Examination, Science of Environmental Change. FFR 166
Oct 22, 2009, 14.00-19.00 in V-buildings

Note ! The time is 5 hours.

Aids:
- -Pocket calculator of category a "Chalmers-approved calculator":
  Casio FX82, Texas TI30, Sharp EL531 (checked by teacher on duty).
- -Language dictionaries.
- -Physical and mathematical tables.

Teacher on duty: Sten Karlsson, extension: 3149, mobile 0737-553398

Grading scale: 40, 60, 80 points (of total 100).
A maximum 14 points from hand-ins and oral presentation is added for grades 4 and 5.
(The points are weighted and rounded to nearest halfpoints.)

Write structured and if possible be concise. Use figures if they make your answers clearer.
Your answers should prove *good understanding* of the subject.

Note! Always start on a *new paper* when you turn to the next question. Write your *exam code* on every paper.

Note! Your answers should be in *English*.

Evert Ljungström:

1 a/ Which is the symbol and name of the element with atomic number 13 ? (1)

b/ Give the oxidation state of nitrogen in the nitrite ion NO_2^- and of carbon in H_2CO_3 (2)

c/ The hydrogen ion concentration $[H^+]$ in a solution is 2.4×10^{-4} mol dm^{-3}. Calculate the pH of the solution. (2)

2 a/ Write a balanced reaction for the process where n-propanol (C_3H_7OH) burns in air forming carbon dioxide and water. (1)

b/ How much carbon dioxide (mass!) and water do you produce when you burn 2000 g n-propanol? (the reaction in 2a/ being right or wrong does not matter for the grading of 2b as long as the calculation is formally correct and well motivated) (4)

3 a/ Calculate the calorific value (kJ/mole) for combustion of methane according to the reaction $CH_4 + 2\ O_2 \ \text{---}> \ CO_2 + 2\ H_2O$

$\Delta_r H^0\ (CH_4)$ -74.6 (kJ/mole)
$\Delta_r H^0\ (CO_2)$ -393.5
$\Delta_r H^0\ (H_2O)$ -241.8 (2)

b/ A calculation shows that the change in Gibbs free energy for a certain reaction is -350 kJ/mole. Does this reaction have the possibility to proceed spontaneously? (1)

c/ Considering the definition of $\Delta_r G$. Is there anything you can suggest to make the reaction below proceed spontaneously if nothing happens at 150° C? (1)

$$2\ HgO\ (solid)\ \rightarrow\ O_2\ (gas)\ +\ 2\ Hg\ (gas)$$

4/ Describe briefly the main anthropogenic and natural sources to the atmosphere for oxidised nitrogen compounds. (3)

5 a/ The atmosphere has always been regarded as a convenient place to get rid of unwanted gaseous substances. But how does the atmosphere (i.e. the troposphere) itself get rid of these substances, considering that they have wide range of properties e.g. regarding reactivity? (3)

b/ Describe with reaction formulas or words, how formation of ground level ozone takes place? (4)

Sten Karlsson

6. a) Define the *residence time* and *age*, respectively, used when dealing with materials fluxes and reservoirs in the environment and explain the difference between these two concepts. (3p)

b) Clouds are important for the radiation fluxes in the atmosphere. Describe the properties of clouds in the solar spectrum and in Earth heat radiation spectrum, respectively. (4p)

c) Bioenergy and wind energy are renewable energy resources possible to utilize when phasing out fossil fuels. What is the ultimate size of these two resources relative to the human turnover, i.e., how does global photosynthesis and generation of kinetic energy in the atmosphere compare in size to the societal use of energy? Give (2) rough figures. (2p)

7. a) Give and explain the formula for the *Carnot factor.* (2p)

b) A thermal solar plant (or concentrating solar power plant, a CSP plant) concentrates solar radiation, which heats an oil to produce electricity via a thermodynamic cycle and a generator. Estimate the exergy efficiency of this device, if the overall energy efficiency of the thermal solar plant is 20 %. Make if necessary reasonable assumptions of your own. (2p)

8 a) In atmospheric science, define the *adiabatic lapse rate*, and explain the connection of this concept to atmospheric stability. (3p)

b) In the ocean there are different inorganic carbon species dissolved.
- Which species?
- In what direction (increase/decrease) will the concentrations of each of these species change as a consequence of human CO_2 emission to the atmosphere? (4p)

9. Categorize the two processes *denitrification* and *methanogenesis* (biological production of methane from organic materials) along dissimilatory/assimilatory, oxic/anoxic, endoterm/exoterm, and reduction/oxidation of nitrogen/carbon respectively. Explain briefly. (4p)

10. The global carbon balance is an important variable in climate change. The carbon on Earth resides in different natural reservoirs.
- Identify these reservoirs and describe the relative sizes of them.
- Also, in which direction (increased/decreased) have these reservoirs changed as an effect of human disturbances in the latest say 200 years? (4p)

11. a) Which human activities/processes contribute to increased nitrogen fixation? (2p)

b) Changes in the amount of active nitrogen compounds in the environment are of importance for environmental effects. Discuss and explain how the amount of active nitrogen in the environment possibly changes when burning a biofuel or a fossil fuel. (4p)

c) The total global sulphur dioxide emissions to the atmosphere will probably decrease as an effect of future increasing pollution abatement in for instance power plants. (Some claim they already have started to decrease globally!) Explain how such a decrease is suggested to accelerate the global warming! (2p)

12. a) Define and explain the following two concepts: *radiative forcing* and *global warming potential.* Which is the connection between the two concepts ? (4p)

b) The dependence of the radiative forcing of greenhouse gases concentration differs between gases. For instance, some have a linear relationship, others are best described by a logarithmic relationship.
- Explain why they differ in this way!
- Give an example of a gas from each of the two mentioned relationships. (4p)

Rod Stevens
13. Using a simple sketch, identify the main reservoirs (at least 4 boxes) and fluxes (at least 6 arrows) in the global hydrological cycle. For each of these, rank them in order from largest to smallest using (separately) 1-4 for reservoirs and A-F for fluxes. (5p)

14. According to Oki & Kanae (2006), what effects will climate change have on renewable fresh water resources (RFWR)? (3p)

Stefan Wirsenius

15. What are “soil colloids”? Specify their typical properties. (3p)

16. a) Explain briefly the difference between natural acidification and anthropogenic acidification. (3p)

b) Describe under what circumstances nitrogen deposition causes *actual* soil acidification and *potential* soil acidification, respectively. (2p)

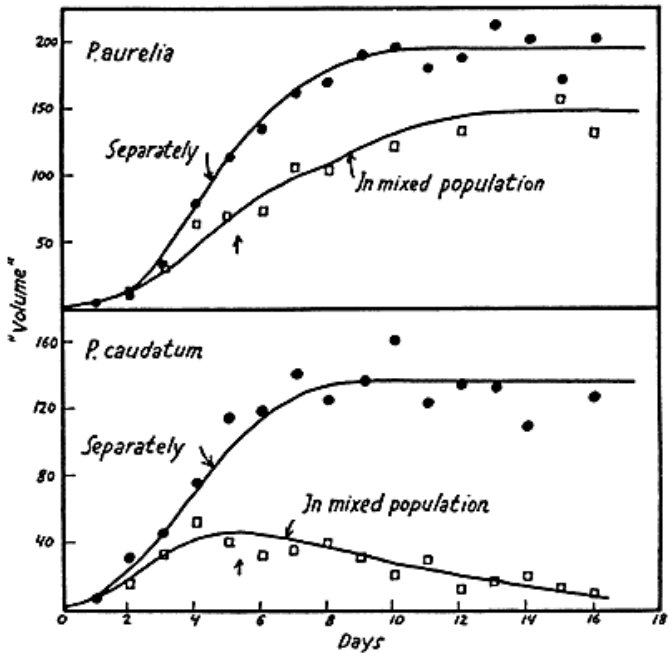
Kjell Wallin

17. The main reason why biological resources are renewable is their internal growth capacity. Explain why

a. populations basically must develop in an exponential manner over time.
b. populations still do not grow exponentially for infinity.

The motivation can preferably be done by using some mathematical models, but “word models” might work as well. 4p.

18. As are shown in the figure below one species of Paramecium outcompetes the other when sharing the same environment. Explain graphically what is required to make competition between two species to result in the same outcome as the one in the figure. 4p.



Thomas Backhaus

19. What is a "tiered approach" in the context of the hazard and risk assessment of a chemical in the environment? What is the rational behind it, what are the specific characteristics? (Tip: think about the following terms "better safe than sorry", "Assessment Factor", "extrapolation") (8p)

PERIODIC TABLE OF THE ELEMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H 1.0079																	2 He 4.0026
3 Li 6.941	4 Be 9.0122											5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180
11 Na 22.990	12 Mg 24.305											13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.066	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.867	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.693	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.64	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57 - 71 La-Lu	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 -103 Ac-Lr	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (277)	109 Mt (268)	110 Ds (281)	111 Uuu (272)	112 Uub (285)		114 Uuq (289)				

PSE.Menu

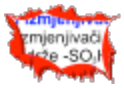
Lanthanide	57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
Actinide	89 Ac (227)	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

ENIG. HOME

SOLID LIQUID GAS 100 °C 101 kPa SYNTHETIC ELEMENT

Relative atomic mass is shown with five significant figures. For the precise value of the atomic mass you must click on an element symbol in periodic table. For elements have no stable nuclides, the value enclosed in brackets indicates the mass number of the longest-lived isotope of the element. However three such elements (Th, Pa and U) do have a characteristic terrestrial isotopic composition, and for these an atomic weight is tabulated. (*Atomic Weights of the Elements 1999*, Pure Appl. Chem., Vol. **73**, No. 4 (2001) 667-683)

CONTENT:



Glossary of chemical terms

Glossary of chemical terms contain a brief definitions of selected terms of importance in chemistry and related fields of science. Individual chemical compounds are not included. It is composed of two parts:

- appendixes
- dictionary

A | B | C | D | E | F | G | H | I | J | K | L
M | N | O | P | R | S | T | U | V | X | Z

Periodic table of the elements contains the basic data about the elements in five languages:

- English (Editors: Aditya Vardhan, Eni Generalic)
- French (Editor: Michel Ditria)
- Croatian (Editors: Eni Generalic, Marija Bralic, Slobodan Brinic)
- German (Editor: Marc Hens)
- Italian (Editor: *editors wanted*)