METÓDY RIEŠENIA FYZIKÁLNYCH ÚLOH 3 leto19 – Príklady 2

Cvičenie 7.3.2019

Príklad 1

Problem 1. **[Classical Mechanics]** Brad Majors and Janet Weiss go bowling. Ever observant, Brad notes that his bowling ball initially skids down the alley, and only slowly begins to roll.

a) Briefly, and in words, why does a ball that initially skids down the alley eventually start to roll down the alley?
b) The bowling ball has radius R. What mathematical constraint holds when the ball begins to roll without slipping?
c) The ball is released with an initial translational speed of v_0 and an initial rotational speed of zero. The coefficient of kinetic friction between the ball and the alley is μ and the mass of the ball is M. Derive an expression for the time, denoted T, between the release of the ball and the onset of rolling without slipping [minor help: $I_{\text{sphere}} = (2/5)MR^2$].

Príklad 2

Problem 3. **[Electromagnetism]** A parallel-plate capacitor, at rest in S_0 and tilted at a 45° angle to the x-axis, carries charge densities $\pm\sigma_0$ on the two plates. System S is moving along the x-axis at speed v relative to S_0.

(a) Find $\mathbf{E}_0$, the field in S_0.
(b) Find $\mathbf{E}$, the field in S.
(c) What angle do the plates make with the x axis?
(d) Is the field perpendicular to the plates in S?

Hint: If you don't remember how electric field components transform, the electromagnetic field tensor is $F^{\mu\nu} = \begin{Bmatrix} 0 & E_x/c & E_y/c & E_z/c \\ -E_x/c & 0 & B_z & -B_y \\ -E_y/c & -B_z & 0 & B_x \\ -E_z/c & B_y & -B_x & 0 \end{Bmatrix}$

Príklad 3

Problem 5. **[Statistical Mechanics/Thermodynamics]** Consider an ideal gas of N identical particles confined to a tall cylinder (*i.e.*, $mgL >> kBT$) of cross-sectional area A, oriented parallel to a gravitational field of strength g. The bottom of the container is at $z = z_0$, and the system is at temperature T.

a) Write down the partition function for this system;
b) Use this partition function to calculate the mean energy and the heat capacity, C_v, of the gas;
c) Use the partition function to compute the force on the bottom of the container

Príklad 4

Problem 8. **[Quantum Mechanics]** Particles with angular momentum 1 are passed through a Stern-Gerlach apparatus, which separates them according to the z-component of their angular momentum. Only the $m = -1$ component is allowed to pass through the apparatus. A second apparatus separates the beam according to its angular momentum component along the u-axis. The u-axis and the z-axis are both perpendicular to the beam direction but have an angle θ between them. Find the relative intensities of the three beams separated in the second apparatus.