QUESTION NO. 1

1.	Suppose in a rectangular coordinate system, a vector A has its tail at the point $P(-2,-3)$ and its tip at $Q(3,9)$. Determine the distance between these two points.
2.	Show that the three vectors $\hat{\imath}+\hat{\jmath}+\hat{k}, 2\hat{\imath}-3\hat{\jmath}+\hat{k}$ and $4\hat{\imath}+\hat{\jmath}-5\hat{k}$ are mutually perpendicular.
3.	The line of action of force, $F=\hat{\imath}-2\hat{\jmath}$ Passes through a point whose position vector is $(-\hat{\imath}+\hat{k})$ Find i) the moment of F about the origin. ii) the moment of F about the point of which the position vector is $\hat{\imath}+\hat{k}$.
4.	The magnitude of dot and cross products of two vectors are $6\sqrt{3}$ and 6 respectively. Find the angle between the vectors.
5.	Define torque. Calculate torque due to force acting on a rigid body.
6	Define scalar product with examples. Write down its any four characteristics.
7	Define vectors product of two vectors. Also write the characteristics of vector product of two vectors.
8.	Derive the expression for the magnitude and direction of the resultant of two vectors, added by rectangular component method.
9.	A boy places a fire cracker of negligible mass in an empty can of 40 g mass. He plugs the end with a wooden block of mass 200 g. After igniting the firecracker, he throws the can straight up. It explodes at the top of its path. If the block shoots out with a speed of $3.0\ \mathrm{ms}^{-1}$, how fast will the can be going?
10.	An electron ($\mathrm{m}=9.1\times10^{-31}$ kg) travelling at $2.0\times10^{7}\ \mathrm{ms}^{-1}$ undergoes a head on collision with a hydrogen atom ($m=1.67\times10^{-27}$ kg) which is initially at rest. Assuming the collision to be perfectly elastic and a motion to be along a straight line, find the velocity of hydrogen atom.
11.	A truck weighing 2500 kg and moving with a velocity of $21\ \mathrm{ms}^{-1}$ collides with stationary car weighing 100 kg. The truck and the car move together after the impact. Calculate their common velocity.
12.	Two blocks of masses 2.0 kg and 0.50 kg are attached at the two ends of a compressed spring. The elastic potential energy stored in the spring is 10 J. Find the velocities of the blocks if the spring delivers its energy to the blocks when released.
13.	A bomber dropped a bomb at a height of 490 m when its velocity along the horizontal was $300\mathrm{kmh}^{-1}$. i) How long was it in air? ii) At what distance from the point vertically below the bomber at the instant the bomb was dropped, did it strike the ground?
14.	A SLBM (submarine launched ballistic missile) is fired from a distance of 3000 km. If the Earth is considered flat and the angle of launched is 45^{0} with horizontal, find the velocity with which the missile is fired and the time taken by SLBM to hit the target.
15.	Define projectile motion. Derive relation for the following terms: i) Time of flight ii) Range of flight
16.	Define elastic and inelastic collision. Explain elastic collision in one dimension to show the relative velocities before and after collision are same. A man pushes a lawn mower with a 40 N force directed at an angle of $20°$ downward from the horizontal. Find the work done by the man as he cuts a strip of grass 20 m long.

QUESTION NO. 2

1.	Ten bricks, each 6.0 cm thick and mass 1.5 kg, lie flat on a table. How much work is required to stack them one on the top of another?
2.	A 1000 kg automobile at the top of an incline 10 meter high and 100 m long is released and rolls down the hill. What is its speed at the bottom of the incline if the average retarding force due to friction is 480 N ?
3.	A diver weighing 750 N dives from a board 10 m above the surface of a pool of water. Use the conservation of mechanical energy to find his speed at a point 5.0 m above the water surface, neglecting friction.
4.	Explain the inter conversion of potential energy and kinetic energy.
5.	Define absolute gravitational P.E. derive expression for the absolute value of gravitational P.E of a body at a distance "r" from the center of the earth.
6.	When two nodes of frequencies f_1 and f_2 are sounded together, beats are formed. If $f_1 > f_2$, what will be the frequency of beats? I) f_1+f_2 ii) $1/2(f_1+f_2)$ iii) f_1-f_2 iv) $1/2(f_1-f_2)$

7.	A stationary wave is established in a string which is $120\ \text{cm}$ long and fixed at both ends. The string vibrates in four segments; at a frequency of $120\ \text{Hz}$. Determine its wavelength and the fundamental frequency?
8.	The frequency of the note emitted by a stretched string is $300\ \text{Hz}$. What will be the frequency of this note when: a) the length of the wave is reduced by one third without changing the tension. b) the tension is increased by one-third without changing the length of the wire.
9.	Organ pipe has a length of $50\ \text{cm}$. Find the frequency of its fundamental note and the next harmonic when it is: a) open at both ends b) closed at one end.
10.	Discuss effect of temperature on speed of sound. Also prove that $v_t = v_0 + 0.61\text{t}$.
11.	Write down newton's formula for speed sound in air explain the Laplace correction by deriving the relation for speed of sound in air.
12.	Define Doppler's effect. Derive apparent frequency if:a) observer moves towards the source b) observer moves away from the source
13.	Explain interference. Find the conditions for i) constructive interference ii) destructive interference
14.	What is drawback of Newton's formula for the speed of sound and how this was corrected by Laplace? Derive the Laplace's expression for the speed of sound and also find the value of speed of sound by using this expression.

QUESTION NO. 3

A disc and a hoop start moving down from the top of an inclined plane at the same time. Which one will be moving faster on reaching the bottom?
A tiny laser beam is directed from the Earth to the Moon. If the beam is to have a diameter of $2.50\ \text{m}$ at the Moon, how small must divergence angle be for the beam? The distance of Moon from the Earth is $3.8 \times 10^8\ \text{m}$.
Calculate the angular momentum of a star of mass $2.0 \times 10^{30}\ \text{kg}$ and radius $7.0 \times 10^5\ \text{km}$. If it makes one complete rotation about its axis once in 20 days. What is its kinetic energy? 4. Explain artificial gravity. Derive $f = \frac{1}{2\pi}\sqrt{\frac{g}{R}}$.
Define artificial satellite. Explain that how real and apparent weight in an elevator for all the cases is related?
Define rotational K.E. Also derive formula for rotational K.E of a disc and hoop coming down an inclined plane.
Define rotational K.E. show that a disc will be moving faster than a hoop on reaching the bottom of an inclined plane, when thrown at the same time.
Calculate the angular momentum of a star of mass $2.0 \times 10^{30}\ \text{kg}$ and radius $7.0 \times 10^5\ \text{km}$. if it makes one complete rotation about its axis one in 20 days, what is its kinetic energy?
What are geostationary satellites? Derive the relation for radius of geostationary orbit.
Certain globular protein particle has a density of 1246kgm^{-3}. It falls through pure water with a terminal speed of 3.0cmh^{-1}. Find the radius of the particle.
Water is flowing smoothly through a closed pipe system. At one point the speed of water is $3.0\ \text{ms}^{-1}$, while at another point $3.0\ \text{m}$ higher, the speed is $4.0\ \text{ms}^{-1}$. If the pressure is 80kPa at the lower point, what is pressure at the upper point?
The radius of the aorta is about $1.0\ \text{cm}$ and the blood flowing through it has a speed of about 30cms^{-1}. Calculate the average speed of the blood in the capillaries using the fact that although each capillary has a diameter of about $8 \times 10^{-4}\ \text{cm}$, there are literally millions of them so that their total cross section is about $2000\ \text{cm}^2$.
Define stoke's law and show that the terminal velocity is directly proportional to square of radius of the object.
State and prove the Bernoulli's equation in dynamic fluid that relates pressure to fluid speed and height.
State and derive equation of continuity $A_1V_1 = A_2V_2$

QUESTION NO. 4

1.	Explain the relation between total energy, potential energy and kinetic energy for a body oscillating with SHM.

2.	A load of 15.0 g elongates a spring by 2.00 cm. If body of mass 294 g is attached to the spring and is set into vibration with an amplitude of 10.0 cm, what will be its: i)period ii)spring constant iii)maximum speed of its vibration.
3.	A block of mass 4.0 kg is dropped from a height of 0.80 m on to a spring of spring constant $k = 1960\text{Nm}^{-1}$. Find the maximum distance through which the spring will be compressed.
4.	A car of mass 1300 kg is constructed using a frame supported by four springs. Each spring has a spring constant $20{,}000\text{Nm}^{-1}$. If two people riding in the car have a combined mass of 160 kg, find the frequency of vibration of the car, when it is driven over a pot hole in the road. Assume the weight is evenly distributed.
5.	Discuss the motion of horizontal mass spring system and also derive formula for time period, displacement and velocity.
6.	A Carnot engine utilizes an ideal gas. The source temperature is $227°\text{C}$ and the sink temperature is $127°\text{C}$. Find the efficiency of the engine and also find the heat input from the source and heat rejected to the sink when 10000 J of work is done.
7.	A reversible engine works between two temperatures whose difference is $100°\text{C}$. If it absorbs 746 J of heat from the source and rejects 546 J to the sink. Calculate the temperature of the source and the sink.
8.	A heat engine performs 100 J of work and at the same time rejects 400 J of heat energy to the cold reservoirs. What is the efficiency of the engine?
9.	A Carnot engine whose low temperature reservoir is at $7°\text{C}$ has an efficiency of 50%. It is desired to increase the efficiency to 70%. By how many degrees the temperature of the source be increased?
10.	A steam engine has a boiler that operates at 450 K. The heat changes water to steam, which drives the piston. The exhaust temperature of the outside air is about 300 K. What is maximum efficiency of this steam engine?
11.	Define pressure of a gas. Prove that $\boldsymbol{P = \frac{2}{3}N_0 < \frac{1}{2}mv^2 >}$.
12.	Define first law of thermodynamics. Explain isothermal and adiabatic process.
13.	What is Carnot heat engine? Show that efficiency of a Carnot heat engine depends on the temperature of the hot and cold reservoirs.
14.	Define molar specific heat and prove that $C_p - C_v = R$
15.	Define and explain entropy with an example. Does entropy decrease for reversible process? Why absolute value of entropy cannot be determined?

QUESTION NO. 5

1.	Calculate the wavelength of light, which illuminates two slits 0.5 mm apart and produce an interference pattern on a screen placed 200 cm away from the slits. The first bright fringe is observed at a distance of 2.40 mm from the central bright image.
2.	A monochromatic light of $\lambda = 588$ nm is allowed to fall on the half silvered glass plate G_1 in the Michelson interferometer. If mirror M_1 is moved through 0.233 mm, how many fringes will be observed to shift?
3.	Blue light of wavelength 480 nm illuminates a diffraction grating. The second order image is formed at an angle of $30°$ from the central image. How many lines in a centimeter of the grating have been ruled?
4.	4. X-rays of wavelength 0.150 nm are observed to undergo a first order reflection at a Bragg angle of 13.3^0 from a quartz (SiO_2) crystal. What is the interplanar spacing of the reflecting planes in the crystal?
5.	Explain Young's Double slit experiment to study the phenomenon of interference of light.
6.	Explain Young's double slit experiment. Derive the relation for position of mth bright and dark fringe from the center of the screen.
7.	Describe the diffraction of X-rays by crystal and derive Bragg's equation.
8.	A converging lens of focal length 5.0 cm is used as a magnifying glass. If the near point of the observer is 25 cm and the lens is held close to the eye, calculate: a)the distance of the object from the lens. b)the angular magnification. What is the angular magnification when the final image is formed at infinity?
9.	A telescope objective has focal length 96 cm and diameter 12 cm. Calculate the focal length and minimum diameter of a simple eye piece lens for use with the telescope, if the linear magnification required is 24 times and all the light transmitted by the objective from a distant point on the telescope

	axis is to fall on the eye piece.
10.	A point object is placed on the axis of and $3.6\ cm$ from a thin convex lens of focal length $3.0\ cm$. A second thin convex lens of focal length $16.0\ cm$ is placed coaxial with the first and $26.0\ cm$ from it on the side away from the object. Find the position of the final image produced by the two lenses.
11.	A compound microscope has lenses of focal length $1.0\ cm$ and $3.0\ cm$. An object is placed $1.2\ cm$ from the object lens. If a virtual image is formed $25\ cm$ from the eye. Calculate the separation of the lenses and the magnification of the instrument.
12.	Sodium light of wavelength $589\ nm$ is used to view an object under a microscope. If the aperture of the objective is $0.90\ cm$, a) find the limiting angle of resolution. b) using visible light of any wavelength. What is the maximum limit of resolution for this microscope?
13.	Discuss Michelson's experiment for the determination of speed of light.
14.	What is compound microscope? Give its construction, working and derive the expression for the angular expression.
15.	What is astronomical telescope? Sketch its ray diagram, write its working and find its angular magnification.