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Royal College - Colombo

Royal College - Colombo 07

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Colombo 07 Royal College

Second Term Test - September 2024

Grade 12

රසායන විද්‍යාව I
Chemistry I

02 E I

පැය එකයි විනාඩි 30
One Hour and 30 minutes

name : M. A. M. Ape Index No. : Grade :

- This paper consists of 06 pages.
- Answer all the questions.
- Use of calculators is not allowed.
- Write your Index Number in the space provided in the answer sheet.
- Follow the instructions given on the back of the answer sheet carefully.
- In each of the questions 1 to 40, pick one of the alternatives from (1), (2), (3), (4), (5) which is correct or most appropriate and mark your response on the answer sheet with a cross (X) in accordance with the instructions given on the back of the answer sheet.

Universal gas constant	R	=	8.314 J K ⁻¹ mol ⁻¹
Avogadro constant	N _A	=	6.022 x 10 ²³ mol ⁻¹
Planck's constant		=	6.626 x 10 ⁻³⁴ J s
Velocity of light		=	3 x 10 ⁸ m s ⁻¹

01) The highest oxidation state and the maximum valency of the element with the atomic number 34, respectively are"

- 1) 0, 2 2) +4, 4 3) +6, 6 4) +4, 6 5) +6, 4

02) Which of the following is false regarding quantum numbers,

- 1) The number of orbitals in a given main energy level (n) is given by n² ✓
- 2) In ²⁴Cr, there are 7 electrons with the angular momentum quantum number is zero
- 3) Number of orbitals in a given sub energy level is given by (2l + 1)
- 4) ²⁰Ca has 12 electrons with magnetic quantum number (m_l) is +1
- 5) Number of orbitals with n = 3 and l = 1 is 3

03) Consider the following elements

C, Cl, H, O, Be

correct increasing order of the electronegativity according to the Pauling's scale is

- 1) H < Be < C < Cl < O
- 2) Be < H < C < Cl < O
- 3) Be < H < C < O < Cl
- 4) H < Be < Cl < C < O
- 5) Be < H < O < C < Cl

0

04) 4.00 g of a gas occupies 415.7 cm^3 at $3 \times 10^5 \text{ Pa}$ and 300K . what is the relative molecular mass of the gas

- 1) 80 2) 40 3) 8.0 4) 20 5) 0.80

05) The compound with the highest ionic character is,

- 1) BaI_2 2) MgBr_2 3) $8\text{Al}_2\text{S}_3$ 4) BaCl_2 5) CaBr_2

06) The kinetic energy of 1 mole of an ideal gas at a certain temperature which occupies $V \text{ dm}^3$ is E . The pressure of the gas under these conditions is,

- 1) $\frac{3E}{3V}$ 2) $\frac{0.02E}{3V}$ 3) $\frac{3E}{2V}$ 4) $\frac{0.03E}{2V}$ 5) $\frac{2E}{0.0030V}$

07) Ethaneperoxic acid ($\text{C}_2\text{H}_4\text{O}_3$) forms the anion ethaneperoxoate. $\text{CH}_3 - \overset{\text{O}}{\underset{\text{O}}{\text{C}}} - \text{O} - \text{O}$
How many unstable Lewis structures does this ion have,

- 1) 1 2) 2 3) 3 4) 4 5) 5

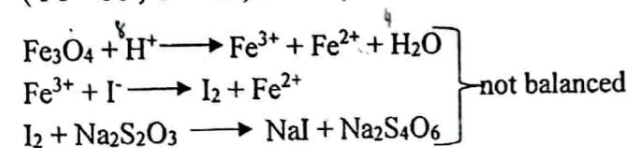
08) Speed of a particle (in ms^{-1}) with the mass $1.0 \mu\text{g}$ whose de-broglie wave length $662 \times 10^{-28}\text{m}$ is,

- 1) 100 2) 10 3) 0.010 4) 0.10 5) 1000

09) Which of the following is true regarding van der Waals equation,

- 1) There are two constants which depend only on temperature
- 2) Constant in the pressure term does not depend on temperature.
- 3) It can not be applied to real gases
- 4) It can not be applied to ideal gases
- 5) For two real gases with equal molar masses, van der Waals constants are equal.

10) 4.64 g sample of Fe_3O_4 ($\text{Fe}_2\text{O}_3 \cdot \text{FeO}$) dissolved in diluted H_2SO_4 and treated with excess KI(aq) . The volume of $2.0 \text{ mol dm}^{-3} \text{ Na}_2\text{S}_2\text{O}_3$ required to react with liberated I_2 is
(Fe = 56, O = 16, S = 32, H = 1, I = 127, K = 39)



- 1) 20 cm^3 2) 40 cm^3 3) 25 cm^3 4) 200 cm^3 5) 60 cm^3

11) Which of the following can be considered as a disproportionation reaction.

- 1) $\text{KIO}_3 + 5\text{KI} + 3\text{H}_2\text{SO}_4 \longrightarrow 3\text{K}_2\text{SO}_4 + 3\text{I}_2 + 3\text{H}_2\text{O}$
- 2) $\text{CuI}_2 + \text{Cu} \longrightarrow 2\text{CuI}$
- 3) $\text{CaC}_2\text{O}_4 \longrightarrow \text{CaO} + \text{CO}_2 + \text{CO}$
- 4) $4\text{S} + 6\text{NaOH} \longrightarrow 2\text{Na}_2\text{S} + \text{Na}_2\text{S}_2\text{O}_3 + 3\text{H}_2\text{O}$
- 5) $2\text{KMnO}_4 \longrightarrow \text{K}_2\text{MnO}_4 + \text{MnO}_2 + \text{O}_2$

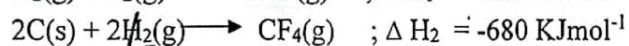
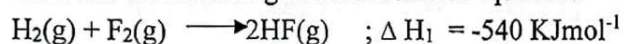
12) Which of the following gases deviates from the ideal gas behaviour to the greatest extent,
 1) He 2) H₂ 3) N₂ 4) SO₃ 5) CO₂

13) Temperature at which the root mean square speed of He gas is equal to the root mean square speed of O₂(g) at 300K (He = 4.0 ; O = 16)
 1) -235.5 °C 2) -198 °C 3) 27 °C 4) 0 °C 5) 19 °C

14) Which of the following is correct regarding the central atom of NO₂F

	Oxidation Number	Charge	Hybridization	Electron Pair geometry	Nature of N-F bond
	+4	+1	sp ² ✓	Trigonal Planar ✓	N : sp ² F : 2p
	+5	+1	sp ²	Angular	N : sp ² F : 2p
	+3	+1	sp ³ ✗	Trigonal Planar ✓	N : sp ² F : 2p
	+5	0	sp ² ✓	Trigonal Planar ✓	N : sp ² F : 2p
	+5	+1	sp ² ✓	Trigonal Planar ✓	N : sp ² F : 2p

15) Consider the following thermochemical equations



The enthalpy change of the reaction



1) +1273 2) -1273 3) -2546 4) +127.3 5) -1220

16) Methane reacts with fluorine gas according to the equation,



following enthalpy data are provided

Bond	Mean bond enthalpy (kJ mol ⁻¹)
C - H	412
C - F	484
H - F	562
F - F	158

Enthalpy change of the above reaction (kJmol⁻¹) is ?

1) -904 2) -1904 3) -2808 4) +1904 5) +2808

17) What is the standard combustion enthalpy of C₇H₈ (l) in kJ mol⁻¹ ?

- $7\text{C}(\text{s}) + 4\text{H}_2(\text{g}) \longrightarrow \text{C}_7\text{H}_8(\text{l}) ; \Delta H = +7 \text{ kJmol}^{-1}$
- Standard combustion enthalpy = -394 kJmol⁻¹
- Standard combustion enthalpy = -286 kJmol⁻¹

1) -390.9 2) +3909 3) -3229 4) -1954.5 5) -3909

18) The inorganic compound X shows the following observations

- Dissolves in water forming a colorless solution
- Brown fumes and a precipitate are formed on addition of diluted sulfuric acid to the aqueous solution
- Colourless solution resulted when few drops of NaOH is added for the aqueous solutions

Which of the following could be the compound X

- 1) NH_4NO_2 2) $\text{Ba}(\text{NO}_3)_2$ 3) $\text{Ba}(\text{NO}_2)_2$ 4) $\text{Pb}(\text{NO}_2)_2$ 5) $\text{Mg}(\text{NO}_2)_2$

19) An aqueous solution (100 cm^3) was prepared by dissolving 0.010 moles of the inorganic compound Y. 25.00 cm^3 of this solution required 30.00 cm^3 of 0.10 mol dm^{-3} KMnO_4 for the complete reaction in acid medium.

The compound Y is,

- 1) CaC_2O_4 2) $\text{Ca}(\text{NO}_2)_2$ 3) $\text{Fe}(\text{NO}_2)_2$ 4) $\text{Al}(\text{NO}_2)_2$ 5) FeSO_3

20) 1.07 g of $\text{KIO}_3(\text{s})$ dissolved in 30.00 cm^3 of 1 mol dm^{-3} $\text{KI}(\text{aq})$ solution and it was acidified with 20.00 cm^3 of 0.50 mol dm^{-3} H_2SO_4 solution. The volume of 2.00 mol dm^{-3} $\text{Na}_2\text{S}_2\text{O}_3$ required to react with liberated I_2 is,

($\text{K} = 39, \text{I} = 127, \text{O} = 16$)

- 1) 20 cm^3 2) 10 cm^3 3) 15 cm^3 4) 25 cm^3 5) 30 cm^3

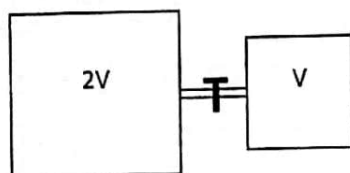
21) A mixture containing $\text{KNO}_3(\text{s})$ and $\text{LiNO}_3(\text{s})$ 1 : 4 mole ratio was heated until a constant mass is obtained the volume of gas evolved, collected at STP was 246.4 dm^3 . Molar volume under these conditions $22.4 \text{ dm}^3 \text{ mol}^{-1}$

($\text{K} = 39, \text{O} = 16, \text{N} = 14, \text{Li} = 7$)

Initial mass of the mixture is,

- 1) 47.8 g 2) 754 g 3) 340 g 4) 675 g 5) 478 g

22)



Initially an ideal gas at temperature T and pressure P_2 is present in A and another ideal gas at $2T$ and pressure P_1 is present in B. The tap is opened keeping the two temperatures unchanged. Final pressure of the system was found to be P_3 .

Which of the following is correct regarding P_1 , P_2 and P_3 .

- 1) $\frac{P_1}{P_2} = \frac{4}{1}$ 2) $P_1 + 4P_2 = 5P_3$ 3) $\frac{P_1}{2} > 2P_2$ 4) $P_1 + 4P_2 = 5P_3$ 5) $\frac{P_1}{2} + 2P_2 > \frac{5P_3}{2}$

23) Consider the following data


Standard dissolution enthalpy of $\text{MX}_2(\text{s})$ in water = -344 kJ mol^{-1}

Standard hydration enthalpy of $\text{M}^{2+}(\text{g}) = -1930 \text{ kJ mol}^{-1}$

Standard lattice dissociation enthalpy of $\text{MX}_2(\text{s}) = +2530 \text{ kJ mol}^{-1}$

Standard hydration enthalpy of $\text{X}^+(\text{g})$ is (kJ mol^{-1})

- 1) -472 2) -944 3) $+472$ 4) -236 5) $+949$

- 24) Correct increasing order of melting points of compounds is?
- 1) $\text{KCl} < \text{KF} < \text{CaCl}_2 < \text{MgCl}_2$
 - 2) $\text{MgCl}_2 < \text{CaCl}_2 < \text{KCl} < \text{KF}$
 - 3) $\text{MgCl}_2 < \text{KCl} < \text{CaCl}_2 < \text{KF}$
 - 4) $\text{MgCl}_2 < \text{CaCl}_2 < \text{KF} < \text{KCl}$
 - 5) $\text{KF} < \text{KCl} < \text{CaCl}_2 < \text{MgCl}_2$
- 25) Intermolecular Hydrogen bonds are not formed by,
- 1) H_2O_2
 - 2) Dimethyl ether ($\text{CH}_3 - \text{O} - \text{CH}_3$)
 - 3) methanol (CH_3OH)
 - 4) aqueous solution of methanal (HCHO)
 - 5) Phenol ()

The instructions for the questions 26 to 32 are given below.

Summary of the instructions				
1	2	3	4	5
Only (a) and (b) correct	Only (b) and (c) correct	Only (c) and (d) correct	Only (d) and (a) correct	Any other response or combination of responses correct

- 26) A, B, C are three consecutive non transition elements in the periodic table First and third ionization energies of A, B and C are given.

	A	B	C
First Ionization energy (kJ mol^{-1})	1402	1314	1681
Third Ionization energy (kJ mol^{-1})	4577	5300	6050

Which of the following is / are true regarding A, B and C

- (a) C belongs for group 17
 - (b) A belongs to group 2
 - (c) B belongs to group 13
 - (d) B belongs for group 16
- 27) Which of the following is / are true regarding the elements in the periodic table
- (a) All elements in s block and d block are metals
 - (b) d block of the periodic table contains amphoteric metals
 - (c) All metals react with dilute HCl
 - (d) Number of gaseous elements at 25°C and 1 atm is greater than the number of metalloids
- 28) Which of the following compounds is / are water soluble
- (a) CaC_2O_4
 - (b) $(\text{NH}_4)_2\text{CO}_3$
 - (c) MgSO_4
 - (d) $\text{Co}(\text{OH})_2$
- 29) Which of the following is / are true regarding molecular kinetic theory of gases?
- (a) Gases have low densities compared to solids and liquids
 - (b) Pressure of a gas is exerted as a result of sum of the collisions of gas particles with each other.
 - (c) Different gases at the same temperature has the same average speed
 - (d) The Kinetic energy of all gaseous particles increases when the temperature is increased

- 30) Which of the following elements react with both aqueous KOH and aqueous H_2SO_4 (dilute)?
 (a) Ca (b) Zn (c) Al (d) Fe
- 31) Ion / molecule with the trigonal bipyramidal electron pair geometry is / are,
 (a) IF_3 (b) XeOF_4 (c) IF_5 (d) SbF_5^{2-}
- 32) Which of the following enthalpy change / changes could be either exothermic or endothermic?
 (a) Standard dissolution enthalpy
 (b) Standard first electron gain enthalpy
 (c) Standard lattice dissociation enthalpy
 (d) Standard atomization enthalpy.

Instructions for question No. 33 to 40

Response	first statement	second statement
(1)	True	true and correctly explain the 1 st statement
(2)	True	true, but does not explain the 1 st statement correctly
(3)	True	False
(4)	False	True
(5)	False	False

	First statement	Second statement
33)	Boiling Point of NH_3 is greater than that of SbH_3	Strong Intermolecular hydrogen bonds exist between the molecules of NH_3
34)	Pressure exerted by a real gas is always less than that of an ideal gas	Pressure exerted by a real gas decreases due to the presence of intermolecular forces
35)	Electron gain enthalpy of group 15 elements is always positive	Valence electron configuration of group 15 elements is stable ($ns^2 np^3$)
36)	Lattice dissociation enthalpy can not be measured directly	Lattice dissociation enthalpy is endothermic
37)	All N-O bonds of NO_3^- ion are identical	For NO_3^- , three stable resonance structures can be drawn
38)	Mg metal reacts with nitrogen gas when heated but Na does not react with nitrogen gas	Charge density of Mg^{2+} ion is greater than that of Na^+
39)	Second ionization energy of oxygen is greater than the second ionization energy of fluorine	Effective nuclear charge of F is greater than the effective nuclear charge of O.
40)	Solubility of certain ionic salts increases with the decrease of temperature	Standard dissolution enthalpy of an ionic compound could either be exothermic or endothermic



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Second Term Test - September 2024

Grade 12

රසායන විද්‍යාව II
Chemistry II

02 E II

Part B – Essay

Answer all questions.

04) a) (i) Define the term standard enthalpy of combustion.

(ii) When 9.20 g of ethanol ($\text{CH}_3\text{CH}_2\text{OH}(l)$) was completely combusted inside a certain calorimeter, its temperature was increased by 55°C . The heat capacity of the system was 5000 JK^{-1} .

I. Calculate the heat change occurred in it.

II. Under which conditions the heat charge calculated above can be considered as an enthalpy change?

III. If the experiment was carried out under the conditions stated in part II above, calculate the enthalpy combustion of ethanol ($\text{CH}_3\text{CH}_2\text{OH}(l)$) at the given temperature.

(iii) Calculate the enthalpy of formation of $\text{CH}_3\text{CH}_2\text{OH}(l)$ using the additional data provided.

Sublimation enthalpy of $\text{C}(s, \text{graphite})$ 719 kJ mol^{-1}

Vapourization enthalpy of $\text{H}_2\text{O}(l)$ $= 40.7 \text{ kJ mol}^{-1}$

Bond dissociation energies kJ mol^{-1}

$\text{H} - \text{H} = 436$

$\text{O} = \text{O} = 498$

$\text{C} = \text{O} = 732$

$\text{O} - \text{H} = 460$

b) (i) Write the chemical equations to indicate the following thermochemical data.

I. Standard enthalpy of lattice dissociation of $\text{CaF}_2(s)$ $= 2460 \text{ kJ mol}^{-1}$

II. Standard enthalpy of hydration of $\text{Ca}^{2+}(g)$ $= -1580 \text{ kJ mol}^{-1}$

III. Standard enthalpy of hydration of $\text{F}^-(g)$ $= -524 \text{ kJ mol}^{-1}$

(ii) Calculate the standard enthalpy of dissolution of $\text{CaF}_2(s)$ using a suitable **enthalpy level diagram**.

(iii) Explain giving reasons how the enthalpy of lattice dissociation of CaCl_2 differ relative to that of $\text{CaF}_2(s)$.

c) (i) Write the equation of molecular kinetic theory and define each of its terms.

(ii) Derive an expression for the root mean square speed starting from the molecular kinetic theory equation.

(iii) The root mean square speed of a gas X_2 at 87°C temperature was 375 ms^{-1} . (Consider that $RT = 3000 \text{ J mol}^{-1}$ at 87°C temperature) Calculate the relative atomic mass of X.

(iv) Explain how the pressure is increased when the temperature of a constant mass of a gas inside a closed rigid container was increased.

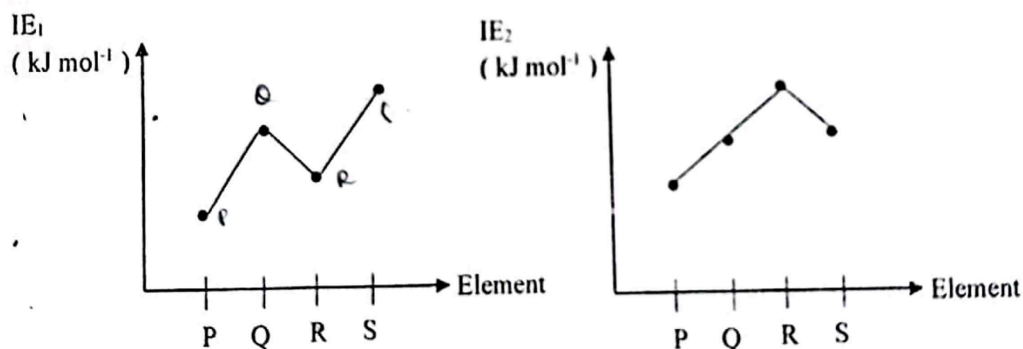
- 05) a) The solid mixture containing $\text{Na}_2\text{C}_2\text{O}_4$, FeC_2O_4 and $\text{H}_2\text{C}_2\text{O}_4$ dissolved in 25.00 cm^3 of water to prepare the solution x.
 10.00 cm^3 of x was taken and titrated with a 0.02 mol dm^{-3} solution of NaOH(aq) using phenolphthalein as the indicator.

The burette reading obtained was 20.00 cm^3 (first titration)

- Another 10.00 cm^3 portion of x was taken and acidified with diluted H_2SO_4 and warmed upto 60°C and titrated with 0.01 mol dm^{-3} solution of KMnO_4 . The burette reading at the end point was 30.00 cm^3 (second titration)
- SO_2 gas was bubbled through the solution obtained from the above titration (second titration) and it was boiled to expel the dissolved SO_2 . Then this solution was titrated with the same KMnO_4 solution used in the above titration. The burette reading at the end point was 6.00 cm^3 . (here SO_2 is oxidized to SO_4^{2-})

- Write balanced chemical equations for the all reactions occurring in the above experiments.
- Write the colour change at the end point of the first titration.
- State the reason for warming / heating the solution in the titration flask before the second titration.
- Calculate the concentrations of $\text{H}_2\text{C}_2\text{O}_4$, $\text{Na}_2\text{C}_2\text{O}_4$ and $\text{H}_2\text{C}_2\text{O}_4$ in solution x.

- b) The variation of first and second ionization energies of 4 consecutive elements P, Q, R and S are shown below.



- Stating reasons, identify the groups to which P, Q, R, S belong.
- State the reasons why the first ionization energy of R is less than that of Q.
- Plot the variation of the first seven ionization energies of the element Q.
- What is the element which acts as the strongest oxidizing agent from P, Q, R and S.
- If the element mentioned in (iv) belongs to the second period, what is the highest oxidation state shown by it. State the reasons for your answer.
- If the element mentioned in (iv) above forms a compound with Ca write the molecular formula of the compound and predict the nature of bonding of it.
- What is the element with highest fifth ionization energy. State reasons.

c) State whether the following statements are true or false with a reason.

- (i) The electronegativity of N varies $\text{NH}_3 < \text{NH}_4^+ < \text{NO}_2^+$
- (ii) The thermal stability of carbonates of group 2 elements increases down the group.
- (iii) The melting point of CH_3F is greater than that of CCl_4 .
- (iv) The boiling point of hydrides increases as $\text{PH}_3 < \text{AsH}_3 < \text{SbH}_3 < \text{NH}_3$
- (v) Even though both graphite and iodine exist as homoatomic lattices, only Iodine undergoes sublimation.

6) a) A is an element belongs to the s block of the periodic table.

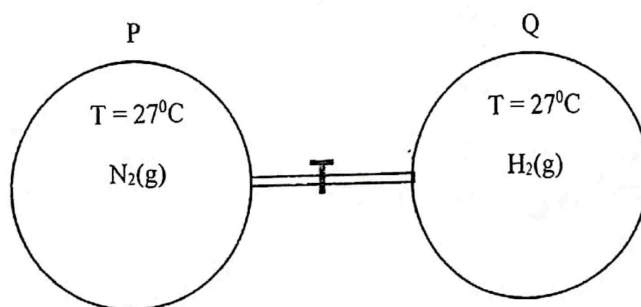
A reacts with cold water forming a colourless gas (B) and an alkaline solution (C). Gas B reacts with A to form an ionic salt-like compound (D). D reacts with water forming B. When A is heated in air, two compounds, E and F are formed. Both E and F react with water forming the same aqueous solution (C). While F liberates the gas G which turns moistened red litmus paper blue. Elements placed above A in the same group do not react with cold water.

- i) Identify A.
- ii) Identify the chemical species from B to G.
- iii) Write balanced equations for the,
 - 1) Reaction of A with cold water
 - 2) Reaction of A when heated in air
 - 3) Reaction of F with water
- iv) Give another chemical test other than the one mentioned, to identify G

b) Briefly explain the following

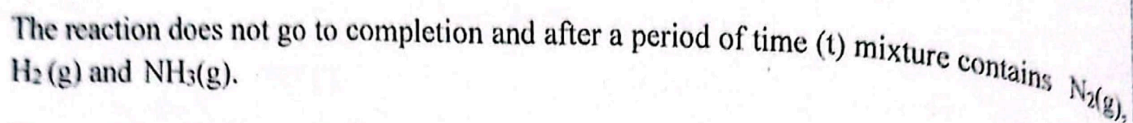
- a) Melting point of Mg is greater than that of Na.
- b) NaHCO_3 exists in solid state but $\text{Mg}(\text{HCO}_3)_2$ does not exist in solid state.
- c) Li reacts with N_2 gas at a higher temperature but Na does not react with N_2 gas.

c) Two rigid containers P and Q are connected by a capillary tube with a negligible volume. The tap is closed at the beginning. Bulb P contains $\text{N}_2(\text{g})$ and Q contains $\text{H}_2(\text{g})$.



Initially the mean kinetic energy of $\text{N}_2(\text{g})$ in bulb P is 1496.52 J and the mean kinetic energy of $\text{H}_2(\text{g})$ in Q is 3741.3 J (N = 14, H = 1)

The gases react as given below



The density of the gas mixture at this point is 5.64 kg m^{-3} .

- moles of $\text{N}_2(\text{g})$ in bulb P.
- moles of $\text{H}_2(\text{g})$ in bulb Q.
- moles of $\text{N}_2(\text{g})$, $\text{H}_2(\text{g})$ and $\text{NH}_3(\text{g})$ after the time t .
- Partial pressures of $\text{N}_2(\text{g})$, $\text{H}_2(\text{g})$ and $\text{NH}_3(\text{g})$ after the time t .
- State the assumptions made during the calculation.

1	1																	2	
	H																	He	
2	3	4																	10
	Li	Be																	Ne
3	11	12																	18
	Na	Mg																	Ar
4	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
5	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	
	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
6	55	56	La-	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	
	Cs	Ba	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
7	87	88	Ac-	104	105	106	107	108	109	110	111	112	113						
	Fr	Ra	Lr	Rf	Db	Sg	Bh	Hs	Mt	Uun	Uuu	Uub	Uut						

57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr