SECTION A (40 MARKS)

ANSWER **ALL** QUESTIONS

Question 1

a) For each question, there are four alternatives A, B, C and D. Choose the correct alternative and circle it. Do not circle more than ONE alternative. If there are more than one choice circled, NO score will be awarded. **[15]**

i. The moon revolves around the earth. Its motion is

A aperiodic.
B periodic and simple harmonic.
C periodic but not simple harmonic.
D simple harmonic but not periodic.

ii. In n-type semi-conductor, the majority and minority charge carriers respectively are

A protons and electrons.
B electrons and protons.
C electrons and holes.
D holes and electrons.

iii. What happens to the acceleration of a soldier after his parachute opens?

A increases and becomes maximum
B decreases and becomes zero
C increases
D decreases

iv. You measure the period of oscillation of a simple pendulum on the Earth's surface as T. If you repeat the experiment inside a coal mine using the same set- up, then the time period will be

A greater than T.
B less than T.
C equal to T.
D infinite.

v. An air tight container is divided into two halves using a partition having a fine hole. The two halves contain the same gas but at different temperatures. The amount of gas will be

A varying constantly with time.
B more at higher temperature.
C less at higher temperature.
D same in both the halves.

vi. The plates of a parallel plate capacitor of capacitance 1 μF are at a distance of 0.2 cm from each other. The area of each plate is

A 226 km^2.
B 226 m^2.
C 226 cm^2.
D 226 mm^2.

vii. A pen rubbed with a piece of cloth picks up a small piece of paper. This demonstrates that

A gravitational force and electrostatic force balance each other.
B gravitational force is stronger than electrostatic force.
C electrostatic force is stronger than gravitational force.
D gravitational force is stronger than nuclear force.

viii. When a closed coil is rotated in a magnetic field, the direction of current induced in the coil changes each time after

A quarter revolution.
B half revolution.
C one revolution.
D two revolutions.

ix. Wires P and Q have the same resistance at room temperature. When they are heated, resistance of P increases and that of Q decreases. We can conclude that

A P is n-type semiconductor and Q is p-type semiconductor.
B P and Q are conductors of different materials.
C P is semiconductor and Q is conductor.
D P is conductor and Q is semiconductor.

x. A boy standing in front of a convex mirror was surprised to see his image behind the mirror at $\frac{f}{2}$, diminished and close. Where do you think he was standing?

A $\frac{f}{2}$
B f
C 2f
D infinity

xi. As you move away from a lighted electric bulb, the wavefront changes from

A linear to plane.
B spherical to linear.
C spherical to plane.
D cylindrical to plane.

xii. In the phenomenon of photoelectric effect on metals, an increase in the frequency of incident radiation increases the

A velocity of emitted electrons.
B work function of the metal.
C threshold frequency.
D rate of emission.

xiii. The need for emission of the neutrino or the antineutrino in the beta decay is to ensure that

A charge is conserved in the interaction.
B strangeness is conserved in the interaction.
C lepton number is conserved in the interaction.
D baryon number is conserved in the interaction.

xiv. A teacher demonstrates process of fusion by taking 2 dough balls as 2 light nuclei of masses M_1 and M_2. She combines the 2 dough balls and makes a single ball of mass M. After learning the concept of fusion, which option must the students choose?

A $M1 + M2 > M$

B $M1 + M2 < M$

C $M1 + M2 = M$

D $M1 + M2 \leq M$

xv. Most of the energy from the sum is emitted as

A visible wavelength.

B infrared wavelength.

C EUV wavelength.

D UV wavelength.

b) Fill in the blanks with appropriate word. **[5]**

i. In SHM, the magnitude of restoring force is directly proportional to _____ of the particle and is always directed towards the _____ position.

ii. The minimum value of input that can be detected by a sensor is called _____and the smallest change in the input that can be detected by a sensor is called_____.

iii. Solar cooker uses _____mirror.

iv. If the speed of a fluid element increases along a horizontal streamline, the pressure of the fluid will_____.

v. On discharging a capacitor, current decreases _____.

vi. Iron loss in transformer can be minimised by using _____core.

vii. In a single slit diffraction pattern, as the width of the slit decreases, the width of the central maximum_____.

viii. Quarks can never exist as _____ particle.

c) Correct the following statements. **[5]**

i. A towel absorbs water due to the phenomenon of viscosity.

ii. The ratio of universal gas constant 'R' to Avogadro's number 'N_A' is equal to dielectric constant.

ii. Carbon nano tubes are light and have low strength.

v. The energy of photon depends upon the intensity of radiation.

v. In the sun, fusion reaction is a multi-step process in which helium is the fuel.

d) **Match each item of Column A with the most appropriate item of Column B. Rewrite the correct pairs by writing the alphabet against the number in the spaces provided.** **[5]**

Column I		Column II	
i)	Stoke's law	a)	electromagnetic induction
ii)	Capacitors in parallel	b)	m > 1
iii)	Generator	c)	spectral analysis
iv)	Auto collimation	d)	maximum velocity
v)	Diffraction grating	e)	m = + 1
vi)	Positron	f)	i_{rms}
vii)	Damped oscillation	g)	same voltage
viii)	Nuclear fusion power plant	h)	$F = 6\pi\eta rv$
ix)	Mean position of SHM	i)	RTS
x)	DC ammeter	j)	$Ae^{\frac{-bt}{2m}}$
		k)	lepton
		l)	same charge
		m)	meson
		n)	$Ae^{\frac{-bt}{m}}$

i)	
ii)	
iii)	
iv)	
v)	
vi)	
vii)	
viii)	
ix)	
x)	

e) Answer the following questions. **[10]**

i. Sometimes when you tune a radio to a certain station, you will catch signals from two stations simultaneously and a distorted sound is heard. Explain the phenomenon involved in the situation given above. [1]

ii. You are a member of a night patrolling team. Which flash light would you prefer, the one with convex lens or concave lens? Why? [2]

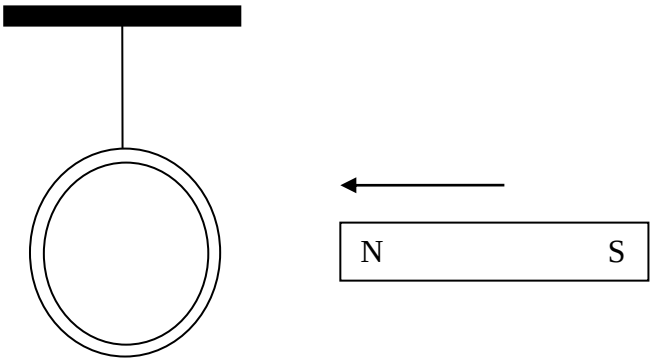
iii. Would the invention of room-temperature superconductors (RTS) be a boon or a curse to the world? Support your view with **TWO** reasons. [2]

iv. The acceleration of a particle executing simple harmonic motion (S.H.M.) is 16 cms^{-2} at a distance of 4 cm from the mean position. What is its time period? [2]

v. Two identical metal balls have charges +4Q and -3Q. They attract each other by a force of F. If they are joined by a conducting wire, what will be the charge on each ball and nature of force between them? [1]

vi. Three capacitors each of capacitance C are connected in series. A teacher asked the students to calculate the total capacitance of the system. Two brilliant students came up with different answers, student 1 got $\frac{C}{3}$ and student 2 got 3C. Who is correct? Why? [1]

vii. Tashi tries to pass a bar magnet through a metal ring as shown in the figure. What would be his observation? [1]



SECTION B (60 MARKS)

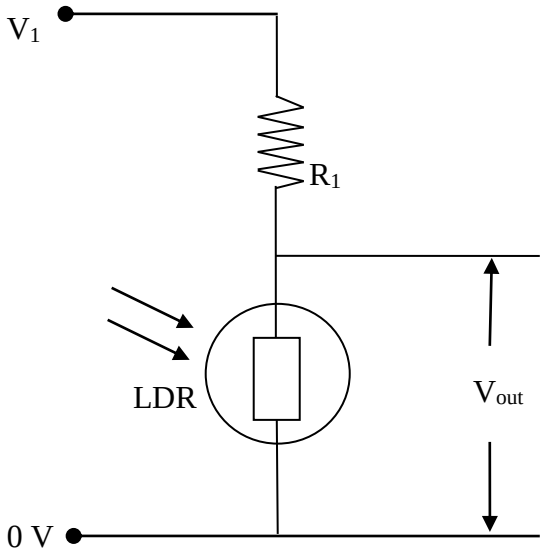
ATTEMPT ANY **SIX** QUESTIONS

Question 2

a) Why does hot soup taste better than cold soup? **[2]**

b) Derive expressions for potential energy and kinetic energy of a body executing simple harmonic motion. **[2]**

c) How does the output voltage change in light and dark (shade) in the diagram given below? **[2]**



d) The phrase ‘objects in the mirror are closer than they appear’ is engraved on rear view mirrors of vehicle. Prove this statement with a ray diagram. **[2]**

e) Compare self-induction and mutual induction. Give at least **TWO** comparisons. **[2]**

Self-induction	Mutual induction

Question 3

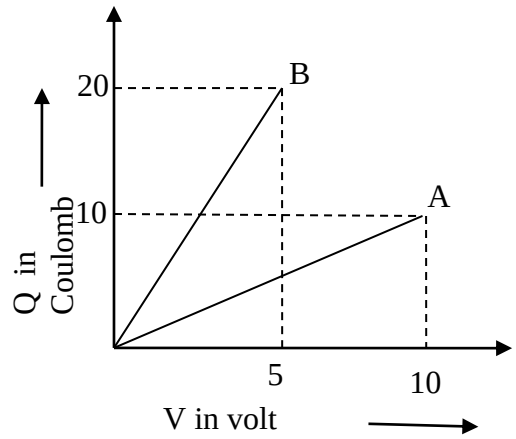
a) Why does the body of a vehicle rattle when it increases or decreases speed? Give a similar example observed around you. **[2]**

b) When hydrogen gas in a closed tin is heated through 1K, the pressure increases by 0.4%. What would be the initial temperature of the gas? **[2]**

c) Compare constructive and destructive interference of sound waves and microwaves. **[2]**

Sound waves	Microwaves

d) Tashi charges two capacitors A and B by increasing the voltage linearly and recorded his observation on a graph as shown below.



i. Which of the two capacitors has a higher capacitance? **[$\frac{1}{2}$]**

ii. What energy is stored in capacitor A? **[1$\frac{1}{2}$]**

e) Write **ONE** property of a proton that is same as its antiparticle and another property that is different. **[2]**

Question 4

a) State the law of conservation of electric charge. **[1]**

b) Do you think Bhutan should invest in a nuclear power plant? Justify. **[2]**

c) Green light of frequency $5.4\times10^{14}\,Hz$ is incident on a surface having work function of 1.9 eV. Calculate the maximum kinetic energy of the ejected electron in joule. **[2]**

d) A capacitor is connected to an AC voltage source, $V = V_m \sin \omega t$. Obtain an expression for the current 'i' flowing through the circuit. Also state whether current leads or lags the voltage. **[3]**

e) The values of Poisson's ratio for cork and rubber are 0 and 0.5 respectively. Explain the above statement. **[2]**

Question 5

a) Derive the expression for Ohm's law of magnetism. **[3]**

b) During your practical examination, you are asked to place a convex lens and concave lens in contact to obtain the combined focal length experimentally. The focal lengths of convex lens and concave lens are 20 cm and 30 cm respectively. Determine the combined focal length theoretically to compare your practical result. **[2]**

c) Define omega effect. **[1]**

d) Copper is a good conductor of electricity whereas dry wood is a bad conductor. Taking this property into consideration, distinguish them in terms of energy band. Give at least **TWO** differences. **[2]**

Copper	Dry wood

e) A complaint lodged by the residents of a village claimed that the blasting carried out by mining companies caused cracks on the walls of their houses. Do you agree with their claim? Support your stand with a scientific justification. **[2]**

Question 6

a) What is critical velocity? **[1]**

b) The displacement of a particle executing simple harmonic motion (S.H.M) is **[3]**
$x = 0.5\cos\left(100\pi t + \frac{3\pi}{4}\right)$ metre.

Find the

i. time period of oscillation.

ii. maximum velocity.

i.	
ii.	

c) Prove that a charged particle follows a parabolic path in a uniform electric field. **[2]**

d) Why are the makeup mirrors concave but the large mirrors in the gym plane, though both are meant for looking at our own reflection? **[2]**

e) How can nanotechnology be used for the treatment of foot odour and brain disorder? **[2]**

Question 7

a) Define magnetic flux linkage. **[1]**

b) What is weak force in particle physics? **[1]**

c) U^{235} disintegrates as follows: **[2]**

$$U^{235} \rightarrow {}^{140}Ce + {}^{94}Zr + n$$

Find the energy released in this reaction.

$U^{235} = 235.0439\,\text{u}$

$\text{Ce}^{140} = 139.9054\,\text{u}$

$\text{Zr}^{94} = 93.9063\,\text{u}$

d) When a pencil is dipped in a tilted position in water, it appears bent. Derive the law involved in the above phenomenon using Hugyen's principle. **[2]**

e) Draw graphs showing inter-relationship between the displacement and velocity of a particle executing simple harmonic motion with phase angle θ equal to zero. **[2]**

f) A minor radio blackout was observed on 9th July 2017 by space weather prediction centre. What is radio blackout and what are its effects? **[2]**

Question 8

a) What are the conditions required by gases to obey Boyle's law? **[1]**

b) Explain the sign convention for height and distance of object and image according to Cartesian sign convention in spherical mirrors. **[2]**

c) i. How can you vary the capacitance of parallel plate capacitor? **[1]**

ii. If the plates of a charged capacitor are brought closer, what will happen to the potential difference between the plates? **[1]**

d) Tungsten has definite work function. But when X-rays fall on tungsten plate, photoelectrons having different energies are emitted. Why? **[2]**

e) You are given a variety of metals and asked to segregate normal metals from superconducting metals. How can you succeed in this task and also differentiate the two metals using graphs. **[3]**

[PHYSICAL CONSTANTS]

Acceleration due to gravity	$g = 9.8\ m/s^2$
Avogadro's number	$N_A = 6.022 \times 10^{23}$
Boltzmann constant	$k = 1.38 \times 10^{-23}\ J/K$
Density of water at 4˚C	$\rho = 1000\ kg/m^3$
Electron charge	$e = 1.6 \times 10^{-19}\ C$
Energy equivalent of	$1u = 931.5\ MeV$
Mass of an electron	$m_e = 9.1 \times 10^{-31}\ kg$
Mass of a neutron	$m_n = 1.008665\ u$
Mass of a proton	$m_p = 1.007276\ u$
Permeability of free space	$\mu_0 = 4\pi \times 10^{-7}\ TmA^{-1}$
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2N^{-1}m^{-2}$
Planck's constant	$h = 6.63 \times 10^{-34}\ J.s$
Speed of electromagnetic wave	$c = 3 \times 10^8\ ms^{-1}$
Standard atmospheric pressure	$1\ atm = 101325\ Pa$
Universal gas constant	$R = 8.31\ J/mol.K$
1 electron volt	$1eV = 1.6 \times 10^{-19}\ J$
	$\pi = 3.14$
Planck's constant	$h = 6.63 \times 10^{-34} J.s$
Electron charge	$e = 1.6 \times 10^{-19}\ C$
1 electron volt	$1eV = 1.6 \times 10^{-19}\ J$
Speed of electromagnetic wave	$c = 3 \times 10^8\ ms^{-1}$
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Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12} C^2N^{-1}m^{-2}$
Permeability of free space	$\mu_0 = 4\pi \times 10^{-7}\ TmA^{-1}$
	$\pi = 3.14$

Rough Work