國立中山大學100學年度碩士班招生考試試題

科目：普通物理學【海資系碩士班丙組選考】

一. 單選題，共二十題，每題三分

1. A force acting on an object moving along the x axis is given by

   $F_X = (14x - 3.0x^2)$ N

   where x is in m. How much work is done by this force as the object moves from $x = -1$ m to $x = +2$ m?

   (A) +12 J (B) +28 J (C) +40 J (D) +42 J (E) –28 J

2. A solid wheel with mass M, radius R, and rotational inertia $MR^2/2$, rolls without sliding on a horizontal surface. A horizontal force F is applied to the axle and the center of mass has an acceleration a. The magnitudes of the applied force F and the frictional force f of the surface, respectively, are:

   (A) F = Ma, f = 0 (B) F = Ma, f = Ma/2

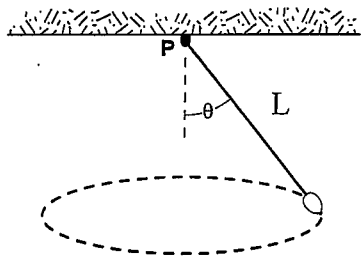
   (C) F = 2Ma, f = Ma (D) F = 2Ma, f = Ma/2

   (E) F = 3Ma/2, f = Ma/2

3. A hanged ball moves in a horizontal circle, as shown in the figure below. The length of the string is L, and the gravitational acceleration is g. What is the period of this circular motion?

   (A) $2\pi\sqrt{\frac{L\cos\theta}{g}}$ (B) $\sqrt{\frac{L\cos\theta}{g}}$ (C) $\frac{1}{2\pi}\sqrt{\frac{L\cos\theta}{g}}$

   (D) $2\pi\sqrt{\frac{L}{g}}\cos\theta$ (E) $\frac{1}{2\pi}\sqrt{\frac{L}{g}}\cos\theta$



4. A simple pendulum is suspended from the ceiling of an elevator. The elevator is accelerating upwards with acceleration a. The period of this pendulum, in terms of its length L, g, and a is:

   (A) $2\pi\sqrt{(L/g)}$ (B) $2\pi\sqrt{(L/(g+a))}$ (C) $2\pi\sqrt{(L/(g-a))}$ (D) $2\pi\sqrt{(L/a)}$ (E) $(1/2\pi)\sqrt{(g/L)}$

5. A spherical shell has inner radius R_1, outer radius R_2, and mass M, distributed uniformly throughout the shell. The magnitude of the gravitational force exerted on the shell by a point particle of mass m located a distance d from the center, outside the inner radius and inside the outer radius, is:

   (A) 0 (B) GMm/d^2 (C) $GMm/(R_2^3 - R_1^3)$

   (D) $GMm(d^3 - R_1^3)/d^2(R_2^3 - R_1^3)$ (E) $GMm/(d^3 - R_1^3)$

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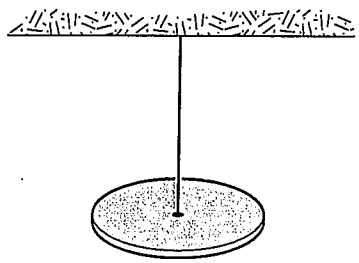
6. A satellite of mass m circles a planet of mass M and radius R in an orbit at a height $2R$ above the surface of the planet. What minimum energy is required to change the orbit to one for which the height of the satellite is $3R$ above the surface of the planet?

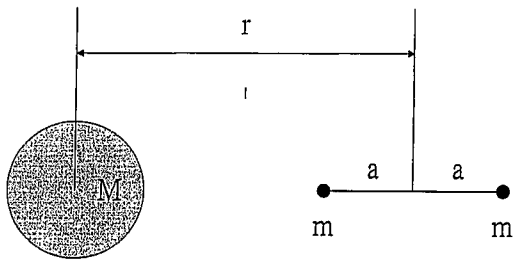
(A) $\frac{GmM}{24R}$ (B) $\frac{GmM}{15R}$ (C) $\frac{GmM}{12R}$ (D) $\frac{2GmM}{21R}$ (E) $\frac{3GmM}{5R}$

7. A torsional pendulum consists of a solid disk (mass = 2.0 kg, radius = 1.0 m) suspended by a wire attached to a rigid support. The body oscillates about the support wire. If the torsion constant is 16 N · m. What is the angular frequency (in rad/s)?



(A) 2 (B) 4 (C) 6 (D) 8 (E) 7

8. A dumbbell has a massless rod and a rod length of 2a. It is placed next to a solid sphere. If r>>a, what is the force difference (the tidal force) between the two particles?



(A) $\frac{4GMa}{5r^3}$ (B) $\frac{4GMa}{r^3}$ (C) $\frac{GMa}{r^3}$ (D) $\frac{GMm}{r^2}$ (E) $\frac{4GMm}{r^3}$

9. The temperature of n moles of an ideal monatomic gas is increased by T at constant pressure. The energy Q absorbed as heat, change E_{int} in internal energy, and work W done by the environment are given by:

(A) $Q = (5/2)nRT$, $E_{int} = 0$, $W = -nRT$
(B) $Q = (3/2)nRT$, $E_{int} = (5/2)nRT$, $W = -(3/2)nRT$
(C) $Q = (5/2)nRT$, $E_{int} = (5/2)nRT$, $W = 0$
(D) $Q = (3/2)nRT$, $E_{int} = 0$, $W = -nRT$
(E) $Q = (5/2)nRT$, $E_{int} = (3/2)nRT$, $W = -nRT$

10. An ideal gas is allowed to expand adiabatically. Assume the process is reversible. The change in entropy is:

(A) 0 (B) nR ln (V_2/V_1) (C) nR ln (T_2/T_1) (D) kn ln (V_2/V_1) (E) kn ln (T_2/T_1).

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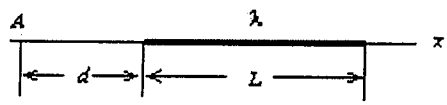
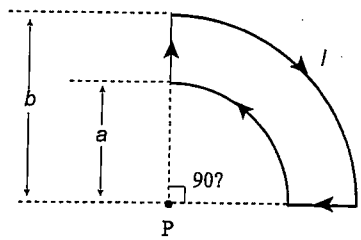
11. Positive charge Q is placed on a conducting spherical shell with inner radius R_1 and outer radius R_2. A point charge q is placed at the center of the cavity. The magnitude of the electric field at a point outside the shell, a distance r from the center, is:
(A) $Q/4\pi\varepsilon_0 R_1^2$ (B) $Q/4\pi\varepsilon_0\left(R_1^2-r^2\right)$ (C) $q/4\pi\varepsilon_0 r^2$
(D) $(q+Q)/4\pi\varepsilon_0 r^2$ (E) $(q+Q)/4\pi\varepsilon_0\left(R_1^2-r^2\right)$

12. A wire of uniform charge density λ and length L lies along the x axis as shown in Figure. What is the electric potential at point A? [$k=1/(4\pi\varepsilon)$]
(A) $k\lambda\ln[1+d/L]$ (B) $k\lambda\ln[1+L/d]$ (C) $k\lambda L/d$
(D) $k\lambda d/L$ (E) $k\lambda d/(L+d)$.



13. The semicircular wire of radius R connects two straight wire segments. If a current I follows along the wire, the magnetic field at the center of the semicircular wire due to the current in the semicircular wire is
(A) $\mu_0 I/(2R)$ (B) $\mu_0 I/(4R)$ (C) $\mu_0 I/(8R)$ (D) $\mu_0 I/(2\pi R)$

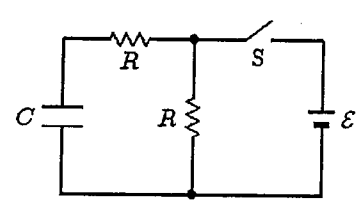
14. If a = 1.0 cm, b = 3.0 cm, and I = 30 A, what is the magnitude of the magnetic field at point P?



(A) 0.62 mT (B)0.59 mT (C)0.35 mT (D)0.31 mT (E)0.10 mT

15. Two conducting spheres have radii R_1 and R_2, with R_1 greater than R_2. If they are far apart the capacitance is proportional to:
(A) $R_1 R_2/(R_1-R_2)$ (B) $R_1^2-R_2^2$ (C) $(R_1-R_2)/R_1 R_2$
(D) $R_1^2+R_2^2$ (E) none of these.

16. In the circuit shown, both resistors have the same value R. Suppose switch S is initially closed. When it is then opened, the circuit has a time constant τ_a. Conversely, suppose S is initially open. When it is then closed, the circuit has a time constant τ_b. The ratio τ_a/τ_b is:
(A) 1 (B) 2 (C) 0.5 (D) 0.667 (E) 1.5



17. If an electron travels with speed **v** around a circle of radius **r**, then the magnitude of the orbital magnetic dipole moment is:
(A) evr/2 (B) ev/r (C) ev/2πr (D) 2πer/v (E) 2πev/r.

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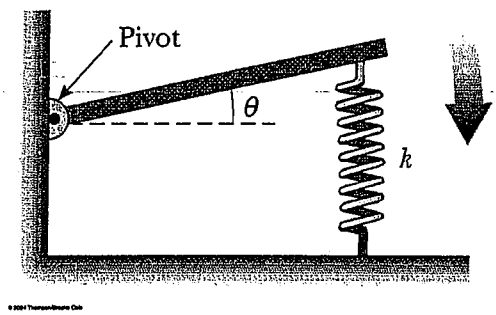
18. An inductance L, resistance R, and ideal battery of emf ε are wired in series. A switch in the circuit is closed at time 0, at which time the current is zero. At any later time t, the emf of the inductor is given by:
(A) $\varepsilon(1-e^{-Lt/R})$ (B) $\varepsilon e^{-Lt/R}$ (C) $\varepsilon(1+e^{-Rt/L})$ (D) $\varepsilon e^{-Rt/L}$ (E) $\varepsilon(1-e^{-Rt/L})$

19. Faraday's law states that an induced emf is proportional to:
(A) the rate of change of the magnetic field.
(B) the rate of change of the electric field.
(C) the rate of change of the magnetic flux.
(D) the rate of change of the electric flux.
(E) zero.

20. A 2-μF capacitor in series with a 2-k resistor is connected to a 60-Hz ac source. Calculate the impedance of the circuit.
(A) 1500 ohms (B)1800 ohms (C)2100 ohms (D)2400 ohms (E)8600 ohms

二. 計算題，每題二十分

1. A horizontal plank of mass m and length L is pivoted at one end. The plank's other end is supported by a spring of force constant k. The moment of inertia of the plank about the pivot is $\frac{1}{3}mL^2$. The plank is displaced by a small angle θ from its horizontal equilibrium position and released. (a) Find the angular frequency when it moves with simple harmonic motion. (10%) (b) Evaluate the frequency if the mass is 5.00 kg and the spring has a force constant of 100 N/m. (10%)



2. A capacitor consists of two long concentric metal cylinders of length L with the line charge density λ. The inner and outer cylinders have radii a and b, respectively.
(a) Find the capacitance of this cylindrical capacitor. (10%)
(b) Find the energy stored in this cylindrical capacitor. (10%)