103 學年第一學期 普通物理 B 第二次段考試題

[Wolfson Ch. 10-14, 32] 2014/12/02, ***8:20AM – 09:50AM***

B

(i)答案卷第一張正面為封面。第一張正、反兩面不要寫任何答案。

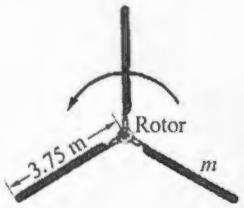
(ii)依空格號碼順序在第二張正面寫下所有填充題答案，不要寫計算過程。

(iii)依計算題之題號順序在第二張反面以後寫下演算過程與答案，每題從新的一頁寫起。

Note: Rotational inertias: disk $I_{CM} = \frac{1}{2}MR^2$, solid sphere $I_{CM} = \frac{2}{5}MR^2$, rod $I_{CM} = \frac{1}{12}ML^2$.

Part I. Filling the blank (4 points per blank)

• A helicopter rotor blade can be considered a long thin rod, as shown in the figure on the right. If each of the three rotor helicopter blades is 3.75 m long and has a mass of $m = 1.60\times10^2$ kg, calculate the moment of inertia of the three rotor blades about the axis of rotation 【1】kg·m^2. How much torque must the motor apply to bring the blades up to a speed of 5.0 rev/s in 8.0 s? 【2】 N·m.



• Consider two spring-mass systems with the same spring constant. A 200-g mass is attached to the first spring and a unknown mass is attached to the second spring. Both springs undergo simple harmonic motion with amplitude 25 cm and 75 cm, respectively. If we find that they have the same maximal acceleration, what is the mass attached to the second spring? 【3】 g.

• A double-slit experiment has slit spacing 0.12 mm. What should be the slit-to-screen distance L if the bright fringes are to be 5.0 mm apart when the slits are illuminated with 633-nm laser light? 【4】 m.

• A five-slit system with 7.5-μm slit spacing is illumined with 633-nm light. What is the angular difference (in degree) between the sixth minima and the first maxima (after the central peak)? 【5】 .

• A car horn emits 1401 Hz sound at rest. Assume the speed of sound in the air is 343 m/s. How fast is the car moving toward you if you hear the car horn at 1601 Hz? 【6】 m/s.

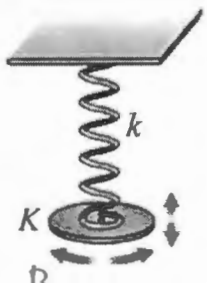
• A uniform rod of mass M and length L can pivot freely (i.e., we ignore friction) about a hinge attached to a wall, as in the figure on the right. The rod is held horizontally and then released at $t = 0$. Determine (a) the angular acceleration of the rod at $t = 0$ 【7】 s^{-2} and (b) the linear acceleration of the tip of the rod at $t = 0$. 【8】m/s^2 . (Express answers in terms of M, L, and g.)

• If a 0.15-kg baseball with a radius of 3.7 cm is thrown with a linear speed of 48 m/s and an angular speed of 42 rad/s. Assume the ball is a uniform, solid sphere. How much of its kinetic energy is rotational energy?【9】.

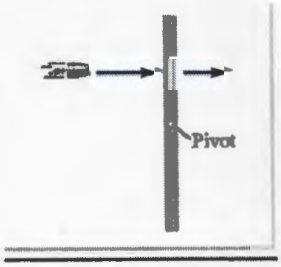
• At 1.0 m from a localized sound source you measure the intensity level as 32 dB. What is the distance you have to move toward the sound source to measure an intensity level at 52 dB? 【10】 m.

• A transverse wave with 30.0-cm amplitude and 7.5-cm wavelength is propagating on a stretched spring with density 0.17 kg/m and tension 7.6 N. (a) The speed of propagation is 【11】 m/s , (b) and the angular frequency is 【12】 s^{-1}.

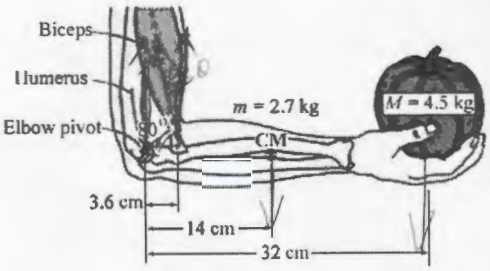
• A solid disk of radius R is suspended from a spring of spring constant k and torsional constant K as shown in the figure. What is the value of R if the period of the vertical oscillation is twice the period of the torsional oscillation? 【13】 .



• A uniform stick 1.0 m long with a total mass of 3.00×10^2 g lies on a horizontal table and is pivoted at its center. A 3.0-g bullet is shot horizontally through the stick midway between the pivot and one end. The bullet approaches at 2.50×10^2 m/s and leaves at 1.40×10^2 m/s. With what angular speed is the stick spinning after the collision? 【14】 rad/s.



• The figure on the right shows a human arm holding a pumpkin, with masses and distances marked. Fid the magnitudes of the biceps tension? 【15】 N and the contact force at the elbow joint. 【16】 N.



Part II Problems (10 points per problem)

1.

A mass m slides along a frictionless horizontal surface at speed v_0. It strikes a spring of constant k attached to a rigid wall, as shown in figure. After an elastic encounter with the spring, the mass heads back in the direction it came from. In terms of k, m, and v_0, determine (a) the time when m is in contact with the spring and (b) the amplitude of the simple harmonic motion when m is in contact with the spring.

2.

An Atwood's machine consists of two masses, m_1, m_2, and $m_1 > m_2$ which are connected by a massless inelastic cord that passes over a pulley, as shown in the right figure. If the pulley has radius R and moment of inertia $MR^2/2$ about its axle, determine (a) the acceleration of the mass m_1, (b) the tension in the cord above m_1 (c) the torque on the pulley during the motion.

3.

A 1.5-m-long pipe has one end open and the other end closed. Among its possible standing-wave frequencies is 225 Hz; the next higher frequency is 375 Hz. Find (a) the fundamental frequency and (b) the sound speed.

4.

As shown in the right figure, a solid sphere of mass M and radius r initially at rest and at a vertical height H on an incline starts to roll without slipping down the incline. Find (a) the magnitude of the friction force f_s, (b) the linear acceleration of center of mass a_{CM} and (c) the speed v when it reaches the bottom.