## 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 is more than one choice circled, NO score will be awarded.*** **[15]**

(i)   When a proton and an electron are placed in a uniform electric field, both will experience forces of

    A   equal magnitude in the same direction.
    B   equal magnitude in opposite directions.
    C   unequal magnitude in the same direction.
    D   unequal magnitude in opposite directions.

(ii)   An alternating emf is given by $E = 200 \sin (50\pi t)$ volt. The rms value of the emf is

    A   282V.
    B   200V.
    C   141V.
    D   50V.

(iii)   5g of oxygen gas occupying a certain volume is enclosed in a vessel at a certain pressure. If there is no exchange of heat between the gas and the surrounding, the variation of volume of the gas with pressure is shown by
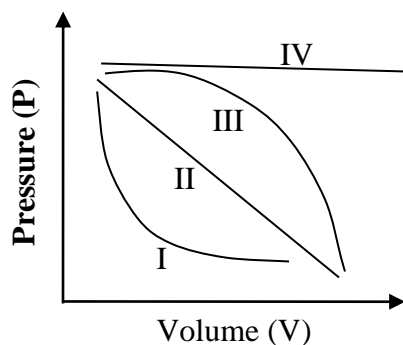
    A   curve I.
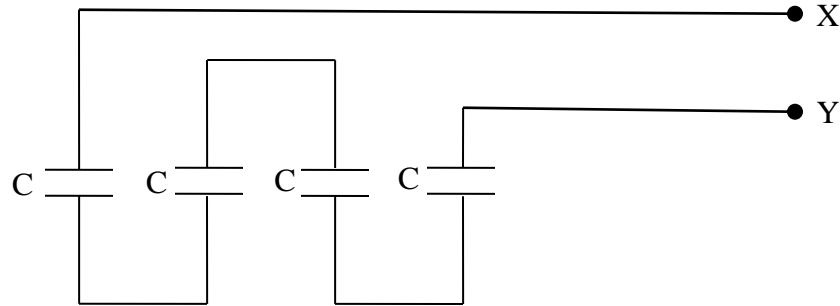   B   curve II.
    C   curve III.
    D   curve IV.

(iv)   A liquid does not wet the surface of a solid, if the angle of contact is

A   zero.
B   right angle.
C   acute angle.
D   obtuse angle.

(v)   Which of the following equation does **NOT** represent simple harmonic motion?

A $x(t) = A\cos(2\pi ft)$
B $x(t) = A\cos(2\pi ft + \phi)$
C $x(t) = A\sin(2\pi ft)\cos(2\pi ft)$
D $x(t) = A\sin(2\pi ft) + B\cos(2\pi ft)$

(vi)   The equivalent capacitance between points X and Y is 1μF.

The capacitance of each identical capacitor is

A   4 μF.
B   1 μF.
C   0.25 μF.
D   0.05 μF.

(vii)   When a metallic core is inserted along the axis of a solenoid, its self inductance will

A   be zero.
B   decrease.
C   increase.
D   remain constant.

(viii)   Which of the following produces a virtual image larger than the object?

       A   concave and convex mirrors
       B   plane and concave mirrors
       C   concave mirror
       D   convex mirror
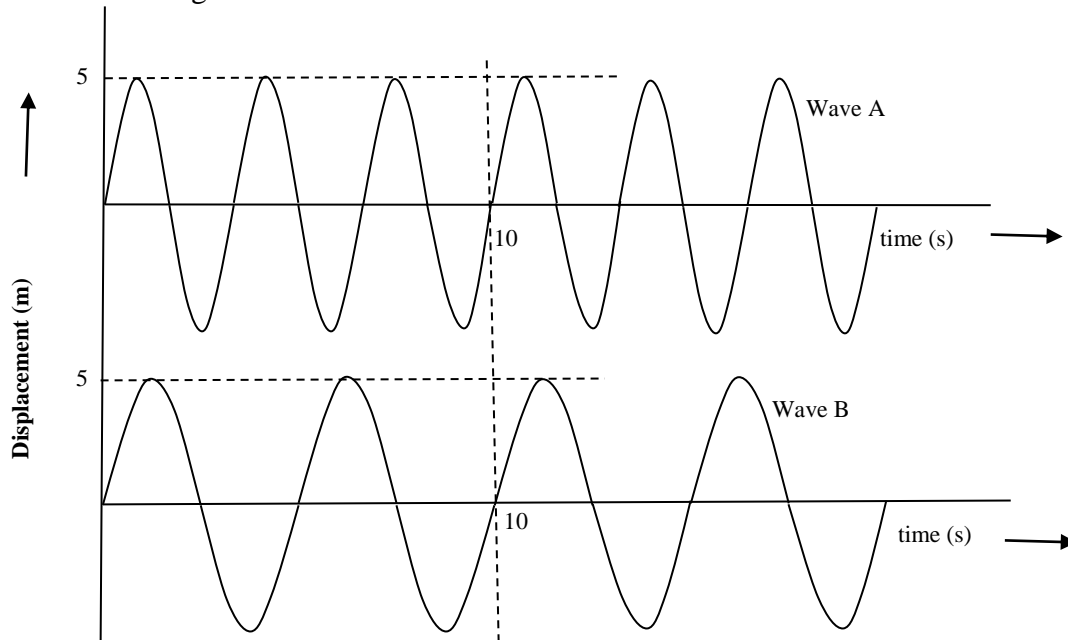
(ix)   The instrument used to study the spectra of the galaxies is

       A   spherometer.
       B   spectrograph.
       C   telescope.
       D   binocular.

(x)   When a photon interacts with matter, it transfers

       A   momentum.
       B   electrons.
       C   intensity.
       D   protons.

(xi)   Two particles execute SHM as shown in the figure below. Which of the following statement is **TRUE** for waves A and B?
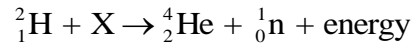

       A   Amplitude of wave A is greater than wave B.
       B   Amplitude of wave A is shorter than wave B.
       C   Frequency of wave B is greater than wave A.
       D   Frequency of wave B is less than wave A.

(xii) A proton is an example of

    A   meson.

    B   quark.

    C   baryon.

    D   lepton.

(xiii) In the equation given below, identify the hydrogen isotope 'X'.

$$^{2}_{1}H + X \rightarrow ^{4}_{2}He + ^{1}_{0}n + energy$$

    A   heavy water

    B   deuteron

    C   tritium

    D   proton

(xiv) A p-type semiconductor is obtained by doping with

    A   phosphorus.

    B   aluminium.

    C   antimony.

    D   arsenic.

(xv) The focal lengths of two double convex lenses are f_A and f_B respectively. Their combined focal length will be

    A $\dfrac{f_A + f_B}{f_A f_B}$.

    B $\dfrac{f_A f_B}{f_A + f_B}$.

    C $\dfrac{f_A + f_B}{f_B}$.

    D $\dfrac{f_A + f_B}{f_A}$

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

(i)   In ………………………. simple harmonic motion, the oscillation is reduced due to friction and its ………………………. always decreases.

(ii)   In a temperature sensor used to detect low temperatures, the output voltage is ……………………. in hot condition and ……………………. in cold condition.

(iii)   In Fresnel's biprism experiment, ……………………….… pattern is produced with the help of …….………………. sources.

(iv)   The top and bottom quarks are known as the ……………………. generation quarks.

(v)   In an uncharged capacitor, the resistance is always ……………………..

(vi)   The voltage stabilization on fluctuating loads will be …………………….. in three phase power systems.

(vii)   The energy of a photon is ………………………….. proportional to its wavelength.

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

Column A	Column B
(a) Simple harmonic motion	i. RC
(b) Semiconductor	ii work function
(c) Time constant	iii. hadrons
(d) Reluctance	iv. mutual induction
(e) Energy	v. maximum amplitude
(f) Quarks	vi. viscosity
(g) Stoke's law	vii. cosine function
(h) Unit magnification	viii. Rt/L
(i) Transformer	ix. AT/Wb
(j) Resonance	x. thermistor
	xi. auto collimation
	xii. aluminium

(a)
(b)
(c)
(d)
(e)
(f)
(g)
(h)
(i)
(j)

(d) *Correct the following statements.*   **[5]**

(i)   The average speed of the molecules of an ideal gas is given by

$$v_{avg} = \sqrt{\frac{RT}{M}} \ .$$

(ii)   The plates of a capacitor are generally separated by a semiconducting material.

(iii)   The intensity in a double-slit interference is directly proportional to the amplitude of the interfering waves.

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(iv)   The electromagnetic force is a universal force and acts between masses.

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(v)   Solar isolation is a form of disturbance that can affect radio communication.

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(e)   Answer the following questions.
(i)   Water emerges from a horizontal pipe at a rate of $0.5 \times 10^{-3} \, m^3 / s$. Find the velocity of water at a point in the pipe where the area of cross-section is 12.6 m^2.   **[1½]**

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(ii)   What is oscillatory motion?   **[1]**

(iii)   Draw the electric field lines due to an isolated negative point charge.   **[1]**

(iv)   How does mutual inductance of two closely wound solenoids depend on the area of each coil?   **[1]**

(v)   Which type of electric source is better, AC or DC ? Justify your answer.   **[2]**

(vi)   When two convex lenses are combined, the magnification of their
        combination is found to be greater than the magnification of the
        individual lenses. What do you think will happen to the magnification
        if the two concave lenses are combined? Support your answer with an
        appropriate explanation.   **[1½]**

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(vii)   Define the term thermal neutron.   **[1]**

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(viii) A boy is playing on a swing. After a while, his sister joins him on the
        same swing. How will this affect the time period of the swing? Explain. **[1]**

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SECTION B (60 marks)
*Answer any **SIX** questions.*

Question 2.

(a)   An electric shock is felt when we touch a wire connected to a capacitor. The shock from a 2µF capacitor is more intense than that from a 0.02µF capacitor when connected to the same potential. Why?   **[2]**

(b)   Define solar irradiation.   **[1]**

(c)   An alternating emf of 100V – 50Hz is applied across a capacitor of reactance
        318Ω and resistor of resistance 100Ω in series. Calculate the current flowing
        through the circuit. (L = 0)   **[3]**

(d)   Derive an expression for a fringe width in Young's interference pattern.   **[2]**

(e)   State any *TWO* sign conventions for spherical mirrors.   **[2]**

Question 3.

(a)   It is more difficult to drain out a cup of honey than a cup of water. Explain.   **[2]**

(b)   At what positions will the velocity and acceleration of a pendulum bob be minimum and maximum when its bob executes SHM?   **[2]**

(c)   Can sustained interference take place from two sources of light? Give a reason to support your answer.   **[2]**

(d)   State *TWO* properties of a positron.   **[1]**

(e)   The current through a 1mH coil drops from 5A to 3A in 1×10^{-3} s.
        Calculate the emf developed in the coil.   **[2]**

(f)   Photoelectric emission is not possible at all frequencies. Why?   **[1]**

Question 4.

(a)   Write the mathematical expression for the ideal gas law.   **[1]**

(b)   The electrical conductivity of a pure semiconductor increases on increasing
        the temperature. Explain the statement.   **[2]**
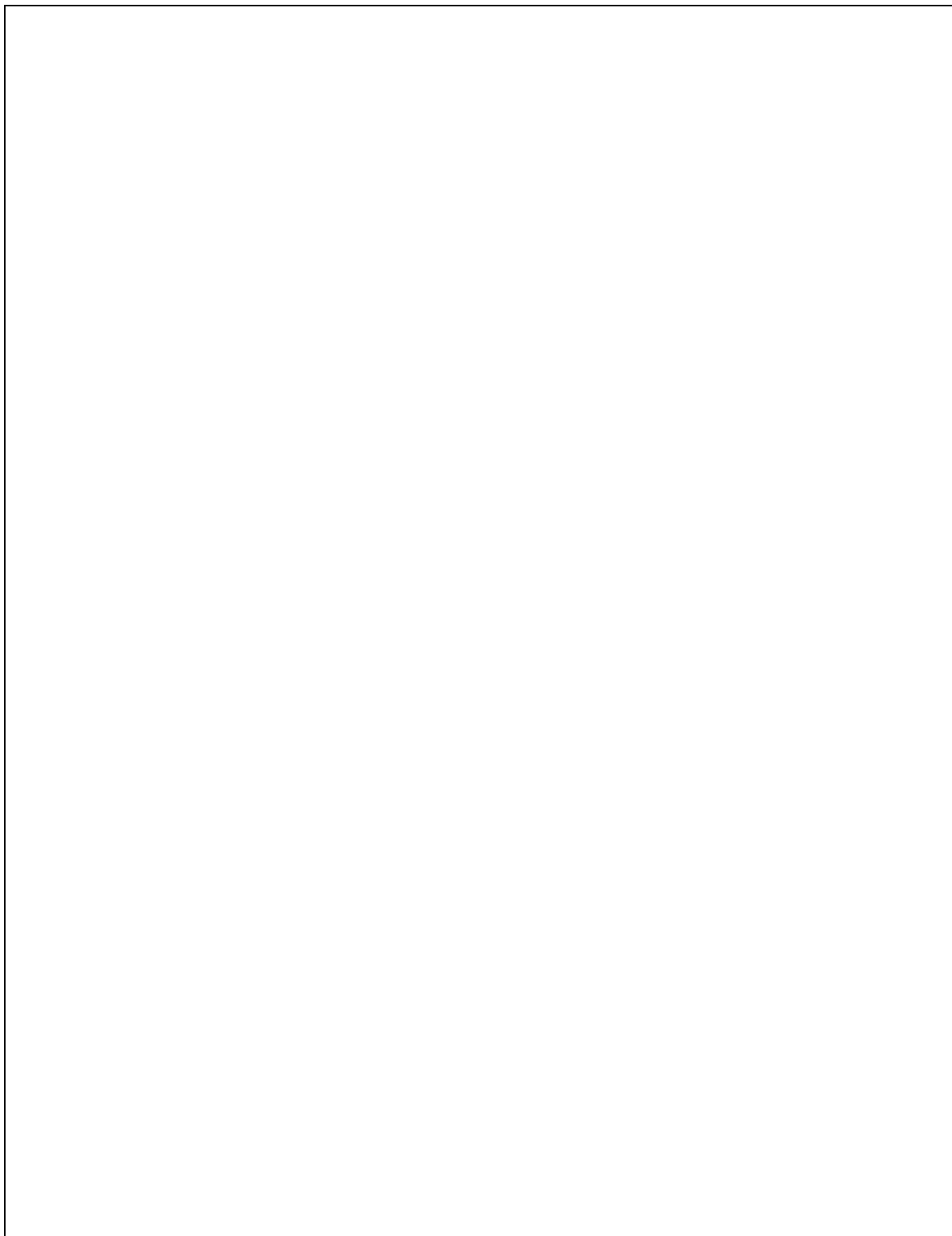

(c)   Electricity can be generated from hydropower plants as well as nuclear
        power plants. Which power plant is better for generating electricity and why?   **[2]**

(d)   Two point charges each of magnitude 1.6×10^{-19}C are separated by a distance of 3×10^{-15}m. Find the magnitude of the force.   **[2]**

(e)   With the help of a ray diagram, derive a mirror equation.   **[3]**

Question 5.

(a)   A simple harmonic motion is represented by an equation, 20y = 0.1 sin50πt, where the displacement y is in meter and the time in second. Find the amplitude and frequency of the particle.   **[3]**

(b)   Explain Lenz's law with the help of a diagram.   **[2]**

(c)   How is the sensitivity of a sensor different from the resolution of a sensor?   **[2]**

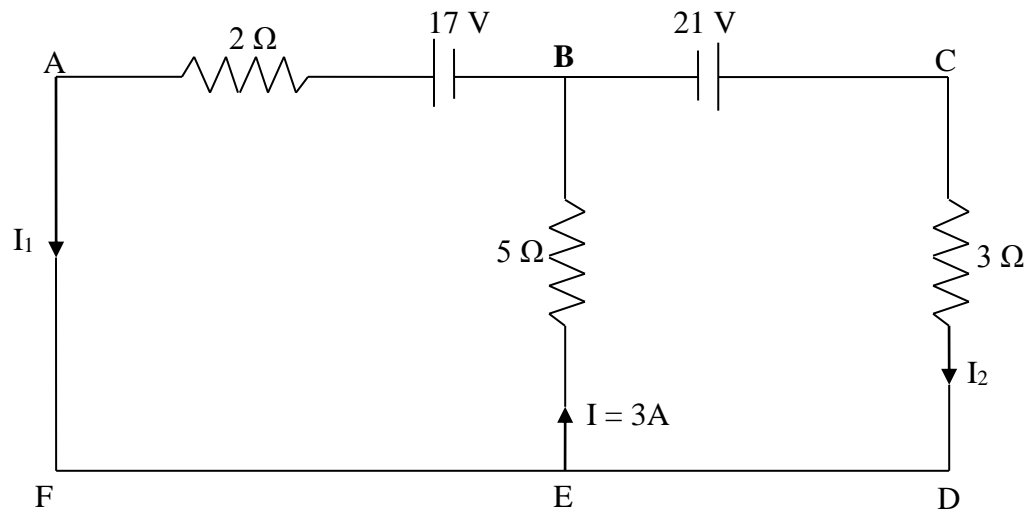(d)   Differentiate between quark and leptons.   **[2]**

Quark	**Lepton**

(e)   Explain the variation of velocity of plasma with respect to its mass.   **[1]**

Question 6.

(a)   Derive an expression for the potential energy of a particle in SHM.   **[2]**

(b)   Both convex and concave mirrors can be used for shaving. Which mirror is
        preferred? Why?   **[2]**

(c)   In the given electric circuit, use Kirchhoff's laws to find currents I_1 and I_2.   **[3]**

(d) When the intensity of light falling on a photocell is increased, what will be its effect on the

  (i) current flowing out of the cell? **[1]**

  (ii) minimum negative potential required to stop the current? **[1]**

(e) Define terminal velocity. **[1]**

Question 7.

(a)   A glass capillary tube of diameter 2×10^{-4}m is dipped in mercury whose
surface tension is 0.547N/m and density is 13500kg/m^3. By how much
will the mercury be depressed in the capillary tube, if the angle of contact
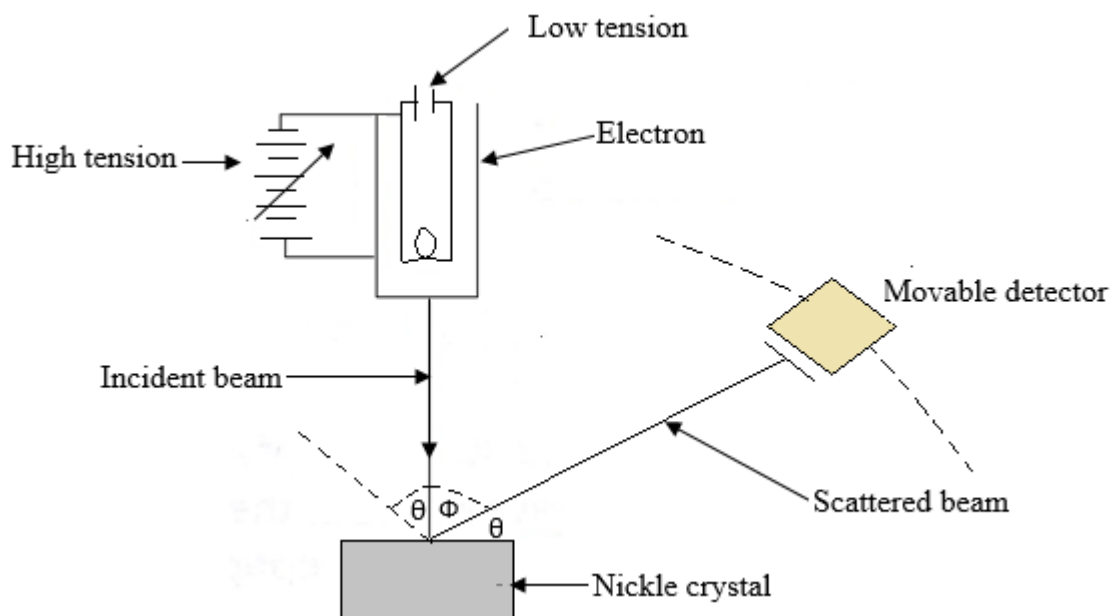of mercury with glass is 135°?   **[2]**

(b)   Give *FOUR* applications of nano technology.   **[2]**

(c)   Obtain an expression, $E = \dfrac{1}{2}CV^2$ for energy stored in a charged capacitor.   **[2]**

(d)   Study the diagram given below.

Name the phenomenon shown in the experimental set-up given above.   **[1]**

(e)   Which of the following examples represent SHM and periodic motion?   **[2]**
       (i)   Rotation of the earth about its axis.

       (ii)   Motion of a bob in a pendulum.

       (iii)   Motion of a ball bearing inside a smooth curved bowl.

(iv)   Motion of the hands of a clock.

(f)   Explain the term radio blackout.   **[1]**

Question 8.
(a)   (i)   Explain the term forced oscillation.   **[1]**

ii)   State the condition which leads to resonance in oscillating bodies.   **[1]**

(b) What type of path is followed by a moving charged particle in a uniform electric field? **[1]**

(c) A stationary conducting loop is held perpendicular to a field between the pole pieces of a fixed permanent magnet. Is the current induced in the loop? Why? **[2]**

(d)   Obtain the average kinetic energy equation, $K_{avg} = \dfrac{3}{2}kT$.   **[2]**

(e)   Draw a ray diagram to show the virtual focus of a convex mirror.   **[1]**

(f)   Calculate the mass defect of helium $\left[{}_2\text{He}^4 \right]$ nucleus and its binding energy in MeV. The mass of helium nucleus is 4.001506 u.   **[2]**
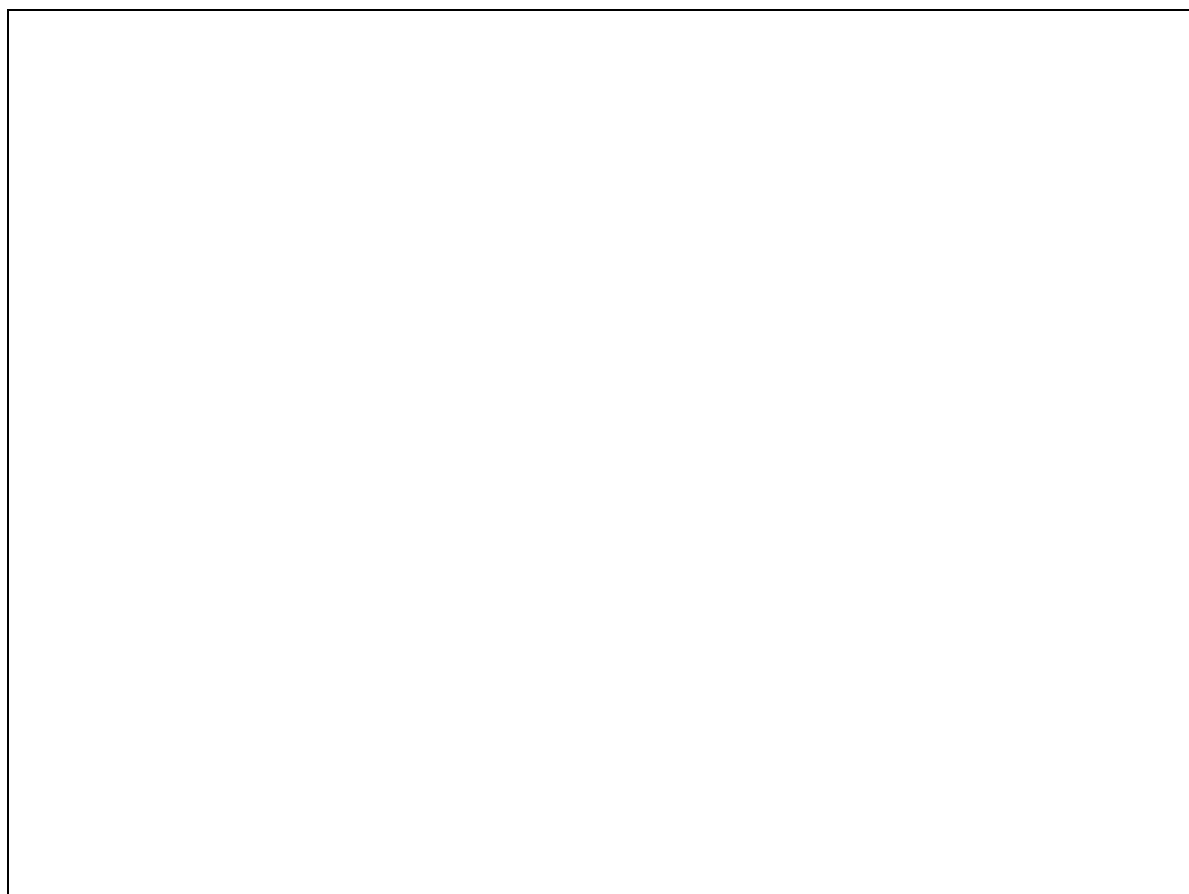
[PHYSICAL CONSTANTS]

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

For rough work