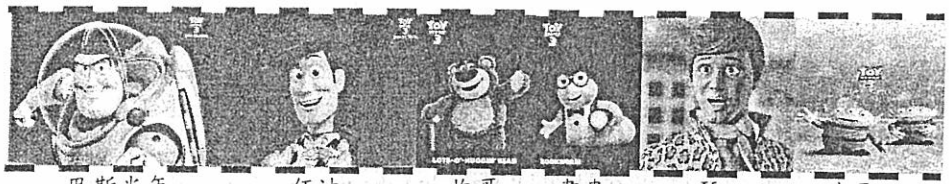
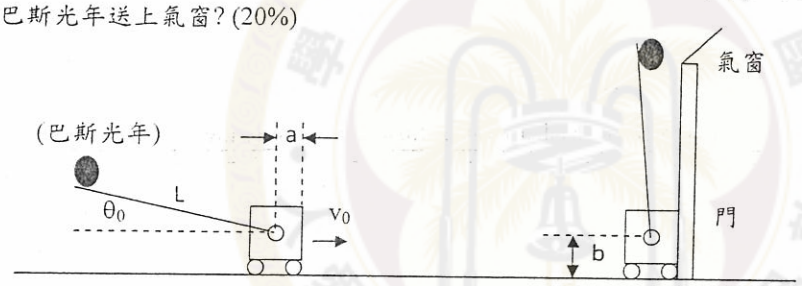
玩具總動員 3 主要人物介紹



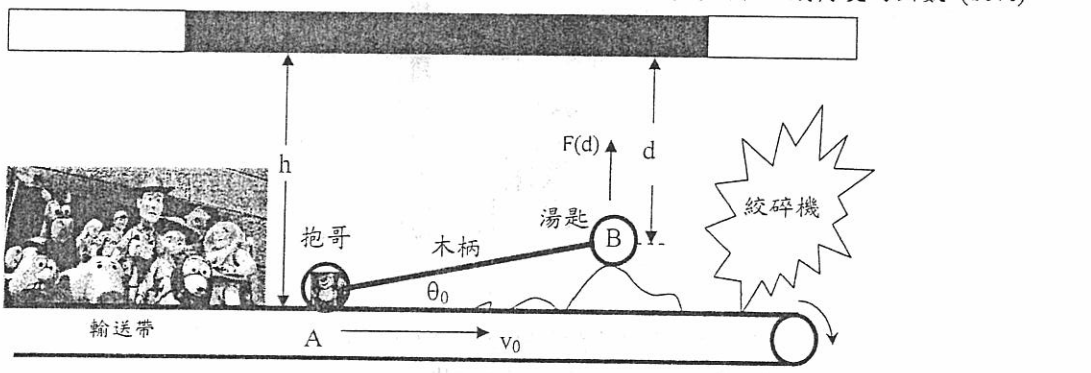
巴斯光年　伍迪　抱哥　書蟲　Ken　外星人

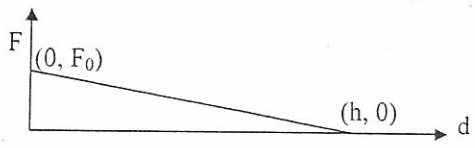
安迪考上了台大，過完暑假就要離溫暖的南部北上了。安迪決定將兒時的玩具收藏在閣樓，只帶著伍迪去台大，媽媽卻無意中將玩具們扔進了垃圾堆，經過一番波折，玩具們爬進捐贈給 Sunnyside 幼兒園的箱子中，他們以為新生活將充滿色彩，沒想到卻在幼兒園受到幼兒霸凌，幫派老大抱哥更限制玩具們的行動，於是玩具們在伍迪的領導下，展開了始前無例的大逃亡.....

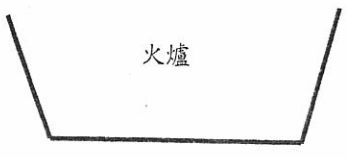
1. 巴斯光年站在玩具車拖桿的一端，大家合力將玩具車推向門口，當車頭碰到門時，拖桿藉著衝擊力向上旋轉，將質量為 m 的巴斯光年彈上門頂的氣窗，逃出幼兒室。若車頭質量為 M，長為 L 的拖桿為均勻桿，質量與巴斯光年相同，推動過程中拖桿角度保持為θ_0，玩具車在撞到門時車速為 v_0。假設彈上過程中，巴斯光年都未離開拖桿頂端，直到拖桿接近垂直位置時才被彈出，請問車速至少要多快，才能將巴斯光年送上氣窗? (20%)



2. 抱哥和玩具們正在速度為 v_0 的輸送帶上要被送入焚化爐銷毀，經過絞碎機之前，玩具們發現上端有巨大的電磁鐵上，於是大家紛紛抓到鐵磁物體的一端，順勢吸到上面免被絞爛。此時抱哥向伍迪求救，伍迪和巴斯光年將抱哥從重物下拖出，抱哥抓到一根鐵湯匙的木柄 A 端，也被吸上去了。假設湯匙頭質量為 m，長的 L 木製柄重量忽略，初始角度為θ_0，電磁吸力 F(d)隨距離變化如圖，抱哥質量亦為 m，吸上過程中由θ_0到垂直位置，A 端與輸送帶間的摩擦力忽略，但 A 端要在 F(d)大到一定程度後才會離開輸送帶，(a)請寫出上吸過程中，木柄 A 端離開輸送帶前的運動方程式 (15%)，(b)運動方程式中有哪幾個未知數? (5%) (c)在木柄 A 端離開輸送帶之前，請將湯匙角速度表示成角度的函數 (10%)。







見背面

3. Andy's loyal toys find themselves in a daycare where untamed tots with their sticky little fingers do not play nice. So, it's all for one and one for all to plan their great escape from the daycare. Woody plans to escape through the transom above the door, which has been locked by the ill-willed teddy bear called Lots-o'-Huggin' Bear, but the transom is too high for him to reach directly. Thus, he tries to take advantage of the bar hanging from the ceiling to get to the top of the door.

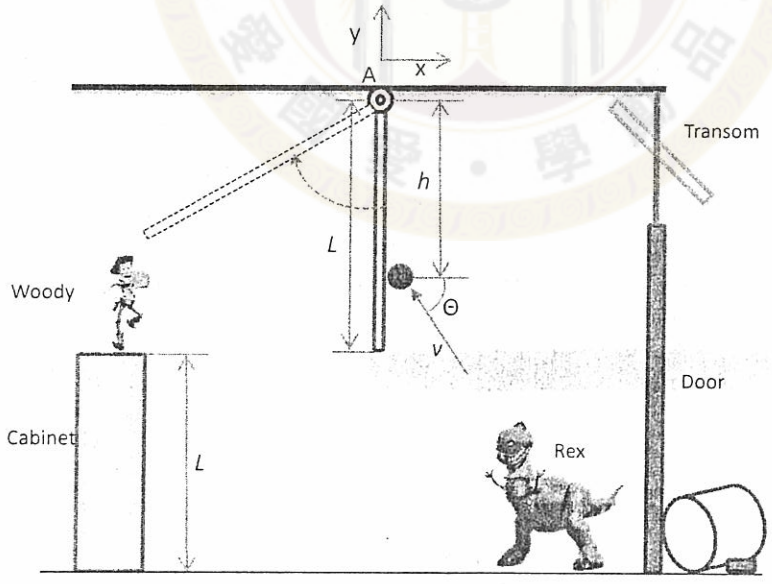
   As shown in the figure below, the bar, whose mass is m_1, whose length is L and whose moment of inertial about its pivot is I_A, is at rest in the vertical position. He asks Rex to obliquely strike the bar with a ball, whose mass is m_2, so that he can reach the bar on top of the cabinet as it swings. Assume the coefficient of restitution for the collision between the bar and the ball is ε and use Δt to denote the duration of the impulse. Also, consider the ball to be a particle, which means that we need not consider its rotation.

   (a) Determine the angular velocity of the bar $\overrightarrow{\omega_f}$ and the velocity of the ball $\overrightarrow{v_{2f}}$ immediately after the collision. (10%)

   (b) Determine the impulse of the pivot force during the collision. (5%)

   (c) Is there a distance h for the impact that minimizes this impulse? (5%)

   (d) Determine the total energy loss as a result of the collision by comparing the total kinetic energy before and after the collision. How does the angle of the impact Θ affect the energy loss? (5%)



4. Brave Woody successfully climbs out the transom and jumps on a heavy barrel, which cannot freely roll on the ground due to the bricks placed underneath it. As shown in the figure blow, Woody is modeled as a homogeneous box, whose mass is **m** and whose centroid G is above the contact C.

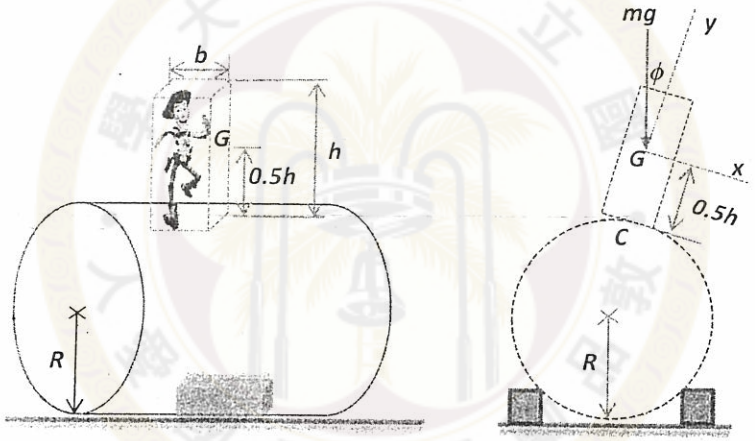
接次頁

(a) Assuming that the box does not slip, derive the differential equation of motion governing the angle ϕ by which the box rotates away from horizontal. (10%)

(b) The governing equation you just derive in (a) is nonlinear, and an analytical solution would be difficult. Thus, it normally resorts to numerical techniques to obtain the solution. Here, we want to derive test solutions to verify the numerical analysis by considering ϕ to be small. Use the approximations $\cos\emptyset \approx 1$, $\sin\emptyset \approx \emptyset$, and drop any terms that have quadratic or higher powers of ϕ to linearize the governing equation. (5%)

(c) If $h > 2R$, is the response of the linearized equation obtained in (b) a good approximation for the nonlinear governing equation derived in (a)? Is there any limitation? Explain. (Hint: Consider the solution form of the linearized equation.) (5%)

(d) If $h < 2R$, what is the influence of the length b on the response of ϕ ? (5%)



試題隨卷繳回