European Project - Transfer of Innovation

Leonardo Da Vinci : CHEMLAB II

Intermediate examinations – 1st year of studies

Basic chemical knowledge

Duration of examination 2 hours
Every multiple choice question (Part A) is graded with 2 points
Each exercise (Part B) is graded with 10 points
In order to succeed in the exams a 30 points should be achieved in each part

PART A

MULTIPLE CHOICE QUESTIONS

1. During the transition of one e- from an energy level E2 to an energy level E1, radiation emits with a wavelength λ.The equations between E1, E2, and λ are

i. $E_1=h*\frac{1}{\lambda 1}$, $E_1=h*\frac{1}{\lambda 2}$, $E_1>E_2$, $\lambda_1<\lambda_2$
ii. $E_1=h*\frac{1}{\lambda 1}$, $E_1=h*\frac{1}{\lambda 2}$, $E_1=E_2$, $\lambda_1=\lambda_2$
iii. $E_1=h*\frac{1}{\lambda 1}$, $E_1=h*\frac{1}{\lambda 2}$, $E_1<E_2$, $\lambda_1<\lambda_2$
iv. $E_1=h*\frac{1}{\lambda 1}$, $E_1=h*\frac{1}{\lambda 2}$, $E_1>E_2$, $\lambda_1>\lambda_2$
v. $E_1=h* \lambda_1$, $E_1=h* \lambda_2$, $E_1>E_2$, $\lambda_1<\lambda_2$

2. For the acids HClO,HBrO,HIO the classification in order of power is

i. HClO=HBrO=HIO
ii. HClO>HBrO>HIO
iii. HClO<HBrO>HIO
iv. HClO<HBrO<HIO
v. HClO>HBrO<HIO

3. The conjugate acid of HPO_4^{2-} is

i. PO_4^{3-}
ii. H_3PO_4
iii. H_3PO_3
iv. $H_2PO_4^-$
v. HPO_4^-

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4. The existence of two or more electrons with ms=-1/2 in the same atomic orbital is against

i. the exclusion principle of Pauling
ii. the principle of minimum energy
iii. the principle of conservation of energy
iv. the principle of building
v. the rule of Hund

5. The elements $_{12}Mg$, $_{16}S$, $_{20}Ca$ are given. For the first ionization energy the correct equation is :

i. ECa<EMg<ES
ii. ECa< ES < EMg
iii. ECa=EMg=ES
iv. ES <EMg< ECa
v. EMg <ES < ECa

6. The orbitals 2s και 3s differ at :

i. their size
ii. their shape
iii. their orientation through space
iv. all the above
v. nothing from the above

7. The elements A and B with atomic numbers 19 and 35 respectively form with each other:

i. covalent compound with chemical form AB
ii. covalent compound with chemical form AB_2
iii. heteropoly compound with chemical form A_2B
iv. heteropoly compound with chemical form AB
v. heteropoly compound with chemical form BA.

8. Design the structure for each compound that corresponds to the following names

i. 4-methoxybenzaldeyde
ii. Bromodimethylbenzene
iii. 3-methyl-5-propylbenzoic acid
iv. 1,4-dinitro-2-chlorobenzene
v. o-chlorobenzonitrile

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9. From the following phrases which is the wrong one?

i. According to the theory of resonance neither the position nor the hybridization of individuals from one resonance structure of benzene in other changes

ii. Benzene is 150kj/mol more stable from the expected because through the hydrogenation, energy of 150kj/mol bigger is emitted

iii. Cyclootratriene is not aromatic

iv. In the pyrrole, nitrogen atom contributes two electrons in the aromatic sextet without participating in a double bond.

v. In contrast to the nitration and bromination, the sulfonation is a reversible reaction carried ie in both directions.

10. The elements A (16η team-2η period) και B(1η team -4η period) are given . Which types are correct for their compounds

i. AB

ii. BA

iii. B_2A

iv. AB_2

v. B_2A_2

11. The sublimation of a substance is its transformation from

i) solid to liquid phase
i) gas to solid phase directly
iii) gas to liquid phase
iv) liquid to solid phase
v) solid to gas phase directly

12. Battery acid is a 40.0% w/w aqueous solution of sulfuric acid (H_2SO_4). Its specific gravity is 1.31. Calculate the mass of pure H_2SO_4 in 250.0 mL of battery acid. The density of H_2O is 1 g/mL at 20 ^oC.

i) 100 g
ii) 52.4 g
iii) 327.5 g
iv) 131 g
v) 13.1 g

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13. How many grams of NH_3 can be produced from the reaction of 59.85 g of N_2 and 12.11 g of H_2? (A_r (N) = 14, A_r (H) = 1)

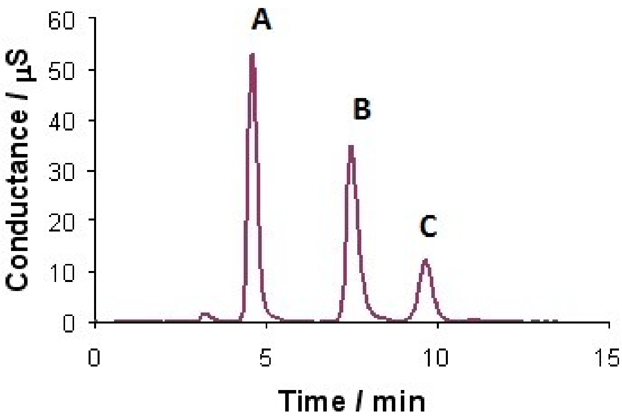
$N_2 + H_2 \rightarrow NH_3$ (un-balanced)

i) 68.62 g
ii) 72.67 g
iii) 2 g
iv) 2.1375 g
v) 4.063 g

14. Which of the following is a redox reaction?

i) $SO_3 + 2\,KOH \rightarrow K_2SO_4 + H_2O$
ii) $CO_2 + CaO \rightarrow CaCO_3$
iii) $3H_2S + 2HNO_3 \rightarrow 3S + 2NO + 4H_2O$
iv) $AgNO_3 + HCl \rightarrow AgCl + HNO_3$
v) $CaO + H_2O \rightarrow Ca(OH)_2$

15. Considering a gas chromatographic separation of three compounds A, B & C (non-polar). How is the retention time of the peak of each compound affected by the increase of column temperature? The stationary phase is consisted of a non-polar polymer.



i) Increase of the retention time of the peaks of A, B & C
ii) Decrease of the retention time of the peaks of A, B & C
iii) The retention time will remain constant for all compounds
iv) Increase of the retention time of the peaks of A, B and decrease of C
v) Decrease of the retention time of the peak of A and increase of peaks of B & C

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16. Which of the following statements is false?

i) In liquid chromatography the composition of the mobile phase plays an important role on the separation of compounds

ii) Gas chromatography is used for the analysis of non-volatile compounds.

iii) the separation of F^-, Cl^-, NO_3^-, SO_4^{-2} anions can be carried out using ion-exchange chromatography.

iv) a UV-Vis detector can be used in liquid chromatography

v) In a chromatogram, the peak area of a compound is generally proportional to its concentration

17. For a hypothetical reaction A + B + C → products the rate law is determined to be

$$\textbf{rate} = k\,[A]\,[B]^3$$

What happens to the reaction rate when we double the concentration of all reactants?

i) increase by a factor of 2
ii) increase by a factor of 4
iii) increase by a factor of 6
iv) increase by a factor of 8
v) increase by a factor of 16

18. Which of the following types of homologous series represents the alkynes?

i) C_vH_{2v+2}
ii) C_vH_{2v}
iii) C_vH_{2v-2}
iv) $C_vH_{2v}X_2$
v) C_vH_{2v-1}

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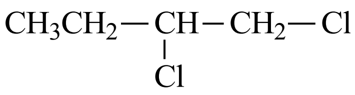
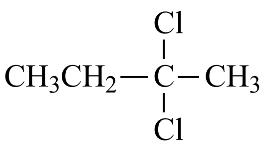
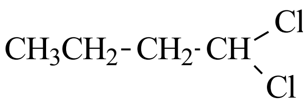
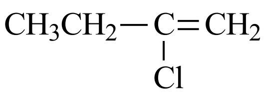
19. An amount of 1-butyne is mixed with an excess amount of HCl. Which of the following will be the final product?

i) 

ii) 

iii) 

iv) 

v) No reaction is carried out

20. Considering the simple reaction $A_{(g)} \rightarrow B_{(g)}$. Which of the following curves represents the concentration of A?

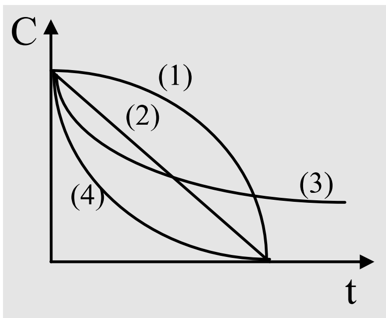
i) curve (1)

ii) curve (2)

III) curve (3)

iv) curve (4)

v) none of the above



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21.The acid dissociation constant Ka depends on:

i. the nature of electrolyte, temperature and nature of solvent
ii. acid concentration, temperature and nature of solvent
iii. nature of solvent and pH
iv. sodium ion presence
v. common ion presence

22.In the reaction HCl + H_2O → H_3O^+ + Cl^- the conjugate pair is:

i. HCl – H_2O
ii. HCl – Cl^-
iii. HCl – H_3O^+
iv. H_2O - Cl^-
v. None of the above

23.Bases according to Lewis theory are:

i. Molecules or ions which donate a pair of electrons to a Lewis acid
ii. Include a hydroxyl radical
iii. React with acids
iv. Change the colour of indicators
v. Can be dissolved in an aqueous solution of an acid

24.During the dilution of an aqueous solution of a weak acid with water, one of the following takes place:

i. The percent dissociation a decreases
ii. The percent dissociation a increases
iii. The percent dissociation a remains constant
iv. The dissociation constant Ka is modified
v. pH remains stable

25.Which of the following reactions produces a buffer solution:

i. 1 mole HCl with 1 mole NaOH
ii. 1 mole HCl with 2 mole NaOH
iii. 1 mole CH_3COOH with 1 mole NaOH
iv. 2 mole CH_3COOH with 1 mole NaOH
v. 1 mole CH_3COOH with 1 mole HCl

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26. During the reaction of a weak acid with a strong base, the equilibrium point will indicate:

i. pH<7
ii. pH>7
iii. pH=7
iv. pH=pKa
v. two different pH values

27. In phasmatophotometry, the Beer-Lambert Law relates linearly:

i. Absorption with wavelength
ii. Absorption with the concentration of the absorptive substance
iii. Wavelength with the size of cuvette
iv. Temperature of the solution with the wavelength
v. Transmittance with absorbance

28. A monochromator is the device that:

i. Isolates a small wavelength area
ii. Selects the size of cuvette
iii. Selects a radiation source
iv. Filters the electronic signal
v. Selects all the possible wavelengths

29. A buffer solution contains a weak monoprotic acid HA 0,1M and the salt NaA 0,2M. If K_a=2.10^{-5} state the pH of the solution under equilibrium:

i. 4
ii. 5
iii. 6
iv. 8

30. A solution D1 containing 10g of dissolved sugar in 190g water and another solution D2 which contains 30g of sugar in 210g water are mixed (D3 solution). What is the weight percent % w/w of D3:

i. 10
ii. 30
iii. 15
iv. 40
v. 100

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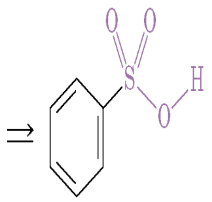
PART B

EXERCISES

1) The elements $_{20}Ca$, $_{15}P$, $_{8}O$ are given. Find

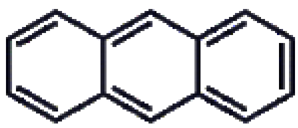
a. In which team and what period of the periodic table belongs each of the three.
b. Which of these elements has more unpaired electrons. Justify your answer.
c. Write the electron type of compound $Ca_3(PO_4)_2$

2) a) With initial compound the benzenesulfonic acid, follow the necessary steps to form the aniline



Βενζολοσουλφονικό οξύ

b) Explain the aromaticity of anthracene



3) An amount of 21.7 g of alkylbromide (R-Br) reacts completely with sodium (Na) in the presence of anhydrous ether forming 2.24 L alkane B (measured at STP conditions). Which is the structural formula of each compound? (Ar (C) = 12, Ar (H) = 1, Ar (Br) = 80)

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4) An amount of iron (Fe) reacts with excess of sulphuric acid (H_2SO_4). The produced gas A reacts completely with chlorine (Cl_2) and the formed gas B passes though a solution of silver nitrate ($AgNO_3$). A mass of 28.7 g of white precipitate was collected. Calculate the mass of the reacted iron. (Ar (Fe) = 56, Ar (Ag) = 108, Ar (Cl) = 35.5)

5. i) 150mL of HCl 8% w/v solution are mixed with 250mL another HCl solution of 16% w/v. What is theconcentration of the final solutionexpressed in % w/v ?

ii) In 400mL of a sugar solution 8% w/v, 5g of additional sugar are dissolved. Regarding the overall volume of the solution to remain stable, what is the final solution concentration expressed in %w/v ?

6. A buffer solution includes 500mL of a monoprotic HA acid , 1M, and the salt NaA, 1M. Calculate the following:

i) pH of the solution under equilibrium

ii) how much will the initial pH change if we add a) 500mL water b) 0,1mol HCl without change of solution volume.

$K_a=10^{-4}$, $K_w=10^{-14}$

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