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**1 Momentum problems**

A small puck of mass m is placed onto the inner surface of the thin hollow cylinder of mass M and of radius R. Initially, the cylinder rests on the horizontal plane and the puck is located at the height R above the plane. Find the interaction force between the puck and the cylinder at the moment when the puck passes the lowest point of its trajectory. Assume that the friction between the puck and the inner surface of the cylinder is absent, and the cylinder moves on the plane without slipping.

**2 Non-symmetric capacitor**

The charge of the left plate of a capacitor is zero. Find the initial charge of the right plate if, after closing the K. A+t R is dissipated the same amount of heat like in the case when the capacitor was initially uncharged.

**5 New SI**

In a new SI some fundamental constants: gravitational constant *G* and speed of light *c* are equal to 1 (so, they are dimensionless).

Show that in this system mass, length and time have the same dimensions.

Let this unit be a centimeter. Express 1 second and 1 gram in centimeters.

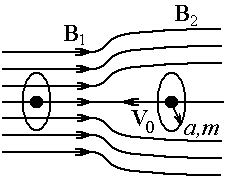
Since 1 kg = 6.67⋅10-11⋅ m3/s2 = 6.67⋅10-11⋅(102)3 /(3⋅1010)2 = 7.4⋅10-26 cm. So

1 eV = 1.6⋅10-19 J = 1.6⋅10-19 kg⋅m2/s2 = 1.6⋅10-19⋅7.4⋅10-26⋅102/ (3⋅1010)2 = 6.7⋅10-43 cm.

1 h.p. = 735 W = 735 kg⋅m2/s3 = 2⋅10-50 (dimensionless).

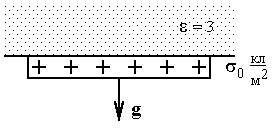
**7 Dyson sphere**

In 1993 the telescope with diameter of 57 cm, placed on a satellite and operating on wavelengths about 10 mkm, discovered an IR space object 0536+467PQ5 with a super large diameter at a distance of 70 light years from the Earth. At which minimal diameter of an object we can resolve it (distinguish from a point)? Object is a Dyson sphere, created by a local civilization and covering their central star.

**14 Magnetic bottle**

The shape of a magnetic field near Earth poles looks like a “magnetic bottle”, here *В*1 and *В*2 – uniform magnetic fields. Thin non-conducting ring with mass *m* and radius *а* is uniformly charged by *Q*0+. Which minimal initial velocity *V*0 should have the ring to pass from*В*2 through “throat” into *В*1 > *В*2? Ring axis always coincides with a “magnetic bottle” axis. 1) Neglect the ring inductivity. 2) Ring inductivity is *L*.

**15 Electric glue**

Thin non-conducting film is charged with a constant surface density *σ*0 Cl/m2. Film is covered by a very thin isolating cover and is placed on the surface of a dielectric material with *ε* = 3. Film thickness is *δ* = 1 mm, mass density ρ = 1 g/cm3. What should be *σ*0, the film not fall down? What should be *σ*0, if we replace dielectric by a conductor?

**1 Moonlight pressure**

Give the upper evaluation of force acting on a Moon by a Moon’s light reflected by Earth. The Solar constant (on the Earth surface) is 1400 W/m2. Angular diameters of Sun and Moon as seen from the Earth are 0.5о.

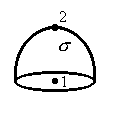
**3 Currency protection**

In an African country (Capo Verde) there is used a system of optical protection of a domestic currency. Digits are covered by a transparent film. Duding rotation in an incident green light (λ = 0.53 mkm) from 0° up to 90о the dig

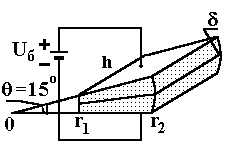
**17 Gas of dipoles**

Maximally charged spherical particle (r0=10 mkm) is in a gas with molecules having dipole moments Р0=10-29 Cl⋅m at a temperature Т=103 К. Find the relative variation of a gas density near the particle if threshold happens at Еmax=104 V/cm.

**18 Escape velocities**

The hemisphere and the disc with radius *R* in a vacuum are charged uniformly by negative surface charge density σ – Clm2. Find ratio of maximal kinetic energies of electrons escaping the hemisphere from points 1 and 2 without initial velocities. Evaluate ratio of maximal velocities of electrons if *R* = 1m and σ – = 8.85 · 10–6 Clm2.

**19 Wedge capacitor**

Well conducting plates of a flat capacitor have a small angleits volume is filled with a mediahaving low conductivity r)=Сr, here С = 10-5 1/Ohm m2. Along the symmetry plane at the thin dielectric film is located with =5, being in a pre-threshold condition: Еcr= 5 104 V/cm. At a certain moment the threshold happens, the film instantly disappears and the conductivity by becomes uniform. What energy conversions will take place in this scheme during time t=1 sec, including threshold moment Uб=103V, r1=1m, r2=2m, h=1m, o?

**22 Damped rotation**

The thin metal ring is in a vertical position (its plane is vertical) and can freely rotate around a vertical axis passing through its diameter. Horizontal uniform magnetic field B passes through the ring. Fast rotation is initiated. Find the characteristic time of rotation damping. Introduce all necessary values by yourself.

**23 Charge dissipation**

The sphere with radius R and uniformly distributed charge Q0 is surrounded by an infinite conductive media with conductivity λ. Find the characteristic time of charge dissipation. Within which part of the media half of energy will be dissipated?

**12 Rotating capacitor**

Find the relative variation of a capacity when we will start fast rotation of a capacitor. Half of the capacitor volume is filled by a liquid with *ε* = 3. Outer radius is *a*, inner radius is *b*. *a*/*b* = 2. Initial position of a capacitor is horizontal. Draw the radial distributions of E and D while rotating.

**24 Под градом ударов**

You throw the balls at the back of the car at speed u, and at a mass rate of σ kg/s.

Автомобиль массой *M* покоится на горизонтальной поверхности, по которой может двигаться без трения. В заднюю вертикальную стенку автомобиля бросают горизонтально мячики со скоростью *u* относительно земли и массой *σ* в единицу времени (*σ* измеряется в кг/с). Найдите зависимости скорости автомобиля и пройденного автомобилем пути как функции времени. Рассмотрите два случая: 1) удары мячей о стенку автомобиля абсолютно упругие; 2) окно в задней стенке открыто, и мячики остаются в автомобиле.

1) ; ; 2) ; .