

School of Bioscience

WRITTEN EXAMINATION

Course Basic Chemistry

Examination Supervised examination I

Course code Ke117G

Credits for written examination 5

Date 2024-10-30

Examination time 8.15-12.30

Examination responsible Patric Nilsson/Magnus Fagerlind

Teachers concerned Patric Nilsson/Magnus Fagerlind

Aid at the exam/appendices: calculators

Other: All answers must be given in the exam sheet. Answers given on extra/additional sheets will NOT be considered. If you have earned bonus points, they will be added to each learning objective.

Instructions

- ☐ Take a new sheet of paper for each teacher.
- ☐ Take a new sheet of paper when starting a new question.
- ☒ Write only on one side of the paper.
- ☒ Write your name and personal ID No. on all pages you hand in.
- ☒ Use page numbering.
- ☒ Don't use a red pen.
- ☒ Mark answered questions with a cross on the cover sheet.

Grade points: To pass the exam, you need to have at least 50% on each learning objective (3 in total).

Grade scale: $F < 35 \leq E < 42 \leq D < 49 \leq C < 56 \leq B < 63 \leq A$

Examination results should be made public within 18 working days

Good luck!

Total number of pages

Learning objective: describe the structure of atoms, molecules and how chemical bonds are formed, and use this knowledge to name and explain the properties and structure of inorganic chemical substances. You need 10/20p to pass the learning objective

1.	Complete the following table for atoms and ions	4																
	<table><tr><td>Atom or ion</td><td>Number of protons</td><td>Number of electrons</td><td>Electrons lost/gained</td></tr><tr><td>K⁺</td><td></td><td></td><td></td></tr><tr><td></td><td>12</td><td>10</td><td></td></tr><tr><td></td><td>8</td><td></td><td>2 e⁻ gained</td></tr></table>	Atom or ion	Number of protons	Number of electrons	Electrons lost/gained	K ⁺					12	10			8		2 e ⁻ gained	
Atom or ion	Number of protons	Number of electrons	Electrons lost/gained															
K ⁺																		
	12	10																
	8		2 e ⁻ gained															
2.	Classify each of the following as ionic or molecular, and name each: a) FePO ₃ b) PCl ₃ c) Cl ₂ O ₇ d) MgCO ₃	1 1 1 1																
3.	Consider three elements with the following abbreviated electron configuration: X=[Ar]4s ² Y=[Ne]3s ² 3p ⁴ Z=[Ar]4s ² 3d ¹⁰ 4p ⁴ a) Identify each element as a metal, a non-metal, or a metalloid b) Which element has the largest atomic size? c) Which elements have similar properties? d) Which element has the highest ionization energy? e) Which element has the smallest atomic size? f) Identify which elements X, Y and Z are?	1 1 1 1 1																
4.	Use VSEPR theory to predict the molecular shape (geometry) for the following compounds (Hint: derive the Lewis structure before you jump into any conclusions) a) CS ₂	1.5																

	b) H_2O c) CH_4 d) NH_3	1.5 1.5 1.5
Learning objective: use thermodynamic principles and laws to explain the mechanisms of chemical reactions and chemical equilibrium. You need 10/20 to pass the learning objective		
5.	Balance each of the following reaction and identify the type of reaction a) $\text{K}_2\text{O}(s) + \text{H}_2\text{O}(g) \rightarrow \text{KOH}(aq)$ b) $\text{C}_8\text{H}_{18}(l) + \text{O}_2(g) \rightarrow \text{CO}_2(g) + \text{H}_2\text{O}(g)$	2 2
6.	Balance the following reaction in basic solution $\text{Zn} + \text{NO}_3^- \rightarrow \text{Zn}^{2+} + \text{NO}_2$	3

7	Under certain conditions, the equilibrium constant, K_c, for the decomposition of $\text{PCl}_5(\text{g})$ into $\text{PCl}_3(\text{g})$ and $\text{Cl}_2(\text{g})$ is 0.0211 M^{-1}. a) Write and balance the reaction b) What are the equilibrium concentrations of $\text{PCl}_3(\text{g})$, $\text{Cl}_2(\text{g})$, and PCl_5 in a mixture that initially contained only PCl_5 at a concentration of 1.00 M? If the system is at equilibrium, how would it respond to each of the following c) Adding more PCl_5 d) Adding a catalyst e) Adding more PCl_3 f) Increasing the volume of the container 1 4 0.5 0.5 0.5 0.5
8.	Ethanol, $\text{C}_2\text{H}_6\text{O}$, reacts with oxygen. As a results carbon dioxide and water are formed. Also, energy is released ($\Delta H = -327 \text{ Kcal}$) a) Write and balance the reaction b) What type of reaction is? c) Is the reaction endothermic or exothermic? d) How much heat, in kilocalories, is produced when 5.00 grams of ethanol reacts 1 1 1 3

Learning objective: perform stoichiometric calculations, balance chemical reactions (and use these skills in the laboratory). You need 15/30p to pass the learning objective

9.	HCl reacts with magnesium (s) to form hydrogen gas and magnesium chloride a) Write and balance the reaction	1
	b) How many milliliters of a 6.00 M HCl solution are required to react with 15.0 grams of Magnesium	4
10.	What is the volume, in Litres, of N ₂ required to react with 18.5 grams of magnesium to produce magnesium nitride at a pressure of 1.20 atm and a temperature of 303K? (Hint: write and balance the reaction, then do the necessary calculations)	5
11.	Determine the initial volume, in millilitres, required to prepare each of the following: a) 255 mL of a 0.200 M HNO ₃ solution using a 4.00 M HNO ₃ solution	2
	b) 715 mL of a 0.100M MgCl ₂ solution using a 6.00 M MgCl ₂ solution	2
	c) 0.100 L of a 0.150 M KCl solution using an 8.00 M KCl solution	2

12.	What is the pH of a buffer prepared with 0.40 M $\text{HC}_2\text{H}_3\text{O}_2$ and 0.20 M $\text{C}_2\text{H}_3\text{O}_2^-$, if the K_a of acetic acid is $1.8 \cdot 10^{-5}$ M?	5
13.	Determine each of the following for a 0.065 M CsOH solution a) $[\text{H}_3\text{O}^+]$ b) pH c) the balanced equation for the reaction with H_2SO_4 d) millilitres of CsOH required to neutralize 60.0 mL of a 0.040 M H_2SO_4 solution	1 1 1 3
14.	Gallium-68 is taken up by tumours; the emission of positrons allows the tumours to be located. a) Write an equation for the positron emission of Gallium-68 b) If the half-life is 68 minutes, how much of a 64-mcg sample is active after 1.36 minutes?	1.5 1.5

Equations and tables

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HÖGSKOLAN
I SKÖVDE

Constants

$$N_A = 6,022 \cdot 10^{23} / \text{mol}$$

$$R = 62.4 \text{ L x mm Hg}/(\text{mol x K}) \text{ or } 0.0821 \text{ L x atm}/(\text{mole x K})$$

$$1 \text{ u} = 1,661 \cdot 10^{-27} \text{ kg}$$

$$0^\circ \text{ C} = 273.15 \text{ K}$$

Equations

$$M = m/n \text{ (Molar Mass = Mass in gram/moles)}$$

$$c = n/V \text{ (concentration = moles/Volume)}$$

$$m = c \cdot V \cdot M$$

$$c_1 \cdot V_1 = c_2 \cdot V_2$$

$$q = c \cdot m \cdot \Delta T$$

$$\Delta G = \Delta H - T \cdot \Delta S \text{ (Gibbs free energy)}$$

$$P \cdot V = n \cdot R \cdot T \text{ (Ideal Gas Law)}$$

$$\text{Boyle's law: } P_1 V_1 = P_2 V_2$$

$$\text{Charles's law: } \frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$\text{Gay-Lussac's law: } \frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$\text{Avogadro's law: } \frac{V_1}{n_1} = \frac{V_2}{n_2}$$

$$\text{Combined gas law: } \frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$E = e^{\circ}_{\text{plus pole}} - e^{\circ}_{\text{minus pole}}$$

$$A = \varepsilon \cdot C \cdot l$$

$$\text{pH} = \text{p}K_a - \log \frac{C_{(\text{syra})}}{C_{(\text{bas})}}$$

$$H^+ = K_a \cdot \frac{C_{(\text{syra})}}{C_{(\text{bas})}}$$

$$[H_3O^+] = 10^{-\text{pH}}; \text{pH} = -\log_{10}[H_3O^+]; \text{p}K_a = -\log_{10}[K_a]$$

$$[OH^-] = 10^{-\text{pOH}}; \text{pOH} = -\log_{10}[OH^-]; \text{p}K_b = -\log_{10}[K_b]$$

$$K_w = [H_3O^+]x[OH^-] = 1x10^{-14}$$

$$\text{pOH} + \text{pH} = 14$$

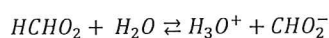
An equation of the form $ax^2 + bx + c = 0$ can be rearranged to solve for x

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Keep in mind that the concentration (x) can only assume positive values.

$$K_a = \frac{[H_3O^+][CHO_2^-]}{HCHO_2}$$

for the following reaction



Solubility rules

Lösligt om saltet innehåller:	Olösligt om saltet innehåller:
NH ₄ ⁺ , Li ⁺ , Na ⁺ , K ⁺ NO ₃ ⁻ , C ₂ H ₃ O ₂ ⁻ (acetat)	CO ₃ ²⁻ , S ²⁻ , PO ₄ ³⁻ , OH ⁻
Cl ⁻ , Br ⁻ , I ⁻	Ag ⁺ , Pb ²⁺ , Hg ₂ ²⁺
SO ₄ ²⁻	Ba ²⁺ , Pb ²⁺ , Ca ²⁺ , Sr ²⁺

Electronegativity values

Grupp	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Period																	
1	H 2,1																
2	Li 1,0	Be 1,5															
3	Na 0,9	Mg 1,2															
4	K 0,8	Ca 1,0															
5	Rb 0,8	Sr 1,0															
6	Cs 0,7	Ba 0,9															
7	Fr 0,7	Ra 0,9															

Electronegativity-bonds

$$\Delta > 1,8$$

Ionic

$$\Delta = 1,8-0,5$$

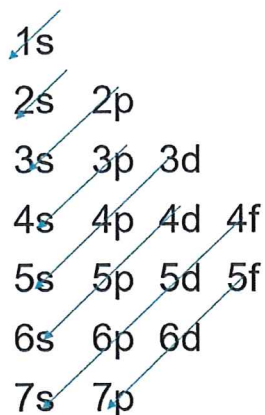
Polar covalent bond

$$\Delta = 0,4-0,0$$

Covalent bond

Element	Symbol	#	Atomic mass (u)	Element	Symbol	Nr	Atomic mass (u)	Element	Symbol	Nr	Atomic mass (u)
Actinium	Ac	89	227,0278	Iodine	I	53	126,9044	Radon	Rn	86	222,0176
Aluminum	Al	13	26,98153	Iron	Fe	26	55,847	Rhenium	Re	75	186,207
Americium	Am	95	243,0614	Cadmium	Cd	48	112,411	Rhodium	Rh	45	102,9055
Antimony	Sb	51	121,75	Calcium	Ca	20	40,078	Rubidium	Rb	37	85,4678
Argon	Ar	18	39,948	Potassium	K	19	39,0983	Ruthenium	Ru	44	101,07
Arsenic	As	33	74,92159	Silicon	Si	14	28,0855	Rutherfordium	Rf	104	261,1087
Astatine	At	85	209,9871	Chlorine	Cl	17	35,4527	Roentgenium	Rg	111	272
Barium	Ba	56	137,327	Kobalt	Co	27	58,9332	Samarium	Sm	62	150,36
Berkelium	Bk	97	247,0703	Carbon	C	6	12,011	Seaborgium	Sg	106	263,1182
Beryllium	Be	4	9,012182	Copper	Cu	29	63,546	Selenium	Se	34	78,96
Bly	Pb	82	207,2	Chromium	Cr	24	51,9961	Silver	Ag	47	107,8682
Bohrium	Bh	107	262,1229	Krypton	Kr	36	83,8	Scandium	Sc	21	44,95591
Boron	B	5	10,811	Mercury	Hg	80	200,59	Strontium	Sr	38	87,62
Bromine	Br	35	79,904	Nitrogen	N	7	14,00674	Sulphur	S	16	32,066
Californium	Cf	98	251,0796	Lanthanum	La	57	138,9055	Oxygen	O	8	15,9994
Cerium	Ce	58	140,115	Lawrencium	Lr	103	260,1053	Thallium	Tl	81	204,3833
Cesium	Cs	55	132,9054	Lithium	Li	3	6,941	Tantalum	Ta	73	180,9479
Copernicium	Cn	112	277	Livermorium	Lv	116		Technetium	Tc	43	98,9063
Curium	Cm	96	247,0703	Lutetium	Lu	71	174,967	Tellurium	Te	52	127,6
Darmstadtium	Ds	110	269	Magnesium	Mg	12	24,305	Tin	Sn	50	118,71
Dubnium	Db	105	262,1138	Manganese	Mn	25	54,93805	Terbium	Tb	65	158,9253
Dysprosium	Dy	66	162,5	Medeleevium	Md	101	258,0986	Titan	Ti	22	47,88
Einsteinium	Es	99	252,0829	Meitnerium	Mt	109	266	Thorium	Th	90	232,0381
Erbium	Er	68	167,26	Molybdenum	Mo	42	95,94	Thulium	Tm	69	168,9342
Europium	Eu	63	151,965	Sodium	Na	11	22,98976	Ununoctium	Uuo	118	
Fermium	Fm	100	257,0951	Neodym	Nd	60	144,24	Ununpentium	Uup	115	
Flerovium	Fl	114		Neon	Ne	10	20,1797	Ununseptrium	Uus	117	
Fluorine	F	9	18,99840	Neptunium	Np	93	237,0482	Ununtrium	Uut	113	
Phosphorous	P	15	30,97376	Nickel	Ni	28	58,69	Uranium	U	92	238,0289
Francium	Fr	87	223,0197	Niobium	Nb	41	92,90638	Vanadium	V	23	50,9415
Gadolinium	Gd	64	157,25	Nobelium	No	102	259,1009	Bismuth	Bi	83	208,9803
Gallium	Ga	31	69,723	Osmium	Os	76	190,2	Tungsten	W	74	183,85
Germanium	Ge	32	72,61	Palladium	Pd	46	106,42	Hydrogen	H	1	1,00794
Gold	Au	79	196,9665	Platina	Pt	78	195,08	Xenon	Xe	54	131,29
Hafnium	Hf	72	178,49	Plutonium	Pu	94	244,0642	Ytterbium	Yb	70	173,04
Hassium	Hs	108	265	Polonium	Po	84	208,9824	Yttrium	Y	39	88,90585
Helium	He	2	4,002602	Praseodymium	Pr	59	140,9076	Zinc	Zn	30	65,39
Holmium	Ho	67	164,9303	Promethium	Pm	61	146,9151	Zirconium	Zr	40	91,224
Indium	In	49	114,82	Protactinium	Pa	91	231,0359				
Iridium	Ir	77	192,22	Radium	Ra	88	226,0254				

The order in which orbitals are filled



Name and formulas of some common polyatomic ions

Formula of ion	Name of ion
OH^-	Hydroxide
NH_4^+	Ammonium
NO_3^-	Nitrate
NO_2^-	Nitrite
ClO_4^-	Perchlorate
ClO_3^-	Chlorate
ClO_2^-	Chlorite
$HClO_2^-$	Hypochlorite
CO_3^{2-}	Carbonate
HCO_3^-	Hydrogen carbonate
CN^-	Cyanide
$C_2H_3O_2^-$	Acetate
SO_4^{2-}	Sulphate
HSO_4^-	Hydrogen sulphate
SO_3^{2-}	Sulphite
HSO_3^-	Hydrogen sulphite
PO_4^{3-}	Phosphate
HPO_4^{2-}	Hydrogen phosphate
$H_2PO_4^-$	Dihydrogen phosphate
PO_3^{3-}	Phosphite

18

57	La	Lanthanum	138.91
58	Ce	Cerium	140.12
59	Pr	Praseodymium	140.91
60	Nd	Neodymium	144.24
61	Pm	Promethium	144.91
62	Sm	Samarium	150.36
63	Eu	Euroium	151.96
64	Gd	Gadolinium	157.25
65	Tb	Terbium	158.93
66	Dy	Dysprosium	162.50
67	Ho	Holmium	164.93
68	Er	Erbium	167.26
69	Tm	Thulium	168.93
70	Yb	Ytterbium	173.05
71	Lu	Lutetium	174.97
89	Ac	Actinium	227.03
90	Th	Thorium	232.04
91	Pa	Protactinium	231.04
92	U	Uranium	238.03
93	Np	Neptunium	237.05
94	Pu	Plutonium	244.06
95	Am	Americium	243.06
96	Cm	Curium	247.07
97	Bk	Berkelium	247.07
98	Cf	Californium	251.08
99	Es	Einsteinium	[254]
100	Fm	Fermium	257.10
101	Md	Mendelevium	258.10
102	No	Nobelium	259.10
103	Lr	Lawrencium	[262]

IN LIFE!