ÉRETTSÉGI VIZSGA • 2010. október 26.

KÉMIA
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KÖZÉPSZINTŰ ÍRÁSBELI ÉRETTSÉGI VIZSGA

JAVÍTÁSI-ÉRTÉKELÉSI ÚTMUTATÓ

NEMZETI ERŐFORRÁS MINISZTÉRIUM

Basic guidelines of the evaluation of written exercises

Evaluation of the written test-papers should follow the distributed correction instructions.

Evaluation of theoretical questions

- No deviation from the correction instruction is allowed.
- ½ points can not be given, the questions can only be evaluated according to the allowed part-points in the correction key.

Evaluation of calculation problems

- Test-papers following the way of solution of the correction instruction, must be evaluated according to the part-points of the correction key.
- Beside objectivity, attention must be paid to ***honesty***. During the evaluation, punishment with a pedagogical intention can not be applied!
- In a given – errorless – solution no points can be subtracted because of the lack of ***not required*** (but in the correction key given) subresults. (Those subresults help only the evaluation of partial solutions.)
- Approaches differing from the correction key – if correct – get maximum points or part-points according to the nodes of the correction key.
- For a bare result ***without any derivation or explanation*** only 1-2 points can be given ***as a maximum*** according to the the points of that result in the correction key!
- A calculation problem gets maximum points even if it contains a ***theoretically incorrect reaction equation*** which is not necessary to the solution (and the question did not ask to write it).
- In case of a problem containing several subproblems, part-points for a given subproblem can be given even if the candidate makes the calculation ***using an incorrect result of a beforegoing subproblem*** – if the solution doesn't lead to a contradiction.
- Relations which can be regarded as **trivial** can be used without any derivation in calculation problems of the maturity examination, and they get maximum points – even without detailed explanation. For example:
  - conversion of mass, number of moles, volume and number of particles,
  - trivial facts following from Avogadro's law (equal stoichiometric ratios or volume ratios in case of gases under the same conditions, and so on),
  - using the mixing (dilution) equation, and so on.
- For each ***calculation error*** maximum 1-2 points can be subtracted (if the candidate continues the calculation correctly with the incorrect subresult, he or she should get all other part-points for the further part of the calculation)!

- In case of a ***smaller error***, the candidate doesn't get points for the incorrect part of the calculation, but the following steps of the calculation using incorrect data should get the corresponding points. A smaller error is for example:
  - incorrect use of density in the conversion of volume and mass,
  - other incorrect simple mathematical procedure,
  - incorrectly balanced equation,

  which doesn't lead to an ***obviously*** unrealistic result.

- In case of a ***gross error***, the candidate doesn't get further points for the given subcalculation as allowed in the correction key even if he continues the calculation correctly with the incorrect subresult. A gross error is for example:
  - a calculation based on an ***incorrect*** (e. g. not occurring) ***reaction equation***,
  - if the result ***estimated*** from the data is ***obviously irrealistic*** (for example if the mass of the solution calculated from the mass of the solute is smaller than the mass of the solute dissolved in it, and so on).

  (The solution of further subcalculations which can be regarded as independent calculation units can be evaluated of course also in this case according to the previously discussed principles. Points can be given – if calculating correctly with incorrect subresults - if the calculation doesn't lead to irrealistic results.)

1. Four types of association (10 points)

Every correct answer gets one point.

1. D
2. C
3. C
4. B
5. A
6. A
7. D
8. D
9. A
10. C

2. Essay (15 points)

a) The liquid component is extracted from the gel. ***1 point***
The liquid component is replaced by a gas. ***1 point***
(Or any answers with a meaning corresponding to that.)

b) Sublimation ***1 point***

c) Thermal insulator, hygroscopic substance, sports equipment, armor of military vehicles
(two correct examples get 2x1 points) ***2 points***

d) Osteoplasty, removal of toxic metals ((cadmium, mercury, lead), preparation of solar cells *(two correct examples get 2x1 points* ***2 points***

e) Solid, blue/transparent, (thermal, electric) insulator, large weight-bearing capacity, very small density, brittle (*5 correct examples*) ***3 points***
(three or four examples: 2 points, one or two examples: 1 point)

f) $M(CO_2) = 44.0$ g/mol, $V_m = 24.5$ dm^3/mol ***1 point***
$n = 1.0$ mol, $\rho = 44.0$ g / 24.5 dm^3 = **1.80 g/dm^3** ***1 point***
ρ (aerogel) = 1.0 mg/cm^3 = 1.0 g/dm^3 ***1 point***
1.0 g/dm^3 100 %,
1.80 g/dm^3 180 %, hence the density of CO_2 is **80.0% higher**. ***1 point***

g) B) ***1 point***

3. Simple choice (8 points)

Every correct answer gets one point.

1. C
2. A
3. D
4. D
5. C
6. D
7. E
8. B

4. Analytical question and calculation problem (16 points)

a) $Cl_2 + H_2O = HOCl + HCl$ ***1 point***

b) quicklime: CaO, slaked lime: $Ca(OH)_2$ (correct use of formulas) ***1 point***
$2\ HCl + CaO = CaCl_2 + H_2O$ ***1 point***
$2\ HCl + Ca(OH)_2 = CaCl_2 + 2\ H_2O$ ***1 point***

c) dissolution of chlorine gas in rain water would cause acid rain
chlorine gas is toxic (poisoning living organisms)
(giving one of the answers) ***1 point***

d) $m(Cl_2) = 130$ kg $= 130000$ g, $M(Cl_2) = 71.0$ g/mol ***1 point***
$n(Cl_2) = 130000$ g / 71.0 g/mol $= 1831.0$ mol ***1 point***
$V(Cl_2) = n \cdot V_M$,
$\boldsymbol{V(Cl_2)} = 1831.0$ mol $\cdot$ 24.5 dm^3/mol $= 44\,860$ dm^3 = **44.9 m^3** ***1 point***

e) *cathode process:* $2\ H_3O^+ + 2\ e^- = H_2 + 2\ H_2O$ (or $2\ H^+ + 2e^- = H_2$) ***1 point***
anode process: $2\ Cl^- = Cl_2 + 2\ e^-$ ***1 point***
writing the equations to the correct place ***1 point***

f) $n(Cl_2) = 1831.0$ mol, $n(HCl) = 2 \cdot 1831.0$ mol $= 3662.0$ mol ***1 point***
$m(HCl) = 3662.0$ mol $\cdot$ 36.5 g/mol $= 133\,663$ g $= 133.663$ kg ***1 point***
knowledge of the composition in m/m% ***1 point***
m(HCl solution) $= 133.663$ kg / $0.150 = 891.1$ kg ***1 point***
$\boldsymbol{V}$**(HCl solution)** $= 891.1$ kg / 1,08 kg/dm^3 = **825 dm^3** ***1 point***

5. Panel question (12 points)

1. Magnesium.	*(1., 4. together)*	***1 point***
2. Metallic lattice.		***1 point***
3. $3s^2$		***1 point***
4. Mg^{2+}		
5. $Mg = Mg^{2+} + 2\ e^-$		***1 point***
6. Oxidation.		***1 point***
7. 12		
8. 10	*(7., 8. together)*	***1 point***
9. Oxygen.		
10. 8	*(9., 10. together)*	***1 point***
11. Molecular lattice.		***1 point***
12. $2s^2\ 2p^4$		***1 point***
13. $O + 2\ e^- = O^{2-}$		***1 point***
14. Reduction.		***1 point***
15. 8		
16. 10	*(15.,16. together)*	***1 point***

6. Alternative question (15 points)

A) Panel question

1. NaOH ***1 point***
2. CH_3COOH ***1 point***
3. NaCl ***1 point***
4. Caustic soda/ caustic stone *(one of the correct answers)* ***1 point***
5. Table salt/ mineral salt/ common salt *(one of the correct answers)* ***1 point***
6. Solid.
7. Liquid.
8. Solid. *(6., 7, 8. together)* ***2 points***
(2 correct answers: 1 point)
9. Molecular lattice. ***1 point***
10. Ionic lattice. ***1 point***
11. Basic.
12. Acidic.
13. Neutral. *(11., 12., 13. together)* ***2 points***
(2 correct answers: 1 point)
14. Spice (vinegar), scale remover. *(one example)* ***1 point***
15. Spice, conserving agent (table salt). *(one example)* ***1 point***
16. $CH_3COOH + NaOH = CH_3COONa + H_2O$ ***1 point***
17. sodium acetate ***1 point***

B) Calculation problem

a)) Let's start with 5.00g NaOH and 1.00g NaCl mixture, m(mixture) = 6.00 g ***1 point***
composition in **m/m%** (knowledge and use of the term): ***1 point***
$\frac{5{,}00}{6{,}00} \cdot 100 =$ **83.3 % NaOH,** $\frac{1{,}00}{6{,}00} \cdot 100 =$ **16.7 % NaCl** ***1 point***

b) pOH = 2.00, ***1 point***
$[OH^-]$ = 0.0100 mol/dm^3 ***1 point***
c(NaOH) = 0.0100 mol/dm^3 ***1 point***
V(solution) = 2.50 dm^3, n(NaOH) = 2.50 · 0.0100 mol/dm^3 = 0.0250 mol ***1 point***
M(NaOH) = 40.0 g/mol, M(NaCl) = 58.5 g/mol ***1 point***
m(NaOH) = 0.0250 mol · 40.0 g/mol = 1.00 g ***1 point***
m(NaCl) = 1/5 · 1.00 g = 0.200 g ***1 point***
m*(mixture) = 1.20 g** ***1 point

c) V(solution) = 0.250 dm^3, n(NaOH) = 0.0250 mol,
c(NaOH) = 0.100 mol/dm^3 (the concentration is tenfold)) ***2 points***
$[OH^-]$ = 0.100 mol/dm^3, ***1 point***
pOH = 1.00, **pH = 13.0** ***1 point***
(for a correct explanation in words – because of one tenth of the volume, the concentration is tenfold and hence, the pH becomes 13.0 instead of 12.0 – all points should be given)

7. Analytical experimental question (13 points)

a) $CaCl_2 + Na_2CO_3 = \underline{CaCO_3} + 2\ NaCl$ ***1 point***
underlining the precipitate ***1 point***
b) Soda water: water containing CO_2, containing carbonic acid H_2CO_3
(both types of answers can be accepted) ***1 point***
$\underline{CaCO_3} + H_2O + CO_2 = Ca(HCO_3)_2$
or $\underline{CaCO_3} + H_2CO_3 = Ca(HCO_3)_2$ (one equation is enough) ***2 points***
in limestone mountains, water containing CO_2 (carbonic acid) dissolves limestone(formation of caves, caverns in limestone mountains) ***1 point***
c) Calcium carbonate, $CaCO_3$ ***1 point***
Scaling ***1 point***
d) From long-chain carbonic acids (soaps are their salts) ***1 point***
e) Calcium phosphate, $Ca_3(PO_4)_2$ ***1 point***
the presence of Ca^{2+} ions hinders foam formation from the soap / decreases cleaning effect (forms a precipitate with the anions of soap). ***1 point***
By formation and filtering of the precipitate, Ca^{2+} ions were removed from the solution, so they did not hinder foam formation from the soap/ they did not decrease the cleaning effect ***1 point***
f) Experiments 1. and 5. (precipitate formation), furthermore boiling as used in experiment 3 *(giving two experiments correctly)* ***1 point***

8. Calculation problem (11 points)

a) Starting from 100g of the compound:
the compound contains 83.3g carbon and 16.7g hydrogen ***1 point***
$n(C) = 83.3\ g / 12.0\ g/mol = 6.94\ mol$, $n(H) = 16.7\ mol$ ***1 point***
$n(C) : n(H) = 6.94 : 16{,}7 = 1 : 2.4 = 5 : 12$ ***1 point***
The formula of the compound is: $\mathbf{C_5H_{12}}$ ***1 point***

b) The equation of combustion: $C_5H_{12} + 8\ O_2 = 5\ CO_2 + 6\ H_2O$ ***2 points***
(for writing correct educts and products, 1 point can be given)
c) In the table, pentane is the corresponding compound: $\Delta_fH(C_5H_{12}) = -147$ kJ/mol
choosing the correct heat of formation ***1 point***
$\Delta_rH = 5 \cdot \Delta_fH(CO_2(g)) + 6 \cdot \Delta_fH(H_2O(l) - \Delta_fH(C_5H_{12})$ (or using it) ***1 point***
$\mathbf{\Delta_rH} = 5 \cdot (-394) + 6 \cdot (-286) - (-147)$ kJ/mol = **–3539 kJ/mol** ***1 point***

d) $M(C_5H_{12}) = 72.0$ g/mol, $n(C_5H_{12}) = 14.4\ g / 72.0\ g/mol = 0.200\ mol$ ***1 point***
At the combustion of 0.20 hydrocarbon:
$Q_r = 0.200 \cdot (-3539) = -707.8$ kJ
During the combustion, **708 kJ** heat was liberated. ***1 point***