Høsten 2016

FYS100 Fysikk: Hand-in I

To be handed in at the latest **Friday 9. September, at 18.00**.
You must hand it in by scanning your handwritten solution/compiling your electronic documents into a single .pdf file, and uploading it to It's learning in "Hand-in 1". Mobil-phone pictures are not acceptable.
You **must**:

- Put your name and student number on each page.
- Make an attempt at all separate problems.
- If you don't get to the end of a problem, write a comment why.
- Make sketches for all problems, where it makes sense (vectors, trajectories, ...).
- Write in a readable, well-structured way.

Failing this, you will be asked to do it again and resubmit.
Pass is 40% correct (including partial credit). There is no grade. You will have a chance to resubmit, if you fail to meet the requirements the first time. But don't plan for several iterations!

Good luck!

Problem 1: Vectors, part I

Consider the 4 position vectors is two dimensions (in some x, y coordinate system)

$$\vec{\mathbf{P}}_1 = (2, 3)\,, \quad \vec{\mathbf{P}}_2 = (-1, 4)\,, \quad \vec{\mathbf{P}}_3 = (-3, -5)\,, \quad \vec{\mathbf{P}}_4 = (-7, 0)\,. \tag{1}$$

a) Find the polar form (r, θ) of each of the 4 vectors $\vec{\mathbf{P}}_{1,2,3,4}$.

b) Find the Cartesian and Polar representations of $\vec{\mathbf{P}}_1 + \vec{\mathbf{P}}_2$, $\vec{\mathbf{P}}_3 + \vec{\mathbf{P}}_4$ and $\vec{\mathbf{P}}_1 + \vec{\mathbf{P}}_2 - \vec{\mathbf{P}}_3 - \vec{\mathbf{P}}_4$.

c) Using the scalar product, find the relative angle between $\vec{\mathbf{P}}_1$ and $\vec{\mathbf{P}}_3$; and between $\vec{\mathbf{P}}_2$ and $\vec{\mathbf{P}}_4$.

Problem 2: Vectors, part II

Three vectors are given in coordinate form by:

$$\vec{\mathbf{A}} = (3, 2, 1), \qquad \vec{\mathbf{B}} = (-3, -1, 4), \qquad \vec{\mathbf{C}} = (2, -5, 0) \tag{2}$$

a) What is the average of these three vectors?

b) What is the (smallest) angle of each of them with the x-axis?

c) What is the projection of $\vec{\mathbf{A}}$ on $\vec{\mathbf{B}}$? Of $\vec{\mathbf{A}}$ on $\vec{\mathbf{C}}$?

d) Show explicitly that $\vec{\mathbf{A}} \times (\vec{\mathbf{B}} + \vec{\mathbf{C}}) = \vec{\mathbf{A}} \times \vec{\mathbf{B}} + \vec{\mathbf{A}} \times \vec{\mathbf{C}}$. What is the length of the resulting vector?

Problem 3: Trigonometry

Consider a triangle of sides 5, 8 and 9 m (exact).

a) What are the angles of the triangle?

b) What is its area?

Problem 4: Ugly Duckling

The "Ugly Duckling" tourist train manages to keep a constant speed of 30.0 km/h going down the famous Danish mountain, "Himmelbjerget", but only 15.0 km/h going up again. What is the average speed by which it can go a full round trip down and up again?

Problem 5: Collision course

A huge tractor and a Tesla full of school children come driving along a winding mountain road, in opposite directions. The tractor has a speed of 40.0km/h and the car zooms along with 80.0 km/h. The Tesla suddenly comes around a corner, sees the tractor, and they both immediately start braking, both with constant accelerations of 5.00 m/s^2 (opposite to their directions of motion).

a) If the initial distance between the two is 60.0 m, do they hit each other? If so, where, and with what relative speed on impact? If not, what is the distance between the two when they both stop?

In fact, it takes both of them 0.50 s to react to seeing each other, so they only start braking 0.50s after the car comes round the corner.

b) What is the answer to the questions in a) in this case?

As it happens the tractor driver is looking the other way, and doesn't brake at all, but continues with his original speed.

c) What should the acceleration a of the Tesla be, to have time to stop before being hit by the tractor (still including the 0.5 s delay from question b))?