

**ENTRANCE EXAMINATION 1D**  
**FOR TECHNOLOGY, COMMUNICATION AND TRANSPORT**  
**2014**

**Family Name** \_\_\_\_\_

**Given name(s)** \_\_\_\_\_

**Date of Birth** \_\_\_\_\_

*Day, month, year*

**ID/Passport Number** \_\_\_\_\_

**Phone Number** \_\_\_\_\_

**E-mail** \_\_\_\_\_

**Country/City where exam taken** \_\_\_\_\_

**Date when the exam taken** \_\_\_\_\_

*Day, month, year*

**Invitation received from** \_\_\_\_\_

*Name of the University of Applied Sciences*

**Signature** \_\_\_\_\_

**Entrance Examination 1D  
for Engineering Education  
Universities of Applied Sciences  
April 2014**

**INSTRUCTIONS**

The examination consists of two parts:

Part 1: Mathematics, Logical reasoning, Physics and Chemistry.

Part 2: English language.

The total duration of exam is 4 hours.

There is no break between the two parts.

**The test in Mathematics, Logical reasoning, Physics and Chemistry**

You may not leave the examination room within the first 30 minutes.

You may only bring your writing material (pencil, sharpener, rubber and ruler) and your calculator\* to the examination. Formula books and dictionaries are not allowed.

Answer sheets and extra paper are distributed with the exam papers.

There are 10 problems to be solved; each worth 3 points.

Write your solutions in the provided space on the answer sheets and the final answer in the specified place.

For problems 8, 9 and 10, you have to choose either A (Physics) or B (Chemistry). If you solve both, the one with the lower score will count.

**Include calculation details whenever the solution requires calculations.**

**Only solutions written on your answer sheets will be checked!**

**All papers must be returned.**

**\*Calculator (all types of calculators) is allowed. The memory of the calculator must be empty, and the calculator must not be able to send or receive information wirelessly.**

**Your mobile phone must be switched OFF.**

**Use of any communication device is denied.**

Each problem is worth 3 points and maximum is 10x3 points.

1. Calculate / simplify

a)  $\frac{2}{7} + \frac{2}{5}$

b)  $8^{2/3}$

c)  $\frac{pq}{9} \cdot \frac{27}{p}$

d)  $\sqrt{36a^4}$

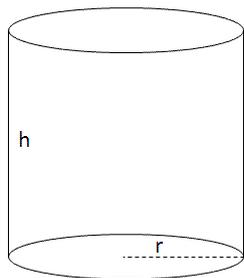
e)  $\sqrt[3]{\frac{a^3b}{1000}}$

f)  $(2rs - 3s^2) - (-3rs + 6s^2)$

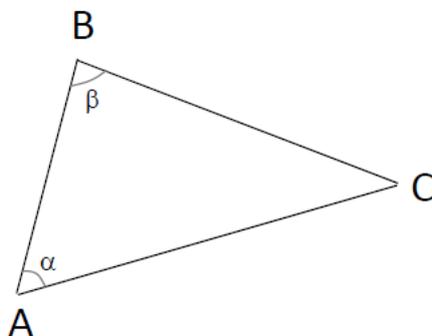
2. Design a right circular cylinder which has a cover.

- Volume  $V$  should be  $1 \text{ m}^3$
- The radius  $r$  should be 0.25 m, 0.35 m, 0.45 m, 0.55 m, 0.65 m or 0.75 m
- Raw material cost (area) should be as small as possible

Determine radius  $r$ . Justify your answer.



3. Let  $A$ ,  $B$  and  $C$  be points on a two-dimensional coordinate system.



Assume  $A = (0,1)$ ,  $B = (0,5)$ ,  $\alpha = 47^\circ$  and  $\beta = 80^\circ$ .

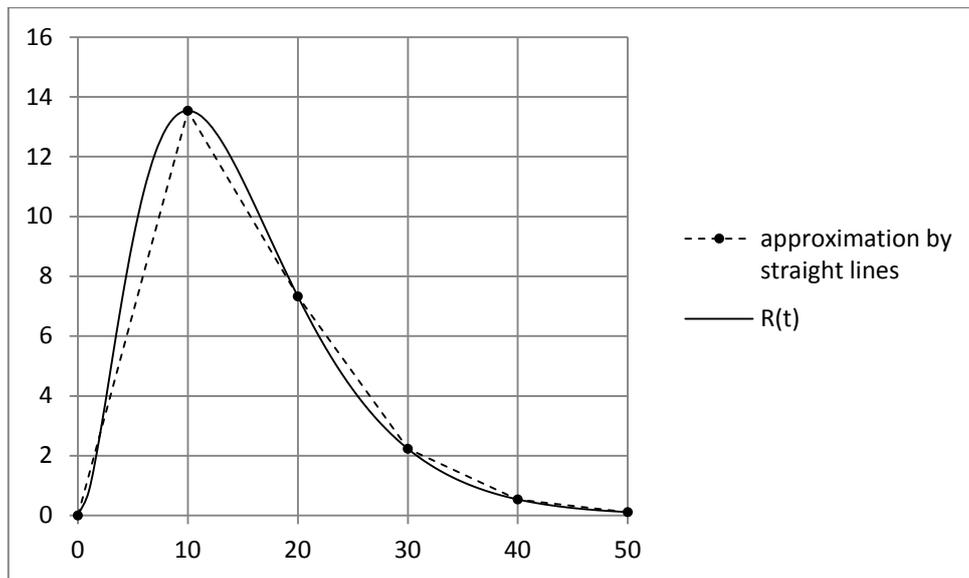
Calculate the coordinates of  $C$  to one decimal place.

4. A population exposed to a pollutant has an elevated probability of liver cancer. The rate at which new cases of liver cancer appear (cases per year) is given by the relationship

$$R(t) = e^{-0.2t}t^2 \quad (e = 2.71828\dots)$$

where  $t$  is time in years. Number of new cases appearing in an interval from  $t_1$  to  $t_2$  is the area below the curve between these points. To make the numerical calculations easier we will approximate the function  $R(t)$  by straight line segments from 0 to 10 years, from 10 to 20 years etc. (see the dashed curve).

- Calculate  $R(10)$  to two decimal places.
- Determine how many new cases of liver cancer appear in an interval from 10 to 40 years.



5. A ship is sailing across the ocean. The sailor is looking into the morning sky in order to get information about how the weather will turn out during the day:

*Red sky at night, Sailor's delight. Red sky in the morning, Sailor take warning.*

The sailor's weather prediction is based on observations on the morning sky.

Sky in the morning	Weather
Red	Storm
Not red (gray)	No storm

Assume that, on average, a storm can be expected every second day. Red sky in the morning can be expected every fourth day and that always means a storm.

- If the morning sky is red, how often will the sailor be right?
- How often will the sailor be right in his weather prediction?

6. The following series of numbers have a certain pattern. What are the missing numbers of the series? Explain the pattern or rule.

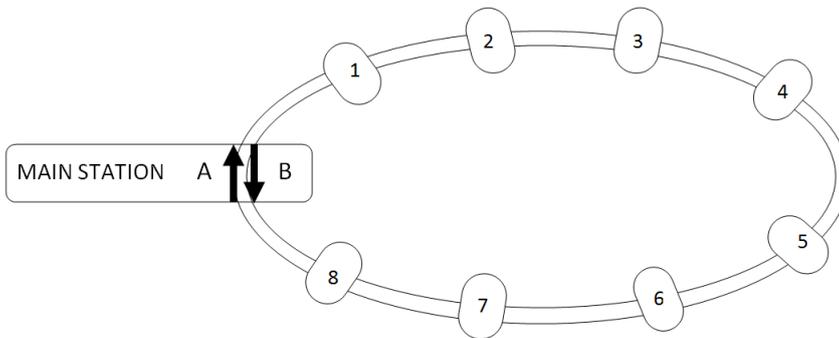
a) 4, 4, 8, 16, 32, \_\_\_\_, \_\_\_\_

Fill the missing two decimals of the following constants.

b) 1 . 4 1 4 \_\_\_\_ \_\_\_\_

c) 3 . 1 4 1 \_\_\_\_ \_\_\_\_

7. A city train travels on double circle rails having a main station and stations 1 – 8 in this order. There are two trains: Train A and train B. Train A travels clockwise and stops only at odd numbered stations and the main station. Train B travels counterclockwise and stops only at even numbered stations and the main station. Only at the main station the travelers can switch one train for another.



Michael travels from station 5 to station 6, Sarah from station 7 to station 4, and Liza from station 2 to station 5.

a) How many times do they totally travel between stations 5 to 6?

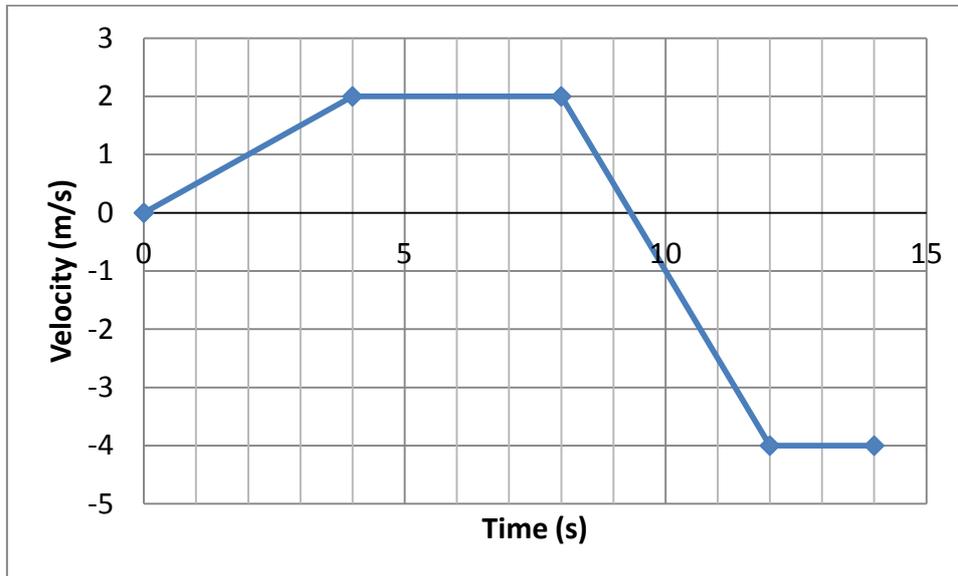
b) Which station of 1 to 8 is passed maximum number of times? How many times?

“Passed” means that the train passes a station without stopping or the traveler doesn’t get out of the train even though the train stops.

**Problems 8, 9 and 10:**

**Solve only A or B. If you solve both, the problem with lower score will count.**

- 8A) What is your final position, if you walk with the velocity shown in the graph below from 0 to 14 seconds?



- 8B) Sodium nitrite  $\text{NaNO}_2$  is produced by decomposing sodium nitrate  $\text{NaNO}_3$  by heating. During heating oxygen is removed from the solid material. Calculate the mass of sodium nitrate needed to produce 880 g of sodium nitrite.

Atomic masses:  $M_{\text{Na}} = 23.0$ ,  $M_{\text{N}} = 14.0$ ,  $M_{\text{O}} = 16.0$

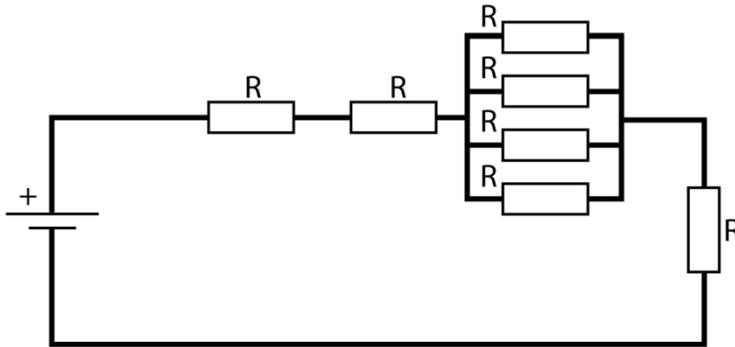
- 9A) Car mechanics use compressed air tools to open bolts. Instead of using an air compressor one can also use a tank of pressurized air. There is an air tank with a volume of 50 L to work with. The pressure of the tank is 50 bars when it is stored indoors at  $20^\circ\text{C}$ . The bolt wrench needs at least 10 bar pressure to operate. How long can the mechanics use the bolt wrench outdoors at  $-20^\circ\text{C}$  if it consumes 200 L/min of air at normal pressure? The normal pressure is 1.0 bar.

- 9B) Waste water leaked into a river in a mine area. The flow of the river water was  $1.80 \text{ m}^3/\text{minute}$  and nickel concentration in the river downstream of the leakage was  $2.2 \text{ mg/L}$ . The river runs into a lake of volume  $1.0 \cdot 10^5 \text{ m}^3$ . The leakage continued for 24 hours and 80 % of all nickel is accumulated into the lake. Did the concentration of nickel in the lake after leakage exceed the limit value  $20 \text{ } \mu\text{g/L}$  for clean water?

L denotes liters.

10A) In an electric circuit the resistors can be connected in series or in parallel. The total resistance of the resistors in series is just the sum of resistances. The total resistance of the resistors in parallel is calculated with the equation  $\frac{1}{R_{tot}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$

- Calculate the total resistance of the circuit below. Each resistance  $R = 40 \Omega$ .
- Calculate also the total current in the circuit when the battery voltage is 13 V.



10B) Poorly sorted energy waste contained 0.62 % of chlorine.  $1.0 \cdot 10^6$  kg of this waste is burned. Assume that all chlorine reacts and forms hydrogen chloride (HCl) vapor when the waste is burned.

- Calculate the mass of hydrogen chloride vapor formed.
- Hydrogen chloride is removed from flue gas by scrubbing and neutralizing it with calcium oxide CaO. Calculate the theoretical mass of CaO needed for the neutralization.

Atomic masses:  $M_{Ca} = 40.1$ ,  $M_O = 16.0$ ,  $M_H = 1.0$ ,  $M_{Cl} = 35.5$

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**The English test**

The English test is compulsory to all applicants and must be passed.

Each reading comprehension true/false question is worth 1.5 points.

Each grammar/vocabulary multiple choice question is worth 1.5 points.

Writing test is worth 15 points.

**Answer on the provided answer sheet.**

**All papers must be returned.**

**Read the following two passages and answer the true and false –statements below.**

**A** (Adapted from Science Daily Nov.18, 2013, www.sciencedaily.com)

A team of researchers has set its sights on improving the materials that make solar energy conversion possible. They have developed a new form of high-performance solar photocatalyst based on the combination of TiO<sub>2</sub> (titanium dioxide) and other “metallic” oxides that greatly enhance the visible light absorption and promote more efficient utilization of the solar spectrum for energy applications.

“This is a fundamentally new way of approaching these matters,” explained Lane Martin, an assistant professor from Illinois. “Our research group incorporates aspects of condensed matter physics, semiconductor device engineering and photochemistry. From these materials we can imagine carbon-neutral energy production, even waste water purification and remediation.

According to Martin the research paper addresses the most pressing limiting factor of these materials for applications – their poor absorption of light. “This paper covers variations where we integrate chemically compatible metallic oxides to produce high-performance photocatalytic heteroconjunctions.”

Jennifer Berhard, the representative of the sponsors is optimistic. “This project reflects the kinds of research endeavors that we are ready to support. The momentum of this work is tremendous. It cuts across disciplines and it has tremendous impact potential. We’re excited to see where the team takes it from here”

**B** (Adapted from Science Daily May 2, 2011, www.sciencedaily.com)

Two technologies have dominated efforts to harness the power of the sun’s energy. Photovoltaics convert sunlight into electric current, while solar-thermal power generation uses sunlight to heat water and produce thermal energy. Photovoltaic cells have been *deployed* widely as flat panels, while solar-thermal power generation *employs* sunlight-absorbing surfaces feasible in residential and industrial settings.

Because of limited material properties solar thermal devices have failed to economically generate electric power. The team has introduced two innovations: a better light-absorbing surface through enhanced nanostructured thermoelectric materials, which was then placed within an energy-trapping, vacuum-sealed flat panel. “The ability to generate electricity by improving existing

technology at minimal cost makes this type of power generation self-sustaining from a cost standpoint.”

All this opens up a promising new approach that has the potential to achieve cost-effective conversion of solar energy, an advance that should impact the rapidly expanding residential and industrial clean energy markets. Because of the new ability to generate valuable electricity, the system promises to give the users a quicker payback on their investment.

### **ARE THE STATEMENTS TRUE OR FALSE?**

Read the statements on the answer sheet concerning the text above and give T or F as answer.

### **VOCABULARY AND GRAMMAR**

Read the sentences on the answer sheet and choose the right alternatives.

### **WRITING PART**

Write on the answer sheet a short text of about 200 -250 words on the topic given below.

Imagine that the Government of your country has decided not to build more nuclear power stations but to favour other sources of energy. As a result there is a heavy energy debate going on in the country. You decide to express your opinion about the matter in a local paper.

Tell your readers whether you find the decision wise or not. Why? Suggest one or two energy sources that could be real alternatives for nuclear energy in your country. Discuss them in some depth.

Give your text a suitable title.

The evaluation is based on the level of language and the overall structure of the text.