107 學年第一學期 普通物理 B 第二次段考試題

[Wolfson Ch. 10-14, 32] 2018/12/07, *8:20am – 09:50am*

A

(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**。

(iv)根據題目給的參數，**注意答案有效數位。(Please express your answer in significant figures.)**

The rotational inertia of a disc is $I = \frac{1}{2} \cdot M \cdot R^2$, of a hollow disc $I = M \cdot R^2$, a solid sphere $I = 2/5 \cdot M \cdot R^2$, and a hollow sphere $I = 2/3 \cdot M \cdot R^2$

Part I. Filling the blank (5 points per blank)

• During startup, a power plant's turbine accelerates from rest at 1.11 rad/s^2. How long does it take to reach its 5000-rpm operating speed? 【1】 *s*. How many revolutions does it make during this time?【2】 *rev.*

• A 5.0 m diameter merry-go-round (旋轉木馬輪) with rotational inertia 100 $kg \cdot m^2$ is spinning freely at 1 *rev/s*. Four 20 *kg* children sit suddenly on the edge of the merry-go-round. Find the new angular speed 【3】 *rad/s* !

• The potential energy associated with a particle at position x is given by $U=2x^3-2x^2-7x+10$, with x in meters and U in joules. Find the positions of any stable and unstable equilibria. 【4】 *m* 【5】 *m*

• A 550 *g* mass on a spring is oscillating at 1.0 *Hz*, with total energy 0.65 *J*. What is the oscillating amplitude? 【6】 *m.*

• A rope is stretched between supports 20.5 *m* apart; its tension is 80.5 *N*. If one end of the rope is tweaked, the resulting disturbance reaches the other end 780 *ms* later. Find the rope's mass. 【7】 *kg*

• A double slit system is used to measure the wavelength of light. The system has slit spacing d=10 μm, and slit to screen distance L=2.5 *m*. If the m=1 maximum in the interference pattern occurs 8 *cm* from the screen center. The wavelength is 【8】 *nm*

• We have an electronic harmonic oscillator. The flow of charge q(t) can be described by the following equation:

$L\frac{d^2q(t)}{dt^2} + R\frac{dq(t)}{dt} + \frac{q(t)}{C} = 0$. The time period of the undamped charge oscillation, i.e. with R = 0, is T =【9】and the time to reduce q(t) to one half in the damped case, i.e. $R \neq 0$, is t =【10】. Give the answers in terms of LRC !

• A disc (radius = 10 *cm*, mass = 100 *g*) is mounted to one end of a massless arm (l=30 *cm*), The arm-disc system rotates around the other end. The rotational inertia in respect to the center of mass is 5×10^{-4} $kg \cdot m$. The rotational inertia of the rotating disc-arm system is 【11】 $kg \cdot m$.

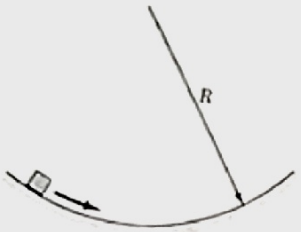
• A bat, moving at 5.00 *m/s*, is chasing a flying insect. If the bat emits a 40.0-*kHz* chirp and receives a back echo at 40.4 *kHz*, the speed of the insect is 【12】 *m/s* (the sound speed is 343 *m/s*).

• A violin string has a length of 0.400 *m* and is tuned to concert G, with $f_G = 3.92\times10^2$ *Hz*. The speed of the mechanical wave inside the string is 【13】 *m/s*. How far from the end of the string must the violinist place her finger to play concert A, with $f_A = 4.40\times10^2$ *Hz*? 【14】 *m*.

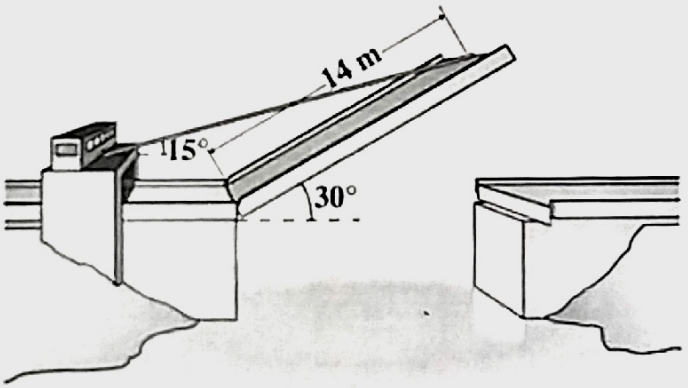
• The rotational inertia of the earth (solid sphere, mass=5.97×10^{24} *kg*, diameter=13×10^3 *km*) is 【15a】 $kg \cdot m^2$. The torque required to change each century the length of a day by 1 *s* is 【15b】 $N \cdot m$.

Part II Problems (10 points per problem)

1. A small particle of mass m slides inside a frictionless spherical bowl of radius R, as shown in the figure below. The force of the gravity on the particle is $m \cdot g$. (a) (5 pts) Show that the motion is simple harmonic for small displacements from the lowest point, (b) (5 pts) What is the period?



2. The raised span of a bridge has a mass of 11,000 kg uniformly distributed over a length of 14 m. Find the tension in the supporting cable.



3. A transverse sinusoidal wave on a string has a period $T = 30.0 \times 10^{-3}$ s and travels in the negative x direction with a speed of 40.0 m/s. At $t = 0.00$ s, an element of the string at $x = 0.00$ cm has a transverse position of 5.00 cm and is traveling downward with a speed of 3.00 m/s. (a) What is the amplitude of the wave? (b) What is the maximum transverse speed of an element of the string?