L-1/T-2/CHE **Date: 15/10/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2020-2021

Sub: **CHE 103** (Engineering Thermodynamics)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** questions.

Symbols have their usual meaning.

1. (a) Briefly explain the concepts of internal energy, enthalpy and state function. **(9)**

   (b) Discuss why a chemical engineering should study phase diagrams? **(7)**

   (c) Is entropy a form of energy? Explain why or why not. **(7)**

   (d) A car engine with a power output of 110 hp has a thermal efficiency of 28 percent. Determine the rate of fuel consumption per hour if the heating value of the fuel is 19,000 Btu/lb_m. **(12)**

2. (a) What is standard heat of reaction, standard heat of formation and standard heat of combustion? Discuss with appropriate examples. **(12)**

   (b) An adiabatic gas turbine expands air at 1,300 kPa and 500°C to 100 kPa and 127°C. Air enters the turbine through a 0.2-m^2 opening with an average velocity of 40 m/s, and exhausts through a 1-m^2 opening. Determine (i) the mass flow rate of air through the turbine and (ii) the power produced by the turbine. Given: The specific heat of air is $Cp = 1.048\ kJ/kg \cdot K$. The gas constant of air is $R = 0.287\ kPa.m^3/kg.K$. **(23)**

3. (a) Draw and state the key features of P-V and P-T diagram of a pure substance. **(10)**

   (b) An ideal gas undergoes the following sequence of mechanically reversible processes in a closed system. **(25)**

   (i) From an initial state of 30°C and 100 kPa, it is compressed adiabatically to 500 kPa.

   (ii) It is then cooled at a constant pressure of 500 kPa to 30°C.

   (iii) Finally, it is expanded isothermally to its original state.

   Calculate Q, W, U^{ig}, and ΔH^{ig} for each of the three processes and for the entire cycle. Take $C_P^{ig} = (7/2)R$ and $C_V^{ig} = (5/2)R$.

4. (a) Starting from the entropy balance for open systems, show that, $W_{ideal} = \Delta H - T_o \Delta S$. **(17)**

   (b) An insulated piston–cylinder device initially contains 300 L of air at 120 kPa and 17°C. Air is now heated for 15 min by a 200-W resistance heater placed inside the cylinder. The pressure of air is maintained constant during this process. Determine the entropy change of air. Given, average specific heat of air, $Cp = 1.02\ kJ/kg \cdot K$. **(18)**

Contd P/2

CHE 103

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE** questions.
Data booklet is attached.

5. (a) If Gibbs energy G = H – TS, then show that $\left(\frac{\partial V}{\partial T}\right)_p = -\left(\frac{\partial S}{\partial P}\right)_T$ **(10)**

(b) One kilogram of water (v_1 = 1003 cm^3/kg) in a piston/cylinder device at 25°C and 1 bar is compressed in a mechanically reversible, isothermal process to 1500 bar. Determine Q, W, ΔU, ΔH and ΔS given that $\beta = 250 \times 10^{-6}\ k^{-1}$ and $K = 45 \times 10^{-6}\ bar^{-1}$ **(10)**

(c) Discuss the importance of residual property in thermodynamics. **(5)**

6. (a) The PVT behaviour of a certain gas is described by the equation of state **(15)**

$$p(V - b) = RT$$

where b is a constant. If in addition C_V is constant show that

(i) γ = constant

(ii) For mechanically reversible process, $p(V-b)^{\gamma}$ = constant.

(b) $Z - 1 = B\rho + C\rho^2$, is the three terms vireal equation. Determine expression for G^R, H^R and S^R. **(20)**

7. (a) Energy balance equation for steady flow process is given by **(20)**

$$\Delta H + \frac{\Delta U^2}{2} + g\Delta Z = Q + W$$

For pipe flow, with appropriate assumption show that

$$\left(1 - M^2\right)Vdp + \left(1 + \frac{\beta U^2}{Cp}\right)Tds - \frac{U^2}{A}dA = 0$$

where M is the Mach number, defined as the ratio of the speed of the fluid in the duct to the speed of sound in the fluid $\left(U/C\right)$.

(b) Steam enters a nozzle at 800 kPa and 280°C at negligible velocity and discharge at a pressure of 525 kPa. Assuming isentropic expansion of the steam in the nozzle what is the exit velocity and what is the cross sectional area at the nozzle exit for a flow rate of 0.75 kg/s? **(15)**

8. (a) With the help of P-V diagram, discuss the air standard Otto cycle. Show that thermal efficiency **(15)**

$$\eta = 1 - \left(\frac{1}{r}\right)^{\gamma - 1}$$

where r is the compression ratio.

(b) A gas turbine engine compress air from 5 bar to 25 bar. Determine the efficiency, η of the ideal air cycle for γ = 1.4. **(5)**

(c) A steam power plant operates on the Rankine cycle. Power rating is 70,000 kW. Steam at 600°C and 8500 kPa is expanded to 10 kPa. If pump and turbine efficiency is 0.8, determine the thermal efficiency of the power plant. **(15)**

L-1/T-2/CHE **Date: 19/10/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2020-2021

Sub: **CHEM 131** (Physical Chemistry I)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** questions.

Symbols used here bear usual meaning. Assume reasonable values for any missing data.

1. (a) Deduce an equation to assess a process in term of entropy change when two ideal gases are mixed. Is the equation equally applicable in the case of solution? Justify your answer. **(11)**

   (b) Derive an expression for entropy change of an ideal gas when the temperature changes from T_1 to T_2 and the volume from V_1 to V_2 and hence modify the equation for an isothermal process. **(15)**

   (c) Calculate ΔS, ΔS_{surr} and ΔS_{univ} if 2.00 mol of an ideal gas expands isothermally and irreversibly at 25°C from a volume of 10.00 L to a volume of 40.00 L at a constant external pressure of 1.01 bar. **(9)**

2. (a) Derive the form of Clapeyron equation which is applicable to solid-liquid phase transformation. **(11)**

   (b) Discuss the merits of Clapeyron equation obtained from 2(a) and hence establish the relation which is applicable to liquid-gas phase transformation. **(15)**

   (c) The freezing point of water at 1 bar is 0°C. At this temperature the density of liquid water is 1.000 g/mL and that of ice is 0.917 g/mL. The increase in enthalpy for melting at this temperature is 6010 J/mol. Estimate the freezing point at 1000 bar. **(9)**

3. (a) With a suitable mathematical expression explain the effect of an inert gas on the equilibrium of the following reaction: **(11)**

$$SO_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons SO_3(g)$$

   (b) Deduce an expression showing the temperature dependence of equilibrium constant and hence show how you can explain exothermic and endothermic nature of chemical reactions. **(15)**

   (c) At 394.8°C the equilibrium constant for the formation of phosgene from chlorine and carbon monoxide is 22.5 with pressure in atm. Calculate the degree of dissociation of phosgene (i) in the presence of N_2 at a partial pressure of 0.40 atm in a total pressure of 1 atm and (ii) compare the result in the absence of N_2 with the same total pressure of the system. **(9)**

Contd P/2

4. (a) Discuss the construction and working principle of Langmuir film balance. Explain how you can determine the molecular area of an amphiphilic molecule with the help of the balance. **(11)**

(b) Utilizing the assumptions of Langmuir adsorption isotherm, deduce an equation for the amount of a gas adsorbed per unit area of an adsorbent and show the condition under which Langmuir adsorption isotherm takes the form of Freundlich isotherm. **(15)**

(c) A film containing 5.14×10^{-5} g of hexadecyl alcohol spread on water was compressed into a monolayer occupying an area of 268.5 cm^2. The density of the alcohol is 0.818 g/cm^3. Calculate the cross sectional area of the molecule and its length. **(9)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE** questions.

5. (a) Define solution and how it differs from a compound? In case of dissolution of solid in liquid, describe the schematic diagrams of the energetics for exothermic, endothermic and thermo-neutral solutions. **(2+8=10)**

(b) What is meant by 'Dynamic equilibrium'? In a saturated solution there exists a state of 'Dynamic equilibrium' — explain. **(5+10=15)**

(c) Body fluids contain a mixture of several electrolytes, such as, Na^+, Cl^-, K^+, Ca^{2+}. The laboratory tests for a patient indicate a blood calcium level of 8.8 mEq/L. **(10)**

(i) How many moles of calcium ion are in 0.5 L of blood?

(ii) If Cl^- is the only other ion present, what is its concentration in mEq/L?

6. (a) State Raoult's Law of elevation of boiling point. Derive an expression for the elevation of boiling point of a solution when a non-volatile solute is dissolved in it and explain as to how the molecular weight of the solute can be evaluated by the elevation of boiling point method? **(2+10+3=15)**

(b) The boiling point of benzene is 353.35 K whereas a 0.2 molal naphthalene solution in benzene shows a boiling point 353.88 K. If 10 g of a non-volatile solute dissolves in 100 g of benzene, then its boiling point is elevated by 0.8 K. Find the molar mass of the non-volatile solute. **(10)**

(c) What is the driving force behind the osmosis? The observed osmotic pressure for an electrolyte solution of $Fe(NH_4)_2(SO_4)_2$ is 39.96 atm at 25°C. Compare and comment on the difference between the expected and experimental values for van Hoff factor. (Consider the concentration of the electrolyte solution is 0.37 M) **(2+8=10)**

Contd P/3

CHEM 131/CHE

7. (a) What are lyophobic colloids? Why are they called irreversible colloids? Describe Berdig's Arc method for preparing a lyophobic sol in details. **(5+5=10)**

(b) Explain why: **(15)**

(i) A true colloidal solution is stable?

(ii) A true solution do not show Tyndall effect and Brownian movement?

(iii) A true suspension do not exhibit Brownian movement?

(c) What are emulsion and emulsifying agent? What distinguishes between emulsions and gels? Explain the role of a synthetic detergent to form a stable Oil-in-Water (O/W) type emulsion. **(5+5=10)**

8. (a) Nanomaterial plays an important role in various catalytic reactions. Define nanomaterials and explain the most crucial feature of nanomaterials. Distinguish between bottom-up and top-down strategies of nanomaterial synthesis. Discuss the bottom-up strategy in the synthesis of Au nanoparticles. **(5+10=15)**

(b) What is heterogeneous catalysis? Derive an expression for an unimolecular reaction onto a catalytic solid surface. **(10)**

(c) Illustrate a general mechanism of acid-base catalytic reaction. Establish the conditions under which a catalytic reaction may be classified into general acid catalysis and specific hydrogen ion catalysis. **(10)**

L-1/T-2/CHE **Date : 03/11/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2020-2021

Sub : **HUM 125** (English)

Full Marks : 140 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** questions, including **Q. No. 1** as compulsory.

Symbols indicate their usual meaning.

1. (a) Explain with reference to the context **any one** of the following: **(8)**

(i) "But we can't possibly have a garden-party with a man dead just outside the front gate."

(ii) "Capital punishment kills a man at once but lifelong imprisonment kills him slowly."

(b) Answer **any one** of the following: **(10)**

(i) Mrs. Matilda Loisel's disposition and greed invite her doom. – Discuss in the context of the story "The Diamond Necklace".

(ii) How does 'The Bet' show "two different perceptions of ultimate meaning of life – the life of worldly pursuits and the life of renunciation".

(c) Answer **any three** of the following: **(12)**

(i) Why did Mrs. Forestier fail to recognize her friend?

(ii) Describe the travails that Mr. and Mrs. Loisel has to undergo to repay the loan for losing the diamond necklace.

(iii) Why did Laura want to stop the garden party?

(iv) Give a brief description of the party as arranged in the story "The Garden Party".

(v) How did the banker try to justify the concept of capital punishment?

2. Recast and correct **any ten** of the following sentences: **(20)**

(i) I am concerned with your health.

(ii) You have to pay custom at the airport.

(iii) Each of the girls must carry their bag.

(iv) I had laid there for some time before getting up.

(v) A bouquet of yellow roses lend color and fragrance to the room.

(vi) The best does not lack integrity.

(vii) The man was cured from his illness.

(viii) We couldn't risk to leave him alone.

(ix) It's a secret between you and I.

(x) John is the tallest of the two boys.

(xi) The reason is because I believe it.

(xii) I'm going to cut my hair.

Contd P/2

HUM 125/CHE

3. (a) Write down meaning of **any ten** of the following words: **(10)**

Abhor, Baffle, Chore, Depict, Eloquence, Foresee, Heed, Sue, Tranquil, Vehemence, Wither, Slit

(b) Make sentences with **any ten** of the following words: **(10)**

Impromptu, Jeopardy, Endeavor, Inquisitive, Limpid, Meddle, Nadir, Ordeal, Profound, Pact, Reiterate, Versatile

4. Write a précis of the following passage with a suitable title: **(20)**

One of the most intriguing stories of the Russian Revolution concerns the identity of Anastasia, the youngest daughter of Czar Nicholas II. During his reign over Russia the czar had planned to revoke many of the harsh laws established by previous czars. Some workers and peasants, however, clamored for more rapid social reform. In 1918, a group of these people known as Bolsheviks overthrew the government. On July 17 or 18, they murdered the czar and what was thought to be his entire family.

Although witnesses vouched that all the members of the czar's family had been executed, there were rumors suggesting that Anastasia had survived. Over the years, a number of women claimed to be Grand Duchess Anastasia. Perhaps the most famous claimant was Anastasia Tschaikovsky, who was also known as Anna Anderson.

In 1920, 18 months after the czar's execution, this terrified young woman was rescued from drowning in a Berlin river. She spent two years in a hospital, where she attempted to reclaim her health and shattered mind. The doctors and nurses thought that she resembled Anastasia and questioned her about her background. She disclaimed any connection with the czar's family. Eight years later, however, she claimed that she was Anastasia. She said that she had been rescued by two Russian soldiers after the czar and the rest of her family had been killed. Two brothers named Tschaikovsky had carried her into Romania. She had married one of the brothers, who had taken her to Berlin and left her there, penniless and without a vocation. Unable to invoke the aid of her mother's family in Germany, she had tried to drown herself.

SECTION – B

There are **FOUR** questions in this section. Answer **Q. No. 5** and any **TWO** from the rest.

5. **Read the following passage carefully and answer the questions that follow:** **(30)**

For almost 300 years, a fictitious character by the name of John Bull has been used as a representation of the "true Englishman", as if the "English" were a homogenous race of people. They are not. In reality, the English are among the more diverse races in Europe. The "Angles", who gave their name of the country, were people from northern Germany, who came over with the Saxons and the Jutes during the "Dark Ages", over 1200 years ago, conquered the "British", who were Celts, and established their settlements.

Contd P/3

HUM 125/CHE

Contd ... Q. No. 5

They were soon followed by Vikings, from Scandinavia, who occupied a large part of eastern Britain. The last successful invasion of England came in 1066, when William the Conqueror, duke of Normandy, defeated the English armies, had himself crowned king of England, and established a new Anglo-Norman state in which everyone important spoke French. Since that time, England has never again been invaded or colonized by people from across the sea; yet in ethnic terms, England has continued to evolve. During the Middle Ages, large numbers of men and women came to England from Flanders, to work in the cloth trade; there were also Jews from Europe, who kept coming to England over the centuries. In the 17th Century, thousands of French Huguenot Protestants fled from religious persecution and came to England, adding 1% to the total British population, and considerably more in the south of England where most of them settled.

In the twentieth century, many more people emigrated to England: victims of Nazi and Stalinist persecution, men and women from the Commonwealth, and workers from Europe. Most of those who arrived before 1960 took British nationality, and some of their children think of themselves as being English. Most consider themselves as British. Thus it is clear that the English, Shakespeare's "happy breed", are a very mixed race. There are few people in today's England, if any at all, who can claim to be pure ethnic "Englishmen" (whatever that may mean). It can be argued that there is indeed no such thing as an English ethnicity. In political terms, the people who talk most about "England" and "Englishness" tend to be Conservatives or on the political right; yet many Conservative politicians today and in the past have come from non-British backgrounds. The most famous Conservative prime minister of the 19th century was Benjamin Disraeli; and two of the four senior ministers in the Conservative government in 2020, Rishi Sunak (Chancellor of the Exchequer) and Priti Patel (Home Secretary), are of Indian origin. More surprisingly, one of the strongest voices on the "English nationalist" wing of the Conservative Party is a staunch Brexiteer with the name of Mark Francois, whose mother was Italian. Try understanding that.

Questions:

(i) Give an appropriate title with justification.

(ii) Give the meanings of the following words:

Fictitious, diverse, persecution, invasion, emigrate

(iii) Who are the English?

(iv) When and how did the duke of Normandy establish a new Anglo-Norman state?

(v) Why did the French Huguenot Protestants come to England?

(vi) Why does the author say "there is indeed no such thing as an English ethnicity?"

Contd P/4

HUM 125/CHE

6. (a) As the Cultural Secretary of BUET Students' Union, you have ordered some books to Oxford University Press (OUP), Walton Street, Oxford, UK. On receiving the consignment, one-fourth of the goods have been found in damaged condition. Write a letter of complaint to the Sales manager, OUP, claiming compensation for those books. **(10)**

   (b) Write phonetic transcription of the following words: **(any five)** **(10)**

   Thought, movement, sure, pleasure, cape, chicken

7. (a) Write a dialogue between two students about a fire and subsequent explosions at a shipping container depot in Chittagong district of Bangladesh. **(10)**

   (b) Write a short composition on **one** of the following topics: **(10)**

   (i) Artificial Intelligence

   (ii) A Rainy Day

   (iii) Patriotism

8. (a) Transform **any five** of the following sentences as directed: **(10)**

   (i) I knew about her previous activities. (Complex)

   (ii) As there was no wind, the ship could not move. (Compound)

   (iii) In spite their huge size, whales can move at a good speed. (Complex)

   (iv) When they walk, they don't make any sound. (Simple)

   (v) Light travels faster than anything else. (Superlative)

   (vi) I went to his home but he did not meet me. (Simple)

   (b) Write short notes on **any two** of the following: **(10)**

   (i) Diphthongs

   (ii) Cohesion and Coherence

   (iii) Back Matter of a Report

L-1/T-2/CHE **Date : 30/10/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2020-2021

Sub : **PHY 171** (Structure of Matter, Electricity & Magnetism and Nanophysics)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Write down the relationship between the electric field and electric lines of forces. Draw electric field lines for a dipole and quadrupole. **(10)**

   (b) State Gauss' law and apply this law to obtain an expression for the electric field at a point (i) inside (ii) outside and (iii) surface of a uniformly charged non-conducting solid sphere. All expressions must be calculated in terms of charge density ρ. **(20)**

   (c) The plates of a capacitor carry charges $+q$ and $-q$. Each plate has an area of 45 cm^2 separated by a distance of 20 mm. Between the plates, the field is constant at E = 150 kV/m and the field is zero outside the plates. Find the charge, q. **(5)**

2. (a) What do you understand by electric potential, electric potential energy and equipotential surface? **(8)**

   (b) Show that the electric potential **(21)**

   (i) $V \propto \frac{1}{r}$ for monopole

   (ii) $V \propto \frac{1}{r^2}$ for dipole

   (iii) $V \propto \frac{1}{r^3}$ for quadrupole

   where the terms have their usual meanings.

   (c) Fig. 2(c) shows the electric field lines and equipotential. When an electron moves from A to B along the line then the electric field does 5.5×10^{-19} J of work on it. Find the electric potential differences (i) $V_B - V_A$ (ii)$V_C - V_A$ (iii) $V_C - V_B$. **(6)**

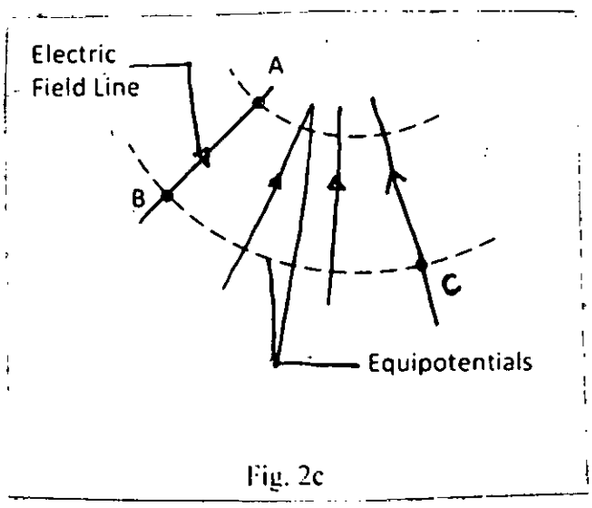

Fig. 2c

Contd P/2

PHY 171/CHE

3. (a) Define self-inductance and mutual inductance with their mathematical expressions. **(6)**

(b) Obtain an expression for the growth and decay of current of an inductor in an LR circuit. What is the time constant of the circuit? Also, explain the nature of the time-current curves if the time constant varies. **(19)**

(c) A toroid of 60 cm circumference and 300 mm^2 cross-sectional area and of 3500 turns bearing a current of 0.8 A. It is wound on an iron ring with a relative permeability of 350. Find the magnetic induction, the flux, the coefficient of self-inductance and the energy stored in the magnetic field. **(10)**

4. (a) What do you mean by wave function? Briefly describe why a wave function needs to be zero at infinity. **(9)**

(b) State the Ehranfest theorem. Hence explain the significance of the Ehranfest theorem. **(8)**

(c) What do you mean by expectation value? The wave function for a particle of mass *m* is given by **(18)**

$$\Psi(x,t) = Ae^{\left(-mx^2\omega - i\omega t\right)}$$ where A, and ω are constant.

(i) Normalize the wave function.

(ii) Calculate the expectation value of position and kinetic energy.

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) What do you mean by stationary states? Describe the properties of stationary states. **(10)**

(b) Plot the wave functions and energy levels of a particle that is trapped inside an infinite square well. Hence explain the idea of quantization of energy. **(10)**

(c) Show that for a particle inside an infinite square well the wave functions are mutually orthogonal to each other. **(15)**

6. (a) What do you mean by the term "nanotechnology"? Briefly describe the uses of nanotechnology in different branches of science and technology. **(10)**

(b) Differentiate between the *top down* and *bottom up* technique for the synthesis of nanomaterials. **(10)**

(c) Write short notes on the following techniques **(15)**

(i) Sol-gel deposition technique for the synthesis of nanomaterials

(ii) Physical vapor deposition for the synthesis of thin films

Contd P/3

PHY 171/CHE

7. (a) How do you determine Miller indices of plane in a crystal lattice? Prove that in an orthorhombic crystal lattice the interplanner spacing between the successive planes of indices (*hkl*) is expressed as, $d_{hkl} = \frac{1}{\sqrt{\left[\frac{h^2}{a^2} + \frac{k^2}{b^2} + \frac{l^2}{c^2}\right]}}$.

Here the symbols carry their usual meanings. **(18)**

(b) Describe the sodium chloride (NaCl) structure. What are the dissimilarities of NaCl structure with the face centered cubic (fcc) structure of an element. **(10)**

(c) Potassium bromide (KBr) have similar crystal structure as NaCl. Ionic radii of K^+ and Br^- ions are 0.133 nm and 0.195 nm, respectively. Evaluate the packing factor of KBr structure. **(7)**

8. (a) Write short notes on – (i) P-type semiconductor, (ii) Covalent bond, (iii) Edge dislocation. **(12)**

(b) Write down the properties of X-rays which are beneficial for crystal structure analysis? Derive Bragg's law of X-ray diffraction. **(16)**

(c) X-rays having a wavelength of 1.54 Å are used to determine the interplanner spacing of (200) plane in an fcc crystal. The Bragg angle for the reflection from the 1st plane is 26.7°. Find out the side of the unit cell of the crystal. **(7)**
