(1) 7/12/18

This question paper contains **4** printed pages]

Roll No. | | | | | | | | | | |

S. No. of Question Paper : **39**

Unique Paper Code : **32171101**

Name of the Paper : **Inorganic Chemistry—I**

Name of the Course : **B.Sc. (H) Chemistry**

Semester : **I**

Duration : 3 Hours Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *six* questions in all.

Question No. **1** is compulsory.

1. Explain any *five* of the following with suitable reason : 5×3

   (*a*) Which is more covalent : NaCl *or* NaI ?

   (*b*) Which has the greater bond dissociation energy : O_2 *or* O_2^+ ?

   (*c*) All the three N-O bonds in NO_3^- are equal.

   (*d*) Shape of dz^2 orbital is different from other *d*-orbitals.

   (*e*) $BeCl_2$ has zero dipole moment while H_2S has some value.

   (*f*) Which has greater melting point : *o*-nitrophenol *or* *p*-nitrophenol ?

P.T.O.

2. (*a*) Calculate the lattice energy of MgO (in $kJmol^{-1}$) :

Given : A = 1.7475; $r\ (Mg^{2+}) = 0.65$ Å; $r\ (O^{2-}) = 1.40$ Å; $n = 7$; $e = 4.8 \times 10^{-10}$ e.s.u.; $N = 6.02 \times 10^{23}$.

(*b*) Define resonance energy and draw the resonating structures of NO_3^- and N_3^-.

(*c*) Are 5*g* and 6*h* sub-shells possible ? Give reasons. If they are possible, show how many orbitals can be present in each sub-shells ? 4,4,4

3. (*a*) Give Allred and Rochow's scale of electronegativity. Calculate the electronegativity of silicon atom using this scale. The covalent radius of Si atom is 1.175 Å.

(*b*) What are isoelectronic ions ? How effective nuclear charge affects the radii of isoelectronic ions : N^{3-}, O^{2-}, F^-, Na^+, Mg^{2+} ?

(*c*) The dipole moment of LiH is 1.964×10^{-29} Cm and bond length for LiH is 1.596 Å. What is the percent ionic character in LiH ? (Charge on one electron = 1.6×10^{-19} C). 4,4,4

4. (*a*) How do you arrive at Schrodinger wave equation for H-atom starting with simple sine wave equation ?

(*b*) Using Slater's rule, calculate Z* for :

(*i*) 3*d*

(*ii*) 4*s* electron in Co atom (Z = 27).

(*c*) Explain the shapes of the following molecules/ions according to VSEPR theory :

I_3^-, H_2O, BrF_2^+, ICl_4^-. 4,4,4

5. (*a*) Draw the MO energy level diagram for N_2^+. Discuss its bond order and magnetic behaviour. Why is the bond order in N_2^+ less than in N_2 molecule ?

(*b*) What are the four special properties which an acceptable wave function must have ? Why these restrictions are reasonable ?

(*c*) Using Pauling's method, calculate the radii of Na^+ and F^- ions. The observed internuclear distance in NaF crystal is 213 pm. 4,4,4

6. (*a*) Taking Z-axis as nuclear axis, explain whether the following orbitals will overlap to form molecular orbitals or not ?

(*i*) $s + p_x$

(*ii*) $p_x + d_{xy}$

(*iii*) $p_y + d_{x^2 - y^2}$.

(*b*) Calculate the limiting radius ratio for the ionic compound when the coordination number of the cation is 4.

(*c*) What is a radial distribution function ? Draw this function for 1*s*, 2*p* and 3*s* orbitals. 4,4,4

7. (*a*) Draw the Born-Haber cycle for the formation of $CaCl_2$ and explain the various terms involved.

(*b*) State Pauli's exclusion principle. Using this principle, calculate the number of electrons in L shell.

(*c*) Define electronegativity. How the electronegativity varies with *s*-character in different hybridisation of organic compounds ? 4,4,4

8. Write short notes on any *three* of the following :

(*i*) Bent's Rule

(*ii*) Band theory of metallic bonding

(*iii*) Hund's rule of maximum multiplicity

(*iv*) Polarisation and polarisabilty. 3×4

(2)

This question paper contains **4+2** printed pages]

Roll No. | | | | | | | | | | | |

S. No. of Question Paper : **40**

Unique Paper Code : **32171102** **I**

Name of the Paper : **Physical Chemistry–I**

Name of the Course : **B.Sc. (Hons.) Chemistry**

Semester : **I**

Duration : **3 Hours** Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *six* questions in all.

Question No. **1** is compulsory.

Use of scientific calculator and log tables is allowed.

Physical constants : $R = 8.314\ JK^{-1}\ mol^{-1}$, $N_A = 6.023 \times 10^{23}\ mol^{-1}$, $k = 1.38 \times 10^{-23}\ JK^{-1}$.

1. Attempt any *five* of the following : 5×3=15

Explain why :

(*a*) The end-centred bravais lattice is not possible for a cubic unit cell ?

P.T.O.

(*b*) The pH of water is *not* 7.0 at 60°C ? Will it remain neutral at this temperature ?

(*c*) Irrespective of their nature, drops of all the liquids falling freely in air are spherical in shape ?

(*d*) Addition of KNO_3 increases the surface tension of water but addition of detergent decreases it ?

(*e*) CO and N_2 have the same speed distribution at the same temperature ?

(*f*) The viscosity of gas increases with temperature but that of liquid decreases with temperature ?

(*g*) The initial slope of the graph of compressibility factor, Z *versus* the pressure, *p*, at constant temperature is positive for some gases and negative for others ?

2. (*a*) Write the mathematical expression for the Maxwell distribution of molecular speeds of a gas, explain briefly the terms involved. How does the change in temperature influence the distribution of molecular speeds ? 4

(*b*) Calculate the temperature at which average velocity of SO_2 equals to that of O_2 at 20 K. 4

(*c*) Derive the relations using van der Waals gas equation : $P_c = a/27b^2$ and $T_c = 8a/27Rb$. 4

3. (*a*) Explain the terms σ, λ, Z_1 and Z_{11}. Discuss the effect of temperature and pressure on these terms. 5

(*b*) Calculate λ, Z_1 and Z_{11} for oxygen at 298 K and 10^{-3} mmHg. Given $\sigma = 3.61 \times 10^{-8}$ cm. 4

(*c*) Write a note on continuity of state. 3

4. (*a*) Starting from the postulates of the kinetic theory of gases, derive the kinetic gas equation. 5

(*b*) Calculate the pressure exerted by 3.023×10^{23} molecules of CH_4 in 0.5 dm^3 at 298 K using van der Waals equation. (Given : $a = 2.253$ L^2 atm mol^{-2}, $b = 0.0428$ L mol^{-1} and $R = 0.0821$ L atm mol^{-1} K^{-1}). 4

(*c*) What are the units of van der Waals constants *a* and *b* ? Do these constants depend upon temperature of the gas ? 3

5. (*a*) Define the surface tension of liquid. Describe drop number method for the determination of surface tension of a liquid. 4

40

(*b*) With the given viscometer, the times of flow at 20°C for water and an unknown liquid (d = 1.22 g cm^{-3}) were found to be 155 sec and 80 sec respectively. Calculate the absolute viscosity of the unknown liquid at 20°C if viscosity and density of water are 1.005 centipoise and 1 g cm^{-3} respectively. 4

(*c*) What is capillary action ? Derive : $\gamma = \pm \frac{1}{2} h\rho gr$, where the symbols have their usual meanings. 4

6. (*a*) What are the differences between crystalline and amorphous solids ? 4

(*b*) When a certain crystal was studied by the Bragg's method using X-rays of wavelength 229 pm, first order X-ray reflection was observed at an angle of 23°20' :

(*i*) What is corresponding inter-planar spacing ?

(*ii*) When another X-ray source was used, a reflection was observed at 15°26' ? What was the wavelength of these X-rays ? 4

40

(*c*) Give the Miller indices of the plane which intercepts the three crystallographic axes at the multiple of unit distance at :

(*i*) 3/2, 2, 1

(*ii*) 1/2, 2/3, ∞. 4

7. (*a*) Show that the concentration of H_3O^+ in an aqueous solution of an acid HA can be computed from the expression :

$$K_a = \frac{\left[H_3O^+\right]^3 - \left[H_3O^+\right] K_w}{\left[H_3O^+\right]\left[HA\right]_0 - \left[H_3O^+\right]^2 + K_w}.$$

Under what conditions can the following expressions be used :

(*i*) $K_a = \dfrac{\left[H_3O^+\right]^2}{\left[HA\right]_0 - \left[H_3O^+\right]}$

(*ii*) $K_a = \dfrac{\left[H_3O^+\right]^2}{\left[HA\right]_0}$. 5

(*b*) What is the pH of a solution containing 10^{-8} M hydronium ion and compare it with the pH value of 10^{-8} M HCl solution ? 4

P.T.O.

(*c*) What is pH of a solution obtained by mixing 50 mL, 0.1 M CH_3COOH and 50 mL, 0.1 M NaOH. Given $pK_a(CH_3COOH) = 4.74$. 3

8. (*a*) Show that the pH of an aqueous solution of salt formed from a weak acid and strong base is given by $pH = 7 + \frac{1}{2}(pK_a + \log c)$. 4

(*b*) Define different types of buffer solutions. Derive Henderson-Hasselbalch equation for pH of acidic and basic buffer. 4

(*c*) What is the solubility of $Ag_2(CrO_4)$ in water if the value of solubility product is $K_{sp} = 1.3 \times 10^{-11}\ M^3$? 4

9. (*a*) What is an indicator and how does it work ? 3

(*b*) Define solubility and solubility product. Determine solubility of $Mg(OH)_2$ in pure water and 0.01 M NaOH solution. K_{sp} of $Mg(OH)_2 = 1.2 \times 10^{-11}\ M^3$. 5

(*c*) Will a precipitate form if 20 cm^3 of 0.01 M $AgNO_3$ and 20 cm^3 of 0.0004 M NaCl are mixed ? Given K_{sp} of AgCl $= 1.7 \times 10^{-10}\ M^2$. 4

Sl. No of Q.P : 1586 (3) 5/12/18

Unique Paper Code : 217101 (CHHT-101)

Name of the Paper : Inorganic Chemistry-1 [Atomic Structure, Periodicity of elements]

Name of the Course : **B.Sc. (H) Chemistry**

Semester : I

Duration: 3 Hours Maximum Marks: 100

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any **six** questions.
3. **Question No. 1** is compulsory and carries 20 marks. All other questions carry equal marks.

1. (a) For the 4s and $3d_{xy}$ hydrogen-like orbitals, sketch the following:

   i) Radial function R

   ii) Radial probability distribution $4\pi r^2R^2$

   iii) Contour map of the electron density

   (b) Give a short answer for the following

   i) How many radial nodes does a 6f orbital have?

   ii) Sketch the angular nodes in a $3d_{xy}$ orbital

   iii) Sketch the angular part of the wavefunction for the five d orbitals.

   (c) Using Slater's Rules calculate Z* for the following elements:

   i) Calculate the Z* for a 4s enlectron in Ca

   ii) Calculate the Z* for a 4s enlectron in Sc

   iii) Calculate the Z* for a 3d enlectron in Sc

   (d) Answer the following:

   i) Write the electron configuration for the following atoms or ions (you may use the noble gas shortcut):

   Fe, Fe^{2+}, Br, Ca^{2+}, Se, I

   ii) Write the chemical equation for 1st ionization energy and 1st electron affinity of V.

   (6+3+3+8)

2. Explain the following:

   (a) What is Bohr's theory of atomic structure and what are its limitations?

   (b) The speed of a 1.0 g projectile is known to within 10^{-6} ms^{-1}. What is the minimum uncertainty in its position?

(c) Write short notes on the following (any 4):

i) Significance of quantum numbers

ii) Radial and angular wave functions

iii) Difference between spin quantum number and magnetic quantum number

iv) Significance of ψ and ψ^2

v) Factors affecting energy of an orbital

(d) Write Schrodinger equation of hydrogen atom and explain various terms in it.

(4+2+8+2)

3. (a) State Heisenberg's uncertainty principle and explain its significance.

(b) Calculate the de Broglie wavelength of a body of mass 1 kg moving with a velocity of 2000 ms^{-1}.

(c) What are three rules that govern the filling of electrons in atomic orbitals?

(d) What are normal and orthogonal wave functions?

(e) What is radial node? Calculate the number of radial nodes for 1s, 2s, 2p, 3d, 4f and 5d orbitals.

(2+2+3+2+7)

4. (a) Rank the following in order of increasing value for the property listed:

1^{st} Ionization Energy	Fe	Ru	V	____ < ____ < ____
Atomic radii	S	Si	Sn	____ < ____ < ____
Atomic/ionic radii	Fe	Fe^{2+}	Fe^{3+}	____ < ____ < ____
Ionization energy	Fe	Fe^{2+}	Fe^{3+}	____ < ____ < ____
Atomic radii	Cl	Br	I	____ < ____ < ____

(b) Define effective nuclear charge. What is the effective nuclear charge for a sodium ion (Na^+), and a fluoride ion (F^-).

(c) What is the difference between atomic radius and ionic radius?

(d) Do you agree that electronegativity of an element increases as s-character increases in the hybrid orbitals of its atom? Explain briefly.

(e) Explain the trends in variation of valency in groups and periods of s and p block of elements.

(5+3+3+2+3)

5. (a) Define Ionization Energy. What are the factors affecting ionization energy?

(b) Why do Li and Mg show similar behaviour?

(c) Explain electronegativity briefly in terms of Pauling's and Mulliken's scale.

(d) Write a short note on inert pair effect.

(e) What is electron gain enthalpy? List the factors affecting electron gain enthalpy.

(4+2+3+2+5)

6. (a) What is the variation in electronegativity with bond order?

(b) Why is cesium atom bigger than sodium atom?

(c) Explain hybridization and shapes of the following species:

ClF_3, I_3^-, XeF_4, SF_4, H_2O

(d) In Group I, elements have 2^{nd} ionization energy much higher than 1^{st} ionization energy. Explain.

(2+2+10+2)

7. (a) Explain briefly the trends in ionization energy along a period and down a group.

(b) Explain the concept of inert pair effect taking Group 14 elements as an example.

(c) What are the different scales of electronegativity? Explain briefly.

(d) Fluorine is the most electronegative element in the periodic table but its electron affinity is lower than that of chlorine. Explain.

(e) Why is the atomic radius of noble gases more than the halogens?

(2+4+4+3+3)

Sr. No. 47 Q.P. 1587 (4) 8/12/18

Unique Paper Code : 217103

Name of the Course : B.Sc(H) Chemistry

Name of the Paper : CHHT-102: Organic Chemistry-I

Semester : I

Time : 3hrs Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Answer any **six** questions. Question No 1 is compulsory.

1. Attempt any ***five*** 3x5=15

(a) Alkynes are less reactive than alkenes towards electrophilic adition reactions. Why?

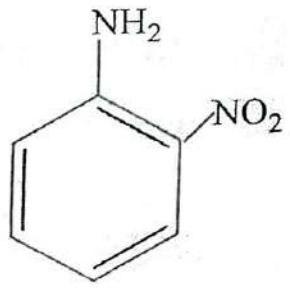
(b) p-chloronitrobenzene has less dipole moment (2.4D) than p-nitrotoluene (4.4D) Explain.

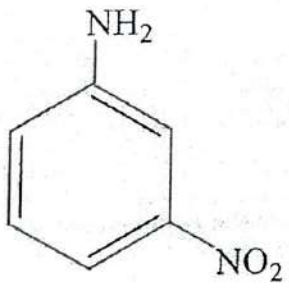
(c) Classify the following into electrophiles and nucleophiles with explanation
SF_4, BF_3, NH_3, SO_3, $:CCl_2$, $CH_3CH_2^-$

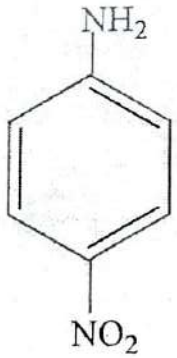
(d) Why does propene react with HBr in presence of peroxides to give 1-bromopropane whereas in absence of peroxides it gives 2-bromopropane?

(e) Arrange the following in increasing order of their stability and give reason in support of your answer
$(CH_3)_3C^+$, CH_3^+, $C_6H_5CH_2^+$, $CH_3CH_2^+$

(f) Arrange the following in the increasing order of basic strength. Give reasons for your answer:







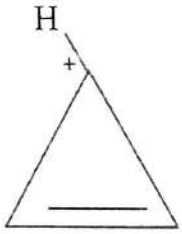
2. (a) Write Newman Projection for the Chair and Boat conformations of cyclohexane. 3

(b) Phenol is more acidic than alcohols but less acidic than carboxylic acids. Explain. 2

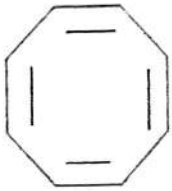
(c) Why is nitration of toluene much faster than nitration of toluene? Name the product(s) formed in each case. 4

(d) With the help of mechanism explain Friedal Crafts Alkylation in benzene. 3

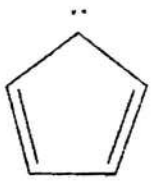
3. (a) What is aromaticity? Giving suitable reason explain which of the following compound is/are aromatic 5



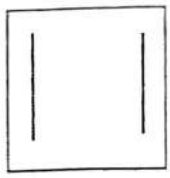
(i)



(ii)



(iii)



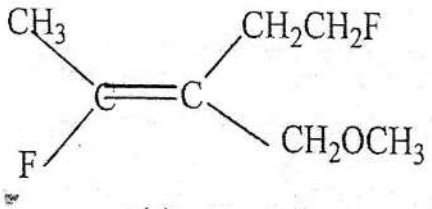
(iv)

(b) Explain Baeyer strain theory. 2

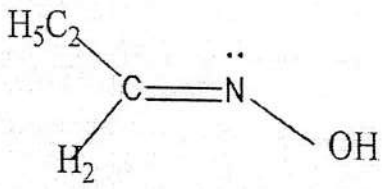
(c) Although halogens are deactivating in aromatic electrophilic substitution but are *ortho* and *para* directors 2

(d) Draw the Newman projection for different conformations possible for butane. Discuss their stability. 3

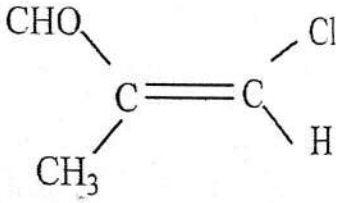
4. (a) Assign E/Z configuration of the following 3



(a)

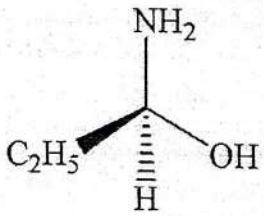


(b)

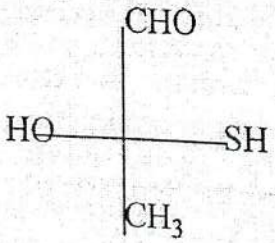


(c)

(b) Assign R and S configuration of the following 3



(a)



(b)

(c) Giving reason, arrange the following in increasing order of acidity 3
Benzoic acid, o-hydroxybenzoic acid, p-hydroxybenzoic acid

(d) Benzyl radical is more stable than allyl radical. Explain 3

5. (a) A hydrocarbon of formula C_6H_{12} decolorizes bromine solution, dissolves in concentrated sulphuric acid, yields 2-methylpentane on the hydrogenation, and on

ozonolysis gives formaldehyde and 3-methylbutanal. What is the structure of the hydrocarbon? Give all the reactions involved. 4

(b) How will you convert: 2x4=8

i. But-1-ne to but-2-ene

ii. Propyne to cis but-2-ene

iii. Benzene to m-nitrobenzoic acid

iv. Propyne to cis-but2-ene

6. Write short notes on the following: (any four) 3x4=12

(a) Diel's Alder Reaction

(b) Stability of cycloalkanes

(c) Hydroboration-oxidation reactions of alkene

(d) Hofmann elimination

(e) Wurtz reaction

(5)

~~S.E.A~~

12/12/18

(This Question Paper contains____ printed pages)

Roll No. _____

Sr. No. of Question Paper: 1588

Unique Paper Code: 235164 (MACT-101)

Name of the Course: B.Sc. (H) Chemistry - I

Name/ Title of the paper: Mathematics - 1

Semester/ ~~Annual~~: ~~Semester~~-1

I

Duration:3Hours

Max. Marks: 75

Instructions for candidates

There are three Sections in this question paper.

Attempt any two questions from each Section.

Students are allowed to use scientific calculator.

SECTION - A

Q1. (a) (i) Find the volume of a rectangular object whose length is given as 7.78 m, whose width is given as 3.486 m, and whose height is 1.376 m, to the proper number of significant digits. $3\frac{1}{2}$

(ii) Show that $\ln(y) = (2.302585\ldots)\log_{10} y$. 3

(b) (i) Solve the quadratic equation
$x^2+2x+2 = 0$. 3

(ii) Manipulate the equation $(P + n^2a/V^2)(V - n\,b) = n\,R\,T$, so that V_m, defined as V/n, occurs instead of V & n occurring separately. 3

Q2. (a) Write the simpler form of $\lim_{x\to 0} \frac{(x^2+2x)^2-x^2(x-2)^2+12x^4}{6x^3+12x^4}$. $6\frac{1}{2}$

(b) (i) Two time intervals have been clocked as 56.57 s ± 0.13 s and 75.12 s ± 0.17 s, Find the probable value of their sum and its probable error. 3

(ii) Find the expression for the propagation of error for Dumas molar mass determination: $M = w\,RT / PV$. 3

Q3. (a) Find the square root of 5 by Newton-Raption Method up to four decimal places. $6\frac{1}{2}$

(b) Evaluate $\lim_{x\to 0} \frac{x^2+\sin 3x}{2x+\tan 2x}$. 6

SECTION – B

Q4. (a) Find the Maclaurin's series for the function : $f(x) = tan^{-1}x$. 5

(b) Test for convergence the series
$\sum_{n=0}^{\infty} \frac{3.6.9\ldots 3n}{7.10.13\ldots(3n+4)} x^n, x > 0$. 5

(c) Find the radius of convergence and the interval of convergence of the power series : $\sum_{n=1}^{\infty} \frac{(n!)^2}{(2n)!} x^n$. 5

(a) Prove that the length of the perpendicular from the foot of the ordinate on any tangent to the curve $y = c \cosh\left(\frac{x}{c}\right)$ is constant. 5

(b) Estimate the percent change in the pressure of 1.000 mol of an ideal gas at $0\ ^0$ C when its volume is changed from 22.4141 to 21.4141 using the formula 5

$$\Delta P \approx \left(\frac{dP}{dV}\right)\Delta V.$$

(c) If x = sin t, y = sin pt; prove that $(1-x^2)\frac{d^2y}{dx^2} - x\frac{dy}{dx} + p^2y = 0$.. 5

(a) Find the maximum and minimum values of the function 5

$f(x) = 4x^{-1}-(x-1)^{-1}$ for all $x \in \mathcal{R}\sim\{0,1\}$.

(b) Show that points of inflexion of the curve $y^2 = (x-a)^2(x-b)$ lie on the line $3x + a = 4b$. 5

(c) Evaluate $\lim_{x\to 0} \frac{1-\cos x^2}{x^2 \sin x^2}$. 5

SECTION-C

(a) Evaluate the integrals

(i) $\int x^3 \ln(x^2)dx$ $2\frac{1}{2}$

(ii) $\int_0^{\pi} Sin[Cos(x)]Sin(x)dx$ $2\frac{1}{2}$

(b) If $z = \tan^{-1}(\frac{x^3+y^3}{x-y})$ show that $x\frac{\partial z}{\partial x} + y\frac{\partial z}{\partial y} = Sin(2z)$. 5

Q8. (a) Show that the differential: $du = dx + xdy$ is inexact and carry out the line integral from (0,0) to (2,2) by two different paths: path1, the straight line segment from (0,0) to (2,2); and path 2, the rectangular path from (0,0) to (2,0) and then to (2,2) 5

(b) Evaluate $\frac{\partial u}{\partial s}$ and $\frac{\partial u}{\partial t}$ if $u(x,y) = ye^{-x} + xy$, $x(s,t) = s^2t$ and $y(s,t) = e^{-s} + t$. 5

(c) If $x = \sin t$, $y = \sin pt$, prove that $(1-x^2)\frac{d^2y}{dx^2} - x\frac{dy}{dx} + p^2y = 0$. 5

Q9 (a) When a gas expand reversely, the work that it does on its surrounding is given by the integral

$W_{surr} = \int_{v_1}^{v_2} PdV$, Where V_1 is the initial volume, V_2 the final volume, and P the pressure of the gas. Certain non ideal gases are described quite well by the van der Waals equation of state,

$$\left(P + \frac{n^2a}{V^2}\right)(V - nb) = nRT$$

Where V is the volume, n is the amount of gas in moles, T is the temperature on the Kelvin scale, and 'a' and 'b' are constants. R is usually taken to be the ideal gas constant.

(i) Obtain a formula for the work done if 1.00 mole of such gas expands reversely at constant temperature from a volume V_1 to the volume V_2 . $2\frac{1}{2}$

(ii) Calculate the work done in the process if the gas is assumed to be ideal. $2\frac{1}{2}$

(b) Using Trapezoidal approximation with five panels, calculate the value of the integral $\int_{10}^{20} 2x^2\,dx$. Calculate the exact value for comparison. 5