PART A / *BAHAGIAN A*

(1). (a). Briefly explain the second law of thermodynamics. What is the limitation of the first law of thermodynamics that led to the development of the second law?

Terangkan secara ringkas hukum termodinamik kedua. Apakah batasan hukum termodinamik pertama yang membawa kepada perkembangan hukum kedua.

(6 marks/*markah)*

(b). If the isothermal expansion of a gas inside a container absorbs 25 kJ of heat energy, how much work is done by the gas in this process?

Jika pengembangan isoterma gas di dalam bekas menyerap 25 kJ tenaga haba, berapa banyak kerja yang dilakukan oleh gas dalam proses ini?

(4 marks/*markah)*

(c). 2 mol of an ideal gas expands at a constant temperature of 0 ^{o}C. If 1 kJ of energy is added into the system and the net change of internal energy $\Delta U = 0$, by what factor does the volume of the gas change?

2 mol gas ideal mengembang pada suhu malar 0 ^{o}C. Jika 1 kJ tenaga ditambah ke dalam sistem dan perubahan bersih tenaga dalaman $\Delta U = 0$, dengan faktor apakah isipadu gas berubah?

(6 marks/*markah)*

(d). Clearly explain this statement by using your own words. Support your answer by providing an appropriate example.

…3/-

Jelaskan dengan jelas kenyataan ini dengan menggunakan perkataan anda sendiri. Sokong jawapan anda dengan menyediakan contoh yang sesuai.

"The enthalpy of an element, by convention is taken to be zero at the reference temperature (usually 298 K), providing the element is in its normal physical state under the conditions considered".

"Entalpi bagi suatu unsur, mengikut kebiasaannya diambil sebagai sifar pada suhu rujukan (biasanya 298 K), dengan syarat unsur itu berada dalam keadaan fizikal yang biasa di bawah syarat yang dipertimbangkan".

(4 marks/*markah)*

(2) (a). A conductivity cell was calibrated using 0.01 M KCl (κ=1.4087 x 10^{-3} S cm^{-1}) in cell, and the measured resistance was 702 Ω. Calculate the cell constant.

Sel konduktiviti telah dikalibrasi menggunakan KCl 0.01 M (κ=1.4087 x 10^{-3} S cm^{-1}) di dalam sel, dan rintangan yang diukur adalah 702 Ω. Kirakan pemalar sel.

(4 marks/*markah)*

(b). A 0.01 M CH_3COOH solution in the same cell had a resistance of 6920 Ω. Calculate the molar conductivity.

Sebuah larutan CH_3COOH 0.01 M dalam sel yang sama mempunyai rintangan sebanyak 6920 Ω. Kira kekonduksian molar.

(4 marks*/markah)*

(c). The values of Λ/(S cm^2 mol^{-1}) at 18 °C for NH_4NO_3, KOH and KNO_3, at 0.001 M, 0.01 M, and 0.1 M are given in Table 1. Base on this information,

Nilai Λ/(S cm^2 mol^{-1}) pada 18 °C untuk NH_4NO_3, KOH dan KNO_3, pada 0.001 M, 0.01 M, dan 0.1 M diberi dalam Jadual 1. Berdasarkan informasi ini,

(i). Sketch Λ against $C^{1/2}$ using the graph paper provided.
Lakarkan Λ melawan $C^{1/2}$ menggunakan kertas graf yang disediakan.

(4 marks*/markah)*

(ii). Determine the molar conductivity at infinite dilution, Λ_o for these substances NH_4NO_3, KOH and KNO_3 and calculate Λ_o for NH_4OH.

Tentukan kekonduksian molar pada pencairan infiniti, Λ_o untuk bahan-bahan ini NH_4NO_3, KOH and KNO_3 dan kirakan Λ_o for NH_4OH.

(4 marks/*markah)*

(iii). Given Λ/(S cm^2 mol^{-1}) = 28, 9.6, and 3.3 at 0.001 M, 0.01 M, and 0.1 M, respectively, for NH_4OH,(aq), calculate percentage of ionization for these concentrations and justify the results obtained.

Diberi Λ/(S cm^2 mol^{-1}) = 28, 9.6, and 3.3 at 0.001 M, 0.01 M, and 0.1 M, masing-masing, untuk NH_4OH,(aq), kirakan peratusan pengionan untuk kepekatan-kepekatan ini dan beri ulasan bagi keputusan yang diperolehi.

(4 marks/*markah)*

…5/-

Table 1: Molar conductivity of the solutions for various concentration at 18 ^oC

Jadual 1: Kekonduksian molar bagi larutan untuk kepekatan berlainan pada 18 ^oC

Concentration of the solution, (M) *Kepekatan larutan, (M)*	Molar Conductivity (S cm^2 mol^{-1}) *Kekonduksian molar (S cm^2 mol^{-1})*		
	NH_4NO_3	KOH	KNO_3
0.001	124.25	234	123.7
0.01	118	228	118.2
0.1	106.6	213	104.8

(3) (a). A first order reaction, A → products, has a rate of reaction of 0.00250 M s^{-1} when [A] = 0.484 M.

Sesuatu tindakbalas tertib pertama, A → produk, mempunyai kadar tindakbalas 0.00250 M s^{-1} apabila [A] = 0.484 M.

(i). Determine the rate constant, *k*, for this reaction?
Hitungkan pemalar kadar, k, untuk tindakbalas tersebut

(3 marks/*markah)*

(ii). Does $t_{1/2}$ or $t_{4/5}$ depend on the initial concentration? Provide a one-sentence explanation.

Adakah $t_{1/2}$ or $t_{4/5}$ bergantung kepada kepekatan asal? Terangkan sebabnya dalam satu ayat.

(2 marks/*markah)*

(b). For a reaction A + B → Product, the rate law is given by r = k$[A]^{½}$ $[B]^2$. Determine the order of the reaction.

Untuk tindakbalas A + B → Produk, hukum kadar diberi sebagai r = k$[A]^{½}$ $[B]^2$. Hitungkan tertib tindakbalas tersebut.

(3 marks/*markah)*

(c). In the first-order decomposition of dinitrogen pentoxide at 335 K,
$N_2O_5(g) \rightarrow 2\ NO_2(g) + ½\ O_2(g)$

Dalam penguraian dinitrogen pentoksida tertib pertama pada 335 K,
N_2O_5(g) → 2 NO_2(g) + ½ O_2(g)

if we start with a 2.50-g sample of N_2O_5 at 335 K and have 1.50 g remaining after 109 s,

Jika bermula dengan 2.50-g sample N_2O_5 pada 335 K dan bakinya 1.50g selepas 109 s,

(i). Calculate the value of the rate constant *K*
Kirakan nilai pemalar kadar K

(4 marks/*markah)*

(ii). Determine the half-life of the reaction
Hitungkan separa hayat tindakbalas tersebut

(4 marks/*markah*)

(iii). Calculate the remaining mass of N_2O_5 will remain after 5.0 min
Kirakan jisim N_2O_5 yang tertinggal selepas 5.0 min.

(4 marks/*markah)*

…7/-

PART B / *BAHAGIAN*

(4). (a). Explain the concept of heat capacity and its significance in thermodynamics. Provide an example how heat capacity varies between different substances and how it influences their ability to store and transfer thermal energy.

Terangkan konsep muatan haba dan kepentingannya dalam termodinamik. Sediakan suatu contoh bagaimana muatan haba berbeza-beza antara bahan yang berbeza dan bagaimana ia mempengaruhi keupayaan mereka untuk menyimpan dan memindahkan tenaga haba.

(6 marks/*markah*)

(b). Calculate the enthalpy change for the reaction:
Kirakan perubahan entalpi untuk tindak balas berikut:

$$CS_2(l) + 3\ O_2(g) \rightarrow CO_2(g) + 2\ SO_2(g)$$

Given/*Diberi:*

$C(s) + O_2(g) \rightarrow CO_2(g)$; ΔH_f = -393.5 kJ/mol
$S(s) + O_2(g) \rightarrow SO_2(g)$; ΔH_f = -296.8 kJ/mol
$C(s) + 2\ S(s) \rightarrow CS_2(l)$; ΔH_f = 87.9 kJ/mol

(6 marks/*markah*)

(c). Calculate the standard free energy change of the reaction at 727^{o}C and 1 atm pressure:

Kirakan perubahan tenaga bebas piawai bagi tindak balas berikut pada 727 °C dan tekanan 1 atm:

$$MoO_3(s) + 3H_2(g) \rightarrow Mo(s) + 3H_2O(l)$$

Given / *Diberi:*

$$\Delta G^o_{727}\,(MoO_3) = -502{,}080 \text{ J/mol}$$
$$\Delta G^o_{727}\,(H_2O) = -190{,}372 \text{ J/mol}$$

Comment on the possibility of reducing MoO_3 by H_2 at 727 °C and 1 atm pressure.

Terangkan kemungkinan untuk menurunkan MoO_3 oleh H_2 pada 727 °C dan tekanan 1 atm.

(8 marks/*markah*)

(5). (a). Zinc melts at 420°C and its standard entropy at 25°C is 41.63 J/K/mol. Calculate the standard entropy of zinc at 750°C.

Zink cair pada 420 °C dan entropi piawainya pada 25 °C ialah 41.63 J/K/mol. Kirakan entropi piawai zink pada 750 °C.

$$C_{p,\,Zn\,(s)} = 22.38 + 10.04 \times 10^{-3}\,T \text{ J K}^{-1} \text{ mol}^{-1}$$
$$C_{p,\,Zn\,(l)} = 31.38 \text{ J K}^{-1} \text{ mol}^{-1}$$

(7 marks/*markah*)

(b). State and explain the Clausius-Clapeyron equation. What is the significance of the Clausius-Clapeyron equation in thermodynamics?

Nyatakan dan terangkan persamaan Clausius-Clapeyron. Apakah kepentingan persamaan Clausius-Clapeyron dalam termodinamik?

(6 marks/*markah*)

…9/-

(c). The heat of evaporation of copper at its normal boiling point is 311.71 kJ/mol. The vapour pressure of copper at 1500 ^oC is 34 N/m^2. Calculate the boiling point of copper.

Haba penyejatan kuprum pada takat didih normal ialah 311.71 kJ/mol. Tekanan wap kuprum pada 1500 ^oC ialah 34 N/m^2. Kira takat didih kuprum.

(7 marks/*markah*)

(6) (a). During the charging of the lead storage cell, the following reaction takes place:

$2PbSO_4(s) + 2H_2O(l) \rightarrow Pb(s) + PbO_2(s) + 2H_2SO_4(aq)$

Given n=2, ΔG^o_{298}= -813.14 for $PbSO_4$ (s), -237.129 for H_2O(l), 0 for Pb(s), -217.33 for PbO_2(s), and -744.53 for H_2SO_4(aq).

Semasa mengecas sel penstoran plumbum, tindak balas berikut berlaku:

$2PbSO_4(s) + 2H_2O(l) \rightarrow Pb(s) + PbO_2(s) + 2H_2SO_4(aq)$

Diberi n=2, ΔG^o_{298}= -813.14 for $PbSO_4$ (s), -237.129 for H_2O(l), 0 for Pb(s), -217.33 for PbO_2(s), dan -744.53 for H_2SO_4(aq).

(i) Calculate the change of Gibbs free energy, ΔG^o_{298}.
Hitung perubahan tenaga bebas Gibbs, ΔG^o_{298}.

(4 marks*/markah)*

(ii) Calculate E^o for this reaction.
Hitung E^o untuk tindak balas ini.

(4 marks/*markah)*

(iii) Determine is this reaction spontaneous under standard conditions or is an outside source of energy required for it to proceed.

Tentukan samada tindakbalas ini adalah spontan di bawah keadaan standard, atau sumber tenaga luar perlu untuk diteruskan?

(4 marks*/markah)*

(b). Determine whether the following reaction would proceed spontaneously as written at 298 K:

$Co(s)+Fe^{2+}(aq)\rightarrow Co^{2+}(aq)+Fe(s)$

Given that $[Co^{2+}]=0.15M$ and $[Fe^{2+}]=0.68M$

Tentukan sama ada tindak balas berikut akan berlaku secara spontan seperti yang ditulis pada 298 K:

$Co(s)+Fe^{2+}(aq)\rightarrow Co^{2+}(aq)+Fe(s)$

Diberi bahawa $[Co^{2+}]=0.15M$ and $[Fe^{2+}]=0.68M$

(4 marks*/markah)*

(c). Explain the difference between Galvanic cell and Electrolytic cell.

Terangkan perbezaan antara sel Galvanik dan sel Elektrolitik.

(4 marks*/markah)*

(7). (a). In a reaction 2A → Products, the concentration of A decreases from 0.5 mol L^{-1} in 10 minutes. Calculate the rate during this interval.

Dalam sesuatu tindakbalas 2A → Produk, kepekatan A menurun daripada 0.5 mol L^{-1} dalam 10 minit. Kirakan kadarnya dalam selang waktu itu.

(4 marks/*markah*)

(b). If the decomposition of nitrogen oxide as $2N_2O_5 \rightarrow 4NO_2 + O_2$ follows a first order kinetics.

Jika penguraian nitrogen oksida di bawah: $2N_2O_5 \rightarrow 4NO_2 + O_2$ mengikut kinetik tertib pertama.

(i). Calculate the rate constant for a 0.05M solution if the instantaneous rate is 1.5×10^{-6} mol/l/s.

Kirakan pemalar kadar untuk larutan 0.05M jika kadar semasa adalah 1.5×10^{-6} mol/l/s

(3 marks/*markah)*

(ii). What concentration of N_2O_5 would give a rate of 2.45×10^{-5} $mol/L^{-1}s^{-1}$?

Apakah kepekatan N_2O_5 yang memberi kadar 2.45×10^{-5} $mol/L^{-1}s^{-1}$?

(3 marks/*markah)*

(c). Rate constants for the first-order decomposition of acetonedicarboxylic acid to acidacetone

$CO(CH_2COOH)_2(aq) \rightarrow CO(CH_3)_2(aq) + 2\ CO_2(g)$

are $k = 4.75 \times 10^{-4}\ s^{-1}$ at 293 K and $k = 1.63 \times 10^{-3}$ at 303 K. Calculate the activation energy, E_a, for this reaction.

Pemalar kadar untuk penguraian asid asitonkarboksilik tertib pertama kepada asid asito

$CO(CH_2COOH)_2(aq) \rightarrow CO(CH_3)_2(aq) + 2\ CO_2(g)$

Adalah $k = 4.75 \times 10^{-4}\ s^{-1}$ *at 293 K and* $k = 1.63 \times 10^{-3}$ *at 303 K. Kirakan tenaga pengaktifan* E_a*, untuk tindakbalas ini.*

(10 marks/*markah)*

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