

**PROBLEMS**

**5.6.2006**

**ENRANCE EXAM FOR ENGINEERING CURRICULUM**

**INSTRUCTIONS**

**The duration of the examination is 2 h 45 min**

**Part 1 (Reading comprehension test)**

There are 10 statements to be marked false or true. The maximum score is 5 points.

**Part 2 (Mathematics + logical deduction + physics/chemistry)**

There are 10 problems to solve, each worth 3 points.

For each problem, write the answer in the space provided on the answer sheet, and include calculation details whenever the solution requires calculation.

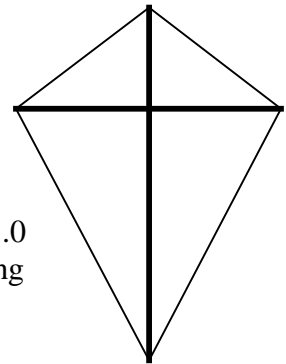
Whenever solving the problems 8 through 10, you have to choose either the one in physics or the one in chemistry, if you solve both, the one with lower score will count.

All papers must be returned.

**DO NOT TURN THE PAGE UNTIL YOU ARE GIVEN THE PERMISSION TO DO SO.**

1.
  - a) Simplify the expression  $2x(1-x) - 3(x-x^2)$ .
  - b) Substitute the values  $a = -10$  and  $b = -2$  and calculate the value of the expression  $\frac{2ab}{2a-15} - b$ . Calculate using fractions.
  - c) Solve for  $x$  in the equation  $x - (a+3) = a - 2(a-x)$ .

2. Calculate the area of the kite in the figure and give the answer in units meters squared. The lengths of the two perpendicular supporting rods are 80.0cm and 105.0 cm. The lengths of the two shorter sides are 50.0 cm and the lengths of the two longer sides are 85.0 cm. Give your answer with an accuracy of two decimals. The supporting rods are drawn with a bolded line in the figure.



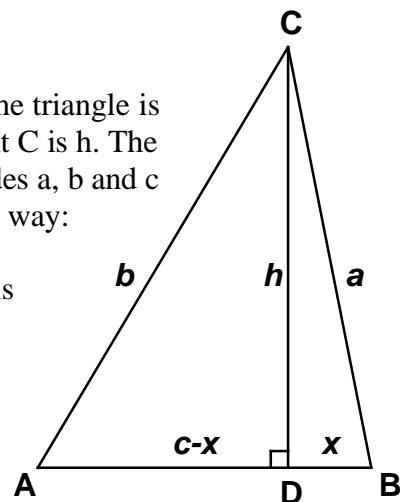
3. A retailer buys a batch of 50 items of a product for 10 000 €. He then sets a price so that the selling price is 80 % higher than the buying price. When there is 40 % left of the batch, the retailer lowers the price and manages to sell off the rest for a reduced selling price of 171 €/item.
  - a) Calculate the discount percentage relative to the initial selling price.
  - b) Calculate the profit percentage for the whole batch.
 Give your answers with an accuracy of one decimal.

4. The sides of the triangle are  $a$ ,  $b$  and  $c$  and each angle of the triangle is less than  $90^\circ$ . The height from point  $D$  on the base to point  $C$  is  $h$ . The line segment  $DB$  has length  $x$ . When the lengths of the sides  $a$ ,  $b$  and  $c$  are known, the height  $h$  can be calculated in the following way:

(i) First calculate the length  $x$  of the line segment  $DB$ . It is given by the formula  $x = \frac{a^2 - b^2 + c^2}{2c}$ .

(ii) Then use Pythagoras' theorem to calculate  $h$ .

Use the method outlined above to calculate the height  $h$  when the lengths of the sides of the triangle are  $a = 8.5$  cm,  $b = 9.2$  cm and  $c = 6.3$  cm.

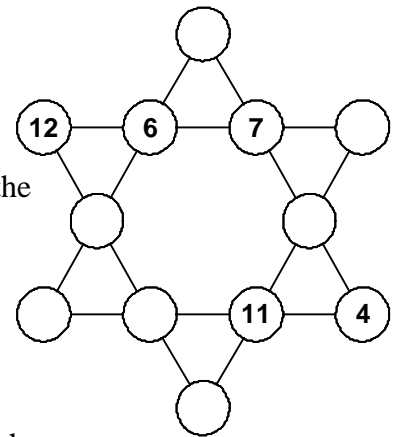


5. Each team has played once against every other team in a tournament. The results were collected in the partly incomplete table below.

team	won	drawn	lost	goals for the team	goals against the team
A	1	1	1	1	1
B	3	0	0	6	1
C	1	1	1	1	3
D	0			1	4

- a) Find the number of draws and the number of losses for team D.  
 b) What was the result of the match B against C?

6. Place the numbers 1, 2, 3, 5, 8, 9 and 10 in the empty circles, so that the sum of the numbers on each straight line is 26. All the numbers have to be placed.



7. A total charge of 50 Ah is stored in a 12 V battery of a car. Each of the bulbs of the four parking lights is labelled 3,6 W / 12 V.
- a) Find the current from the battery when only the parking lights are switched on.  
 b) What is the resistance of one bulb?  
 c) How long does it take before the battery becomes dead if the parking lights are on? Assume that the internal resistance of the battery and the resistances of the connecting wires are negligible.
- 8A. a) How much energy is required to heat 1.5 L of water at a temperature of 20 °C to the boiling point 100 °C?  
 c) There is 1.5 L of water in a kettle on a cooking plate of 2.0 kW. It takes 7.0 minutes to heat the water from a temperature of 20 °C to the boiling point. How much electrical energy is required? What is the efficiency of the heating process?

The density of water is 1000 kg/m<sup>3</sup> and the specific heat capacity of water is  $4.2 \frac{\text{kJ}}{\text{kg} \cdot \text{°C}}$ .

8B. The methane in natural gas burns completely in oxygen according to the reaction equation:



- Complete the reaction equation by filling in the missing coefficients for oxygen, carbon dioxide and water.
- How many kilograms of water do you get when you burn 1 kg of methane completely?  
Atomic masses: C: 12, H: 1, O: 16.
- Write the reaction equation for burning ethanol ( $\text{C}_2\text{H}_5\text{OH}$ ) in oxygen completely.

9A. A beach mattress filled with air has a volume of 120 L and a mass of 6.0 kg. What is the maximum load the mattress can carry on the surface of the Dead Sea? The saline water of the Dead Sea has a density of  $1240 \text{ kg/m}^3$ ? Assume that the mattress retains its shape and volume regardless of load.

9B. The reaction rate of nitrogen monoxide and oxygen into nitrogen dioxide is given by the expression

$$r = k [\text{NO}]^2 [\text{O}_2],$$

where  $r$  = reaction rate

$k$  = reaction rate coefficient, which increases with increasing temperature.

- What is the increase in the reaction rate when the concentration of nitrogen oxide is doubled and the concentration of oxygen is tripled?
- How much do you need to increase the nitrogen concentration to affect a nine-fold increase in reaction rate, without changing other factors that affect the reaction rate?

10A. The mass of a van with a driver is 2000 kg . When the van accelerates, the velocity increases with a uniform acceleration of  $3.0 \text{ m/s}^2$ .

- The van starts at rest. Find the velocity after 4.0 s.
- How far does the van travel in the first 4.0 s?
- Find the acceleration when an additional load of 1200 kg is added onto the van. Assume that the accelerating force remains unchanged.

10B. When the gas hydrogen chloride (HCl) dissolves in water it acts as a strong acid.

- Write the reaction equation for hydrogen chloride dissolving in water.
- Find the pH of the solution formed when 0.040 mol of hydrogen chloride gas dissolves in 0.80 litres of pure water at a temperature of 298.15 K.