



Chemistry Form 12

English



1. Ethanol is one of the more environment-friendly propellant fuels available as an alternative to petrol. Calculate from the data in the table how much energy is developed per ml in the combustion of the two substances. On the basis of your result, discuss which of the two substances would be the most effective fuel. Assume that petrol consists only of octane.

	Ethanol	Petrol
$\Delta H_{\text{combustion}}$ (kJ/mol)	-1367	-4902
Density (g/ml)	0,79	0,70

8 points

2. In a bioreactor, the pH is to be lowered with acetic acid. The solution to be adjusted can for the calculation of pH be assumed to be pure water and it has a volume of 800 litre. To carry out this adjustment, a dosing solution of acetic acid is first prepared. This solution is prepared from a relatively concentrated solution of acetic acid in order to obtain a dosing solution with a concentration of 5,00 mol acetic acid/litre. On the bottle containing the concentrated acetic acid solution (a mixture of acetic acid and water) there is a label with the following data:

Acetic acid (CH_3COOH)

50 wt % acetic acid

Density $1,0575 \text{ kg/dm}^3$ (20°C)

Dissociation constant acetic acid $K_a = 1,8 \times 10^{-5} \text{ mol/dm}^3$

- a. Describe how to prepare 10 litre of the dosing solution **2 points**
- b. Explain the units for the dissociation constant **1 point**
- c. 1,00 litre of the dosing solution are added to the 800 litres of liquid in the bioreactor. What will the pH in the bioreactor then be if the pH in the reactor was originally 7,0? **5 points**

3. There is something called a “chemical clock”. Chemicals are mixed and an oscillating change in colour is seen. We see this type of periodic oscillation with a chemical mixture of potassium bromate (V) (oxidizing agent), cerium (IV) sulphate (yellow), malonic acid (reducing agent) and citric acid in dilute sulphuric acid. Cerium (III) ions are colourless. How would you describe the chemical reactions which take place? Give chemical reaction equations and explain what you believe to be the mechanism driving the chemical clock – the oscillating behaviour between a yellow and a colourless liquid. **8 points**



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4. The physical-chemical properties of organic substances.
- Four organic compounds: butanoic acid (butyric acid), pentanal (pentanaldehyde), n-hexane and 1-pentanol, have different boiling points (69 °C, 103 °C, 137 °C, och 164 °C, but NOT in this order). Match each boiling point with the correct compound. Explain your answer! **4 points**
 - Explain with the help of chemical structures which two of the following substances are the most easily soluble in water and why. **4 points**
 - benzene
 - toluene
 - di-methyl ketone
 - phenylamine
 - hexanoic acid
 - phenol
5. Choose one of the following alternatives to each question. The correct answer gives **2 points**, an incorrect answer gives – **1 point**, an unanswered question gives **0 point**. You cannot receive a total of less than 0 point for this question.
- Butanone is formed by the oxidation of
 - 2-methyl-2-propanol
 - 2-butanol
 - 2-propanol
 - Propene is a molecule which:
 - occurs as both *trans*- and *cis*-isomers
 - can participate in a substitution reaction with e.g. hydrogen bromide
 - can easily be oxidised to propanol
 - This question deals with alcohols
 - 2-butanol and 2-methyl-2-propanol are isomers
 - the solubility of ethanol in ethanal (acetaldehyde) is low because ethanal cannot participate in hydrogen bonding
 - The first reaction product formed when propanol is oxidised is propanoic acid (propionic acid)
 - This question deals with chloroalkanes
 - Dichloromethane is formed in an addition reaction between methane and a chlorine molecule.
 - Trichloromethane is a polar molecule and is a very good solvent for fats



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- 3) Chloromethane and chloroethane are extensively used in the production of other organic compounds because the chlorine atoms can easily be replaced by other atoms. **8 points**