

PROBLEMS

7.6.2004

ENTRANCE EXAM FOR ENGINEERING CURRICULUM

The duration of the examination is 2 h 15 min.

Mathematics, logical deduction and physics/chemistry

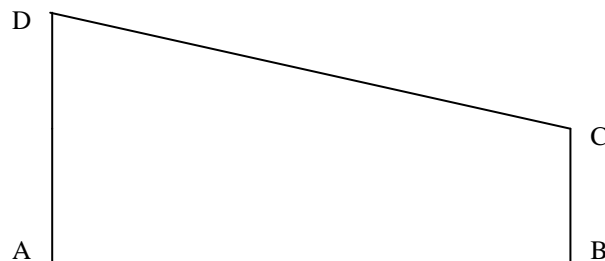
For each problem, write the answer in the space provided on the answer sheet, and include calculation details whenever the solution requires calculation.

When solving any of problems 7 through 9, you have to choose either the one in physics (A) or the one in chemistry (B). If you solve both, the one with lower score will count.

DO NOT TURN THE PAGE UNTIL THE SUPERVISOR GIVES PERMISSION!

The problems:

1. a) Solve the equation $5x + 1 = 3x + 9$
 b) Solve the equation $3(4y - 5) = 7$
 c) Solve the equation $3t - \frac{t-1}{2} = 5$
2. a) Simplify $x(1 + y) + y(3 - x)$
 b) Given $r = \sqrt{x^2 + y^2 + z^2}$, evaluate r when $x = -2$, $y = 4$ and $z = -4$
 c) Simplify $\frac{\frac{1}{a} + a}{a} - \frac{1}{a^2}$
3. When the price of a product was reduced by 20 %, the sales in euros rose by 4 %. Find the percent increase in the number of products sold.
4. The trapezoid in the figure has right angles at points A and B, and a 102° angle at point C. Given lengths $AB = 9.1$ m and $BC = 2.3$ m, find the length of AD.

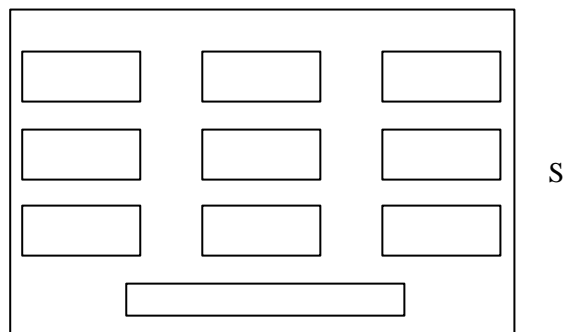


5. On the football pools, one tries to predict the result of a match by choosing from three alternatives: 1, x or 2. Four people, A, B, C and D, filled in their football pools coupons as follows:

	A	B	C	D
Match 1	x	2	1	x
Match 2	x	2	1	2
Match 3	1	1	2	x

It turned out that one of them had predicted all three matches wrong, whereas the others had correctly predicted two matches each. Determine the match results in football pools terms (1, x or 2).

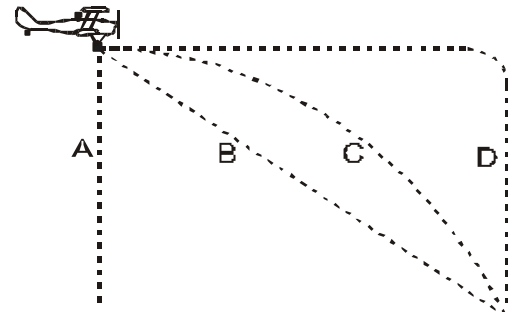
6. In a classroom, there are nine students, A, B, C, D, E, F, G, H and I, sitting in three desk rows with three students in each row. Find their places given that
- A and B are as far from each other as possible
 - A, C and H are at the same distance from the wall S
 - F is not in the back row
 - I is in the back row
 - G is in the middle of the classroom
 - E and F are sitting one after the other
 - E and H are at the same distance from the back wall.



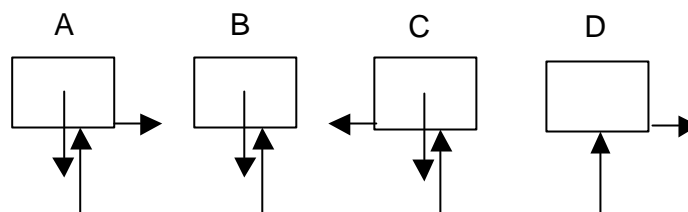
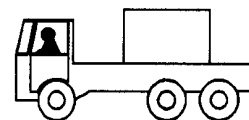
When solving any of problems 7 through 9, you have to choose either the one in physics (A) or the one in chemistry (B). If you solve both, the one with lower score will count.

- 7 A. This problem includes three parts, marked I, II and III. The right answer to each of them gives you one point. For each part, write the capital letter of the alternative you believe to be correct in the space provided for the part on the answer sheet.

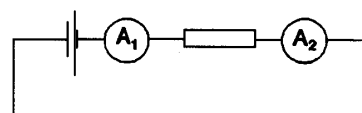
- I The aircraft in the figure is flying at a constant horizontal speed. Suddenly a wheel comes off the landing gear. Which one of the four paths describes that of the falling wheel as seen by an observer on the ground?



- II A heavy crate rests on the bed of a lorry, as shown in the figure. The lorry begins to move forwards, but the friction prevents the crate from sliding on the bed. Which one of the four diagrams below best describes the forces acting on the crate during the acceleration?



- III There are two ammeters in the circuit in the diagram. The reading of meter A_1 is 0.35 A, and that of meter A_2 is 0.25 A. The most likely explanation for the discrepancy between the readings is that



- A the resistance of meter A_2 is smaller than that of meter A_1 .
- B the resistance of meter A_2 is larger than that of meter A_1 .
- C because of the resistor connected between the two ammeters, less current reaches meter A_2 .
- D at least one of the ammeters is out of order.

- 7 B. Read the statements a through f below, and decide which of them are true and which are false. Indicate your choice by writing the number 1 (true) or the number 0 (false) in the space provided on the answer sheet.

Marking criteria: 3 points for 6 correct, 2 for 5, 1 for 4.

- a) The ionic compounds contain only nonmetals.
- b) Na_2O and CaCl_2 are molecular compounds.
- c) Sulphur and chlorine have similar chemical properties because they are in the same period of the periodic table.
- d) Fluorine and chlorine, which are in the same group of the periodic table, have similar chemical properties.
- e) An Fe^{2+} ion has 26 protons and 24 electrons.
- f) An O^{2-} ion has 6 protons and 8 electrons.

Use the periodic table on the last page.

- 8 A. A heavy, 94-kg crate is pushed a distance of 5.2 m at a speed of 0.40 m/s on the floor of a warehouse. The coefficient of the kinetic friction is 0.25.
- Determine the magnitude of the horizontal force needed to move the crate.
 - Find out the work done in moving the crate.
 - What is the power involved in moving the crate? ($g = 9,8 \text{ m/s}^2$)
- 8 B.
- What is the mass of one mole of $\text{Ca}(\text{NO}_3)_2$?
 - How many Ca^{2+} ions are there in 0.05 moles of $\text{Ca}(\text{NO}_3)_2$?
 - How many moles of NaCl are there in 450 g of this substance?
(Avogadro's number is $6.022 \times 10^{23} \text{ 1/mol.}$)

Use the periodic table on the last page.

- 9 A. There is 0.76 kg of water in a well-insulated electric kettle. The water is being heated by a 41- Ω resistor that is connected to a voltage of 230 V. How short is the time needed for the temperature of the water to rise by 15 °C? The specific heat of water is 4190 J/(kg°C).
- 9 B. When solutions of sodium phosphate and barium nitrate are mixed, a precipitate of barium phosphate is formed according to the equation
- $$2 \text{Na}_3\text{PO}_4(\text{aq}) + 3 \text{Ba}(\text{NO}_3)_2(\text{aq}) \rightarrow \text{Ba}_3(\text{PO}_4)_2(\text{s}) + 6 \text{NaNO}_3(\text{aq})$$
- What mass of $\text{Ba}_3(\text{PO}_4)_2$ is formed when a solution containing 410 g of Na_3PO_4 is mixed with a solution containing an excess of $\text{Ba}(\text{NO}_3)_2$?

Use the periodic table on the last page.