INDEX NO :

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THE OPEN UNIVERSITY OF SRILANKA
B. Sc Degree Programme – Level 3
Final Examination Paper – 2017/2018
CYU3201 – Basic Principles of Chemistry II - *(PART A)*
(02 hours)

Date - 09th April 2019   Time -9.30 am – 11.30 am

INSTRUCTIONS:

- This question paper consists of two parts **(Part A and Part B).**

  මෙම ප්‍රශ්න පත්‍රය ප්‍රධාන කොටස් දෙකකින් (02) සමන්විත ය. (A සහ B)

- **Part A – Short answer Questions (Recommended time 30 min).**

- A කොටසෙහි ප්‍රශ්න සඳහා කෙටි පිළිතුරු ලියන්න. (නිර්දේශිත කාලය විනාඩි 30)

- **Answers to Part A should be written in the spaces provided.**

- A කොටස සඳහා පිළිතුරු සැපයිය යුත්තේ දී ඇති ඉඩ ප්‍රමාණයේ පමණි.

- Answer <u>all</u> questions in **Part A** / A කොටසේ සියලුම ප්‍රශ්නවලට පිළිතුරු සපයන්න.

- Submit the answer scripts for each part separately.

  එක් එක් කොටස සඳහා වූ පිළිතුරු පත් වෙන වෙනම බාරදිය යුතුය.

- The use of a **non-programmable** electronic calculator is permitted.

  ප්‍රකුමණය කළ නොහැකි විද්‍යුත් ගණක යන්ත්‍ර භාවිතා කළ හැක.

- You are **NOT allowed** to keep Mobile phones with you during the examination. Please **switch off** and leave them in a safe place.

  විභාග ශාලාව තුලට ජංගම දුරකථන ගෙන ඒම තහනම්, ඒවා ක්‍රියාවිරහිත කොට සුරක්ෂිත ස්ථානයක තබා පැමිණෙන්න.

Gas constant (R)   = 8.314 J K^{-1}mol^{-1} Avogadro constant   = 6.023 × 10^{23} mol^{-1}

Faraday constant (F)   = 96,500 C mol^{-1} Planck's constant (h)   = 6.63 × 10^{-34} J s

Velocity of light (c)   = 3.0 × 10^8 m s^{-1} Standard Atmospheric pressure = 10^5 Pa (N m^{-2})

Mass of an electron   = 9.1 x 10^{-31}kg

$$\Delta G = -nFE \qquad I = 0.5 \times \sum_j c_j Z_j^2 \qquad \log(\gamma_\pm) = -\frac{A Z^2 \sqrt{I}}{1 + aB\sqrt{I}} \qquad E = E^0 - \frac{RT}{nF}\ln(Q)$$

Data :   A = 0.509 dm$^{3/2}$ mol$^{-1/2}$ aB = 1.25 dm$^{3/2}$ mol$^{-1/2}$

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Part A

(Recommended time 30 minutes)

(නිර්දේශිත කාලය විනාඩි 30 කි.)

Ques	Marks
1	
2	
3	
Total	ℯ⋅

- This section consists of 3 Short answer Questions.
  මෙම කොටසෙහි ප්‍රශ්න තුන (03) සඳහා කෙටි පිළිතුරු ලියන්න.
- Part A consists of six pages. A කොටස පිටු හයකින් සමන්විත වේ.
- Answer all the parts. සියලුම කොටස් වලට පිළිතුරු සපයන්න.

1. a) What is the physical concept of the term "State function"? Briefly explain using a suitable example.   "අවස්ථා ශ්‍රිතය"   යන පදයෙන් හැඟවෙන භෞතික සංකල්පය කුමක් ද? සුදුසු උදාහරණයක් මගින් පහදන්න.

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   (08 marks)

   b) Calculate w, ΔU and ΔH for a <u>free</u> isothermal expansion of one mole of an ideal gas from 5 dm^3 initial volume to 10 dm^3 final volume.

   පරිපූර්ණ වායු මවුල 1 ක් ආරම්භක පරිමාව 5 dm^3 සිට 10 dm^3 අවසාන පරිමාව දක්වා, සමෝෂ්ණ නිදහස් ප්‍රසාරණයකට භාජනය වුයේ නම්, එම ක්‍රියාවලිය සඳහා w, ΔU සහ ΔH ගණනය කරන්න.

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   (08 marks)

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c) What do you mean by the term intensive property? Which of the following properties are extensive properties?

Surface tension, Chemical potential, Heat capacity C_p, Refractive index, Internal energy, mass, density, Gibbs free energy, Enthalpy

සටනා ගුණය යන පදයෙන් අදහස් වන්නේ කුමක් ද? පහත දී ඇති ගුණ අතරින්, විත්ති ගුණ මොනවාදැයි සඳහන් කරන්න.

පෘෂ්ඨීය ආතතතිය, රසායනික විභවය, තාප ධාරිතාව C_p, වර්තන අංකය, අභ්‍යන්තර ශක්තිය, ස්කන්ධය, සනත්වය, ගිබ්ස් යෝජ්‍ය ශක්තිය, එන්තැල්පිය.

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(16 marks)

d) 1 mole of an ideal gas at 300 K and 8 atm pressure undergoes reversible expansion isothermally to one fourth of the initial pressure Calculate ΔS for this process.

උෂ්ණත්වය 300 K සහ පීඩනය 8 atm ක පවතින පර්පූර්ණ වායු මවුල 1 ක් සමෝෂ්ණව එහි ආරම්භක පීඩනයෙන් ¼ ක් බවට ප්‍රත්‍යාවර්තව ප්‍රසාරණය වේ. මෙම ක්‍රියාවලිය සඳහා ΔS ගණනය කරන්න.

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(08 marks)

e) (i) Write down the mathematical expression for the compressibility factor (Z) and identify all the terms. සම්පීඩ්‍යතා සාධකය සඳහා ගණිතමය ප්‍රකාශනය සඳහන් කර, එහි අඩංගු සියලුම පද හඳුන්වන්න.

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(ii) Explain using a diagram why intermolecular attraction in a real gas have the effect of lowering the compressibility factor.

රූප සටහනක් ආධාරයෙන්, තාත්වික වායුවක පවතින අන්තර් අණුක ආකර්ෂණ බල විසින් සම්පීඩ්යතා සාධකය අඩුවීමට හේතු මන්දැයි පැහැදිලි කරන්න.

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(20 marks)

2. (i) Write down the rate equation (in terms of $-\frac{d[A]}{dt}$) for the hypothetical elementary reaction

$$2A + 3B \longrightarrow \text{products} \quad එල$$

යන උපකල්පිත මූලික ප්‍රතික්‍රියාව සඳහා සීසුකා සමීකරණය ($-\frac{d[A]}{dt}$ ආකාරයට) ලියා දක්වන්න.

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(ii) Give the relationship between the rate of decomposition of A and rate of decomposition of B? A වියෝජනය වන සීසුතාවය සහ B වියෝජනය වන සීසුතාවය අතර සම්බන්ධතාවය සඳහන් කරන්න.

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(iii) Consider the following expression giving the relationship between the two variables k and T

k හා T විචල්‍යයන් දෙක අතර පවත්නා සම්බන්ධතාවය පෙන්වන පහත ප්‍රකාශනය සලකන්න.

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$$\ln k = Q\left(\frac{1}{T}\right) + \ln A$$ (Q and A are constants. Q සහ A නියත වේ.)

Transform the above equation to its exponential form where k is the subject
ඉහත සමීකරණය එහි සාතිය ආකාරයට පරිවර්තනය කර k සඳහා සමීකරණයක් ලියන්න.

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(iv) The following value for the rate constant (k) of a reaction is reported as

k = 3.0 x 10⁻⁴ mol⁻¹ dm³ min⁻¹. Calculate the value of k, in **SI   units**

ප්‍රතික්‍රියාවක සීසුතා නියතය (k) සඳහා පහත අගය වාර්තාකර ඇත. $k = 3.0 \times 10^{-4}$ mol⁻¹ dm³ min⁻¹ k හි අගය **SI** ඒකක වලින් ගණනය කරන්න.

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(v) You wish to carry out a reaction between a solid B and an aqueous acid solution, L at a certain temperature, T. Name three factors that could be changed to increase the rate of this reaction.
T උෂ්ණත්වයේදී, සන B සහ ජලීය අම්ල ද්‍රාවණයක් අතර ප්‍රතික්‍රියාවක් සිදු කිරීමට, ඔබට අවශ්‍ය වේ. මෙම ප්‍රතික්‍රියාවේ සීසුතාවය වැඩි කිරීම සඳහා යොදා ගත හැකි සාධක තුනක් නම් කරන්න.

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(20 marks)

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3. A student prepared a solution by dissolving $0.500\,\text{mol}$ of $Ca(NO_3)_2$ in distilled water to prepare $1000.00\,\text{cm}^3$ of solution. Calculate the activity of $Ca^{2+}(aq)$ ions in the above solution, using the Debye Huckel limiting law.

සිසුවෙක් $Ca(NO_3)_2$ මවුල 0.500 ක් ආසුත ජලයේ දියකර $1000.00\,\text{cm}^3$ ක ද්‍රාවණයක් සාදන ලදී. ඩෙබායි-හියුකල් සීමාකාරී නියමය (Debye Huckel limiting law) භාවිතා කර මෙම ද්‍රාවණයේ ජලීය $Ca^{2+}(aq)$ අයනවල සක්‍රියතාවය ගණනය කරන්න.

(20 marks)

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THE OPEN UNIVERSITY OF SRILANKA

B. Sc Degree Programme – Level 3

Final Examination Paper – 2017/2018

CYU3201 – Basic Principles of Chemistry II - *(PART A)*

(02 hours)

Date : 09th April 2019   Time :9.30 am – 11.30 am

INSTRUCTIONS:
அறிவுறுத்தல்கள்:

- This question paper consists of two parts. **(Part A and Part B).**
  இவ் வினாத்தாளானது இரு பகுதிகளை கொண்டுள்ளது. (பகுதி A மற்றும் பகுதி B)

- **Part A – Short Answer Questions** (Recommended time 30 min).
  பகுதி A – குறுகிய விடை வினாக்கள் (பரிந்துரைக்கப்படும் காலம் 30 நிமிடங்கள்)

- **Answers to Part A should be written in the spaces provided.**
  பகுதி A இற்கான விடைகளை தரப்பட்ட இடத்தில் எழுதுக.

- Answer **all** questions in **Part A**.
  பகுதி B இன் **அனைத்து** வினாக்களுக்கும் விடையளிக்குக.

- Submit the answer scripts for each part separately.
  ஒவ்வொரு பகுதிக்குமான விடைத்தாள்களையும் வெவ்வேறாக சமர்ப்பிக்கவும்.

- The use of a **non-programmable** electronic calculator is permitted.
  செயல் நிறற்படுத்தப்படாத கணிப்பான்களின் பாவனை அனுமதிக்கப்படும்.

- You are **NOT allowed** to keep Mobile phones with you during the examination. Please **switch off** and leave them in a safe place.
  பரீட்சை மண்டபத்தினுள் கையடக்கத் தொலைபேசியின் பாவனைக்கு அனுமதியில்லை. அதனை **நிறுத்தி** வெளியில் வைத்து விட்டு வரவும்.

Gas Constant / வாயு மாறிலி (R)	=	8.314 J K^{-1} mol^{-1}
Avogadro Constant / அவகாதரோ மாறிலி (L)	=	6.023 x 10^{23} mol^{-1}
Planck Constant / பிளாங்கின் மாறிலி (h)	=	6.63 x 10^{-34} Js
Velocity of light / ஒளியின் வேகம் (C)	=	3.0 x 10^{8} ms^{-1}
Standard Atmospheric Pressure / நியம வளிமண்டல அழுக்கம் (π)	=	10^{5} Pa (Nm^{-2})
Faraday constant / பரடே மாறிலி (F)	=	96,500 C mol^{-1}
Mass of an electron	=	9.1 x 10^{-31} kg

$$\Delta G = -nFE \qquad I = 0.5 \times \sum_j c_j Z_j^2 \qquad \log(\gamma_\pm) = -\frac{A Z^2 \sqrt{I}}{1 + aB\sqrt{I}} \qquad E = E^0 - \frac{RT}{nF}\ln(Q)$$

Data : $A = 0.509 \, dm^{3/2} \, mol^{-1/2}$ $aB = 1.25 \, dm^{3/2} \, mol^{-1/2}$

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Part A
பகுதி A

(Recommended time 30 minutes)
(பரிந்துரைக்கப்படும் காலம் 30 நிமிடங்கள்)

- **This section consists of 3 Short Answer Questions.**
  இப் பகுதியானது 3 குறுகிய விடை வினாக்களை கொண்டுள்ளது.
- **Part A consists of Six pages.**
  பகுதி A ஆனது ஆறு பக்கங்களை கொண்டுள்ளது.
- **Answer all the parts in the space provided.**
  எல்லா பகுதிகளுக்குமான விடைகளை தரப்பட்ட இடத்தில் எழுதுக.

01.

a) What is the physical concept of the term "State function"? Briefly explain using a suitable example.

பௌதீக எண்ணக்கருவில் "நிலைத் தொழிற்பாடு" என்றால் என்ன? பொருத்தமான உதாரணம் ஒன்றை தருவதன் மூலம் சுருக்கமாக விளக்குக.

(08 Marks)

b) Calculate w, ΔU and ΔH for a <u>free</u> isothermal expansion of one mole of an ideal gas from 5 dm^3 initial volume to 10 dm^3 final volume.

ஒரு மூல் இலட்சிய வாயுவானது அதன் ஆரம்ப கனவளவு 5 dm^3 இல் இருந்து இறுதி கனவளவு 10 dm^3 ஆகும் வரை சமவெப்பத்தில் <u>சுயாதீனமாக</u> விரிவடைகின்றது. இங்கு w, ΔU மற்றும் ΔH ஆகியவற்றை கணிக்குக.

(08 Marks)

2

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c) What do you mean by the term **intensive** property? Which of the following properties are **extensive** properties?

Surface tension, Chemical potential, Heat capacity C_p, Refractive index, Internal energy, mass, density, Gibbs free energy, Enthalpy

செறிவுசார் பண்பு என்பதில் இருந்து நீர் விளங்குவது யாது ? பின்வரும் பண்புகளில் எவை விரிவுசார் பண்புகள்.

மேற்பரப்பிழு விசை, இரசாயன அழுத்தம், வெப்பக் கொள்ளளவு C_p, முறிவுச் சுட்டி, அகச்சக்தி (உள்ளீட்டுசக்தி), தினிவு, அடர்த்தி, கிப்சின் சுயாதீன சக்தி, வெப்பவுள்ளுறை.

(16 Marks)

d) 1 mole of an ideal gas at 300 K and 8 atm pressure undergoes reversible expansion isothermally to one fourth of the initial pressure. Calculate ΔS for this process.

300 K வெப்பநிலை மற்றும் 8 atm அழுக்கத்தில், 1 மூல் இலட்சிய வாயுவானது சமவெப்பத்தில் மீளும்தன்மையுடன், அழுக்கம் ஆரம்ப அழுக்கத்தின் ஒன்றின் கீழ் நான்கு ஆகும் வரை விரிவடைகின்றது. செயற்பாட்டின் ΔS ஐக் கணிக்குக.

(08 Marks)

e) (i) Write down the mathematical expression for the compressibility factor (Z) and identify all the terms.

அழுக்கப்படு குணகத்திற்கான (Z) கணித கோவை தந்து, அவற்றில் உள்ள பதங்களை இனம் காண்க.

3

(ii) Explain using a diagram why intermolecular attraction in a real gas have the effect of lowering the compressibility factor.

மெய் வாயுக்களின் மூலக்கூற்றிடை கவர்ச்சி விசை ஏன் அழுக்கப்படு குணகத்தினை குறைவடையச் செய்கின்றது என விளக்க வரைபடம் ஒன்றை தருவதன் மூலம் விளக்குக.
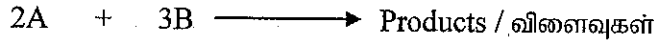
(20 Marks)

02.

a) Write down the rate equation (in terms of $-\frac{d[A]}{dt}$) for the hypothetical elementary reaction,

கீழ்வரும் எடுகோட்முதன்மைத் தாக்கத்திற்கான தாக்க வீதச்சமன்பாட்டை ($-\frac{d[A]}{dt}$ பதங்களில்) எழுதுக.

$$2A \quad + \quad 3B \longrightarrow \text{Products / விளைவுகள்}$$

b) Give the relationship between the rate of decomposition of A and rate of decomposition of B ?

A இன் மறைவு வீதத்திற்கும் B இன் மறைவு வீதத்திற்கும் இடையிலான தொடர்பை தருக.

c) Consider the following expression giving the relationship between the two variables k and T

இரு மாறும் கணியங்களான k மற்றும் T என்பவற்றுக்கிடையிலான தொடர்பினை காட்டும் பின்வரும் கோவையைக் கருதுக.

$$\ln k = Q\left(\frac{1}{T}\right) + \ln A$$

Q and A are constants

இங்கு Q மற்றும் A ஆகியன மாறிலிகள்.

Transform the above equation to its exponential form where k is the subject

மேலே உள்ள சமன்பாட்டில் k இனை எழுவாய் மாற்றி அடுக்குக்குறிய வடிவில் தருக.

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d) The following value for the rate constant (k) of a reaction is reported as $k = 3.0 \times 10^{-4}$ mol^{-1} dm^3 min^{-1}. Calculate the value of k, in **SI units**

தாக்கவீத மாறிலிக்கான (k) பெறுமானம் $k = 3.0 \times 10^{-4}$ mol^{-1} dm^3 min^{-1} என அறிவிக்கப்பட்டுள்ளது. k இற்கான பெறுமானத்தை SI அலகில் கணிக்குக.

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e) You wish to carry out a reaction between a solid B and an aqueous acid solution, L at a certain temperature, T. Name three factors that could be changed to increase the rate of this reaction.

குறிப்பிட்ட வெப்பநிலை T இல், திண்ம B மற்றும் அமில நீர்க்கரைசல் L என்பவற்றுக்கிடையில் தாக்கம் ஒன்றை நடாத்த விரும்புகின்றீர். இத்தாக்கத்திற்கான தாக்கவீதத்தை அதிகரிப்பதற்கு நீர் மாற்றங்களை மேற்கொள்ளக்கூடிய மூன்று கணியங்களை தருக.

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5

(20 Marks)

03. A student prepared a solution by dissolving $0.500 \, mol$ of $Ca(NO_3)_2$ in distilled water to prepare $1000.00 \, cm^3$ of solution. Calculate the activity of $Ca^{2+}(aq)$ ions in the above solution, using the Debye Huckel limiting law.

$1000.00 \, cm^3$ கரைசல் ஒன்றை பெற மாணவன் ஒருவன் 0.500 மூல் $Ca(NO_3)_2$ ஐ காய்ச்சி வடித்த நீரில் கரைத்தான். Debye Huckel இன் எல்லைப்படுத்தும் விதியை பயன்படுத்தி மேற்கூறப்பட்ட கரைசலில் $Ca^{2+}(aq)$ அயன்களின் தொழிற்பாட்டை கணிக்குக.

(20 Marks)