G 000

PHYS-A0110 Yliopistofysiikan perusteet (TFM) 4
Final exam
23.10.2015 3

Suomeksi toisella puolella.

This final exam is only a part of the course assessment and is not sufficient for completing the course alone. The weight of this exam on the final grade is 20%.

In the exam, you are allowed to have usual writing tools (no calculators or tables), and one yellow one-sided A4-sheet with handwritten notes. Please write your name on the yellow sheet and return it with your exam answers. It will be also evaluated (max. 1 point).

Final exam

1. (Max. 6p) According to a research, the sea level during the last ice age was roughly 120–150 meters lower than today.
   a) Estimate, how big volume of ice does this amount to?
   b) How much ice there is on Earth today?
   Provide some kind of arguments for the quantities you know the least and estimates for the error margins. Estimate also the validity of your final result.

2. (Max. 6p) Gravitational force depends linearly on the product of the masses and inversely proportional to the square of the distance. Derive, using *dimensional analysis* the dependence of Earth's orbital period on the radius (distance to Sun). Note: only solution derived using dimensional analysis can get full points. The problem can be solved using Newton's equations of motion, but it is not required, and such solution alone is not enough for full points.

3. (Max. 6p) Wave equation that describes propagation of waves along one dimension is
$$\frac{\partial^2}{\partial t^2}\psi(x,t) = v_s^2 \frac{\partial^2}{\partial x^2}\psi(x,t), \tag{2}$$
   where v_s is the speed of a wave. Let us assume, that the medium is non-dispersive, in which case v_s does not depend on wave length. Show, that a wave packet $\psi(x,t) = Ae^{-(x+vt)^2}$ satisfies the wave equation if $|v| = |v_s|$. Sketch how the wave packet looks like at time $t = 0$, and explain how your graph evolves as a function of time.

4. (Max. 6p) Viscosity of a fluid (i.e. gas or liquid) affects what kind of flows are created in the fluid by a moving object. A slowly moving small object in a sufficiently viscous fluid generates a laminar flow. Friction forces due to laminar flow are linearly proportional to speed v, in contrast with the quadratic dependence due to a turbulent flow. Assuming laminar flow, solve the velocity as a function of time for an object falling in a viscous liquid.