4^{th} year
1. series
deadline
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FX [f:ks]

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This is the first series of problems of the fourth year of the correspondence seminar FX (pronounced as f:ks).

FX is a bonus category of FKS: if the A or B categories are not enough for you (for qualitative or quantitative reasons), go for FX! You'll be rewarded by interesting and not completely trivial problems, which will (as we hope) broaden the horizons of your world of physics.

FX works similarly as FKS – send your solutions by mail or e-mail to the addresses given above before the deadline also given above. (The deadlines for FX will be a week after the deadlines for FKS.) We will send you back your marked solutions and new problems. You can also find all the materials online – including an archive of problems and model solutions of last years' FX.

Before jumping straight into the problems, we would like to remind you that FX is here for you. Hence, if you have any comments, questions or doubts (concerning the seminar or physics or in fact anything vaguely related), don't hesitate and drop us a line.

Good luck!

FX1 Mirrors

A half-transparent mirror with transparency α (where $0 \leq \alpha \leq 1$) is a mirror which, if shined upon with a ray of intensity I (from either side), transmits a ray of intensity αI and reflects a ray of intensity $(1-\alpha)I$.

(a) Filip took a mirror with transparency α_1 and put a mirror with transparency α_2 right behind it, keeping the two mirrors parallel. What fraction of an incident ray will this pair of mirrors transmit if we shine on it from the front? And from the back?

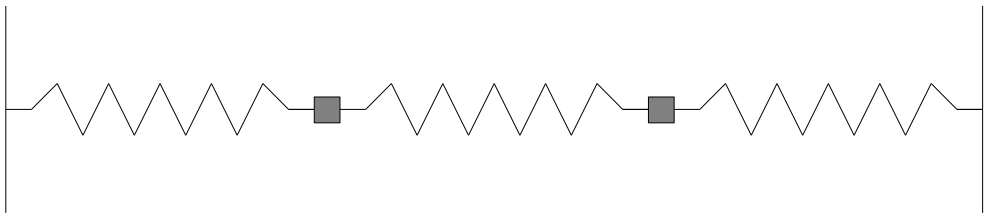
(b) Vlado didn't want to stay behind, so he took all the half-transparent mirrors he found in his garage, and put them all next to each other. Their transparencies are $\alpha_1, \alpha_2, \ldots, \alpha_n$, in this order. How will his system of mirrors behave?

FX2 Asteroid

Azag was playing with his new telescope when he found a moving asteroid. He found out that the asteroid was at distance d from the Sun, that its speed at that moment was v, and its velocity subtended an angle α with the line asteroid-Sun. What is the period of orbit of the asteroid around the Sun?

FX3 Springs

Samo found N small bodies of mass m, $N+1$ springs of stiffness k, and one straight line. He connected the springs one after another and put one of the small bodies between each pair of consecutive springs. He fixed the free ends of the first and the last spring, but let the bodies move freely along the given line. The picture shows the situation for $N = 2$:



(a) Find the period of all harmonic motions which the system can exhibit for $N = 2$.

(b) Find the period of all harmonic motions which the system can exhibit for $N = 3$.

(c) Describe qualitatively what happens for larger values of N.