Norges teknisk-naturvitenskapelige universitet,
Trondheim
Institutt for kjemi

KJ1000 Generell kjemi, General Chemistry
Norsk og Engelsk

Student no.:
Studieprogram:

Eksamen mandag 18. 12. 2006, 0900-1300
Hjelpemidler/Permitted aid: Kalkulator HP 30S
Oppgavesettet består av 13 sider.
Svar på oppgavearket/*Answer on the examination paper.*
Kontakt under eksamen: Professor Thorleif Anthonsen tlf 73596206 eller 91897167 og Førsteamanuensis Elisabeth Jacobsen, tlf 73594190 eller 98843559
Svar kort og konsist. Ikke bruk unødvendig mange ord. Vis utregning der det er mulig.
English version in italics.

Del/Part 1

Flervalgsoppgaver/*Multiple choice exercises*

Sett ring rundt rett svar. Vis utregning. /*Circle the right answer, show your calculations.*

1 Tettheten av etanol er 0,798 g/mL. Regn ut massen til 17,4 mL av væsken.
The density of ethanol is 0.798 g/mL. Calculate the mass of 17.4 mL of the liquid.

A) 13.9 g
B) 21.8 g
C) 7.20×10^{-2} g
D) 4.59×10^{-2} g

2 Hva er formelen for kobber (II) cyanid?
What is the formula of copper (II) cyanide?

A) CuCN
B) $Cu(CN)_2$
C) Cu_2CN
D) CuNCO

3 Hvor mange atomer er det i 5,10 mol svovel (S)?
How many atoms are there in 5.10 moles of sulfur (S)?

A) 3.07×10^{24}
B) 9.59×10^{22}
C) 6.02×10^{23}
D) 9.82×10^{25}

4 Hva er massen i gram av ett atom Hg?
What is the mass in grams of a single atom of Hg?

A) 1.208×10^{26} g
B) 3.002×10^{21} g
C) 8.278×10^{-27} g
D) 3.331×10^{-22} g

5 Hvilken av de følgende forbindelser har den største massen av klor?
Which of the following substances contains the greatest mass of chlorine?

A) 5.0 g Cl_2
B) 60.0 g $NaClO_3$
C) 0.10 mol KCl
D) 0.50 mol Cl_2

6 Hvilken av de følgende forbindelser er en svak elektrolytt?
Which of the following substances is a weak electrolyte?

A) CH_3COOH
B) $C_{12}H_{22}O_{11}$
C) HCl
D) H_2O

7 Eddiksyre (CH_3COOH) er en viktig ingrediens i eddik. En prøve av 50,0 mL av kommersiell eddik titreres med en 1,00 M NaOH-løsning. Hva er konsentrasjonen (i M) av eddiksyre i eddiken hvis 5,75 mL av basen brukes for å nå ekvivalenspunktet?

Acetic acid (CH_3COOH) is an important ingredient of vinegar. A sample of 50.0 mL of commercial vinegar is titrated against a 1.00 M NaOH solution. What is the concentration (in M) of acetic acid present in the vinegar if 5.75 mL of the base are needed for the titration?

A) 0.288 M
B) 0.115 M
C) 288 M
D) 0.833 M

8 Regn ut konsentrasjonen av syre (eller base) som fortsatt er tilstede i løsningen når 10,7 mL 0,211 M HNO_3 adderes til 16,3 mL 0,258 M NaOH.
Calculate the concentration of the acid (or base) remaining in solution when 10.7 mL of 0.211 M HNO_3 are added to 16.3 mL of 0.258 M NaOH.

A) 0.0174 M HNO_3
B) 0.0722 M NaOH
C) 0.235 M NaOH
D) 0.240 M HNO_3

9 En gass som opptar et volum på 725 mL ved et trykk på 0,970 atm utvides ved konstant temperatur til trykket når 0,541 atm. Hvilket volum får gassen til slutt?
A gas occupying a volume of 725 mL at a pressure of 0.970 atm is allowed to expand at constant temperature until its pressure reaches 0.541 atm. What is its final volume?

A) 380 mL
B) 1.30×10^3 mL
C) 130 mL
D) 1.34×10^3 mL

10 Hva er volumet av et mol av en ideell gass ved standard trykk og temperatur?
What is the volume of one mole of an ideal gas at STP?

A) 24.5 L
B) 22.4 L
C) 1.0 L
D) 10.0 L

11 En prøve av nitrogengass utvider seg i volum fra 1,6 L til 5,4 L ved konstant temperatur. Regn ut arbeidet som utføres (i joule) hvis gassen utvider seg ved et kontant trykk på 0,80 atm. (1L x atm = 101,3 J)
A sample of nitrogen gas expands in volume from 1.6 L to 5.4 L at constant temperature. Calculate the work done in joules if the gas expands against a constant pressure of 0.80 atm. (1L x atm = 101.3 J)

A) –3.0J
B) 310 J
C) –310 J
D) 3.8 J

12. Følgende reaksjon skjer spontant.
The following reaction is spontanious.

$2\ H^+(aq) + Ca(s) \rightarrow Ca^{2+}(aq) + H_2(g)$

Skriv den balanserte oksidasjons-halvreaksjonen:
Write the balanced oxidation-reduction half reaction:

A) $2\ H^+(aq) + 2\ e^- \rightarrow H_2(g)$
B) $2\ H^+(aq) \rightarrow H_2(g) + 2\ e^-$
C) $2\ H^+(aq) + Ca(s) \rightarrow 2\ e\ -$
D) $Ca(s) + 2\ e^- \rightarrow Ca^{2+}\ (aq)$
E) $Ca(s) \rightarrow Ca^{2+}\ (aq) + 2\ e^-$

13 Elektronkonfigurasjonen av et nøytralt atom er $1s^2 2s^2 2p^6 3s^2$. Hvilket grunnstoff er dette?
The electron configuration of a neutral atom is $1s^2 2s^2 2p^6 3s^2$. Name the element.

A) Si
B) Na
C) Mg
D) Al

14 Alkoholholdige drikkevarer inneholder:
Alcoholic beverages contain:

A) CH_3CHO
B) CH_3COCH_3
C) CH_3COOH
D) CH_3CH_2OH

15 Hva er molariteten av 30 g NH_3 i 70 g vann? Tettheten til løsningen er 0,982 g/mL.
What is the molarity of 30 g of NH_3 in 70 g of water? The density of the solution is 0.982 g/mL.

A) 34.6 M
B) 17.3 M
C) 8.06 M
D) 3.60 M

16. Hvilken av de følgende reaksjoner vil gå lengst mot produktsiden?
Which of the following reactions will to the greatest extent proceed to the product?

A) $H_2(g) + Br_2 \rightleftharpoons 2\ HBr(g)$ $K_c = 8 \times 10^{18}$
B) $2NO(g) \rightleftharpoons N_2(g) + O_2(g)$ $K_c = 2 \times 10^{30}$
C) $2BrCl \rightleftharpoons Br_2 + Cl_2$ $K_c = 0.145$
D) $3\ H_2(g) + N_2(g) \rightleftharpoons 2NH_3(g)$ $K_c = 4 \times 10^{8}$
E) $2H_2O(g) \rightleftharpoons 2H_2(g) + O_2(g)$ $K_c = 7 \times 10^{-18}$

17 Et eksempel på en Brønsted base er:
An example of a Brønsted base is :

A) BF_3
B) NH_4^+
C) HCN
D) NH_3

18 K_b for NH_3 er 1,8 x 10^{-5}. K_a av NH_4^+ er :
The value of K_b for NH_3 is 1.8 x 10^{-5}. The value of K_a of NH_4^+ is :

A) 5.6 x 10^{-10}
B) 5.6 x 10^{4}
C) 1.8 x 10^{-19}
D) 1.8 x 10^{-9}

19 Hvilken av de følgende er en bufferløsning?
Which of the following would be a buffer solution?

A) KCl / HCl
B) NH_3 / NH_4Cl
C) Na_2SO_4 / H_2SO_4
D) KNO_3 / HNO_3

Del II, Part II (Vis utregninger / Show your calculations) 40 points

20 (10p)
2,00 mL 0,200 M NaOH tilsettes 1,00 L 0,100 M $CaCl_2$ løsning.
To 2.00 mL 0.200 M NaOH is added 1.00 L 0.100 M $CaCl_2$ solution.

a) Hva er mulig bunnfall? *What is the possible precipitate?*

b) Vil det bli bunnfall? *Will there be a precipitate?*

Løslighetsproduktkonstanter for noen delvis løslige ioniske stoffer er vist i tabellen.
Solubility product constants for some slightly soluble ionic compounds are shown in the table below.

Table 16.2 Solubility Products of Some Slightly Soluble Ionic Compounds at 25°C

Compound	K_{sp}	Compound	K_{sp}
Aluminum hydroxide [$Al(OH)_3$]	1.8×10^{-33}	Lead(II) chromate ($PbCrO_4$)	2.0×10^{-14}
Barium carbonate ($BaCO_3$)	8.1×10^{-9}	Lead(II) fluoride (PbF_2)	4.1×10^{-8}
Barium fluoride (BaF_2)	1.7×10^{-6}	Lead(II) iodide (PbI_2)	1.4×10^{-8}
Barium sulfate ($BaSO_4$)	1.1×10^{-10}	Lead(II) sulfide (PbS)	3.4×10^{-28}
Bismuth sulfide (Bi_2S_3)	1.6×10^{-72}	Magnesium carbonate ($MgCO_3$)	4.0×10^{-5}
Cadmium sulfide (CdS)	8.0×10^{-28}	Magnesium hydroxide [$Mg(OH)_2$]	1.2×10^{-11}
Calcium carbonate ($CaCO_3$)	8.7×10^{-9}	Manganese(II) sulfide (MnS)	3.0×10^{-14}
Calcium fluoride (CaF_2)	4.0×10^{-11}	Mercury(I) chloride (Hg_2Cl_2)	3.5×10^{-18}
Calcium hydroxide [$Ca(OH)_2$]	8.0×10^{-6}	Mercury(II) sulfide (HgS)	4.0×10^{-54}
Calcium phosphate [$Ca_3(PO_4)_2$]	1.2×10^{-26}	Nickel(II) sulfide (NiS)	1.4×10^{-24}
Chromium(III) hydroxide [$Cr(OH)_3$]	3.0×10^{-29}	Silver bromide (AgBr)	7.7×10^{-13}
Cobalt(II) sulfide (CoS)	4.0×10^{-21}	Silver carbonate (Ag_2CO_3)	8.1×10^{-12}
Copper(I) bromide (CuBr)	4.2×10^{-8}	Silver chloride (AgCl)	1.6×10^{-10}
Copper(I) iodide (CuI)	5.1×10^{-12}	Silver iodide (AgI)	8.3×10^{-17}
Copper(II) hydroxide [$Cu(OH)_2$]	2.2×10^{-20}	Silver sulfate (Ag_2SO_4)	1.4×10^{-5}
Copper(II) sulfide (CuS)	6.0×10^{-37}	Silver sulfide (Ag_2S)	6.0×10^{-51}
Iron(II) hydroxide [$Fe(OH)_2$]	1.6×10^{-14}	Strontium carbonate ($SrCO_3$)	1.6×10^{-9}
Iron(III) hydroxide [$Fe(OH)_3$]	1.1×10^{-36}	Strontium sulfate ($SrSO_4$)	3.8×10^{-7}
Iron(II) sulfide (FeS)	6.0×10^{-19}	Tin(II) sulfide (SnS)	1.0×10^{-26}
Lead(II) carbonate ($PbCO_3$)	3.3×10^{-14}	Zinc hydroxide [$Zn(OH)_2$]	1.8×10^{-14}
Lead(II) chloride ($PbCl_2$)	2.4×10^{-4}	Zinc sulfide (ZnS)	3.0×10^{-23}

21 (12p)

a) Hva er pH i en 0,05 M HF løsning? *What is the pH of a 0.05 M HF-solution?*
($K_a = 7{,}1 \times 10^{-4}$)

b) Beregn pH i en løsning som inneholder 0,30 M maursyre (HCOOH, $K_a = 1{,}7 \times 10^{-4}$) og 0,52 M kaliumformiat (HCOOK).

Calculate the pH of a solution that contains 0,30 M formic acid (HCOOH, $K_a = 1{,}7 \times 10^{-4}$) and 0,52 M potassium formiate (HCOOK)

c) Hva er fellesioneffekt? (*What is common ion effect?*)

22 (8p)

a) Tegn strukturen til en α-aminosyre. *Draw the structure of an amino acid.*

b) Hva er et kiralt molekyl? *What is chiral molecule?*

c) Er α-aminosyrer kirale? *Are α-amino acids chiral?*

d) Hva er en peptidbinding? *What is a peptide bond?*

e) Hva er et protein? *What is a protein?*

f) Gjør rede for proteiners struktur. *Explain the structure of proteins.*

g) Hva slags krefter er viktige for strukturen?
What kind of forces are important for the structure?

h) Hva er DNA? *What is DNA?*

23 (4p)

Vi har reaksjonen: A + B → Produkter
Consider the reaction: A + B → Products

[A] (M)	[B] (M)	Rate (M/s)
1,50	1,50	$3{,}20 \times 10^{-1}$
1,50	2,50	$3{,}20 \times 10^{-1}$
3,00	1,50	$6{,}40 \times 10^{-1}$

Bestem reaksjonsorden og beregn rate konstanten (hastighetskonstanten)
Determine the order of the reaction and calculate the rate constant.

24 (6p)
Under er vist en tabell for standard reduksjonspotensialer.
Below is shown a table for standard reduction potentials.
a) Hva menes med standard tilstand? *What do we mean by standard state?*

b) Hva er diagonalregelen? What is the diagonal rule?

c) Bruk denne til å avgjøre om Pb^{2+} *(aq)* vil reagere spontant med Zn *(s)*.
Use this rule to decide if Pb^{2+} *(aq) will react spontaneuously with Zn (s).*

d) Hva er produktene? *What are the products?*

Table 19.1 Standard Reduction Potentials at 25°C*

Half-Reaction	$E°$(V)
$F_2(g) + 2e^- \longrightarrow 2F^-(aq)$	+2.87
$O_3(g) + 2H^+(aq) + 2e^- \longrightarrow O_2(g) + H_2O$	+2.07
$Co^{3+}(aq) + e^- \longrightarrow Co^{2+}(aq)$	+1.82
$H_2O_2(aq) + 2H^+(aq) + 2e^- \longrightarrow 2H_2O$	+1.77
$PbO_2(s) + 4H^+(aq) + SO_4^{2-}(aq) + 2e^- \longrightarrow PbSO_4(s) + 2H_2O$	+1.70
$Ce^{4+}(aq) + e^- \longrightarrow Ce^{3+}(aq)$	+1.61
$MnO_4^-(aq) + 8H^+(aq) + 5e^- \longrightarrow Mn^{2+}(aq) + 4H_2O$	+1.51
$Au^{3+}(aq) + 3e^- \longrightarrow Au(s)$	+1.50
$Cl_2(g) + 2e^- \longrightarrow 2Cl^-(aq)$	+1.36
$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \longrightarrow 2Cr^{3+}(aq) + 7H_2O$	+1.33
$MnO_2(s) + 4H^+(aq) + 2e^- \longrightarrow Mn^{2+}(aq) + 2H_2O$	+1.23
$O_2(g) + 4H^+(aq) + 4e^- \longrightarrow 2H_2O$	+1.23
$Br_2(l) + 2e^- \longrightarrow 2Br^-(aq)$	+1.07
$NO_3^-(aq) + 4H^+(aq) + 3e^- \longrightarrow NO(g) + 2H_2O$	+0.96
$2Hg^{2+}(aq) + 2e^- \longrightarrow Hg_2^{2+}(aq)$	+0.92
$Hg_2^{2+}(aq) + 2e^- \longrightarrow 2Hg(l)$	+0.85
$Ag^+(aq) + e^- \longrightarrow Ag(s)$	+0.80
$Fe^{3+}(aq) + e^- \longrightarrow Fe^{2+}(aq)$	+0.77
$O_2(g) + 2H^+(aq) + 2e^- \longrightarrow H_2O_2(aq)$	+0.68
$MnO_4^-(aq) + 2H_2O + 3e^- \longrightarrow MnO_2(s) + 4OH^-(aq)$	+0.59
$I_2(s) + 2e^- \longrightarrow 2I^-(aq)$	+0.53
$O_2(g) + 2H_2O + 4e^- \longrightarrow 4OH^-(aq)$	+0.40
$Cu^{2+}(aq) + 2e^- \longrightarrow Cu(s)$	+0.34
$AgCl(s) + e^- \longrightarrow Ag(s) + Cl^-(aq)$	+0.22
$SO_4^{2-}(aq) + 4H^+(aq) + 2e^- \longrightarrow SO_2(g) + 2H_2O$	+0.20
$Cu^{2+}(aq) + e^- \longrightarrow Cu^+(aq)$	+0.15
$Sn^{4+}(aq) + 2e^- \longrightarrow Sn^{2+}(aq)$	+0.13
$2H^+(aq) + 2e^- \longrightarrow H_2(g)$	0.00
$Pb^{2+}(aq) + 2e^- \longrightarrow Pb(s)$	−0.13
$Sn^{2+}(aq) + 2e^- \longrightarrow Sn(s)$	−0.14
$Ni^{2+}(aq) + 2e^- \longrightarrow Ni(s)$	−0.25
$Co^{2+}(aq) + 2e^- \longrightarrow Co(s)$	−0.28
$PbSO_4(s) + 2e^- \longrightarrow Pb(s) + SO_4^{2-}(aq)$	−0.31
$Cd^{2+}(aq) + 2e^- \longrightarrow Cd(s)$	−0.40
$Fe^{2+}(aq) + 2e^- \longrightarrow Fe(s)$	−0.44
$Cr^{3+}(aq) + 3e^- \longrightarrow Cr(s)$	−0.74
$Zn^{2+}(aq) + 2e^- \longrightarrow Zn(s)$	−0.76
$2H_2O + 2e^- \longrightarrow H_2(g) + 2OH^-(aq)$	−0.83
$Mn^{2+}(aq) + 2e^- \longrightarrow Mn(s)$	−1.18
$Al^{3+}(aq) + 3e^- \longrightarrow Al(s)$	−1.66
$Be^{2+}(aq) + 2e^- \longrightarrow Be(s)$	−1.85
$Mg^{2+}(aq) + 2e^- \longrightarrow Mg(s)$	−2.37
$Na^+(aq) + e^- \longrightarrow Na(s)$	−2.71
$Ca^{2+}(aq) + 2e^- \longrightarrow Ca(s)$	−2.87
$Sr^{2+}(aq) + 2e^- \longrightarrow Sr(s)$	−2.89
$Ba^{2+}(aq) + 2e^- \longrightarrow Ba(s)$	−2.90
$K^+(aq) + e^- \longrightarrow K(s)$	−2.93
$Li^+(aq) + e^- \longrightarrow Li(s)$	−3.05

Increasing strength as oxidizing agent ↑

Increasing strength as reducing agent ↓

* *For all half-reactions the concentration is 1 M for dissolved species and the pressure is 1 atm for gases. These are the standard-state values.*