the spaceship and everything inside it are in a state of free fall towards the Earth. They are accelerating towards the center of the Earth with the same acceleration as gravity (g). In this condition, the floor of the spaceship does not push up on the astronaut, meaning the normal reaction force is zero ($F_N = 0$). Without this support force, the astronaut experiences apparent weightlessness.
Q.NO.16 : Calculate the power of a crane in kilowatts which lifts a mass of 1000 kg to a height of 100 m in 20 seconds.
Answer : First, calculate the force and work done:

$$\text{Force } F = mg$$
$$= 1000\,\text{kg} \times 9.8\,\text{ms}^{-2}$$
$$= 9800\,\text{N}$$
$$\text{Work } W = F \times h$$
$$= 9800\,\text{N} \times 100\,\text{m}$$
$$= 980{,}000\,\text{J}$$
$$\text{Power is the rate of doing work: } P = \frac{W}{t}$$
$$= \frac{980{,}000\,\text{J}}{20\,\text{s}}$$
$$= 49{,}000\,\text{W}$$
$$\text{Converting to kilowatts: } 49{,}000\,\text{W} = 49\,\text{kW}.$$

Q.NO.17 : When will you say that a force is conservative?
Answer : A force is considered conservative if it satisfies one of two conditions:
1. The work done by the force in moving a body between two points is independent of the path taken.
2. The total work done by the force in moving a body along a closed path (starting and ending at the same point) is zero. The gravitational force is a classic example of a conservative force.

Q.NO.18 : Why is work done against friction non-conservative?
Answer : The work done against friction is non-conservative because the energy dissipated (usually as heat) cannot be fully recovered to return the body to its original state. Furthermore, the work done depends on the total length of the path traveled; a longer path results in more work against friction. Therefore, the work done along a closed path is not zero, violating the condition for conservative forces.
Q.NO.19 : Calculate the volume of a sheet with length 2.03 m, breadth 1.22 m, and thickness 0.95 cm.
Answer : First, convert thickness to meters: $0.95\,\text{cm} = 0.0095\,\text{m}$.
Calculate the volume: $V = L \times B \times H = 2.03 \times 1.22 \times 0.0095 = 0.0235277\,\text{m}^3$
The least accurate factor (thickness) has 2 significant figures. Therefore, the answer must be rounded to 2 significant figures: $V = 2.4 \times 10^{-2}\,\text{m}^3$
Q.NO.20 : Give the correct number of significant figures for 0.0054 m.
Answer : This value has **2 significant figures** (the digits 5 and 4). The zeros to the left of the first non-zero digit are used only to locate the decimal point and are not considered significant.
Q.NO.21 : Give the correct number of significant figures for 40.0 m.
Answer : This value has **3 significant figures**. Zeros located to the right of a significant figure in a decimal fraction are significant. They indicate the precision of the measurement.
Q.NO.22 : Give the correct number of significant figures for 8.20×10^{-3}m.
Answer : This value has **3 significant figures**. In scientific notation, the number of significant figures is determined by the digits in the coefficient (the number before the power of ten). Here, 8, 2, and 0 are all significant.
Q.NO.23 : The mass of a metal box is 3.25 kg. Two coins of masses 10.01 g and 10.02 g are added. What is the total mass?
Answer : Convert coin masses to kg: $10.01\,\text{g} = 0.01001\,\text{kg}$ and $10.02\,\text{g} = 0.01002\,\text{kg}$. Sum $= 3.25 + 0.01001 + 0.01002 = 3.27003\,\text{kg}$. For addition, the result is limited by the least precise measurement (3.25 kg, which has 2 decimal places). Thus, we round the result to 2 decimal places: **Total Mass = 3.27 kg**.
Q.NO.24 : Can a measurement be precise but not accurate?

Answer : Yes, a measurement can be precise without being accurate. **Precision** refers to the exactness or the limit of the instrument (least count). **Accuracy** refers to how close the measured value is to the true value. For example, if a zero-error Vernier Calliper reads 0.45 cm for a length that is actually 1.00 cm, the reading is precise (small unit) but not accurate (far from true value).

Q.NO.25 : What is the formula for calculating total uncertainty when multiplying two measured values?

Answer : When multiplying or dividing measured quantities, the uncertainty in the final result is found by adding the percentage uncertainties of the individual quantities. Total % Uncertainty $=$ (% Uncertainty in A) $+$ (% Uncertainty in B)

This sum gives the percentage uncertainty of the product or quotient.

Q.NO.26 : A car travelling at 10 ms^{-1} accelerates uniformly at 2 ms^{-2}. Calculate its velocity after 5 s.

Answer : We use the first equation of motion: $v_f = v_i + at$.

$$\text{Given: } v_i = 10\,\mathrm{ms}^{-1},\ a = 2\,\mathrm{ms}^{-2},\ t = 5\,\mathrm{s}$$
$$v_f = 10 + (2 \times 5)$$
$$v_f = 10 + 10 = 20\,\mathrm{ms}^{-1}$$

The final velocity is 20 meters per second.

Q.NO.27 : A car travels with initial velocity 15 ms^{-1}. It accelerates at 2 ms^{-2} for 4 seconds. Find the displacement.

Answer : We use the second equation of motion: $S = v_i t + \frac{1}{2}at^2$.

$$\text{Given: } v_i = 15\,\mathrm{ms}^{-1},\ a = 2\,\mathrm{ms}^{-2},\ t = 4\,\mathrm{s}$$
$$S = (15 \times 4) + \frac{1}{2}(2)(4)^2$$
$$S = 60 + 16 = 76\,\mathrm{m}$$

The total displacement is 76 meters.

Q.NO.28 : An iron ball of mass 1 kg is dropped from a tower and reaches the ground in 3.34 s. Find the height of the tower.

Answer : For a dropped object, initial velocity $v_i = 0$ and acceleration is $g = 9.8\,\mathrm{ms}^{-2}$.

$$\text{Using } S = v_i t + \frac{1}{2}gt^2$$
$$h = 0 + \frac{1}{2}(9.8)(3.34)^2$$
$$h = 4.9 \times 11.1556 = 54.66\,\mathrm{m}$$

Rounding to reasonable significant figures, the height is approximately 54.6 m.

Q.NO.29 : A 1500 kg car has its velocity reduced from 20 ms^{-1} to 15 ms^{-1} in 3.0 s. How large was the average retarding force?

Answer : We use the impulse-momentum theorem: $F \times t = mv_f - mv_i$

$$F \times 3.0 = 1500(15) - 1500(20)$$
$$3F = 22500 - 30000 = -7500$$
$$F = -2500\,\mathrm{N}$$

The magnitude of the retarding force is 2500 N (or 2.5 kN).

Q.NO.30 : What is the effect of air resistance on projectile motion?

Answer : Air resistance acts as a retarding force that opposes the motion of the projectile. It has two main effects:

1. It reduces the horizontal component of velocity, decreasing the horizontal range.
2. It reduces the vertical height attained. Consequently, the trajectory is no longer a perfect parabola but is skewed, with the descent being steeper than the ascent.

Q.NO.31 : Why does a coasting rotating system slow down as water drips into the beaker?

Answer : This phenomenon is explained by the conservation of angular momentum ($L = I\omega$). As water drips into the beaker (assuming the beaker is located at a distance $r$from the axis), the total mass at distance $r$increases. This increases the moment of inertia (I). Since Lmust remain constant, if Iincreases, the angular velocity ωmust decrease, causing the system to slow down.

Q.NO.32 : Planets move around the Sun in elliptical orbits. Why does orbital velocity increase when nearer the Sun?

Answer : Planetary motion is governed by the conservation of angular momentum. The angular momentum is $L = mvr$(assuming perpendicular motion for simplicity). As a planet approaches the Sun, the distance $r$decreases. To keep the product mvrconstant, the velocity $v$must increase. Therefore, planets move faster when they are at the perihelion (closest to the Sun).

Q.NO.33 : An electric fan rotating at 3 rev s^{-1} is switched OFF. It comes to rest in 18.0 s. Find its deceleration.

Answer : Given: $\omega_i = 3.0 \text{ rev s}^{-1}$, $\omega_f = 0$, $t = 18.0$ s.

Using the angular equation of motion $\alpha = \frac{\omega_f - \omega_i}{t}$

$$\alpha = \frac{0 - 3.0}{18.0}$$
$$= -0.167 \text{ rev s}^{-2}$$

The deceleration is 0.167 rev s^{-2}.

Q.NO.34 : A ball is swung in a vertical circle. What is the tension at the top (Point A)?

Answer : At the highest point of a vertical circle, both the tension in the string (T) and the weight of the ball ($w = mg$) act downward toward the center. Together, they provide the necessary centripetal force (F_c)

$$T + mg = \frac{mv^2}{r}$$
$$T = \frac{mv^2}{r} - mg$$

This shows tension is minimum at the top.

Q.NO.35 : Can you prove that the work done along a closed path by the gravitational force is zero?

Answer : Yes, the gravitational field is a conservative field. If you move an object in a closed loop (e.g., up and then down), the negative work done by gravity while rising is exactly cancelled by the positive work done by gravity while falling. Mathematically, the closed loop integral of the force is zero: $\oint \vec{F}_g \cdot d\vec{r} = 0$.

Q.NO.36 : Does the international space station have gravitational P.E. and/or Kinetic energy?

Answer : The International Space Station (ISS) possesses **both** types of energy.

1. **Kinetic Energy:** Because it is constantly orbiting the Earth with a high orbital velocity.
2. **Gravitational Potential Energy:** Because it is located at a specific altitude within the Earth's gravitational field, giving it potential energy $U = -\frac{GMm}{r}$.

Q.NO.37 : Give the answer to appropriate significant figures: $602 \text{ kg} + 36.02 \text{ kg} + 54.1 \text{ kg}$**.**

Answer : Sum the values first: $602 + 36.02 + 54.1 = 692.12$. We must round to the precision of the least precise term. The term "602" has no decimal places (precision is to the ones place). Therefore, the final answer must also be rounded to the ones place. **Answer = 692 kg**.

Q.NO.38 : How many significant figures are in the measurement 0.00560 g?

Answer : This measurement has **3 significant figures**.

- The leading zeros (0.00...) are placeholders and not significant.
- The digits '5' and '6' are significant.
- The trailing zero '0' is significant because it comes after the decimal point and a non-zero digit, indicating precision.

Q.NO.39 : Define Scalar Product.

Answer : The scalar product (or dot product) of two vectors $\vec{A}$and $\vec{B}$is a scalar quantity defined as the product of their magnitudes and the cosine of the angle θbetween them. $\vec{A} \cdot \vec{B} = AB\cos\,\theta$

Physically, it represents the component of one vector in the direction of the other multiplied by the magnitude of the other vector.

Q.NO.40 : Define Vector Product.

Answer : The vector product (or cross product) of two vectors $\vec{A}$and $\vec{B}$is a vector quantity defined as: $\vec{A} \times \vec{B} = (AB\sin\ \theta)\hat{n}$

Here, $AB\sin\ \theta$is the magnitude, and $\hat{n}$is a unit vector perpendicular to the plane containing $\vec{A}$and $\vec{B}$, determined by the right-hand rule.

Q.NO.41 : What is the work done when the angle between force and displacement is $90°$?

Answer : The work done is **Zero**. The formula for work is $W = Fd\cos\ \theta$. When the force is perpendicular to the displacement ($\theta = 90°$), the cosine term becomes $\cos\ 90° = 0$. Therefore, $W = Fd(0) = 0$. An example is the work done by centripetal force, which is always perpendicular to velocity.

Q.NO.42 : Derive the first equation of motion $v_f = v_i + at$.

Answer : Acceleration is defined as the rate of change of velocity.

$a = \frac{v_f - v_i}{t}$

Multiply both sides by t: $at = v_f - v_i$

Rearranging to solve for the final velocity: $v_f = v_i + at$

Q.NO.43 : Derive the second equation of motion $S = v_i t + \frac{1}{2}at^2$.

Answer : Displacement $S$is the product of average velocity and time.

$$S = v_{av} \times t = \left(\frac{v_i + v_f}{2}\right) \times t$$

Substitute $v_f = v_i + at$ into the equation: $S = \left(\frac{v_i + (v_i + at)}{2}\right) \times t = \left(\frac{2v_i + at}{2}\right) \times t$

$$S = v_i t + \frac{1}{2}at^2$$

Q.NO.44 : Derive the third equation of motion $2aS = v_f^2 - v_i^2$.

Answer : Start with the average velocity equation $S = \left(\frac{v_i + v_f}{2}\right)t$.

From the first equation, $t = \frac{v_f - v_i}{a}$

Substitute this for t

$$S = \left(\frac{v_f + v_i}{2}\right)\left(\frac{v_f - v_i}{a}\right)$$

$$2aS = (v_f + v_i)(v_f - v_i)$$

Using the algebraic identity $(a + b)(a - b) = a^2 - b^2$

$$2aS = v_f^2 - v_i^2$$

Q.NO.45 : What is the trajectory of a projectile?

Answer : The path followed by a projectile is called its trajectory. In the absence of air resistance, the horizontal velocity remains constant while the vertical motion undergoes constant acceleration due to gravity. The combination of uniform horizontal motion and uniformly accelerated vertical motion results in a **parabolic path**.

Q.NO.46 : What is the time of flight of a projectile?

Answer : The time of flight is the total time taken by the projectile to travel from the point of projection to the point where it hits the ground. It is derived from the vertical motion equation $h = v_{iy}t - \frac{1}{2}gt^2$. Setting height $h = 0$ for the return to ground gives: $t = \frac{2v_i\sin\ \theta}{g}$

Q.NO.47 : What is the maximum height of a projectile?

Answer : The maximum height is the peak vertical distance a projectile reaches above the projection level. At the highest point, the vertical velocity component is zero ($v_{fy} = 0$). Using the motion equation: $H = \frac{v_i^2\sin^2\theta}{2g}$

This value depends on the initial velocity and the square of the sine of the angle of projection.

Q.NO.48 : Define Linear Momentum.

Answer : Linear momentum ($\vec{p}$) is a physical quantity defined as the product of the mass $m$of a body and its velocity $\vec{v}$. $\vec{p} = m\vec{v}$

It is a vector quantity that possesses the same direction as the velocity. The SI unit of momentum is $kg \cdot ms^{-1}$ or Newton-second (Ns).

Q.NO.49 : State Newton's Second Law in terms of momentum.

Answer : Newton's Second Law can be stated as: The time rate of change of momentum of a body is equal to the net external force applied to it.

$$F = \frac{\Delta p}{t}$$
$$= \frac{mv_f - mv_i}{t}$$

This formulation is more general than $F = ma$ because it applies even when mass is varying (like in rocket propulsion).

Q.NO.50 : What is a radian?

Answer : The radian is the standard unit of angular measure. One radian is defined as the angle subtended at the center of a circle by an arc whose length is exactly equal to the radius of the circle. Since the circumference is $2\pi r$, a full circle is 2πradians. 1 revolution $= 2\pi$ rad $\approx 57.3°$

Q.NO.51 : Define Angular Velocity.

Answer : Angular velocity (ω) is the rate at which angular displacement changes with respect to time.

$$\omega = \lim_{\Delta t \to 0} \frac{\Delta\theta}{\Delta t}$$

It is a vector quantity directed along the axis of rotation (determined by the right-hand rule). The SI unit is radians per second ($rad\ s^{-1}$).

Q.NO.52 : Define Angular Acceleration.

Answer : Angular acceleration (α) is the rate of change of angular velocity with respect to time.

$$\alpha = \lim_{\Delta t \to 0} \frac{\Delta\omega}{\Delta t}$$

It occurs when the speed of rotation changes. The SI unit is radians per second squared ($rad\ s^{-2}$).

Q.NO.53 : What is the relationship between linear and angular velocity?

Answer : For a particle moving in a circle of radius r, the linear velocity v(tangential speed) is directly proportional to the angular velocity ω.

$$v = r\omega$$

This equation holds true when $\omega$is measured in radians per second.

Q.NO.54 : What is the relationship between linear and angular acceleration?

Answer : The tangential acceleration $a_t$of a particle in circular motion is related to the angular acceleration $\alpha$by the radius r.

$$a_t = r\alpha$$

This relates the change in magnitude of linear velocity to the change in angular velocity.

Q.NO.55 : Define Centripetal Force.

Answer : Centripetal force is the net force required to keep an object moving in a circular path. It is always directed perpendicular to the velocity, towards the center of the circle.

$$F_c = \frac{mv^2}{r}$$
$$= mr\omega^2$$

Without this force, inertia would cause the object to move in a straight line tangent to the path.

Q.NO.56 : What is the critical velocity for a satellite?

Answer : Critical velocity is the minimum horizontal velocity required to put a satellite into a stable circular orbit around the Earth. For a low-Earth orbit (where $r \approx R$), it is given by: $v_c = \sqrt{gR}$

Using Earth's radius $R = 6400$ km and $g = 9.8\ \text{ms}^{-2}$, this velocity is approximately $7.9\ \text{km s}^{-1}$.

Q.NO.57 : What is Moment of Inertia?

Answer : Moment of inertia (I) is the rotational equivalent of mass. It measures a body's resistance to angular acceleration. $I = \sum mr^2$

It depends on the total mass of the body and how that mass is distributed relative to the axis of rotation. A mass further from the axis contributes more to the moment of inertia.

Q.NO.58 : Define Angular Momentum (L).

Answer : Angular momentum is the rotational analogue of linear momentum. For a single particle, it is the cross product of position vector $\vec{r}$and linear momentum $\vec{p}$.

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

For a rigid body rotating about a fixed axis, it is expressed as $L = I\omega$, where $I$is the moment of inertia and $\omega$is angular velocity.

Q.NO.59 : State the Law of Conservation of Angular Momentum.

Answer : The law states that if no external torque acts on a system, the total angular momentum of the system remains constant.

$$L = I\omega = \text{constant}$$

If the moment of inertia Ichanges (e.g., by changing shape), the angular velocity ωmust change inversely to keep Lconstant.

Q.NO.60 : What is a Gyroscope?

Answer : A gyroscope is a device consisting of a heavy flywheel that is spun at high speed. It is mounted in gimbal rings so that its axis is free to turn in any direction. Because of the conservation of angular momentum, the spin axis resists changes to its orientation. This property makes it useful for navigation and stabilization systems.

Q.NO.61 : What is Artificial Gravity?

Answer : Artificial gravity is a simulated gravity created in space stations by rotating the station around its axis. The rotation creates a centripetal force requirement; the floor presses against the astronaut to provide this force. The reaction force (centrifugal effect) felt by the astronaut mimics weight. The required frequency is $f = \frac{1}{2\pi}\sqrt{\frac{g}{R}}$.

Q.NO.62 : Define Work.

Answer : Work is defined as the product of the component of force in the direction of displacement and the magnitude of the displacement.

$$W = \vec{F} \cdot \vec{d} = Fd\cos\,\theta$$

Work is a scalar quantity. It is positive if force aids motion, zero if force is perpendicular to motion, and negative if force opposes motion.

Q.NO.63 : What is the unit of Work?

Answer : The SI unit of work is the **Joule (J)**. One Joule is defined as the work done when a force of one Newton acts on a body and displaces it through a distance of one meter in the direction of the force.

$$1\,\text{J} = 1\,\text{N}$$
$$1\,\text{m} = 1\,\text{Nm}$$

Q.NO.64 : How is work calculated for a variable force?

Answer : When force is not constant, work cannot be calculated by simple multiplication. Instead, the path is divided into very small intervals where force is approximately constant. The total work is the sum of work in these intervals. Graphically, work is equal to the **area under the Force-displacement curve** ($F\cos\,\theta$ vs d).

Q.NO.65 : Define Escape Velocity.

Answer : Escape velocity is the minimum initial velocity a body must possess to escape the gravitational field of a planet and never return. It is derived by equating initial kinetic energy to the absolute gravitational potential energy work.

$$v_{esc} = \sqrt{2gR} \approx 11.2\,\text{km s}^{-1}\text{ (for Earth)}$$

Q.NO.66 : State the Work-Energy Theorem.

Answer : The Work-Energy Theorem states that the work done on an object by the net force acting on it is equal to the change in its kinetic energy.

$$W_{net} = \Delta K.E. = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

This principle connects the concepts of force, displacement, and energy.

Q.NO.67 : Define Absolute Potential Energy.
Answer : Absolute gravitational potential energy is defined as the work done by the gravitational force in bringing an object from infinity (where force is zero) to a specific point in the gravitational field.

$$U = -\frac{GMm}{r}$$

It is always negative, indicating that the force is attractive and work is done by the field.
Q.NO.68 : What is Stress?
Answer : Stress is defined as the deforming force applied per unit area of a body.

$$\sigma = \frac{F}{A}$$

It represents the internal restoring force developed within the material. The SI unit is the Pascal (Pa) or Newton per square meter (Nm^{-2}). Types include tensile, compressive, and shear stress.
Q.NO.69 : What is Strain?
Answer : Strain is the measure of deformation produced in a body due to stress. It is defined as the fractional change in dimensions (length, volume, or shape).

$$\epsilon = \frac{\Delta L}{L} \text{ (Tensile Strain)}$$

Since it is a ratio of two similar quantities, strain is a dimensionless quantity and has no units.
Q.NO.70 : Define Young's Modulus.
Answer : Young's Modulus (Y) is the ratio of tensile stress to tensile strain within the elastic limit. It measures the stiffness of a material.

$$Y = \frac{\text{Stress}}{\text{Strain}} = \frac{F/A}{\Delta L/L}$$

A material with a higher Young's Modulus is more rigid and less elastic (harder to stretch).
Q.NO.71 : What is the Elastic Limit?
Answer : The elastic limit is the maximum stress that a material can withstand without undergoing permanent deformation. Up to this limit, the material returns to its original shape when the stress is removed. Beyond this point, the material enters the plastic region and retains a permanent set.
Q.NO.72 : Differentiate between Ductile and Brittle substances.
Answer : Ductile substances (like copper and lead) have a large plastic region; they can be drawn into wires and deform significantly before breaking. **Brittle substances** (like glass and high-carbon steel) have very little or no plastic region; they break shortly after passing the elastic limit without significant deformation.
Q.NO.73 : What is Strain Energy?
Answer : Strain energy is the potential energy stored in a body due to elastic deformation. It equals the work done by the deforming force. For a stretched wire obeying Hooke's Law:

$$\text{Energy} = \frac{1}{2}F \times \Delta L$$
$$= \frac{1}{2}(\text{Elastic constant})x^2$$

In terms of modulus: $U = \frac{1}{2} \times \text{Stress} \times \text{Strain} \times \text{Volume}$.
Q.NO.74 : Define Ultimate Tensile Strength (UTS).
Answer : The Ultimate Tensile Strength is the maximum stress that a material can withstand while being stretched or pulled before necking (thinning) occurs. It corresponds to the highest point on the stress-strain graph. Beyond this point, the material weakens and eventually fractures.
Q.NO.75 : What happens when the angle of projection is $90°$ for a projectile?
Answer : When the angle of projection is 90°, the object is thrown straight up. The horizontal range formula is $R = \frac{v_i^2}{g}\sin(2 \times 90°) = \frac{v_i^2}{g}\sin(180°)$. Since $\sin(180°) = 0$, the range is zero. The projectile moves only vertically and returns to the starting point.
Q.NO.76 : A ball is thrown at $30°$ with speed 30 ms^{-1}. Find maximum height.

Answer : Given: $v_i = 30\ \text{ms}^{-1}$, $\theta = 30°$, $g \approx 19.6\ \text{ms}^{-2}$(or 9.8).

$$\text{Using } H = \frac{v_i^2 \sin^2\theta}{2g}$$

$$H = \frac{30^2 \times (\sin\ 30°)^2}{2 \times 9.8}$$

$$= \frac{900 \times (0.5)^2}{19.6}$$

$$H = \frac{900 \times 0.25}{19.6} = 11.48\ \text{m}$$

Q.NO.77 : Find the horizontal range for the ball in Q.NO.76.

Answer :

$$\text{Using } R = \frac{v_i^2 \sin\ 2\theta}{g}$$

$$R = \frac{30^2 \times \sin(60°)}{9.8}$$

$$= \frac{900 \times 0.866}{9.8}$$

$$R = \frac{779.4}{9.8} = 79.53\ \text{m}$$

The ball covers a horizontal distance of approximately 79.5 meters.

Q.NO.78 : Find the time of flight for the ball in Q.NO.76.

Answer : Using $t = \frac{2v_i \sin\ \theta}{g}$: $t = \frac{2 \times 30 \times \sin\ 30°}{9.8}$

$$t = \frac{60 \times 0.5}{9.8} = \frac{30}{9.8}$$

$$t = 3.06\ \text{s}$$

Q.NO.79 : Why are banked tracks used?

Answer : Banked tracks (where the outer edge is higher than the inner edge) are used to provide the necessary centripetal force for vehicles turning at high speeds. The banking angle allows the normal force component to contribute to the centripetal force, reducing the reliance on friction. This prevents skidding and allows for safer, faster turns.

Q.NO.80 : How does a centrifuge work?

Answer : A centrifuge works on the principle of centrifugal force (inertia). When a mixture spins at high speed, denser particles possess greater inertia and tend to move towards the outer edge (bottom of the tube). Less dense particles are displaced towards the center. This effectively separates components based on density, such as separating plasma from blood cells.

Q.NO.81 : What is the frequency of rotation for a space station to create artificial gravity (g)? Answer :

To create artificial gravity equal to Earth's gravity g, the centripetal acceleration $a_c = R\omega^2$must equal g. Substituting

$$\omega = 2\pi f$$

$$g = R(2\pi f)^2$$

$$= 4\pi^2 f^2 R$$

Solving for frequency f

$$f = \frac{1}{2\pi}\sqrt{\frac{g}{R}}$$

Q.NO.82 : Calculate the orbital speed of a satellite 200 km above Earth (Radius 6400 km).

Answer :

Total orbital radius

$$r = R + h$$

$$= 6400 + 200$$

$$= 6600\ \text{km}$$

$$= 6.6 \times 10^6 \text{ m}$$

$$\text{Using } v = \sqrt{\frac{GM}{r}}$$

$$v = \sqrt{\frac{6.67 \times 10^{-11} \times 6.0 \times 10^{24}}{6.6 \times 10^6}}$$

This yields $v \approx 7.8 \times 10^3 \text{ ms}^{-1}$or 7.8 km/s.

Q.NO.83 : What is the moment of inertia of a solid sphere?

Answer : For a solid sphere of mass $M$and radius Rrotating about an axis through its center: $I = \frac{2}{5}MR^2$

This value is smaller than that of a hollow sphere because the mass is distributed closer to the center.

Q.NO.84 : What is the moment of inertia of a thin rod?

Answer : For a thin rod of mass $M$and length L, rotating about an axis perpendicular to the rod and passing through its center: $I = \frac{1}{12}ML^2$

If it rotates about one end, the moment of inertia increases to $I = \frac{1}{3}ML^2$.

Q.NO.85 : What is the moment of inertia of a solid disc/cylinder?

Answer : For a solid disc or solid cylinder of mass $M$and radius Rrotating about its central axis: $I = \frac{1}{2}MR^2$

This formula applies regardless of the length of the cylinder, as long as the axis is longitudinal.

Q.NO.86 : What is the moment of inertia of a thin ring or hoop?

Answer : For a thin ring or hoop of mass $M$and radius R, where all the mass is located at the distance $R$from the axis: $I = MR^2$

This shape has the highest moment of inertia per unit mass because the mass is distributed as far as possible from the axis.

Q.NO.87 : A 70g ball collides with a 140g ball at rest. Initial velocity 9 ms^{-1}. Find velocity of first ball after elastic collision.

Answer : Formula: $v_1' = \frac{m_1 - m_2}{m_1 + m_2} v_1$

Here $m_1 = 70$, $m_2 = 140$, $v_1 = 9$

$$v_1' = \frac{70 - 140}{70 + 140} \times 9$$

$$v_1' = \frac{-70}{210} \times 9$$

$$= -\frac{1}{3} \times 9$$

$$= -3 \text{ ms}^{-1}$$

The first ball rebounds with a speed of 3 m/s.

Q.NO.88 : Find velocity of the second ball in Q.NO.87.

Answer : Formula: $v_2' = \frac{2m_1}{m_1 + m_2} v_1$

$$v_2' = \frac{2(70)}{70 + 140} \times 9$$

$$v_2' = \frac{140}{210} \times 9 = \frac{2}{3} \times 9 = 6 \text{ ms}^{-1}$$

The second ball moves forward with a speed of 6 m/s.

Q.NO.89 : What is the rotational analogue of Newton's second law ($F = ma$)?

Answer : The rotational analogue replaces Force with Torque (τ), Mass with Moment of Inertia (I), and Linear Acceleration with Angular Acceleration (α). $\tau = I\alpha$

This equation states that the net torque acting on a rigid body is equal to the product of its moment of inertia and its angular acceleration.

Q.NO.90 : What is the relationship between torque and moment of inertia?

Answer : Torque is the cause of angular acceleration, and moment of inertia is the resistance to it. The relationship is linear: $\tau = I\alpha$
Just as a larger force is needed to accelerate a larger mass, a larger torque is needed to angularly accelerate a body with a larger moment of inertia.
Q.NO.91 : Explain how a diver uses conservation of angular momentum.
Answer : When a diver jumps, they may have a small initial rotation. To spin faster (perform somersaults), they tuck their body into a ball. This reduces the moment of inertia (I). Since $L = I\omega$is constant, ωincreases drastically. To stop spinning before hitting the water, they extend their limbs, increasing $I$and reducing ω.
Q.NO.92 : A stone whirled in a vertical circle breaks the string. Why?
Answer : The tension in the string varies at different points of the vertical circle. It is maximum at the bottom-most point, where Tension = Centripetal force + Weight ($T = \frac{mv^2}{r} + mg$).
If the speed is high enough that this maximum tension exceeds the breaking strength of the string, the string will snap at the bottom.
Q.NO.93 : What determines the best position to hold an umbrella in rain with wind?
Answer : To best protect oneself from rain, the umbrella should be aligned with the **relative velocity** of the rain with respect to the person. If the person is stationary and wind blows rain at an angle, hold it at that angle. If the person is moving, they must account for their own velocity vector, effectively tilting the umbrella forward into the rain.
Q.NO.94 : Define Power.
Answer : Power is defined as the time rate of doing work. If an agent does work ΔWin time interval Δt, the average power is given by $P_{av} = \frac{\Delta W}{\Delta t}$. In the limit as Δtapproaches zero, it becomes instantaneous power. The SI unit of power is the Watt (W). It can also be expressed in terms of force and velocity as $P = \vec{F} \cdot \vec{v}$.
Q.NO.95 : A machine gun fires 6 bullets/min, velocity 700 ms^{-1}, mass 40g. Find Power.
Answer : Calculate the mass fired per second: $\dot{m} = \frac{6\times 0.040\text{ kg}}{60\text{ s}} = 0.004$ kg/s. Power is the rate of Kinetic Energy generated: $P = \frac{1}{2}\dot{m}v^2$

$$P = \frac{1}{2}(0.004)(700)^2 = 0.002 \times 490{,}000 = 980\text{ W}$$

Q.NO.96 : What is the dimension of Force?
Answer : Force is defined as $F = ma$. Dimension of mass $m = [M]$. Dimension of acceleration $a = [LT^{-2}]$. Therefore, the dimension of Force is: $[F] = [M][LT^{-2}] = [MLT^{-2}]$
Q.NO.97 : What is the dimension of Pressure?
Answer : Pressure is defined as Force per unit Area ($P = F/A$). $[P] = \frac{[MLT^{-2}]}{[L^2]}$

$$[P] = [M][L^{1-2}][T^{-2}] = [ML^{-1}T^{-2}]$$

Q.NO.98 : What is the dimension of Power?
Answer : Power is Work per unit Time ($P = W/t$).
Dimension of Work = Force ×Distance = $[MLT^{-2}][L] = [ML^2T^{-2}]$.
Therefore, Power: $\left[P\right] = \frac{[ML^2T^{-2}]}{[T]} = \left[ML^2T^{-3}\right]$
Q.NO.99 : What is the dimension of Density?
Answer : Density (ρ) is defined as Mass per unit Volume ($\rho = m/V$). Dimension of mass = $[M]$. Dimension of volume = $[L^3]$. Therefore, the dimension of Density is: $\left[\rho\right] = \frac{[M]}{[L^3]} = \left[ML^{-3}\right]$
Q.NO.100 : Check the homogeneity of $S = vit + 1/2at^2$.
Answer : We check the dimensions of each term:
- LHS (S): Dimension is Length $[L]$.
- RHS Term 1 ($v_i t$): $[LT^{-1}][T] = [L]$.
- RHS Term 2 (at^2): $[LT^{-2}][T^2] = [L]$.

- Since each term has the dimension of length $[L]$, the equation is dimensionally homogeneous and correct.

Q.NO.101 : What are the dimensions of the Gravitational Constant (G)?
Answer : According to Newton's law of gravitation,

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

Rearranging for G, we get $G = \frac{Fr^2}{m_1 m_2}$.

Substituting the dimensions of Force $[MLT^{-2}]$, distance $[L]$, and mass $[M]$

$$\left[G\right] = \frac{[MLT^{-2}][L^2]}{[M][M]} = \frac{[ML^3T^{-2}]}{[M^2]} = [M^{-1}L^3T^{-2}]$$

Thus, the dimensions of the gravitational constant are $[M^{-1}L^3T^{-2}]$.

Q.NO.102 : How does instrumental uncertainty arise in measurements?
Answer : Instrumental uncertainty arises due to the inherent limitation of the measuring device. Every instrument is calibrated to a certain smallest division, known as its least count. The uncertainty in any measurement is generally taken as the least count of the instrument. For example, a metre rule graduated in millimetres has an absolute uncertainty of ± 1 mmor ± 0.1 cm.

Q.NO.103 : A person falling on a heap of sand does not get hurt as much as falling on a concrete floor. Why?
Answer : This is explained by the impulse-momentum relationship ($F \times t = \Delta p$). When a person falls on a heap of sand, the sand yields, increasing the time of impact (t) for the body to come to rest. Since the change in momentum (Δp) is constant for the fall, increasing the time $t$significantly reduces the average force Fexerted on the body ($F = \Delta p / t$), thereby preventing injury. On concrete, the stop is sudden (small t), leading to a large damaging force.

Q.NO.104 : Does a moving object have impulse?
Answer : No, a moving object possesses **momentum** ($p = mv$), not impulse. Impulse is defined as the product of force and the time interval during which it acts ($J = F \times t$). It represents the *change* in momentum or the transfer of momentum when the object interacts with something else (like a collision), rather than a property the object holds while moving.

Q.NO.105 : Why is electrical power required when an elevator is descending?
Answer : Even when descending, an elevator requires power to control its speed and prevent it from falling freely under gravity. The motor acts to provide a retarding force (tension) to lower the cabin smoothly at a constant velocity or controlled acceleration. Furthermore, friction in the pulleys and guides must be overcome. If the motor acts as a generator during descent, it still manages the energy transfer to limit speed.

Q.NO.106 : What is the sign of work done when a body is lifted vertically upward?
Answer : When a body is lifted:

1. **Work done by the lifting force** is **positive**, because the direction of the applied force (upward) and the displacement (upward) are the same ($\theta = 0°$).
2. **Work done by the gravitational force** is **negative**, because the weight acts downward while the displacement is upward ($\theta = 180°$, so $\cos\ 180° = -1$).

Q.NO.107 : Is the total mechanical energy conserved for a body falling in air?
Answer : No, the total mechanical energy is not conserved if air resistance is considered. As the body falls, a portion of its potential energy is used to do work against the frictional force of air resistance ($W_f = fh$). This energy is dissipated as heat and sound and cannot be recovered.
The relationship becomes

$$\text{Loss in P.E.} = \text{Gain in K.E.} + \text{Work done against friction}$$

Q.NO.108 : A loaf of bread is lying on a rotating plate. If a crow picks it up, what happens to the plate's rotation? Answer : The rotation speed of the plate **increases**. This is due to the Law of Conservation of Angular Momentum ($L = I\omega = \text{constant}$). When the crow removes the bread, the total mass on the plate decreases, which reduces the moment of inertia (I). To keep angular momentum conserved, the angular velocity (ω) must increase.

Q.NO.109 : What will be the time period of a simple pendulum in an artificial satellite?

Answer : The time period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{l}{g}}$. Inside an artificial satellite orbiting the Earth, everything is in a state of free fall, and the effective value of $g$is zero ($g_{eff} = 0$).

$$T = 2\pi\sqrt{\frac{l}{0}} = \infty$$

This means the pendulum will not oscillate; if displaced, it will remain in that position.

Q.NO.110 : Is the motion of a satellite in its orbit uniform or accelerated?

Answer : The motion of a satellite is **accelerated**. Although it may move with a constant *speed* (uniform orbital speed), its *velocity* is constantly changing direction as it moves along the circular path. This continuous change in direction implies the presence of an acceleration, specifically **centripetal acceleration**, directed towards the center of the Earth.

Q.NO.111 : A light and a heavy body have the same linear momentum. Which one has greater Kinetic Energy? Answer : The **light body** has greater Kinetic Energy. The relationship between Kinetic Energy ($K.E.$) and momentum (p) is $K.E. = \frac{p^2}{2m}$. Since $p$is the same for both, $K.E.$is inversely proportional to mass ($K.E. \propto \frac{1}{m}$). Therefore, the body with the smaller mass (m) will have a larger Kinetic Energy.

Q.NO.112 : Can a slow-moving truck have less kinetic energy than a fast-moving car?

Answer : Yes, it is possible. Kinetic energy depends on both mass and velocity ($K.E. = \frac{1}{2}mv^2$). Although the truck has a much larger mass, the car has a much higher velocity. Since kinetic energy depends on the *square* of the velocity, a sufficiently high speed for the car can result in a kinetic energy ($1/2m_{car}v_{car}^2$) that exceeds that of the slow-moving truck ($1/2m_{truck}v_{truck}^2$).

Q.NO.113 : Does wind contain kinetic energy?

Answer : Yes, wind contains kinetic energy. Wind consists of moving air molecules that possess mass and velocity. Any moving mass has kinetic energy given by $\frac{1}{2}mv^2$. This energy is utilized in wind turbines to generate electricity or in sailboats to produce motion.

Q.NO.114 : A force acts on a ball moving with 14 m/s and reduces its speed to 6 m/s. Is the work done positive or negative?

Answer : The work done is **negative**.

According to the Work-Energy Theorem, $W = \Delta K.E. = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$.

Since the final speed (6 m/s) is less than the initial speed (14 m/s), the change in kinetic energy is negative. Physically, the force is a retarding force acting opposite to the direction of displacement ($\theta = 180°$), resulting in negative work.

Q.NO.115 : Why does a hunter aiming at a distant bird miss if he aims exactly at it?

Answer : If the hunter aims exactly at the bird, he will miss because the bullet will fall downwards due to gravity during its flight. By the time the bullet reaches the horizontal distance of the bird, it will have dropped a vertical distance $h = \frac{1}{2}gt^2$below the line of sight. To hit the bird, the hunter must aim slightly above the target to compensate for this projectile drop.

Q.NO.116 : Describe a case where velocity is zero but acceleration is not zero.

Answer : When a body is projected vertically upward, at the highest point of its trajectory, its instantaneous velocity becomes **zero** ($v = 0$). However, the acceleration due to gravity ($g \approx 9.8\ \text{ms}^{-2}$) is still acting on it downwards. Thus, at the peak height, velocity is zero, but acceleration is non-zero.

Q.NO.117 : Describe a case where acceleration is zero but velocity is not zero.

Answer : When a body moves with **uniform velocity** in a straight line, its change in velocity is zero, which means its acceleration is **zero** ($a = 0$). However, the body is still moving, so its velocity is non-zero ($v \neq 0$). An example is a car cruising at a constant speed on a straight highway.

Q.NO.118 : Describe a case where velocity and acceleration are perpendicular to one another.

Answer : In **uniform circular motion**, the velocity vector is always tangent to the circular path, while the centripetal acceleration vector is directed radially inward towards the center. The angle between the tangent (velocity) and the radius (acceleration) is always 90°. Thus, $v$and $a$are perpendicular.

Q.NO.119 : Why does the acceleration of a rocket increase as it moves upward?

Answer : The acceleration of a rocket is given by $a = \frac{F_{thrust}}{M}$. As the rocket ascends, it burns fuel at a tremendous rate, causing its total mass $M$to decrease continuously. Since the thrust remains roughly constant or increases, the decreasing mass leads to an increasing acceleration ($a \propto 1/M$).

Q.NO.120 : Under what condition is the law of conservation of linear momentum valid?

Answer : The law of conservation of linear momentum holds strictly for an **isolated system**. An isolated system is defined as one on which no external unbalanced force acts. In such a system, the mutual forces between pairs of particles (internal forces) may cause changes in individual momenta, but the total vector sum of the momenta remains constant.

Q.NO.121 : Why does the range of a projectile remain the same when the angle of projection is changed from $\theta$to $90^\circ - \theta$?

Answer : The range formula is $R = \frac{v_i^2}{g}\sin\ 2\theta$.

If we replace $\theta$with $(90^\circ - \theta)$, the term becomes: $\sin\ 2(90^\circ - \theta) = \sin(180^\circ - 2\theta)$

Since $\sin(180^\circ - x) = \sin\ x$, we get $\sin(180^\circ - 2\theta) = \sin\ 2\theta$. Thus, the range is the same for complementary angles (e.g., 30°and 60°).

Q.NO.122 : Calculate the work done by air friction if a body dropped from height Hreaches the ground with speed $1.2\sqrt{gH}$.

Answer : This hypothetical speed ($1.2\sqrt{gH}$) is actually greater than the free-fall speed $\sqrt{2gH} \approx 1.41\sqrt{gH}$, which implies a gain in energy, usually impossible with friction. *Correction based on standard textbook problems:* If the speed were *less* (e.g., v),
we use

$$\text{Loss in P.E.} = \text{Gain in K.E.} + \text{Work by friction } mgH$$
$$= \frac{1}{2}mv^2 + W_f \implies W_f = mgH - \frac{1}{2}mv^2.$$

Q.NO.123 : At what angle are the scalar product and vector product of two vectors equal in magnitude?

Answer : The magnitude of the scalar product is $A \cdot B = AB\cos\ \theta$.

The magnitude of the vector product is $|A \times B| = AB\sin\ \theta$.

Equating them: $AB\cos\ \theta = AB\sin\ \theta$.

Dividing by $AB\cos\ \theta$,

we get $\tan\ \theta = 1$. Therefore, $\theta = 45^\circ$.

Q.NO.124 : What is the frequency of rotation required to provide artificial gravity equal to Earth's gravity in a spaceship of radius R?

Answer : To simulate gravity, the centripetal acceleration must equal $g(a_c = g)$. Since $a_c = R\omega^2$and $\omega = 2\pi f$, we have: $R(2\pi f)^2 = g4\pi^2 f^2 R = gf = \frac{1}{2\pi}\sqrt{\frac{g}{R}}$

Q.NO.125 : A machine gun fires 6 bullets per minute with a velocity of 700 ms^{-1}. Each bullet has mass 40g. Find the power.

Answer : Number of bullets per second $n = 6/60 = 0.1$.

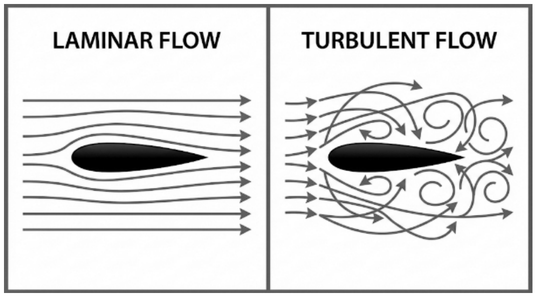
Mass per second $\dot{m} = n \times m = 0.1 \times 0.040$ kg $= 0.004$ kg/s.

Power is the kinetic energy delivered per second: $P = \frac{1}{2}\dot{m}v^2 = \frac{1}{2}(0.004)(700)^2$

$$P = 0.002 \times 490{,}000 = 980 \text{ W}$$

Question NO.3

Q.NO.1 : Differentiate between streamline and turbulent flow of a fluid.
Answer : Streamline (Laminar) flow is the flow in which every particle of the fluid that passes a particular point moves along the same path as the particles that passed that point earlier. The velocity at any fixed point remains constant. **Turbulent flow** is an irregular, unsteady flow where the velocity of the fluid particles at any point changes continuously and erratically with time. It occurs when the speed of the fluid exceeds a certain critical value.



Q.NO.2 : How does pressure change with depth in fluids?
Answer : Pressure in a fluid increases with depth due to the weight of the fluid column above. The relationship is given by the hydrostatic equation:

$$P = P_{atm} + \rho g h$$

Where $P$is the pressure at depth h, $\rho$is the density of the fluid, and $g$is the acceleration due to gravity.
Q.NO.3 : How is variation in pressure related to the speed of a fluid?
Answer : According to Bernoulli's Principle, for an ideal fluid, points of higher fluid speed correspond to points of lower pressure, and points of lower fluid speed correspond to higher pressure. $P + \frac{1}{2}\rho v^2 =$ constant This inverse relationship is fundamental to fluid dynamics.
Q.NO.4 : Why does an object float or sink according to Archimedes' Principle?
Answer : An object floats if the upthrust (buoyant force) acting on it is equal to or greater than its weight. This occurs if the object's density is less than the fluid's density. An object sinks if its weight is greater than the upthrust, which happens when the object is denser than the fluid. Archimedes' Principle states the upthrust equals the weight of the fluid displaced.
Q.NO.5 : How did Archimedes reportedly discover the principle that bears his name?
Answer : Archimedes reportedly discovered the principle while stepping into a bathtub. He noticed that the water level rose as he submerged, and realized that the volume of water displaced was equal to the volume of the submerged part of his body. This insight allowed him to determine the purity of a gold crown.
Q.NO.6 : Why is standing near a fast-moving train dangerous? Explain briefly.
Answer : When a fast train passes, the air between the person and the train moves at high speed. According to Bernoulli's principle, this high speed creates a region of low pressure. The air behind the person is stationary (high pressure) and pushes the person towards the train (low pressure), which can be fatal.
Q.NO.7 : Differentiate between stress, strain, and Young's modulus. Write down their SI units.
Answer :

- **Stress (σ):** Force applied per unit area (F/A). SI Unit: Nm^{-2}or Pascal (Pa).
- **Strain (ϵ):** Fractional change in dimension (e.g., $\Delta L/L$). SI Unit: Dimensionless (No unit).
- **Young's Modulus (Y):** Ratio of tensile stress to tensile strain within the elastic limit. SI Unit: Nm^{-2}or Pascal (Pa).

Q.NO.8 : State 2nd law of thermodynamics in two different form.
Answer :

1. **Kelvin-Planck Statement:** It is impossible to construct a heat engine that operates in a cycle and extracts heat from a source to convert it entirely into work without rejecting any heat to a sink.

2. **Clausius Statement:** It is impossible to construct a device (refrigerator) that transfers heat from a cold body to a hot body without any external work being done on the system.

Q.NO.9 : Is it possible to construct a heat engine of 100% efficiency? Explain.

Answer : No, it is not possible. According to the Kelvin-Planck statement of the Second Law of Thermodynamics, some heat energy must be rejected to a low-temperature sink ($Q_L \neq 0$) to complete the cycle. Efficiency is $\eta = 1 - Q_L/Q_H$. Since $Q_L$cannot be zero, ηcan never be 1 (100%).

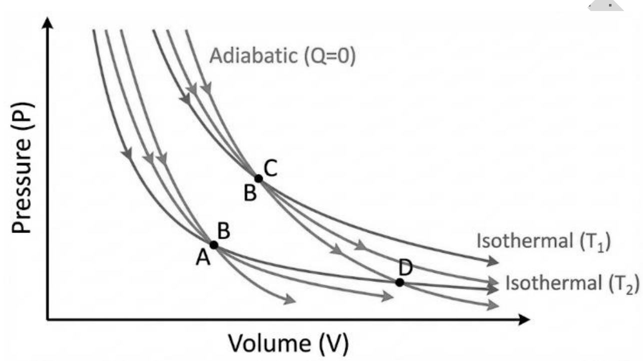
Q.NO.10 : Differentiate between reversible and irreversible processes.

Answer :

- **Reversible Process:** A process that can be retraced in the reverse direction so that the system and surroundings return to their original states without any net change (e.g., slow isothermal expansion).
- **Irreversible Process:** A process that cannot be retraced exactly; usually involves dissipative forces like friction or rapid changes (e.g., explosion, heat flow from hot to cold).

Q.NO.11 : Why adiabate is steeper than isotherm? Explain.

Answer : An adiabat is steeper than an isotherm because, in adiabatic expansion, both pressure and temperature decrease, causing a faster drop in pressure for a given volume change compared to isothermal expansion where temperature is constant. Mathematically, the slope of an adiabat is γtimes the slope of an isotherm ($\text{Slope}_{adi} = \gamma \times \text{Slope}_{iso}$), and since $\gamma > 1$, the adiabat is steeper.



Q.NO.12 : A refrigerator transforms heat from cold to hot body. Does this violate the second law of thermodynamics? Justify your answer.

Answer : No, it does not violate the Second Law. The Clausius statement says heat cannot flow from cold to hot *spontaneously* (without external aid). A refrigerator uses electrical energy (external work) to force this heat transfer. Since external work is supplied, the process is consistent with the Second Law.

Q.NO.13 : Explain briefly heat death of universe in terms of entropy.

Answer : The Second Law states that the entropy of the universe is constantly increasing. Eventually, all energy will be distributed uniformly, and the universe will reach a state of thermodynamic equilibrium with maximum entropy. At this point, no heat flow or useful work will be possible, leading to the "Heat Death" of the universe.

Q.NO.14 : How is work done (i) by a gas (ii) on a gas?

Answer : (i) **Work done by a gas:**

During expansion, the gas pushes the piston outward. Work is positive ($W = +P\Delta V$).

(ii) **Work done on a gas:** During compression, an external force pushes the piston inward. Work is negative ($W = -P\Delta V$). Graphically, it is the area under the PV curve.

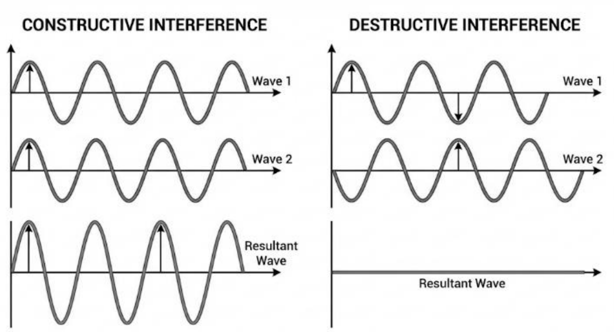
Q.NO.15 : What are the conditions for interference to occur? Answer :

1. The sources must be **coherent** (maintain a constant phase difference).
2. The waves must be **monochromatic** (single wavelength/frequency).
3. The waves should travel in the same direction.
4. The amplitudes of the waves should be nearly equal for good contrast.

Q.NO.16 : Differentiate between constructive and destructive interference of waves. Answer :

- **Constructive:** Crest meets crest or trough meets trough. Path difference is an integral multiple of wavelength ($d = m\lambda$). Amplitude is maximum.

- **Destructive:** Crest meets trough. Path difference is an odd integral multiple of half-wavelength ($d = (m + 0.5)\lambda$). Amplitude is minimum (or zero).



Q.NO.17 : What are coherent waves and coherent sources? Give examples.
Answer : Coherent sources are sources that emit waves having the same frequency and a constant phase difference relative to each other.

- **Example:** Light from a laser is coherent. Two slits illuminated by a single source in Young's experiment act as coherent sources.

Q.NO.18 : How would you apply Doppler effect in studying cardiac problems in humans?
Answer : Doppler ultrasound is used to monitor blood flow in the heart. Ultrasonic waves are directed towards an artery. The reflected waves from moving blood cells undergo a Doppler shift in frequency. By measuring this shift, the speed and direction of blood flow can be determined, helping detect blockages or valve problems.
Q.NO.19 : What is meant by diffraction of waves? For what purpose is the ripple tank used?
Answer : Diffraction is the bending or spreading of waves around the sharp edges of an obstacle or through an opening. A **Ripple Tank** is a device used to demonstrate and study water wave properties, including reflection, refraction, interference, and diffraction, by generating controlled waves on a shallow water surface.
Q.NO.20 : Why are polaroid sunglasses better than ordinary sunglasses?
Answer : Ordinary sunglasses only reduce the intensity of light (making it darker). Polaroid sunglasses contain a polarizing filter that blocks horizontally polarized light, which constitutes most of the glare reflected from flat surfaces like roads and water. This significantly reduces glare and improves visual clarity.
Q.NO.21 : Is light from the sky partially polarized? How is it so?
Answer : Yes, skylight is partially polarized. This happens due to the scattering of sunlight by air molecules in the atmosphere. The scattered light is polarized perpendicular to the direction of propagation of the original sunlight. The degree of polarization is maximum at $90°$from the sun.
Q.NO.22 : How is Malus's law used in everyday life?
Answer : Malus's Law ($I = I_0 \cos^2 \theta$) explains how intensity changes when polarized light passes through an analyzer. It is used in adjusting the brightness of LCD screens, in photography filters to control reflections, and in stress analysis of plastics (photoelasticity).
Q.NO.23 : The ratio stress/strain remains constant for small deformation. What will be the effect on this ratio when the deformation made is very large?
Answer : For small deformations (within the elastic limit), the ratio (Young's Modulus) is constant, obeying Hooke's Law. If deformation becomes very large and crosses the elastic limit into the plastic region, stress is no longer proportional to strain. The ratio decreases, and the material eventually yields and fractures.
Q.NO.24 : According to Bernoulli's theorem, the pressure of a fluid should remain uniform in a pipe of uniform radius. But actually, it goes on decreasing. Why is it so?
Answer : Bernoulli's theorem applies strictly to "ideal" fluids which are non-viscous. Real fluids possess viscosity (internal friction). As a real fluid flows through a pipe, work is done against viscous forces to overcome friction between fluid layers and the pipe walls. This energy loss manifests as a gradual drop in pressure along the pipe.
Q.NO.25 : Why are the wings of an aeroplane rounded outward while flattened inward?

Answer : The wing (airfoil) is curved on top and flat on the bottom. Air traveling over the curved upper surface must travel a longer distance and thus moves faster than the air below. According to Bernoulli's principle, higher speed on top creates lower pressure, while slower speed below creates higher pressure. The net upward pressure difference provides the **lift**.

Q.NO.26 : How does the shape of a curveball in baseball relate to Bernoulli's principle?

Answer : This is the Magnus Effect. As the ball spins, it drags a layer of air with it. On one side, the spin aids the airflow (increasing speed, lowering pressure), and on the other side, it opposes airflow (decreasing speed, increasing pressure). The pressure difference causes the ball to curve toward the low-pressure side.

Q.NO.27 : A steel wire 12 mm in diameter is fastened to a log and pulled by a tractor. The length of the wire is 11 m. A force of 10,000 N is required to pull the log. Calculate the stress in the wire.

Answer : Diameter $d = 12$ mm $= 0.012$ m, Radius $r = 0.006$ m. Force $F = 10{,}000$ N.

$$\text{Area } A = \pi r^2 = 3.14 \times (0.006)^2$$
$$= 1.13 \times 10^{-4} \text{ m}^2$$
$$\text{Stress} = \frac{F}{A}$$
$$= \frac{10{,}000}{1.13 \times 10^{-4}}$$
$$= 8.85 \times 10^7 \text{ N m}^{-2}$$

Q.NO.28 : A wooden cube of sides 10 cm each is dipped completely in water. Calculate the upthrust of water acting on it.

Answer : Volume of cube $V = (0.1 \text{ m})^3 = 0.001 \text{ m}^3$

$$\text{Density of water } \rho = 1000 \text{ kg m}^{-3}.$$
$$\text{Upthrust } F_b = \rho V g$$
$$= 1000 \times 0.001 \times 9.8$$
$$= 9.8 \text{ N}.$$

Q.NO.29 : Why does a ship made of heavy steel float on water, while a small rock sink?

Answer : A ship is hollow and occupies a very large volume. Its average density (Mass of steel + air / Total Volume) is less than the density of water. Therefore, the weight of water it displaces is equal to the total weight of the ship, providing sufficient upthrust to float. A rock is solid and denser than water, so its weight exceeds the upthrust.

Q.NO.30 : Why does the internal energy of an ideal gas remain constant during isothermal expansion?

Answer : For an ideal gas, internal energy (U) depends only on temperature ($U \propto T$). In an isothermal process, the temperature $T$is kept constant ($\Delta T = 0$). Therefore, the change in internal energy $\Delta U = 0$. All heat added is converted directly into work done by the gas.

Q.NO.31 : Why does a deck of cards become more disordered when shuffled?

Answer : This is related to Entropy and Probability. There is only one specific arrangement where cards are perfectly ordered, but there are countless arrangements where they are disordered. Shuffling moves the system from a state of low probability (order) to a state of high probability (disorder), increasing the entropy.

Q.NO.32 : The turbine in a steam power plant takes steam from a boiler at 427 °C and exhausts into a low temperature reservoir at 77 °C. What is the maximum possible efficiency?

Answer :

$$T_H = 427 + 273 = 700 \text{ K}$$
$$T_L = 77 + 273 = 350 \text{ K}$$
$$\text{Maximum (Carnot) Efficiency } \eta = 1 - \frac{T_L}{T_H}$$
$$= 1 - \frac{350}{700}$$
$$= 1 - 0.5$$
$$= 0.5$$

Percentage Efficiency = 50%.

Q.NO.33 : A stationary wave is formed on a string with frequency of 100 Hz. If the string is 2 m long, how many nodes and antinodes are formed?

Answer : (Assuming the string vibrates in its fundamental mode unless specified otherwise for "formed"). In the fundamental mode (1st harmonic), there are nodes at both fixed ends and one antinode in the center. Nodes = 2, Antinodes = 1. (If the frequency 100 Hz corresponds to a higher harmonic, more info on wave speed is needed from the text. Based on standard examples, usually fundamental is implied).

Q.NO.34 : Can you find decibel level of a travelling wave whose intensity is 10 W m^{-2}?

Answer : Yes. Reference intensity $I_o = 10^{-12}$ W m^{-2}

$$SL(dB) = 10\log\left(\frac{I}{I_o}\right)$$
$$= 10\log\left(\frac{10}{10^{-12}}\right)$$
$$SL = 10\log(10^{13})$$
$$= 10 \times 13 = 130 \text{ dB}$$

Q.NO.35 : A beam of light strikes the surface of a plate of glass with a refractive index of $n$at the polarizing angle. What will be the angle of refraction of the wave of light?

Answer : At the polarizing angle (i_p), the reflected and refracted rays are perpendicular (90° apart).

Therefore, $i_p + r = 90°$

Angle of refraction $r = 90° - i_p$.

Q.NO.36 : Find the refractive index of a medium if polarizing angle is 54.5°.

Answer : Using Brewster's Law: $n = \tan\ i_p$. $n = \tan\ (54.5°) \approx 1.40$

Q.NO.37 : Polarized light with an intensity of 75 W m^{-2} passes through an analyzer with its axis at 30° to the polarizer's axis. What is the emerging intensity?

Answer : Using Malus's Law:

$$I = I_o\cos^2\theta$$
$$I = 75 \times (\cos\ 30°)^2$$
$$= 75 \times \left(\frac{\sqrt{3}}{2}\right)^2$$
$$I = 75 \times 0.75 = 56.25 \text{ W m}^{-2}$$

Q.NO.38 : A polarized light with an amplitude of 5 units passes through a polarizer with its electric field aligned at 60° to the original polarization direction. Find the amplitude of the wave after passing through the analizer.

Answer : The amplitude transmitted is given by $A = A_o\cos\ \theta$

$$A = 5 \times \cos 60°$$
$$= 5 \times 0.5 = 2.5 \text{ units}$$

Q.NO.39 : A beam of unpolarized light passes through a foggy atmosphere. Tell the polarization state of the scattered light.

Answer : The scattered light is **partially polarized**. The light scattered at right angles to the incident beam is plane-polarized, while light scattered in other directions has varying degrees of polarization.

Q.NO.40 : What are ductile and brittle substances? Gives an example of each.

Answer :

- **Ductile:** Materials that undergo significant plastic deformation before breaking (can be drawn into wires). Example: Copper, Lead.
- **Brittle:** Materials that break just after the elastic limit with very little plastic deformation. Example: Glass, High-carbon steel.

Q.NO.41 : What is difference in elasticity and plasticity?

Answer :

- **Elasticity:** The property of a material to return to its original shape and size after the removal of the deforming force.

- **Plasticity:** The property of a material to undergo permanent deformation and fail to return to its original shape after the force is removed.

Q.NO.42 : If the strain in a wire is doubled, by what factor does the stored energy changed? Answer : Strain energy per unit volume is $U = \frac{1}{2}Y \times (\text{Strain})^2$. Since energy is proportional to the square of strain ($U \propto \epsilon^2$), if strain is doubled (2ϵ), the energy becomes $(2)^2 = 4$ times the original.

Q.NO.43 : Describe what is Ideal Fluid? Can an Ideal Fluid exist in nature?

Answer : An Ideal Fluid is defined as:

1. **Non-viscous** (No internal friction).
2. **Incompressible** (Density is constant).
3. **Steady flow** (Laminar).
4. **Irrotational**. No, a truly ideal fluid does not exist in nature; it is a theoretical approximation.

Q.NO.44 : When there is a change in the width of the river. The speed of the water decreases in wider regions whereas the speed of water increases in the narrower regions. Why?

Answer : This is due to the **Equation of Continuity** ($A_1 v_1 = A_2 v_2 = \text{constant}$). The product of cross-sectional area and speed is constant. If the width (Area) increases, the speed must decrease to maintain the same flow rate. Conversely, if the Area decreases (narrower), speed increases.

Q.NO.45 : Verify that pressure has units of energy per unit volume.

Answer :

$$\text{Pressure } P = \frac{\text{Force}}{\text{Area}} = \frac{N}{m^2}$$

Multiply numerator and denominator by meters (m)

$$P = \frac{N \cdot m}{m^2 \cdot m}$$

$$= \frac{\text{Joule}}{m^3}$$

$$= \frac{\text{Energy}}{\text{Volume}}$$

Hence verified.

Q.NO.46 : If you lower the window on a car while moving, an empty plastic bag can sometimes fly out the window. Why does this happen?

Answer : Air moves rapidly outside the moving car, creating a region of **low pressure** (Bernoulli's Principle). Inside the car, the air is relatively stationary and at higher pressure. This pressure difference (High inside →Low outside) exerts an outward force that pushes the light plastic bag out of the window.

Q.NO.47 : If you suddenly turn on your shower water at full speed, why is the shower curtain pushed inward?

Answer : The fast-moving water spray drags air along with it, creating a stream of fast-moving air inside the shower area. According to Bernoulli's Principle, this high speed reduces the air pressure inside. The higher atmospheric pressure outside the curtain pushes it inward towards the low-pressure zone.

Q.NO.48 : Define Stoke's law.

Answer : Stoke's Law states that the drag force F_d on a sphere of radius r moving slowly with speed v through a fluid of viscosity η is given by: $F_d = 6\pi\eta r v$

Q.NO.49 : Why fog droplets appear to be suspended in air?

Answer : Fog droplets are extremely small. Their terminal velocity ($v_t \propto r^2$) is directly proportional to the square of their radius. Since r is microscopic, v_t is negligible. Therefore, they fall so slowly that they appear to be suspended in the air.

Q.NO.50 : Define internal energy.

Answer : Internal energy (U) is the sum of all forms of kinetic energy (translational, rotational, vibrational) and potential energy associated with the random motion and configuration of the molecules of a substance. For an ideal gas, it depends only on temperature.

Q.NO.51 : Can we increase the internal energy by mechanical work? Explain?

Answer : Yes. According to the First Law of Thermodynamics ($Q = \Delta U + W$), if we perform work **on** the system (adiabatic compression where $Q = 0$), the work done is converted into internal energy ($\Delta U = -W_{on}$). Example: Rapidly pumping a bicycle tyre heats it up.

Q.NO.52 : Out of solid, liquid and gas of same mass and temperature, which one has greatest internal energy? And which one has least internal energy?

Answer : Greatest: Gas. The molecules have the highest kinetic energy and are furthest apart (highest potential energy). **Least:** Solid. The molecules are tightly bound with minimal vibrational kinetic energy and lowest potential energy.

Q.NO.53 : How would you explain the sign convention of First Law of Thermodynamics?

Answer :

- **Heat (Q):** Positive ($+$) if absorbed by the system; Negative ($-$) if released by the system.
- **Work (W):** Positive ($+$) if work is done **by** the system (expansion); Negative ($-$) if work is done **on** the system (compression).
- **Internal Energy (ΔU):** Positive if temperature increases; Negative if temperature decreases.

Q.NO.54 : Prove that: W = PΔV

Answer : Consider a gas in a cylinder with a movable piston of area A.

Force exerted by gas $F = PA$.

If the piston moves a small distance Δy,

Work $W = F\Delta y$. Substituting F

$W = (PA)\Delta y$.

Since $A\Delta y = \Delta V$(Change in Volume)

$W = P\Delta V$

Q.NO.55 : Justify! Work and heat are similar.

Answer : Work and heat are similar because both are modes of **energy transfer**. Neither is a property of the system (state function); they only exist during the process of transfer. Both change the internal energy of a system and have the same SI unit (Joule).

Q.NO.56 : State first law of thermodynamics and give its mathematical form.

Answer : The First Law states that energy can neither be created nor destroyed, but can be changed from one form to another. In thermodynamic terms: The heat energy supplied to a system is equal to the sum of the change in its internal energy and the work done by the system.

Equation: $Q = \Delta U + W$.

Q.NO.57 : As we know PV^{γ}= Constant. What do you know about "γ" (gamma) in this relation?

Answer : γ(Gamma) is the **Adiabatic Index** or ratio of specific heats. $\gamma = \frac{C_p}{C_v}$

Where $C_p$is molar specific heat at constant pressure and $C_v$is at constant volume. Its value depends on the atomicity of the gas (e.g., 1.67 for monatomic, 1.4 for diatomic).

Q.NO.58 : Is it possible to convert internal energy into mechanical energy? Explain with an example.

Answer : Yes, it is possible. In an **adiabatic expansion** of a gas, no heat enters the system ($Q = 0$). The work done by the gas in expanding comes at the expense of its internal energy ($\Delta U = -W$). Example: In a heat engine power stroke, the hot gas expands, cooling down and turning the crankshaft.

Q.NO.59 : What is meant by irreversible process? Give its example.

Answer : An irreversible process is one that occurs in one direction only and cannot be reversed to restore the system and surroundings to their initial states without leaving a change elsewhere. **Example:** Free expansion of a gas, explosion, or heat transfer from a hot cup of tea to room air.

Q.NO.60 : Is it possible, according to the second law of thermodynamics, to construct a heat engine that is free from thermal pollution?

Answer : No. Thermal pollution refers to the waste heat rejected to the environment. According to the Second Law (Kelvin-Planck statement), a heat engine *must* reject some heat (Q_L) to a sink to operate. Therefore, releasing exhaust heat (thermal pollution) is unavoidable.

Q.NO.61 : Define Carnot theorem in two ways.

Answer :

1. No heat engine operating between two given heat reservoirs can be more efficient than a Carnot engine operating between the same two reservoirs.
2. All Carnot engines operating between the same two heat reservoirs have the same efficiency, regardless of the working substance.

Q.NO.62 : What is the difference between heat engine and refrigerator?
Answer :

- **Heat Engine:** Converts heat into mechanical work. Takes heat from high temp, rejects to low temp. Work is the output.
- **Refrigerator:** Transfers heat from low temp to high temp. Requires external work as input.

Q.NO.63 : Why the Entropy of the universe always increases?
Answer : Natural processes are irreversible and spontaneous, moving from order to disorder. Since probability favors disordered states, the total entropy (measure of disorder) of an isolated system (like the universe) always increases over time ($\Delta S > 0$).
Q.NO.64 : State second law of thermodynamics is terms of entropy.
Answer : In any natural (irreversible) process, the total entropy of the system and its surroundings always increases. $\Delta S_{total} \geq 0$
Q.NO.65 : Entropy has often called as "time arrow". Explain?
Answer : Entropy provides a direction to time. In the macroscopic world, events happen in a sequence where entropy increases (e.g., a glass breaking). We never see the reverse (glass assembling) because it decreases entropy. Thus, the increase of entropy distinguishes the past from the future, acting as an "arrow of time."
Q.NO.66 : Does entropy of a system increases or decreases due to friction?
Answer : Entropy **increases**. Friction converts mechanical energy into heat (thermal energy). This heat dissipates, increasing the random motion of molecules, thereby increasing disorder and entropy.
Q.NO.67 : What is the conditions on the path difference for constructive interference of two waves?
Answer : For constructive interference, the path difference (d) between the two waves must be an integral multiple of the wavelength. $d = m\lambda$, where $m = 0,1,2, ...$
Q.NO.68 : What is the conditions on the path difference for destructive interference of two waves?
Answer : For destructive interference, the path difference (d) must be an odd integral multiple of half-wavelengths. $d = \left(m+\frac{1}{2}\right)\lambda$where $m = 0,1,2, ...$
Q.NO.69 : Does destructive interference of two waves involve a loss of energy? Explain.
Answer : No, energy is not lost. The Law of Conservation of Energy holds. In interference, energy is merely **redistributed**. The energy missing at points of destructive interference (dark fringes) appears at points of constructive interference (bright fringes). The average energy remains constant.
Q.NO.70 : On what factors does the speed of stationary waves in a stretched string depend?
Answer : The speed $v$depends on:

1. **Tension (F):** The force stretching the string.
2. **Linear Mass Density (m):** Mass per unit length of the string. Formula: $v = \sqrt{\frac{F}{m}}$

Q.NO.71 : If you blow air across the mouth of an empty soda bottle, you hear a tone. Why is it that if you put some water in the bottle, the pitch of the tone increases?
Answer : The bottle acts as a closed organ pipe. The fundamental frequency is inversely proportional to the length of the air column ($f = v/4L$). Adding water reduces the length (L) of the air column. As Ldecreases, the frequency f(pitch) increases.
Q.NO.72 : Define "BEATS" and "BEATS" frequency.
Answer : Beats: The periodic variation (waxing and waning) in the intensity of sound heard when two notes of slightly different frequencies are sounded together. **Beat Frequency:** The number of beats heard per second, equal to the difference between the two frequencies ($f_{beat} = f_1 - f_2$).
Q.NO.73 : Can you apply Doppler Effect for light wave and source of light?

Answer : Yes. If a light source moves towards an observer, the frequency appears higher (Blue Shift). If it moves away, the frequency appears lower (Red Shift). This is used by astronomers to calculate the speed of stars and galaxies.

Q.NO.74 : If both the source and the observer are moving in the same direction with the same speed, will there be a Doppler shift? Why or why not?

Answer : No, there will be no Doppler shift. The Doppler effect depends on the **relative velocity** between the source and the observer. If they move with the same velocity in the same direction, the relative velocity is zero, so the observed frequency equals the actual frequency.

Q.NO.76 : Can sound waves be polarized? Explain.

Answer : No, sound waves cannot be polarized. Polarization is a property unique to **transverse waves**, where vibrations can be restricted to one plane. Sound waves are **longitudinal** (compressional), meaning vibrations are parallel to the direction of propagation, making polarization impossible.

Q.NO.77 : Unpolarized light falls on two polarizing sheets so oriented that on light is transmitted. If a third polarizing sheet is placed between them, can light be transmitted? If so, explain how.

Answer : Yes. Initially, the two sheets are crossed (90°), blocking all light. If a third sheet is placed between them at an angle (e.g., 45°), it rotates the plane of polarization of the light emerging from the first sheet. A component of this rotated light is now parallel to the axis of the last sheet, allowing some light to pass through.

Q.NO.78 : Differentiate between Tensile and Compressive Modes of Stress and Strain.

Answer :

- **Tensile:** Forces act outwards to stretch the body. Increases length. (Positive strain).
- **Compressive:** Forces act inwards to squeeze the body. Decreases length or volume. (Negative strain).

Q.NO.79 : Draw stress-strain curves for ductile and brittle materials.

Answer : (Since I cannot draw, I will describe).

- **Ductile Curve:** Shows a linear elastic region, a yield point, a long plastic region where the curve flattens, and finally a fracture point.
- **Brittle Curve:** Shows a linear elastic region that ends abruptly at the fracture point with little to no plastic deformation.

Q.NO.80 : What are ductile and brittle substances? Give an example of each.

Answer : (Refer to Q.NO.40). Ductile: Copper (large plastic region). Brittle: Glass (no plastic region).

Q.NO.81 : Define the term (i). Elastic limit (ii). Ultimate tensile strength from stress strain curve.

Answer : (i) **Elastic Limit:** The maximum stress a material can withstand without permanent deformation. Beyond this, it does not return to the original shape. (ii) **Ultimate Tensile Strength (UTS):** The maximum stress (peak of the curve) the material can support before it begins to neck and eventually fracture.

Q.NO.82 : Explain how swing is produced in a fast-moving cricket ball.

Answer : Swing is produced by the difference in airflow over the two sides of the ball (smooth vs rough/seam). This creates a turbulent boundary layer on one side and laminar on the other, or delays separation. The resulting pressure difference (Bernoulli/Magnus effect) causes the ball to deviate (swing) sideways.

Q.NO.83 : Explain what do you understand by the term viscosity.

Answer : Viscosity is the internal friction of a fluid. It is the property by virtue of which a fluid opposes the relative motion between its different layers. Liquids with high viscosity (honey) flow slowly, while those with low viscosity (water) flow easily.

Q.NO.84 : Explain how thermodynamics relates to the concept of energy conservation.

Answer : Thermodynamics is essentially the study of energy conservation. The **First Law of Thermodynamics** is the statement of the Law of Conservation of Energy applied to thermal systems: Heat added = Increase in Internal Energy + Work done. It ensures that energy is never lost, only transformed.

Q.NO.85 : Explain how thermodynamics applies to biological systems, such as human body.

Answer : The human body acts as a thermodynamic system. We take in chemical energy (food), convert it into internal energy (metabolism), do mechanical work, and release heat to the surroundings. The First Law ($\Delta U = Q - W$) applies to our energy balance and metabolic rate.

Q.NO.86 : A gas is expanding adiabatically. Explain what happens to temperature and pressure of the gas.

Answer : During adiabatic expansion ($Q = 0$), the gas does work at the expense of its own internal energy.

1. **Internal Energy decreases**, so **Temperature falls**.
2. **Pressure decreases** significantly because both volume increases and temperature decreases (Pressure falls faster than in isothermal expansion).

Q.NO.87 : How we can explain different weather patterns through thermodymical processes like wind, rain, etc.

Answer : Weather is driven by thermodynamic processes. Solar heating creates temperature differences (First Law). Hot air rises (convection), expands adiabatically, and cools. When it cools to the dew point, water vapor condenses (phase change/latent heat), forming clouds and rain. Winds are caused by pressure differentials driven by these thermal changes.

Q.NO.88 : Can you compare the compressions and rarefactions of a longitudinal wave with the peaks and troughs of a transverse wave.

Answer : Yes.

- **Compression:** A region of high density/pressure in a longitudinal wave corresponds to a **Crest** (peak) in a transverse wave.
- **Rarefaction:** A region of low density/pressure corresponds to a **Trough** in a transverse wave.

Q.NO.89 : How should a source of sound move with respect to an observer so that the frequency of its sound does not change? Write two examples.

Answer : The frequency does not change if the **relative radial velocity** is zero.

1. The source and observer move in the same direction with the **same speed**.
2. The source moves in a **circle** around the stationary observer (transverse motion).

Q.NO.90 : Why is it difficult to recognize beats when the frequency difference is greater than 10 Hz? Exemplify.

Answer : The human ear has a "persistence of hearing" of about 0.1 seconds. If the beat frequency is higher than 10 Hz (more than 10 beats per second), the ear cannot distinguish the individual intensity rises and falls. The sound is perceived as a continuous tone or a rattle rather than distinct beats.

Q.NO.91 : Which measurement of a wave is the most important when determining the wave's intensity?

Answer : The **Amplitude**. Intensity is directly proportional to the square of the amplitude ($I \propto A^2$). A small increase in amplitude results in a large increase in intensity (energy transmitted).

Q.NO.92 : Can you apply Doppler effect to light waves? Describe briefly.

Answer : Yes. When a light source moves relative to an observer, the observed frequency changes. Moving away causes a shift toward lower frequency/red end (**Red Shift**). Moving closer causes a shift toward higher frequency/blue end (**Blue Shift**).

Q.NO.93 : Would it be possible to use a polarizer as an analyzer? If yes, give examples.

Answer : Yes, a polarizer and an analyzer are physically the same device (e.g., a sheet of Polaroid). The name depends on the function: the first sheet produces polarized light (Polarizer), and the second sheet tests/analyzes it (Analyzer). Example: Two identical sunglass lenses can be used to demonstrate this.

Q.NO.94 : How will the sky appear without an atmosphere?

Answer : The sky would appear **black**, even during the day. The blue color of the sky is due to the scattering of sunlight by atmospheric molecules (Rayleigh scattering). Without an atmosphere, there would be no scattering, and we would look directly into the dark void of space.

Q.NO.95 : Explain how Malus's law is used in the design of polarized sunglasses. How do these surfaces reduce glare from reflective surface? Provide an example to illustrate your answer.

Answer : Light reflected from horizontal surfaces (roads, water) is partially polarized horizontally. Polarized sunglasses have a vertical transmission axis. According to Malus's Law, when the horizontal glare meets the vertical filter ($\theta = 90°$), the transmitted intensity is $I = I_o \cos^2 90° = 0$. Thus, glare is eliminated.

Q.NO.96 : What is the significance of detecting gravitational waves?

Answer : Detecting gravitational waves confirms Einstein's General Theory of Relativity. It provides a new way to observe the universe, allowing us to detect cataclysmic events like colliding black holes or neutron stars that do not emit light, revealing "invisible" cosmic processes.

Q.NO.97 : How are tidal forces formed?

Answer : Tidal forces are formed due to the **differential gravitational pull** of the Moon (and Sun) on different parts of the Earth. The side of Earth closest to the Moon feels a stronger pull than the center, and the center feels a stronger pull than the far side. This difference stretches the Earth (and oceans), creating high tides.

Question NO.4

Q.NO.1 : Define electric intensity and electric potential.

Answer : Electric Intensity (E): The force experienced by a unit positive test charge placed at a point in an electric field. It is a vector quantity. SI unit is NC^{-1}or Vm^{-1}.

Electric Potential (V): The work done in bringing a unit positive charge from infinity to a point in the electric field against the electric force. It is a scalar quantity. SI unit is Volt (V) or JC^{-1}.

Q.NO.2 : Is electron-volt a unit of potential difference or energy? Explain.

Answer : Electron-volt (eV) is a unit of **energy**, not potential difference. It is defined as the amount of kinetic energy gained or lost by an electron when it moves through a potential difference of one volt.

$$1\text{ eV} = 1.6 \times 10^{-19}\text{ J.}$$

Q.NO.3 : A copper wire of length L has resistance R. It is stretched to double of its length. What will be the resistance of the new length of wire?

Answer : When a wire is stretched to double its length ($L' = 2L$), its volume remains constant ($V = AL = A'L'$), so the area of cross-section becomes half ($A' = A/2$).

New Resistance $R' = \rho\frac{L'}{A'} = \rho\frac{2L}{A/2} = 4\left(\rho\frac{L}{A}\right) = 4R$.

The resistance increases by a factor of 4.

Q.NO.4 : Why does the resistance of a conductor rise with an increase in temperature?

Answer : As temperature increases, the amplitude of vibration of the atoms in the crystal lattice increases. This increases the probability of collisions between the free electrons and the vibrating atoms. These frequent collisions offer more opposition to the flow of current, thereby increasing the resistance.

Q.NO.5 : Is the filament resistance lower or higher in a 500W-220V light bulb than in a 100W-220V bulb?

Answer : The resistance is **lower** in the 500W bulb.

$$\text{Formula: } P = \frac{V^2}{R} \Rightarrow R = \frac{V^2}{P}.$$

Since voltage $V$is constant (220V), Resistance is inversely proportional to Power ($R \propto 1/P$).

Therefore, the higher power bulb (500W) has lower resistance.

Q.NO.6 : Why does the resistance of a thermistor decrease as temperature increases?

Answer : Thermistors are made of semiconductor materials. As temperature increases, more electron-hole pairs are generated due to thermal energy, increasing the number of charge carriers. This increase in charge carrier density enhances conductivity and thus decreases resistance (Negative Temperature Coefficient).

Q.NO.7 : An uncharged conducting hollow sphere is placed in the field of a positive charge q. What will be the net flux through the shell?

Answer : The net electric flux through the closed surface of the shell is **zero**.

According to Gauss's Law :

$$\phi_e = Q_{enclosed}/\epsilon_0$$

since the sphere encloses no net charge (it is uncharged and the external charge $q$is outside), the total flux entering equals the total flux leaving.

Q.NO.8 : A potential difference is applied across the ends of a copper wire. What is the effect on the drift velocity of free electrons by (i) increasing the potential difference? (ii) decreasing the length and the temperature of the wire?

Answer : Drift velocity $v_d = \frac{eV}{mL}\tau$(where $\tau$is relaxation time).

(i) **Increasing PD (V):** Drift velocity increases ($v_d \propto V$).
(ii) **Decreasing Length (L):** Drift velocity increases ($v_d \propto 1/L$).
(iii) **Decreasing Temperature:** Increases relaxation time τ(less collisions), so drift velocity increases.

Q.NO.9 : Why does the terminal potential difference of a battery decrease when the current drawn from it is increased?

Answer : The terminal potential difference (V_t) is given by $V_t = \varepsilon - Ir$, where $\varepsilon$is EMF and $r$is internal resistance. When current Iincreases, the potential drop across the internal resistance (Ir) increases. Consequently, the terminal potential difference $V_t$decreases.

Q.NO.10 : A square loop of wire is moving through a uniform magnetic field. The normal to the loop is oriented parallel to the magnetic field. Is an emf induced in the loop? Give a reason for your answer.

Answer : No, emf is not induced. Reason: The magnetic field is uniform, so the magnetic flux ($\phi_B = B \cdot A$) passing through the loop remains constant as it moves. According to Faraday's Law, induced emf depends on the *rate of change* of flux. Since $\Delta\phi/\Delta t = 0$, emf is zero.

Q.NO.11 : Can a single moving proton produce a magnetic field?

Answer : Yes. A moving charge constitutes a current (microscopically), and every current produces a magnetic field. Therefore, a moving proton produces a magnetic field in the space around it.

Q.NO.12 : A magnetic field is necessary if there is to be a magnetic flux through a coil of wire. Yet, just because there is a magnetic field does not mean that a magnetic flux will pass through a coil. Account for this situation.

Answer : Magnetic flux is defined as $\Phi_B = \vec{B} \cdot \vec{A} = BA\cos\ \theta$. If the plane of the coil is parallel to the magnetic field lines, the angle θbetween the area vector and the field is 90°. Then $\Phi_B = BA\cos\ 90° = 0$. Thus, a field exists, but zero flux passes *through* the coil.

Q.NO.13 : A charge is lying stationary between the opposite poles of two magnets. Is a magnetic force exerted on it? Why?

Answer : No, no magnetic force is exerted. The magnetic force on a charge is given by $F = qvB\sin\ \theta$. Since the charge is stationary, its velocity $v = 0$. Therefore, the force $F = 0$.

Q.NO.14 : Is it possible to change both the area of the loop and the magnetic field passing through the loop and still not have an induced emf in the loop? Give reason.

Answer : Yes, it is possible. If the area $A$and magnetic field Bchange simultaneously in such a way that the product (Magnetic Flux $\Phi = BA$) remains constant, then the rate of change of flux is zero ($\Delta\Phi/\Delta t = 0$). Hence, no induced emf is produced.

Q.NO.15 : Does the application of uniform magnetic field to a moving charged particle result in a change in kinetic energy of the particle? Explain.

Answer : No. The magnetic force (F_m) always acts perpendicular to the velocity of the particle. Therefore, the work done by the magnetic force is zero ($W = \vec{F} \cdot \vec{d} = 0$). Since no work is done, the kinetic energy of the particle remains constant; only its direction changes.

Q.NO.16 : A conductor moves in a magnetic field when a current is passed through the conductor. Would you expect the reverse effect to occur? That is, would a current be produced if a conductor is moved across the magnetic field?

Answer : Yes, the reverse effect occurs. This is the phenomenon of **Electromagnetic Induction**. When a conductor moves across a magnetic field, it cuts magnetic flux lines, and an induced emf (motional emf) is generated, which drives an induced current if the circuit is closed.

Q.NO.17 : What will you do if you want to save a sensitive instrument from stray magnetic fields?
Answer : To protect a sensitive instrument from stray magnetic fields, I would place it inside an enclosure (box) made of a soft ferromagnetic material (like soft iron). The magnetic field lines will pass through the ferromagnetic material rather than the air space inside, effectively shielding the instrument (Magnetic Shielding).
Q.NO.18 : What are the two postulates of special theory of relativity?
Answer :
1. **Principle of Relativity:** The laws of physics are the same in all inertial frames of reference.
2. **Constancy of Speed of Light:** The speed of light in free space (c) is constant and independent of the motion of the source or the observer.

Q.NO.19 : Describe why it is impossible for a material particle to move with speed of light.
Answer : According to the relativistic mass equation $m = \frac{m_0}{\sqrt{1-v^2/c^2}}$, as the speed $v$approaches the speed of light c, the denominator approaches zero, and the mass $m$approaches infinity. An infinite mass would require an infinite amount of energy to accelerate, which is impossible.
Q.NO.20 : What is meant by proper time, and proper length?
Answer :
- **Proper Time (t_0):** The time interval measured by an observer who is at rest with respect to the events (the events happen at the same location in their frame).
- **Proper Length (L_0):** The length of an object measured by an observer who is at rest with respect to the object.

Q.NO.21 : What is meant by relativistic mass, length and time?
Answer :
- **Relativistic Mass:** Mass increases with speed ($m = \gamma m_0$).
- **Length Contraction:** Moving objects appear shorter in the direction of motion ($L = L_0/\gamma$).
- **Time Dilation:** Moving clocks run slower compared to stationary clocks ($t = \gamma t_0$).

Q.NO.22 : Why mass of a moving object increases?
Answer : According to Einstein's Special Theory of Relativity, energy and mass are equivalent. When energy is supplied to an object to increase its speed, at relativistic speeds, a part of this energy increases its inertia (mass) rather than just speed, following the relation $m = \frac{m_0}{\sqrt{1-v^2/c^2}}$.
Q.NO.23 : Explain that speed of light is an ultimate limit for any object.
Answer : No material object can reach the speed of light because, at $v = c$, the relativistic mass becomes infinite, time stops, and length becomes zero. The energy required to reach $c$is infinite, which is physically unattainable. Thus, $c$is the cosmic speed limit.
Q.NO.24 : Give examples where the results of special theory of relativity have been verified.
Answer :
1. **Muon Decay:** Muons created in the upper atmosphere reach the Earth's surface due to time dilation (their lifetime extends).
2. **GPS Satellites:** Atomic clocks on satellites must be corrected for relativistic time dilation to provide accurate positioning.
3. **Nuclear Energy:** Mass defect converting to energy ($E = mc^2$) in fission/fusion.

Q.NO.25 : If the speed of light is just 50 m/s, how would everyday events appear to?
Answer : If $c = 50$ m/s, relativistic effects would be noticeable in daily life. Cars moving at highway speeds would appear significantly shortened (length contraction), people in motion would age slower (time dilation), and objects would become noticeably heavier as they speed up.
Q.NO.26 : If the speed of light were infinite, what would the equations of special theory of relativity reduce to?
Answer : If $c \to \infty$, the factor $\frac{v^2}{c^2} \to 0$and $\gamma = \frac{1}{\sqrt{1-0}} = 1$. The relativistic equations would reduce to classical Galilean transformation equations: $t = t_0$(Time is absolute) and $m = m_0$(Mass is constant).

Q.NO.27 : According to Einstein's equation $E = mc^2$, is it possible to create a single electron from energy?
Explain. Answer : No, it is not possible to create a *single* electron. Energy can convert into mass via **Pair Production**, where a photon creates an electron-positron pair to conserve charge, momentum, and lepton number. Creating a single electron would violate the law of conservation of charge.
Q.NO.28 : What do different isotopes of a given element have in common? How are they different?
Answer :

- **Common:** They have the same number of protons (Atomic Number Z) and same chemical properties.
- **Different:** They have different numbers of neutrons (Mass Number A) and different physical properties (like stability, mass).

Q.NO.29 : Fill in the missing particle or nucleus:
Answer :
a. $^{45}_{20}\text{Ca} \rightarrow \ ^{45}_{21}\text{Sc} + e^- + \bar{\nu}$(Beta decay increases Z by 1).
b. $^{58}_{29}\text{Cu}^* \rightarrow \ ^{58}_{29}\text{Cu} + \gamma$(Gamma decay changes energy state, not Z or A).
Q.NO.30 : Why neutrino must be released in the positron emission?
Answer : A neutrino (specifically an electron neutrino, ν_e) is released to satisfy the laws of **conservation of energy, momentum, and angular momentum (spin)**. Without it, the energy distribution of the emitted positron would be violated.
Q.NO.31 : Distinguish between fermions and bosons.
Answer :

- **Fermions:** Particles with half-integer spin ($1/2, 3/2\ldots$). They obey Pauli's Exclusion Principle (e.g., electrons, protons, quarks).
- **Bosons:** Particles with integer spin ($0,1,2\ldots$). They do not obey Pauli's Exclusion Principle (e.g., photons, gluons).

Q.NO.32 : Can there be pair production for photons having energy 20 keV? Explain briefly.
Answer : No. Pair production requires a minimum photon energy of **1.02 MeV** (rest mass energy of electron + positron). 20 keV is far below this threshold, so it cannot create an electron-positron pair; it may instead undergo photoelectric effect or Compton scattering.
Q.NO.33 : What is the difference between beta particle and electron?
Answer : They are identical in mass and charge, but differ in **origin**.

- **Beta particle:** Emitted from the *nucleus* due to the decay of a neutron.
- **Electron:** Exists in the *orbital shells* surrounding the nucleus.

Q.NO.34 : How do a proton and a neutron convert to each other?
Answer : They convert via weak nuclear force interactions:

- **Neutron to Proton:** $n \rightarrow p + e^- + \bar{\nu}_e$(Beta-minus decay).
- **Proton to Neutron:** $p \rightarrow n + e^+ + \nu_e$(Beta-plus decay) or via Electron Capture ($p + e^- \rightarrow n + \nu_e$).

Q.NO.35 : Differentiate between hadron and leptons with examples.
Answer :

- **Hadrons:** Particles that experience the **Strong Nuclear Force**. They are made of quarks (e.g., Protons, Neutrons, Mesons).
- **Leptons:** Particles that *do not* experience the Strong Nuclear Force. They are fundamental particles (e.g., Electrons, Neutrinos, Muons).

Q.NO.36 : What are Mesons? Give example.
Answer : Mesons are unstable hadrons composed of one quark and one antiquark pair. They are the carriers of the strong nuclear force between nucleons. Examples: Pi-meson (Pion, π), K-meson (Kaon).
Q.NO.37 : Is meson or boson or fermion? Give reason.
Answer : A meson is a **Boson**. Reason: It is composed of a quark (spin 1/2) and an antiquark (spin 1/2). Their combined spin is an integer (0 or 1), which characterizes bosons.
Q.NO.38 : Which is more energetic alpha decay or beta decay? Justify your answer.

Answer : Alpha decay is typically more energetic in terms of the particle's kinetic energy (several MeV) because the heavy alpha particle carries away most of the reaction energy. Beta particles have a continuous spectrum of energy, sharing it with neutrinos, and generally have lower average energy.

Q.NO.39 : Why does the α-particles not make physical contact with the nucleus when headed directly toward it?

Answer : Due to the strong **electrostatic force of repulsion** (Coulomb force). Both the alpha particle and the nucleus are positively charged. As the alpha particle approaches, the repulsive force slows it down until it stops at the "distance of closest approach" before turning back, preventing physical contact.

Q.NO.40 : Does an electrostatic force exist between a charged and an uncharged body?

Answer : Yes. An electrostatic force (attraction) exists due to **electrostatic induction**. The charged body induces opposite charges on the near side of the uncharged body and like charges on the far side. Since the opposite charges are closer, the net force is attractive.

Q.NO.41 : Why is it advised to wear rubber soled shoes while handling electric appliances?

Answer : Rubber is a good **insulator** (dielectric). Wearing rubber-soled shoes breaks the electrical contact between the person's body and the ground (Earth). This prevents current from flowing through the body to the ground in case of accidental contact with a live wire, protecting against electric shock.

Q.NO.42 : A particle carrying a charge of 2e falls through a potential difference of 3.0 V. Calculate the energy required by it.

Answer : Energy $E = qV$

$$q = 2e, V = 3.0\text{ V}$$
$$E = (2e)(3.0\text{ V})$$
$$= 6\text{ eV}$$
$$\text{In Joules: } 6 \times 1.6 \times 10^{-19}$$
$$= 9.6 \times 10^{-19}\text{ J.}$$

Q.NO.43 : A copper wire has a cross-sectional area of $2 \times 10^{-5} m^2$ and carries a current of 3A. If the number of electrons per unit volume is $8.5 \times 10^{28} m^{-3}$ calculate the drift velocity.

Answer : Formula: $I = nAev_d \Rightarrow v_d = \frac{I}{nAe}$

$$v_d = \frac{3}{(8.5 \times 10^{28})(2 \times 10^{-5})(1.6 \times 10^{-19})}$$
$$v_d = \frac{3}{27.2 \times 10^4} \approx 1.1 \times 10^{-5}\text{ m/s.}$$

Q.NO.44 : 0.75 A current flows through an iron wire when a battery of 1.5 V is connected across its ends. The length of the wire is 5.0 m and its cross-sectional area is $2.5 \times 10^{-7} m^2$. Compute resistivity.

Answer : $R = V/I = 1.5/0.75 = 2\,\Omega$

$$\text{Resistivity } \rho = \frac{RA}{L} = \frac{2 \times 2.5 \times 10^{-7}}{5.0}$$
$$\rho = \frac{5.0 \times 10^{-7}}{5.0}$$
$$= 1.0 \times 10^{-7}\ \Omega\text{m.}$$

Q.NO.45 : Why is a three pin plug used in some electric appliances?

Answer : The third pin is the **Earth pin**. It connects the metal casing of the appliance to the ground. If a fault occurs and the live wire touches the casing, the current flows safely to the earth through the earth wire (low resistance path) instead of through the user, blowing the fuse and preventing shock.

Q.NO.46 : A 20.0 cm wire carrying current of 10.0 A placed in a uniform magnetic field of 0.30 T. If the wire makes an angle of 40° with the field, find the force.

Answer : $F = ILB\sin\,\theta$. $L = 0.2\text{ m}, I = 10\text{ A}, B = 0.3\text{ T}, \theta = 40^\circ$. $F = 10 \times 0.2 \times 0.3 \times \sin\,40^\circ = 0.6 \times 0.6428$. $F \approx 0.386\text{ N}$.

Q.NO.47 : Why does a picture become distorted when a magnetic bar is brought near to the screen of TV, Computer, Monitor or Oscilloscope?

Answer : These screens (CRTs) use electron beams to create images. Moving electrons are deflected by magnetic fields ($F = qv \times B$). Bringing a magnet near modifies the path of the electron beam due to the external magnetic force, causing it to strike the wrong phosphors, which distorts the image and colors.

Q.NO.48 : Find the mass m of a moving object with speed 0.8 c.

Answer : $m = \frac{m_0}{\sqrt{1-v^2/c^2}}$. Given $v = 0.8c$, so $v^2/c^2 = 0.64$. $m = \frac{m_0}{\sqrt{1-0.64}} = \frac{m_0}{\sqrt{0.36}} = \frac{m_0}{0.6}$. $m \approx 1.67m_0$.

Q.NO.49 : Repulsion is sure test for electrification. Explain.

Answer : Attraction can occur between a charged body and an uncharged body (due to induction) OR between oppositely charged bodies. However, **repulsion** only occurs between two bodies having like charges. Therefore, if bodies repel, they must both be charged.

Q.NO.50 : What is the effect of medium between the charges upon coulomb's force? Explain.

Answer : The presence of a dielectric medium (insulator) reduces the Coulomb force. $F_{med} = \frac{F_{vac}}{\epsilon_r}$.

Since relative permittivity $\epsilon_r > 1$for all dielectrics, the force decreases.

Q.NO.51 : If the electric force between two charges is 20 N when they are 5 meters apart, what will be the force when they are 2 meters apart?

Answer : $F \propto \frac{1}{r^2}$

$$\frac{F_2}{F_1} = \frac{r_1^2}{r_2^2}$$
$$= \frac{5^2}{2^2}$$
$$= \frac{25}{4}$$
$$= 6.25$$
$$F_2 = 20 \times 6.25$$
$$= 125 \text{ N}.$$

Q.NO.52 : Define electric flux. Write its SI units.

Answer : Electric flux is the total number of electric field lines passing perpendicularly through a given area. $\Phi_e = \vec{E} \cdot \vec{A}$. SI Unit: Nm^2C^{-1}or Volt-meter (Vm).

Q.NO.53 : Does the total flux depend upon the shape or geometry of the closed surface?

Answer : No. According to Gauss's Law, $\Phi_e = Q/\epsilon_0$. The total flux depends only on the net charge enclosed within the surface, not on the shape, size, or geometry of the Gaussian surface.

Q.NO.54 : Define and give the SI units of electric potential.

Answer : Electric potential is the electric potential energy per unit charge. It is the work done moving a unit positive charge from infinity to that point. SI Unit: Volt (V), where $1V = 1J/C$.

Q.NO.55 : Derive relation for potential gradient $E = \Delta V/\Delta r$.

Answer : Work done moving charge $q_0$through dist Δr against field E is $\Delta W = -F\Delta r = -q_0E\Delta r$.

Also $\Delta W = q_0\Delta V$

Equating: $q_0\Delta V = -q_0E\Delta r \Rightarrow \Delta V = -E\Delta r$. $E = -\frac{\Delta V}{\Delta r}$.

Q.NO.56 : What is the potential gradient? Write its units.

Answer : Potential gradient is the rate of change of electric potential with respect to distance ($\frac{\Delta V}{\Delta r}$). Its direction is opposite to the electric field. SI Unit: Volts per meter (Vm^{-1}).

Q.NO.57 : Show that $1\,N/C = 1\,V/m$.

Answer : $1\,V = 1\,J/C = 1\,(N \cdot m)/C$.

So, $1\,V/m = \frac{1\,N \cdot m/C}{1\,m} = 1\,N/C$. Hence proved.

Q.NO.58 : Define electron volt. Answer : It is the energy acquired or lost by an electron when it passes through a potential difference of 1 volt. It is a non-SI unit of energy used in atomic physics.

Q.NO.59 : Show that: $1eV = 1.6 \times 10^{-19} J$**. Answer :** $\Delta KE = q\Delta V$. For an electron, $q = e = 1.6 \times 10^{-19}$ C. Let $\Delta V = 1$ Volt. 1 eV $= (1.6 \times 10^{-19}$ C$)(1$ J/C$) = 1.6 \times 10^{-19}$ J.

Q.NO.60 : What are the difficulties in testing whether the filament of a lighted bulb obeys Ohm's law?

Answer : Ohm's law requires physical state (temperature) to remain constant. In a lighted bulb, the temperature of the filament rises significantly as voltage increases (due to heating effect). The resistance changes (increases), so the I-V graph is not a straight line, making it difficult to verify Ohm's law in the linear sense.

Q.NO.61 : Differentiate between resistance and resistivity, their units.

Answer :

- **Resistance (R):** Opposition to current. Depends on dimensions (L, A). Unit: Ohm (Ω).
- **Resistivity (ρ):** Intrinsic property of material, independent of dimensions. Unit: Ohm-meter (Ωm).

Q.NO.62 : Define temperature co-efficient of resistance and write its formula.

Answer : It is the fractional change in resistance per unit change in temperature (kelvin).

Formula: $\alpha = \frac{R_t - R_0}{R_0 t}$. Unit: K^{-1}or C^{-1}.

Q.NO.63 : What is the negative co-efficient of temperature? Give two substances.

Answer : It means resistance decreases as temperature increases. This is typical of semiconductors and insulators. Examples: **Carbon (Graphite)**, **Silicon**, **Germanium**.

Q.NO.64 : A wire of length 10 m has resistance 100 Ω. If the wire is stretched to increase its length three times, what will be its new resistance?

Answer : Stretched to 3 times ($L' = 3L$). Area becomes $1/3(A' = A/3)$.

$$R' = \rho \frac{3L}{\frac{A}{3}}$$
$$= 9\rho \frac{L}{A} = 9R$$
$$R' = 9 \times 100$$
$$= 900\ \Omega.$$

Q.NO.65 : Prove that: Volt x Ampere = Watt.

Answer :

Volt = Joule/Coulomb (J/C)

Ampere = Coulomb/Second (C/s)

Volt ×Ampere = $\frac{J}{C} \times \frac{C}{s} = \frac{J}{s} =$ Watt.

Q.NO.66 : Three bulbs 40 W, 60 W and 100 W are connected to 220 V mains. Which bulb will glow brightly, if they are connected in series?

Answer : In series, current I is same. Brightness depends on Power dissipated ($P = I^2R$).

Resistance $R = V^2/P_{rated}$. The 40W bulb has the highest resistance.

Since $P \propto R$in series, the **40 W bulb** (highest R) glows brightest.

Q.NO.67 : Three bulbs 40 W, 60 W and 100 W are connected to 220 V mains. Which bulb will glow brightly, if they are connected in parallel?

Answer : In parallel, voltage $V$is same. Brightness depends on Power ($P = V^2/R$). Since voltage is constant, the bulb with the lowest resistance draws the most power. The **100 W bulb** (designed for highest power) glows brightest.

Q.NO.68 : What is meant by an electromotive force (emf)? Give its unit.

Answer : EMF is the energy supplied by a source (battery/cell) to a unit charge to move it once around a complete circuit. SI Unit: Volt (V) or Joule per Coulomb (J/C).

Q.NO.69 : Under what conditions emf of a cell and terminal potential difference become equal?

Answer : $V_t = E - Ir$. They become equal ($V_t = E$) when the current drawn from the cell is **zero** ($I = 0$), i.e., when the circuit is **open**.

Q.NO.70 : Distinguish between electromotive force and potential difference.

Answer :

- **EMF:** Cause of current; energy supplied by source; exists even when circuit is open.
- **PD:** Effect of current; energy dissipated across components; becomes zero when circuit is open.

Q.NO.71 : What is short-circuit and open circuit mean to you?
Answer :
- **Short-circuit:** A path of zero (or very low) resistance, causing excessive current flow ($I \rightarrow \infty$).
- **Open circuit:** A break in the circuit (infinite resistance), causing zero current flow ($I = 0$).

Q.NO.72 : Under what circumstances can the terminal potential difference of a battery exceed its emf?
Answer : When the battery is being **charged**. An external source drives current *into* the positive terminal, reversing the internal drop. $V_t = E + Ir$, so $V_t > E$.
Q.NO.73 : Write down the rules for finding the potential changes along a circuit?
Answer :
1. Moving across a resistor in direction of current: Potential drop ($-IR$). Opposite: Gain ($+IR$).
2. Moving across a battery from - to +: Gain ($+E$). From + to -: Drop ($-E$).

Q.NO.74 : Give statement of Kirchhoff 1^{st} rule and 2^{nd} rule. Answer :
- **1st Rule (Current Rule):** Algebraic sum of all currents meeting at a junction is zero ($\sum I = 0$). Based on conservation of charge.
- **2nd Rule (Voltage Rule):** Algebraic sum of potential changes in a closed loop is zero ($\sum V = 0$). Based on conservation of energy.

Q.NO.75 : Why does no current pass through galvanometer in a balanced wheat stone bridge although the two keys in the circuit are closed?
Answer : In a balanced bridge ($R_1/R_2 = R_3/R_4$), the potential at point B equals the potential at point D. Since there is no potential difference ($V_B - V_D = 0$), no current flows through the galvanometer connected between them.
Q.NO.76 : Why we prefer potentiometer in place of voltmeter for measuring potential difference?
Answer : A voltmeter draws some current from the circuit to operate, altering the potential it measures (loading effect). A potentiometer measures potential using a null method (no current drawn at balance point), giving an accurate, ideal measurement.
Q.NO.77 : Define motional emf. Give its unit.
Answer : The emf induced across the ends of a conductor when it moves across a magnetic field. Formula: $\varepsilon = vBL\sin\ \theta$. Unit: Volt ($V$).
Q.NO.78 : On what factors the induced current due to motional emf depend?
Answer : Induced current $I = \varepsilon/R = (vBL)/R$. It depends on:
1. Speed of conductor (v).
2. Magnetic field strength (B).
3. Length of conductor (L).
4. Resistance of the loop (R).

Q.NO.79 : State Faraday's law of electromagnetic induction.
Answer : The magnitude of induced emf in a circuit is directly proportional to the time rate of change of magnetic flux passing through it. $\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$.
Q.NO.80 : A particle which produces more ionization is less penetrating. Why?
Answer : Ionization requires energy. A particle that produces intense ionization (like Alpha) loses its kinetic energy very rapidly in collisions with atoms. Consequently, it travels a shorter distance before stopping, resulting in low penetrating power.
Q.NO.81 : If you swallowed an α-source and a β-source, which would be the more dangerous to you? Explain why?
Answer : The **α-source** is more dangerous internally. Though α-particles can't penetrate skin, inside the body they cause massive ionization in a small volume, severely damaging living cells and DNA close to the source.
Q.NO.82 : If U_{92}^{233} decays twice by α-emission what is the resulting isotope?
Answer : 1st Alpha: Mass -4, Z -2 → 90^{229}Th. 2nd Alpha: Mass -4, Z -2 → 88^{225}Ra(Radium-225).

Q.NO.83 : How many α-decay occur in the decay of Thorium $_{90}Th^{230}$ into $_{82}Pb^{214}$?
Answer : Change in Mass $A = 230 - 214 = 16$. Each alpha particle reduces mass by 4. Number of Alpha decays = $16/4 = 4$. (Check Z: $90 - 4(2) = 82$. Correct).
Answer: 4 Alpha decays.
Q.NO.85 : State and Explain Coulomb's Law.
Answer : The electrostatic force between two point charges is directly proportional to the product of the magnitudes of charges and inversely proportional to the square of the distance between them. $F = k\frac{q_1 q_2}{r^2}$.
Q.NO.86 : What are the factors upon which the electric flux depends?
Answer :
1. Number of electric field lines passing through the surface.
2. Area of the surface (A).
3. Orientation of the surface relative to the field (θ). Flux $\Phi = EA\cos\ \theta$.

Q.NO.87 : State Gauss's law. Answer : The total electric flux through any closed surface is equal to $1/\epsilon_0$times the total net charge enclosed by that surface. $\Phi_e = \frac{Q_{enclosed}}{\epsilon_0}$.
Q.NO.89 : Give similarity and difference between Coulomb and Gravitational forces.
Answer :
- **Similarity:** Both follow inverse square law ($1/r^2$) and are conservative forces.
- **Difference:** Coulomb force can be attractive or repulsive; Gravitational force is always attractive. Coulomb force is much stronger.

Q.NO.90 : Define Electronic and Conventional current. Answer :
- **Electronic Current:** Flow of electrons from negative terminal to positive terminal.
- **Conventional Current:** Equivalent flow of positive charge from positive terminal to negative terminal (standard direction used in analysis).

Q.NO.92 : What is the importance of minus sign in the expression $\epsilon = -N\Delta\Phi/\Delta t$?
Answer : The minus sign represents **Lenz's Law**. It indicates that the direction of the induced emf (and current) is such that it opposes the change in magnetic flux that produced it.
Q.NO.93 : Define Flux and Flux Density.
Answer :
- **Magnetic Flux (Φ):** Total magnetic field lines passing through an area. $\Phi = B \cdot A$. Unit: Weber.
- **Flux Density (B):** Magnetic flux per unit area perpendicular to field. $B = \Phi/A$. Unit: Tesla or Wb/m^2.

Q.NO.94 : How you express Magnetic Flux? On what factor it depends?
Answer : $\Phi = BA\cos\ \theta$. Depends on: Magnetic field strength (B), Surface Area (A), and Orientation angle (θ).
Q.NO.95 : Differentiate between inertial and non-inertial frame of reference.
Answer :
- **Inertial Frame:** A frame at rest or moving with constant velocity (zero acceleration). Newton's laws hold true.
- **Non-Inertial Frame:** An accelerating frame. Newton's laws do not hold without "fictitious" forces.

Q.NO.96 : When the switch in the circuit is closed, a current is established in the coil and the metal ring jumps upward. Why? Describe what would happen to the ring if the battery polarity were reversed?
Answer :
- **Why jump?** Changing current induces magnetic flux. By Lenz's law, the ring induces an opposing current (magnetic pole), causing repulsion against the coil's field.
- **Reversed polarity?** The ring would **still jump upward**. The induced current in the ring will always oppose the *change*, creating a repulsive force regardless of the field's polarity.

Q.NO.97 : A nucleus undergoes Gamma decay, emitting Gamma ray photon with energy 1.5 MeV. Calculate: (i) frequency (ii) wavelength (iii) momentum.
Answer : Energy $E = 1.5$ MeV $= 1.5 \times 10^6 \times 1.6 \times 10^{-19} = 2.4 \times 10^{-13}$ J.
(i) **Frequency:** $f = E/h = 2.4 \times 10^{-13}/6.63 \times 10^{-34} \approx 3.62 \times 10^{20}$ Hz.
(ii) **Wavelength:** $\lambda = c/f = 3 \times 10^8/3.62 \times 10^{20} \approx 8.29 \times 10^{-13}$ m.

(iii) **Momentum:** $p = E/c = 2.4 \times 10^{-13}/3 \times 10^{8} = 8 \times 10^{-22}$ kg m/s.

LONG QUESTION

Question NO.5

1	What is meant by significant figures? Write two reasons for using them in measurements. How to find the uncertainty in timing experiment such as the time period of a simple pendulum?	**Most Important**
2	Check the homogeneity of the relation: $v = \sqrt{\frac{T \times \ell}{m}}$ where v is the speed of transverse wave on a stretched string of tension T, length ℓ and mass m.	**Most Important**
3	Define and explain scalar product. Write down its important characteristics.	**Most Important**
4	Define and explain vector product of two vectors. Discuss important characteristics of vector product.	**Most Important**
5	Derive the following expressions for projectile motion: (i) time of flight (ii) height attained (iii) range for projectile.	**Most Important**
6	Explain elastic collision in one dimension. Show that magnitude of relative velocities before and after collision are equal.	**Most Important**
7	Define orbital velocity and derive an expression for the same.	**Most Important**
8	Define moment of inertia. Prove that torque acting on rotating rigid body is equal to the product of its moment of inertia and angular acceleration.	**Most Important**
9	What is meant by angular momentum? Explain the law of conservation of angular momentum with daily life examples.	**Most Important**

Question NO.6

1	Define conservative field. Show that gravitational field is conservative in nature.	**Most Important**
2	Define escape velocity. Show that an expression for escape velocity can be expressed as $\sqrt{2Rg}$, where R and g denote radius of the Earth and acceleration due to gravity, respectively. Also find its numerical value near the surface of the Earth.	**Most Important**
3	State and derive equation of continuity.	**Most Important**
4	State and prove Bernoulli's equation.	**Most Important**
5	Why wings of an aeroplane are rounded outward while flattened inward?	**Most Important**
6	Define terminal velocity of a body and show that terminal velocity is directly proportional to the square of radius of the body ($v_t \propto r^2$).	**Most Important**
7	Explain first law of thermodynamics in detail. Give an example in support of your explanation. Give its two applications.	**Most Important**
8	What is Carnot engine? Describe Carnot cycle. State Carnot theorem and derive an expression for efficiency of Carnot engine.	**Most Important**
9	Define and explain the term "Entropy".	**Most Important**

Question NO.7

1	State and explain the principle of superposition of waves. Apply this principle to elaborate the working of noise canceling headphones.	**Most Important**
2	What are standing waves? Illustrate a detailed experiment that demonstrates the standing waves using stretched strings.	**Most Important**
3	Find the frequencies of the harmonics produced in an organ pipe when it is open at both ends and when it is closed at one end.	**Most Important**
4	What is meant by the term beats? Prove that number of beats per second is equal to the difference between the frequencies of vibrating tuning forks.	**Most Important**

5	Keeping in mind "Doppler effect", analyze the following cases: (a) when source of sound moves away from stationary observer (b) when source moves towards stationary observer.	**Most Important**
6	State Malus's law. Explain the intensity formula.	**Most Important**
	Question NO.8	
1	Explain the electric potential and prove that electric field intensity is equal to the negative of potential gradient.	**Most Important**
2	State and explain Kirchhoff's rules.	**Most Important**
3	What is a Wheatstone bridge? Explain its working with the help of a diagram.	**Most Important**
4	What is a potentiometer? Describe its working.	**Most Important**
5	State and derive Faraday's Law of electromagnetic induction.	**Most Important**
	Question NO.9	
1	State two postulates of special theory of relativity. Give its three consequences (Time dilation, length contraction, mass variation).	**Most Important**
2	Explain the phenomenon of pair annihilation with an example. Explain the utility of its principle in the medical field.	**Most Important**
3	What is meant by radioactivity? Compare the properties and behaviour of three types of radiations (α, β, γ).	**Most Important**
4	Differentiate between hadrons and leptons with examples.	**Most Important**
5	Describe four fundamental forces in nature.	**Most Important**

Numerical Problems

1	Show that the expression; $v_f^2 - v_i^2 = 2aS$is dimensionally correct, where $v_i$is the initial velocity, $a$is the acceleration and $v_f$is the velocity after covering a distance S.
2	Show that the famous "Einstein equation" $E = mc^2$is dimensionally consistent.
3	The magnitude of cross and scalar products of two vectors are $4\sqrt{3}$and 4, respectively. Find the angle between the vectors.
4	A helicopter is ascending vertically at the rate of 19.6 m/s. When it is at a height of 156.8 m above the ground, a stone is dropped. How long does the stone take to reach the ground?
5	A cricket ball is hit upward with velocity of 20 m/s at an angle of 45° with the ground. Find its: (a) time of flight (b) maximum height (c) how far away it hits the ground.
6	An aeroplane is moving horizontally at a speed of 200 m/s at a height of 8 km to drop a bomb on a target. Find horizontal distance from the target at which the bomb should be released.
7	A 70 g ball collides with another ball of mass 140 g. The initial velocity of the first ball is 9 m/s to the right while the second ball is at rest. If the collision were perfectly elastic, what would be the velocity of the two after the collision?
8	A car is moving with a speed of 108 km/h. If its wheel has a diameter of 60 cm, find its angular speed in rad/s and rev/s.
9	A satellite is orbiting the Earth at an altitude of 200 km. Assuming the Earth's radius is 6400 km, calculate the orbital speed of the satellite.
10	The flywheel of an engine is rotating at 2100 rev/min when the power source is shut off. What torque is required to stop it in 3 minutes? The moment of inertia of the flywheel is 36 kg·m².
11	A diver comes off a board with arms straight up and legs straight down, giving him a moment of inertia of 18 kg·m² about his rotation axis. Then tucks into a small ball, decreasing his moment of inertia to 3.6 kg·m². While tucked, he makes two complete rotations in 1.0 second. If he had not tucked at all, how many revolutions would he have made in 1.5 s from board to water?
12	An object weighing 98 N is dropped from a height of 10 m. Its speed just before hitting the ground is 12 m/s. What is the frictional force acting on it?

13	A force acts on a ball moving with 14 m/s speed and brings its speed to 6 m/s. Has the force done positive or negative work? Explain your answer.
14	A 70 kg man runs up a long flight of stairs in 4.0s. The vertical height of the stairs is 4.5 m. Calculate his power output in watts.
15	A machine gun fires 6 bullets per minute with a velocity of 700 m/s. If each bullet has a mass of 40 g, then find power developed by the gun?
16	A motorcycle rider weighing 60 kg is coasting down a 24° slope. The weight of motorcycle is 30 kg. At the top of the slope, the speed of motorcycle is 3.2 m/s. If the kinetic frictional force is 100 N, what will be the speed of the motorcycle 72 m downhill?
17	An object weighing 98 N is dropped from a height of 10 m. Its speed just before hitting the ground is 12 m/s. What is the frictional force acting on it?
18	A steel wire of length 2 metres and cross-sectional area of 2×10^{-6}m² is stretched by a force of 400 N. If the Young's modulus of steel is 2×10^{11}N/m², calculate the extension of the wire.
19	A tiny water droplet of radius 0.010 cm descends through air from a high building. Calculate its terminal velocity, given that η for air = 19×10^{-6}kg/m·s and density of water $\rho = 1000$kg/m³.
20	A tank filled with water has a hole at a depth of 5 m from the water surface. Calculate the velocity of water flowing out of the hole.
21	A Carnot engine is operating between a high temperature reservoir at 600 K and a low temperature reservoir at 300 K. Calculate: (i) the maximum possible efficiency. (ii) the amount of work output if the engine absorbs 500 J of heat from the high temperature reservoir.
22	A refrigerator extracts 1200 J of heat from its interior (the cold reservoir) and releases 1800 J of heat to the surrounding environment (the hot reservoir) during each cycle. Calculate: (i) the work input required per cycle. (ii) the coefficient of performance (COP) of the refrigerator.
23	An organ pipe has a length of 1 m. Determine the frequencies of the fundamental and the first two harmonics: (a) if the pipe is open at both ends and (b) if the pipe is closed at one end. (Speed of sound in air is 340 m/s)
24	A tuning fork A produces 4 beats per second with another tuning fork B. It is found that by loading B with some wax, the beat frequency increases to 6 beats per second. If the frequency of A is 320 Hz, determine the frequency of B when loaded.
25	A train is approaching a station at 90 km/h sounding a whistle of frequency 1000 Hz. What will be the apparent frequency of the whistle as heard by a listener sitting on the platform? What will be the apparent frequency heard by the same listener if the train moves away from the station with the same speed? (Speed of sound is 340 m/s)
26	We wish to use a glass plate of refractive index of 1.5 in air as a polarizer. Find the polarizing angle and angle of refraction.
27	What angle is required between the direction of polaroid light and the axis of a Polaroid filter to reduce its intensity by 85%?
28	A particle of charge $+20\mu$C is placed between two parallel plates, 10 cm apart and having a potential difference of 0.5 kV between them. Calculate the electric field between the plates, and the electric force exerted on the charged particle.
29	The copper winding of an electric fan has a resistance of 50 Ω at 30°C. After running for some time, the resistance becomes 52 Ω. How much is the increase in temperature of the winding? [For copper $\alpha = 0.0039$K⁻¹]
30	A coil of 10 turns and 35 cm² area is in a perpendicular magnetic field of 0.5 T. The coil is pulled out of the field in 1.0 s. Find the induced emf in the coil as it is pulled out of the field.
31	An electron is accelerated to a speed of 0.995 c which passes down an evacuated tube 500 m long. How long will the tube appear to the electron?
32	The period of a pendulum is measured to be 3.0 s in the inertial reference frame of the pendulum. What is its period measured by an observer moving at a speed of 0.95 c with respect to the pendulum?

33	Uranium-238 is an alpha emitter. In the process, it is transmuted into a daughter nucleus. What is the mass number A and charge number Z of the daughter nucleus? What is its chemical symbol?
34	Calculate the Q-value for the reaction taking place in Rutherford's experiment on artificial disintegration of nitrogen by bombardment with alpha particles. Relative masses are: $N^{14} = 14.007515u, He^{4} = 4.003837u, O^{17} = 17.004533u, H^{1} = 1.008142u.$