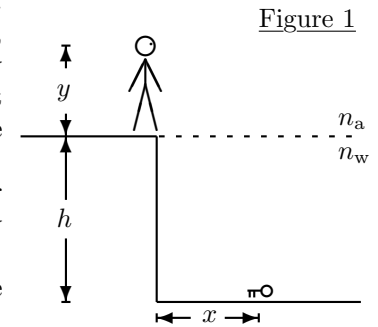


Write down your name and applicant number on each paper. Solve each problem on a separate sheet of paper and explain briefly the formulas which you use.

- A1** A goalkeeper in a football (soccer) game kicks a goalkick which gives the ball an initial speed of 23 m/s. In what angle above the horizontal plane should the ball be kicked in order to go in the air directly to the feet of a midfielder who is at a distance of 51 m from the initial position of the ball? Air resistance is neglected.
- A2** Lasse (mass 55 kg) skies downhill along a slope which is 45 m long and has an angle of inclination of  $17^\circ$ . The kinetic coefficient of friction between Lasse's skies and the snow is 0.16. The temperature for both the snow and the air is  $0^\circ\text{C}$ .
- What is Lasse's speed at the bottom of the slope, if he starts from rest? Air resistance is neglected.
  - How far does Lasse slide along the horizontal section after the slope?
  - What is the maximum amount of snow that may melt under Lasse's skies?
- A3** A gas bubble, with a radius of 5.0 mm, is released from the oxygen apparatus of a diver at a depth of 56 m. The temperature in the water is  $19^\circ\text{C}$  at the surface and  $11^\circ\text{C}$  at the depth of the diver.
- What is the pressure in the gas bubble that is released from the oxygen apparatus? Explain. (2p.)
  - What is the radius of the gas bubble just before it reaches the surface? (4p.)
- A4** Two light bulbs (filament lamps), which have a resistance  $R_1 = R_2 = 1.3\ \Omega$ , are connected to a battery with a terminal voltage  $U = 1.5\ \text{V}$ . Assume that the resistances of the lightbulbs and the terminal voltage of the battery are constant.
- Explain how the light bulbs should be connected to the battery in order to glow most brightly. Draw the circuit. (4p.)
  - Calculate the power dissipation in one of the light bulbs when it glows most brightly. (2p.)

|                   |                               |   |
|-------------------|-------------------------------|---|
| <b>CONSTANTS:</b> | Absolute zero point           | $T_0 = -273.15\ ^\circ\text{C}$               |
|                   | Acceleration of gravity       | $g = 9.807\ \text{m s}^{-2}$                  |
|                   | Attenuation constant of Al    | $\mu_{\text{Al}} = 22.8\ \text{m}^{-1}$       |
|                   | Avogadro's number             | $N_A = 6.0221 \cdot 10^{23}\ \text{mol}^{-1}$ |
|                   | Density of water              | $\rho_w = 1.00 \cdot 10^3\ \text{kg m}^{-3}$  |
|                   | Half-life of $^{22}\text{Na}$ | $T_{1/2} = 2.6\ \text{a}$                     |
|                   | Heat of fusion, ice (snow)    | $L_f = 333\ \text{kJ kg}^{-1}$                |
|                   | Index of refraction, air      | $n_a = 1.00$                                  |

- A5** You have dropped your house keys in a swimming pool which is filled to the brink (see Figure 1). When you are standing on the edge of the pool, you can see your keys in a direction  $58.0^\circ$  below the horizontal plane. Your eyes are at a height  $y = 1.62\ \text{m}$  above the edge of the pool and the depth of the swimming pool is  $h = 3.00\ \text{m}$ .
- Do your keys appear to be closer or farther away from the wall of the pool than they really are? Draw a figure. (2p.)
  - Calculate the distance  $x$  from the keys to the wall of the pool. (4p.)



- A6** A radioactive salt solution is kept in a closed aluminium container. The walls of the container have a thickness of 3.0 cm. The radioactive isotope in the solution is  $^{22}\text{Na}$ , which decays by  $\beta^+$ -decay. The daughter nucleus is in an excited state after the decay and it emits a gamma photon with an energy of 1.28 MeV in the transition to the ground state. A radiation detector outside the container detects  $22 \cdot 10^6$  events from the decay process per second. The highest allowed activity for a one time release of radioactivity into the sewer system is 15 MBq. How long must the salt solution be stored before all of it can be poured at a time into the sewer system? Assume that the radiation propagates perpendicularly to the walls of the container.

|                             |  |
|-----------------------------|--|
| Index of refraction, water  | $n_w = 1.33$                                 |
| Molar gas constant          | $R = 8.3145\ \text{J mol}^{-1}\text{K}^{-1}$ |
| Molar mass of air           | $M_a = 29.0\ \text{g mol}^{-1}$              |
| Normal air pressure         | $p_0 = 1.013 \cdot 10^5\ \text{Pa}$          |
| Planck's constant           | $h = 6.6261 \cdot 10^{-34}\ \text{Js}$       |
| Specific heat of ice (snow) | $c_i = 2.10\ \text{kJ kg}^{-1}\text{K}^{-1}$ |
| Specific heat of water      | $c_w = 4.19\ \text{kJ kg}^{-1}\text{K}^{-1}$ |
| Speed of light in vacuum    | $c = 2.998 \cdot 10^8\ \text{m s}^{-1}$      |