國立台灣大學九十二學年度碩士班招生考試試題

科目：普通物理學(C)

1. (15%) Consider two balls with radius r and mass m on a billiard table as shown in Figure 1. Assume the balls do not rotate and ignore the friction between the balls and the table.
(a) (10%) In what direction should you hit the white ball such that the red ball will go in the corner pocket?
(b) (5%) What is the final direction of the white ball after its collision with the red ball?

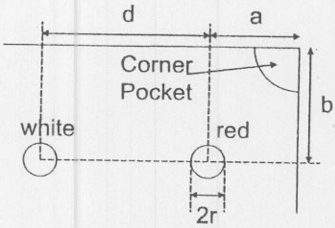

Figure 1 (Problem 1)

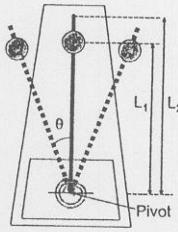

Figure 2 (Problem 2)

2. (30%) Consider a metronome as shown in Figure 2. A 500g disk, 2cm in diameter, is attached to a massless rod, which is pivoted at its end. The disk can be moved up and down along the rod to change the tempo. A torsion spring is connected to the rod. The restoring torque of the torsion spring is $\tau = -\kappa\theta$, where κ is the torsion constant, and θ is the displacement angle of the rod in either direction from its equilibrium position $\theta = 0$. You can assume the θ of interest is small.
(a) (10%) Assume the disk's center of mass is located at $L_1 = 10cm$ from the pivot. Derive and calculate the rotational inertia of the disk about the pivot.
(b) (10%) Same as in (a) ($L_1 = 10cm$), how do you choose the torsion constant κ such that the tempo is 60 beats per second?
(c) (10%) What is the length of the rod L_2 such that the metronome's slowest tempo is 40 beats per second?

3. (30%) A tank with cross-sectional area A is filled with water to a height H. The tank is mounted on a stand of height $2H$. A hole with cross-sectional area a is punched in one of the walls at a depth h below the water surface (see Figure 3).
(a) (10%) What is the speed v of the water emerging from the hole?
(b) (10%) What is the distance x from the wall of the tank to the point at which the resulting stream strikes the floor?
(c) (10%) At what depth should the hole be placed to make the emerging stream strike the ground at the maximum distance from the wall of the tank?

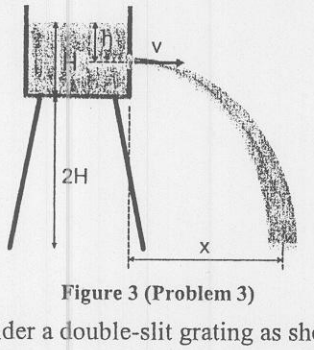

Figure 3 (Problem 3)

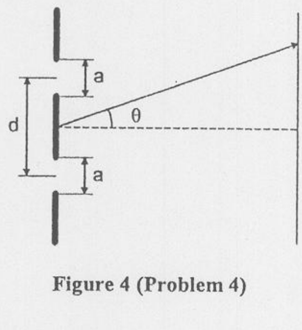

Figure 4 (Problem 4)

4. (25%) Consider a double-slit grating as shown in Figure 4.
(a) (10%) If $a << \lambda$, derive an expression of the intensity interference pattern as a function of θ.
(b) (10%) If a is in the order of λ, derive again the intensity interference pattern as a function of θ.
(c) (5%) If $d = a$, show that the result from (b) reduces to the diffraction pattern for a single slit grating.

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