Examination, Science of Environmental Change. FFR 166
Oct 25, 2012, 8.30-13.30 in Vasa Building 3

Note ! The available 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: 3: 37p; 4: 55p; 5: 73p (of total 92 points).
The achieved points from the three assignments (max 60) and the oral presentation (16) are multiplied with a factor 14/76, rounded to nearest halfpoints and then added to exam points for grades 4 and 5. (Thus max 14 additional points.)

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*.

Katarina Gårdfeldt

1 a/ Give examples of three cations and examples of three anions. (3p)
b/ Give an example of an ionic compound. (1p)
c/ give an example of a covalent compound. (1p)

2/ Methane reacts with the hydroxyl radical in the atmosphere according to second order kinetics with the rate constant k. Write a balanced reaction formula for the initial step and the rate expression for the reaction. (4p)

3 a/ How is the hydroxyl radical formed in the troposphere, explain with words and by help of chemical formulas. (3p)

b/ How is the nitrate radical formed in the troposphere, explain with words and by help of chemical formulas. (2p)

4 a/ What is the end product from oxidation of methane in the troposphere? (1p)

b/ What is the end product from oxidation of nitrogen dioxide and the hydroxyl radical in the troposphere? Write balanced chemical reaction formula. (3p)

5 a/ Under which conditions are London smog formed and which are the primary and secondary pollutants? (3p)

b/ Under which conditions are photochemical smog formed and which are the primary and secondary pollutants? (3p)

Sten Karlsson

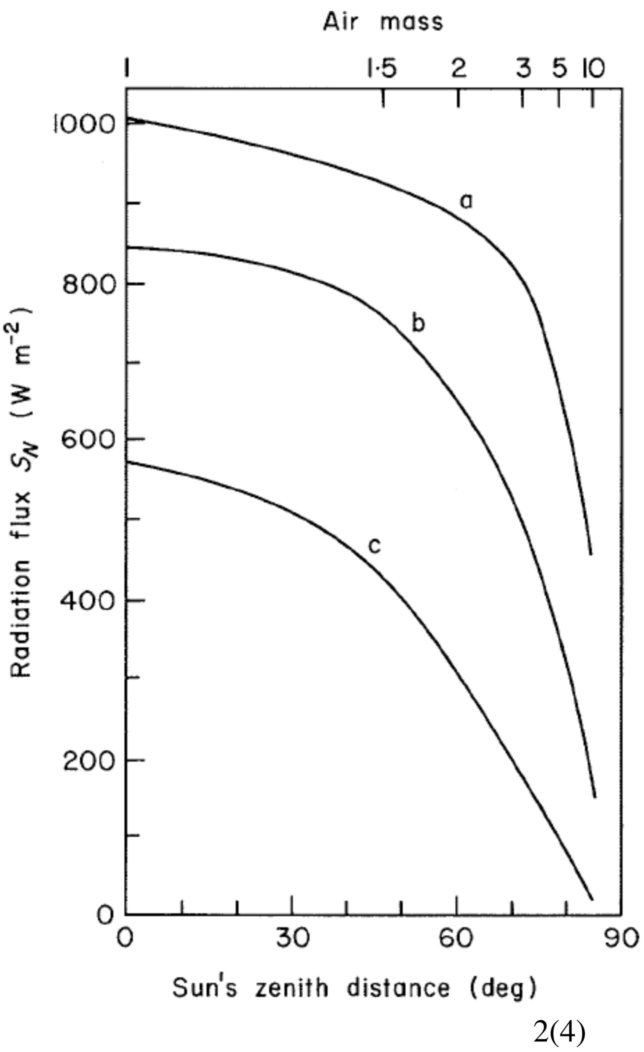
6. a) Define the *residence time* and *turnover time*, respectively, used when dealing with materials fluxes in the environment. How are they related ? (3p)

b)

- Define *the solar constant*. How large is it? (2p)

The diagram below gives the radiation flux for direct solar radiation at the Earth's surface (in W/m^2 surface) for different cleanliness of the air, and when no clouds. Curve b is for a clean atmosphere and c is an example for a dirty atmosphere. (Curve a is for an "ideal" atmosphere not so interesting.) The Sun's angle from zenith in Gothenburg is minimum 34 degrees (at midday around midsummer) and is around 80 degrees at midday around Christmas (i.e. the sun is only 10 degrees above the horizon) Now:

- Use your estimate of the solar constant above and the diagram below to calculate the *optical depth* for solar radiation at the surface in Gothenburg at the two points in time, respectively, mentioned above, assuming clean atmosphere and no clouds. (If you have no answer to the value of the solar constant, you can assume a value and do the calculation from that.) (2p)



7. a) For a wind power plant, what is the *energy quality factor* (exergy flux per unit energy flux) for the wind energy flux towards it and electricity output from it, respectively? (2p)

b) A sunny spring day in Sweden with an air temperature of 10 ºC, a solar water heater produces 700 W of hot water (60 ºC) per m^2, and a solar cell equipment produces 120 W of electricity per m^2. Demonstrate by a calculation which one of these two equipments has the highest exergy efficiency. (3p)

8. a) Describe the atmospheric *hydrostatic balance*, *geostrophic balance*, and *thermal wind shear*, respectively. Give one atmospheric property/phenomena related to each of these three concepts, respectively. (6p)

b) Temperature and salinity are important parameters for density and circulation in the ocean and are affected by the atmosphere above the ocean.
-How varies in general the salt concentration in the surface ocean from equator to pole?
-How is this variation connected to the atmospheric general circulation? (3p)

9. In processes of oxidation of organic materials, C, N and S species can be utilized as electron acceptors to yield energy/exergy.
- Gives examples of end product species in these processes for C, N and S, respectively.
- What is a common condition for these processes to take place? (4p)

10. - Describe the inorganic carbon chemistry of the ocean: the species and chemical balances involved.
- Give also an account of how an increase in the CO_2 pressure in the atmosphere will affect the concentration of these species in the surface ocean.
- Also demonstrate how this CO_2 pressure increase will affect the surface ocean alkalinity. (6p)

11. a) Which are the dominating process and societal sectors behind nitrate NO_3^-, ammonia NH_3, and NO_x emission/leaching, respectively. (3p)

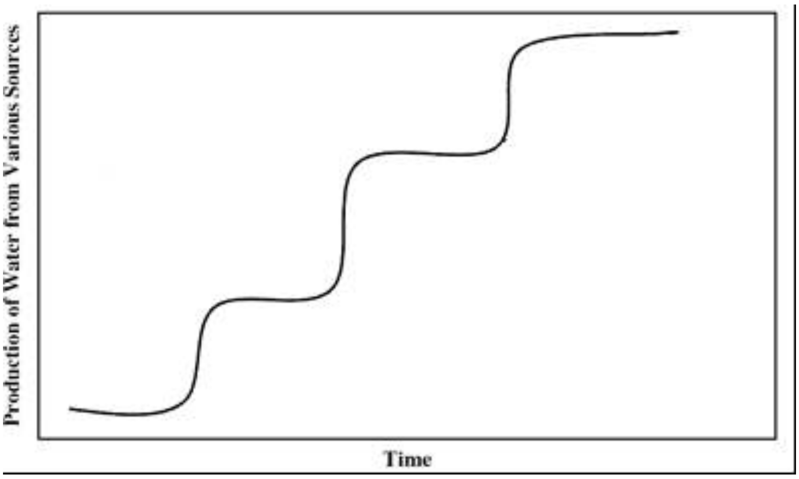
b) Explain how a sulphidic mine waste heap can contribute to metal leakage if not…, yes if not what? (2p)

12 a) There are (at least) two slightly different radiative forcing concepts in use. Define/describe them and point especially to how they differ. Which are the bigger one and why? (4p)

b) In the IPCC table accounting for the current radiative forcing due to different gases and other emissions or to environmental changes, CFCs (chloroflorocarbons) are present twice due to their involvement in two different processes contributing to the forcing. Explain where, why and how the CFCs are affecting the forcing in these two instances! (4p)

Rod Stevens

13. Explain the figure showing water production over time for a typical watershed with limited water resources (from Gleick & Palaniappan 2010). (3p)



14. Sketch a simple water budget for a temperate climate region (like southern Sweden). Show the main water fluxes and give approximate values, given a precipitation of 700 mm/year. (3p)

15. Why does groundwater often has better water quality than does surface water? Why is groundwater not used as the main water supply for most major cities? (2p)

Stefan Wirsenius

16. What are "soil colloids"? Specify their characteristic physical and chemical properties. Also, describe how soil colloids influence soil fertility. (4p)

17. Describe the two cases where nitrogen deposition does and does *not* cause *actual* soil acidification. For each case, explain the mechanisms of the soil acidification processes and make drawing(s) of the relevant flows in the soil-plant profile. (4p)

Kjell Wallin

18 a) List at least five fundamental ecological interactions. (5p)

b) For a Darwinian evolution to occur there are a need for three requirements. Which are these requirements? (3p)

IUPAC Periodic Table of the Elements

Key:

atomic number **Symbol** name standard atomic weight

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 **H** hydrogen 1.007 94(7)																	2 **He** helium 4.002 602(2)
3 **Li** lithium 6.941(2)	4 **Be** beryllium 9.012 182(3)											5 **B** boron 10.811(7)	6 **C** carbon 12.0107(8)	7 **N** nitrogen 14.0067(2)	8 **O** oxygen 15.9994(3)	9 **F** fluorine 18.998 4032(5)	10 **Ne** neon 20.1797(6)
11 **Na** sodium 22.989 769 28(2)	12 **Mg** magnesium 24.3050(6)											13 **Al** aluminium 26.981 5386(8)	14 **Si** silicon 28.0855(3)	15 **P** phosphorus 30.973 762(2)	16 **S** sulfur 32.065(5)	17 **Cl** chlorine 35.453(2)	18 **Ar** argon 39.948(1)
19 **K** potassium 39.0983(1)	20 **Ca** calcium 40.078(4)	21 **Sc** scandium 44.955 912(6)	22 **Ti** titanium 47.867(1)	23 **V** vanadium 50.9415(1)	24 **Cr** chromium 51.9961(6)	25 **Mn** manganese 54.938 045(5)	26 **Fe** iron 55.845(2)	27 **Co** cobalt 58.933 195(5)	28 **Ni** nickel 58.6934(2)	29 **Cu** copper 63.546(3)	30 **Zn** zinc 65.409(4)	31 **Ga** gallium 69.723(1)	32 **Ge** germanium 72.64(1)	33 **As** arsenic 74.921 60(2)	34 **Se** selenium 78.96(3)	35 **Br** bromine 79.904(1)	36 **Kr** krypton 83.798(2)
37 **Rb** rubidium 85.4678(3)	38 **Sr** strontium 87.62(1)	39 **Y** yttrium 88.905 85(2)	40 **Zr** zirconium 91.224(2)	41 **Nb** niobium 92.906 38(2)	42 **Mo** molybdenum 95.94(2)	43 **Tc** technetium [98]	44 **Ru** ruthenium 101.07(2)	45 **Rh** rhodium 102.905 50(2)	46 **Pd** palladium 106.42(1)	47 **Ag** silver 107.8682(2)	48 **Cd** cadmium 112.411(8)	49 **In** indium 114.818(3)	50 **Sn** tin 118.710(7)	51 **Sb** antimony 121.760(1)	52 **Te** tellurium 127.60(3)	53 **I** iodine 126.904 47(3)	54 **Xe** xenon 131.293(6)
55 **Cs** caesium 132.905 4519(2)	56 **Ba** barium 137.327(7)	57-71 lanthanoids	72 **Hf** hafnium 178.49(2)	73 **Ta** tantalum 180.947 88(2)	74 **W** tungsten 183.84(1)	75 **Re** rhenium 186.207(1)	76 **Os** osmium 190.23(3)	77 **Ir** iridium 192.217(3)	78 **Pt** platinum 195.084(9)	79 **Au** gold 196.966 569(4)	80 **Hg** mercury 200.59(2)	81 **Tl** thallium 204.3833(2)	82 **Pb** lead 207.2(1)	83 **Bi** bismuth 208.980 40(1)	84 **Po** polonium [209]	85 **At** astatine [210]	86 **Rn** radon [222]
87 **Fr** francium [223]	88 **Ra** radium [226]	89-103 actinoids	104 **Rf** rutherfordium [261]	105 **Db** dubnium [262]	106 **Sg** seaborgium [266]	107 **Bh** bohrium [264]	108 **Hs** hassium [277]	109 **Mt** meitnerium [268]	110 **Ds** darmstadtium [271]	111 **Rg** roentgenium [272]							

57 **La** lanthanum 138.905 47(7)	58 **Ce** cerium 140.116(1)	59 **Pr** praseodymium 140.907 65(2)	60 **Nd** neodymium 144.242(3)	61 **Pm** promethium [145]	62 **Sm** samarium 150.36(2)	63 **Eu** europium 151.964(1)	64 **Gd** gadolinium 157.25(3)	65 **Tb** terbium 158.925 35(2)	66 **Dy** dysprosium 162.500(1)	67 **Ho** holmium 164.930 32(2)	68 **Er** erbium 167.259(3)	69 **Tm** thulium 168.934 21(2)	70 **Yb** ytterbium 173.04(3)	71 **Lu** lutetium 174.967(1)
89 **Ac** actinium [227]	90 **Th** thorium 232.038 06(2)	91 **Pa** protactinium 231.035 88(2)	92 **U** uranium 238.028 91(3)	93 **Np** neptunium [237]	94 **Pu** plutonium [244]	95 **Am** americium [243]	96 **Cm** curium [247]	97 **Bk** berkelium [247]	98 **Cf** californium [251]	99 **Es** einsteinium [252]	100 **Fm** fermium [257]	101 **Md** mendelevium [258]	102 **No** nobelium [259]	103 **Lr** lawrencium [262]

Notes
- "Aluminum" and "cesium" are commonly used alternative spellings for "aluminium" and "caesium."
- IUPAC 2005 standard atomic weights (mean relative atomic masses) as approved at the 43rd IUPAC General Assembly in Beijing, China in August 2005 are listed with uncertainties in the last figure in parentheses [M. E. Wieser, *Pure Appl. Chem.*, in press]. These values correspond to current best knowledge of the elements in natural terrestrial sources. For elements that have no stable or long-lived nuclides, the mass number of the nuclide with the longest confirmed half-life is listed between square brackets.
- Elements with atomic numbers 112 and above have been reported but not fully authenticated.