Admission Test

Applied Physics - Computacional Physics

Second Semester 2018

Candidate's Code:

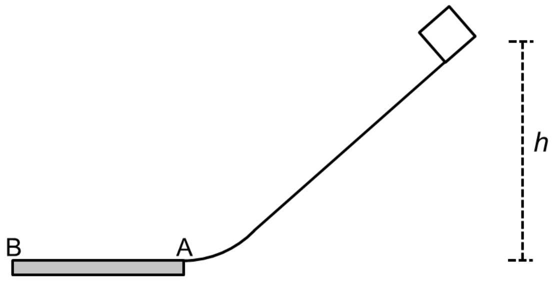
QUESTIONS OF PHYSICS

Question 1:

A block of mass m is at the top of a hill of height h. It then slides from rest with negligible friction to point A. Arriving at point A, it is braked by a sand-covered surface AB for a time T until it reaches rest.

a) What is the speed of the block at the bottom of the ramp?

b) What is the coefficient of kinetic friction between the block and the sand while the block is in surface AB?



Question 2:

A student fires a bullet of mass m_b into a hanging wooden box of mass m_c, hung by a wire of negligible mass. The bullet strikes the box and passes through it completely. A laser device indicates that the bullet has emerged at half its initial velocity. The wooden box swings upward to a certain height h. Neglecting air resistance, determine h.

Question 3:

A student decides to test a new wire for possible use in a piano. The wire specifications tell that the 3m-long wire has a linear mass density of 0,0025kg/m. The student finds two adjacent resonant frequencies at 252Hz and at 336Hz, respectively.

a) Determine the fundamental frequency of the wire.
b) Determine whether the wire is safe to keep in the piano, considering that safety issues start to arise if the tension in the wire gets above 700N.

Question 4:

An object oscillates in x direction with angular frequency ω . At $t = 0\,s$ the object is at x_0 with an initial velocity v_0 .

a) Find the phase constant for the motion

b) Find the oscillation amplitude.

Question 5:

Two liters of water are left in a jar in the sunlight all day, reaching the temperature of $40°C$. In a Styrofoam cup, 250g of this water is poured and two ice cubes (each with a mass of 25g at a temperature of $0°C$) are added. Consider the specific heat of the water as $1 cal/g°C$ and the latent heat of fusion of the ice as $80 cal/g$.

a) Assuming no heat is released to the surroundings (not even to the cup), what is the final equilibrium temperature of the water in the cup?
b) A new amount of 250g of water is poured in another cup. What is the largest number of ice cubes (each with a mass of 25g at a temperature of $0°C$) that could be added so that no ice remains without melting?

QUESTIONS OF COMPUTACIONAL PHYSICS

Question 1:

Write a program that reads from the user a positive integer value N, computes the following:

1) $\sum_{a=1}^{N} \sum_{b=1}^{N} f(a,b)$

2) $\max_{1 \leqslant a,b \leqslant N} f(a,b)$

3) $\min_{1 \leqslant a,b \leqslant N} f(a,b)$

where $f(a,b) = 3ab - 2a + 5b + 10$, and shows these values to the user.

Question 2:

Write a **function**, named **reorder**, that receives an 1D array (vector) of integer numbers and reorders them *in the same array* such that the final ordering on return from the function satisfies all of the following conditions:

a) All the values in the input array, with their multiplicity, are preserved, and no new values are inserted.

b) All odd values must come before all even values.

c) Odd values must be ordered in increasing order.

d) Even values must be ordered in decreasing order.

For example, if the array has the following values (in order) on function entry:

```
1 -2 7 0 8 -5  0 11
```

on function exit the values must be ordered as

```
-5 1 7 11 8 0 0 -2
```

Question 3:

Present the basic formula (interactive) underlying the root finding algorithm known as Newton-Raphson as applied for searching for a root of a function f(x).

Questão 4:

Transform the vector **a** into an AVL tree, following the order of vector elements. Show the steps for each inserted element:

a = (98, 18, 24, 1, 3, 58, 13, 7, 6, 71, 21, 19, 8)

Question 5:

Write a function that returns the maximum degree of a graph, how many vertices have a maximum degree, and what are they. The graph must by represented by its adjacency matrix.