類組：物理類　科目：普通物理(2002)　　共 3 頁 第 1 頁

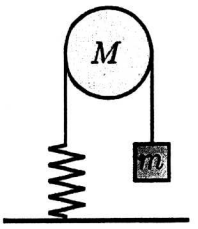
※請在答案卡內作答

單選題，一題5分，答錯倒扣1分，不作答不計分亦不扣分。

參考用

1. Two masses placed on a flat surface (friction coefficient $\mu$ = 0.1) are connected by a spring. Initially, the spring has an extension of 1 m and both masses are at rest. Given that both masses are equal, $m_1 = m_2 = 1$ kg, and the spring constant k = 9.8 N/m; what is the maximum compression of the spring? (A) 1 m (B) 0.8 m (C) 0.6 m (D) 0.4 m (E) None of the above.


2. A puck $m_1$ is sliding without friction on the ice at a speed 5 m/s along +x direction. It collides with another puck $m_2$ initially at rest. After collision, $m_1$ no longer moves along +x direction and its speed reduces to 4 m/s, see figure below. Given that $m_2 = 3\ m_1$, please find the angle between puck $m_1$ and puck $m_2$ after collision. $\theta_1 + \theta_2$ = (A) 75° (B) 90° (C) 115.66° (D) 121.33° (E) 135°.
3. A block of mass 1 kg rests on a horizontal table for which the coefficient of static friction is 0.75. One can apply a force $\vec{F}$ to pull the block. Let's say the force makes an angle of to the horizontal table. What is the minimum value of the force $|\vec{F}|$ needed to start the block moving? (A) 4.56 N (B) 5.88 N (C) 6.92 N (D) 7.35 N (E) 9.02 N.
4. Four uniform solid balls of radius R are made by lead, copper, iron, and aluminum, respectively (ordered by density as lead is the highest). Therefore, they have different masses. Given that solids balls are released from rest at the same height on an incline and they roll without slipping, which one has the largest translational speed as they reach the bottom? (A) Lead (B) Copper (C) Iron (D) Aluminum (E) All the same.
5. A pendulum consists of a massless rod and a uniform circular disk as its bob. The mass of the disk is 2 kg and the radius is 20 cm. Given that the distance between the pivot point to the center of the disk is 60 cm and it is released when the rod is 30° to the vertical. What is the speed of center of mass of the disk when the rod is vertical? (The moment of inertia of a disk is 1/2 $MR^2$) (A) 1.18 m/s (B) 1.22 m/s (C) 1.26 m/s (D) 1.30 m/s (E) 1.34 m/s.
6. A block of mass m = 0.6 kg is attached to a vertical spring (k = 0.1 N/m) via a string that hangs over a pulley (I = 1/2 $MR^2$) of mass M = 2 kg and radius R = 0.1 m, see figure. The string does not slip. What is the angular frequency of small oscillations? (A) 0.10 rad/s (B) 0.20 rad/s (C) 0.25 rad/s (D) 0.32 rad/s (E) 0.50 rad/s.




7. A certain wire stretches 4 cm when a force F is applied uniformly to the end of the wire. The same force is applied to a wire of the same material but with twice the diameter and twice the length. The second wire stretches (A) 1 cm (B) 2 cm (C) 4 cm (D) 8 cm (E) None of the above.
8. To transmit a transverse waves with an average power $P_{av}$, speed v, amplitude A and angular frequency $\omega$, along a stretched string with a tension F and a linear density $\mu$. If the tension increased fourfold, the wave velocity becomes v'. With the wavelength unchanged, the new frequency is $\omega'$. If the same amount of average power ($P'_{av} = P_{av}$) is transmitted as before, but with this new $\omega'$, then the ratio of the new amplitude to the original amplitude must be (A) 0.25 (B) 0.35 (C) 0.5 (D) 0.7 (E) 1.

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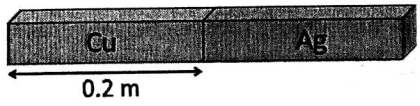
類組：物理類　科目：普通物理(2002)　　共 3 頁 第 2 頁

※請在答案卡內作答

9. An open organ pipe of length 0.6 m resonates in its fundamental mode, while a closed pipe organ of length 0.31 m also resonates in its fundamental mode. What is beat frequency heard by an audience nearby? Take the speed of sound to be 340 m/s. (A) 2.28 Hz (B) 4.57 Hz (C) 6.85 Hz (D) 9.14Hz (E) 11.43 Hz.

10. Two slits separated by 0.5 mm are illuminated with light of wavelength 480 nm. Assume the screen is far away from the slits. What is the path difference between waves that results in the first-order bright fringe? (A) 120 nm (B) 240 nm (C) 480 nm (D) 960 nm (E) None of the above.

11. Two rods of different metals are in contact as shown in the figure. The left end of the Cu rod is in contact with a hot reservoir at 500 K and the right end of the Ag rod is in contact with a cold reservoir at 150 K. The thermal conductivity for Cu and Ag are 400 W/m·K and 300 W/m·K, respectively. The length of each metal is 0.2 m and the cross section of the metal rods is 0.001 $m^2$. After a while, the temperature everywhere no longer changes with time. What is the temperature at the interface of Cu and Au? (A) 325 K (B) 328.57 K (C) 345. 68 K (D) 350 K (E) 366.67 K




12. The inventor of engine Ω claims that it has a work output W = 180 J per cycle and operates between the boiling and freezing points of water with an efficiency of $\epsilon$ = 60%. If engine Ω actually exists, what would be the entropy change for the system (reservoirs and engine) per cycle? (A) -0.51 J/K (B) -0.36 J/K (C) 0 J/K (D) 0.36 J/K (E) 0.51 J/K.

13. Three moles of an ideal monatomic gas with an initial temperature 400 K and initial pressure 5 Pa undergoes an adiabatic expansion to one-half its initial pressure. What is the ratio of the final volume to the initial volume? (A) 1.52 (B) 1.66 (C) 1.71 (D) 1.85 (E) 2.

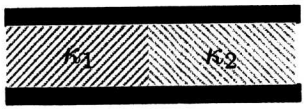
14. The propagation of sound waves in the air is very close to which of the following thermodynamic process? (A) adiabatic (B) isothermal (C) isobaric (D) isochoric (E) reversible.

15. A bulb with 200 W when operating at 120 V and another bulb with 100 W when operating at 80 V are in series connection with each other. Now a 100 V voltage source is used to operate them. What is the corresponding power? (A) 73.53 W (B) 120.67 W (C) 145.84 W (D) 178.45 W (E) 237.55 W.

16. A non-conducting sphere of radius R in the vacuum has a cavity of radius *b* at its center. The rest of the sphere has a uniform charge density ρ C/$m^3$. What is the electric field at $b < r < R$? (A) $\frac{1}{3\epsilon_0 r^2}\rho(R^3 - a^3)$ (B) $\frac{1}{3\epsilon_0 r^2}\rho(R^3 - r^3)$ (C) $\frac{1}{3\epsilon_0 a^2}\rho(R^3 - r^3)$ (D) $\frac{1}{3\epsilon_0 r^2}\rho(r^3 - a^3)$ (E) None of the above.

17. Two identical drops of mercury have identical charges and a potential of $V_0$ at each surface. The drops collide and combine into a larger drop with no loss in charge. What is the potential at the surface of The large drop? (A) $\frac{1}{\sqrt{2}}V_0$ (B) $\frac{1}{\sqrt[3]{2}}V_0$ (C) $\frac{2}{\sqrt[3]{2}}V_0$ (D) $\sqrt[3]{2}V_0$ (E) $\sqrt{2}V_0$.

18. The space between the plates of a parallel-plate capacitor is filled with two dielectrics of equal size, as shown in the figure. What is the

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resulting capacitance in terms of $\kappa_1$, $\kappa_2$, and $C_0$, the capacitance with a vacuum between plates?

(A) $\frac{C_0}{2}(\kappa_1+\kappa_2)$ (B) $C_0(\kappa_1+\kappa_2)$ (C) $C_0\frac{\kappa_1\kappa_2}{(\kappa_1+\kappa_2)}$ (D) $C_0\frac{2\kappa_1\kappa_2}{(\kappa_1+\kappa_2)}$ (E) None of the above.

19. A square coil of side L carries a current $I_0$. What is the magnetic field strength at its center? (A) $\frac{\mu_0 I_0}{\pi L}$ (B) $\sqrt{2}\frac{\mu_0 I_0}{\pi L}$ (C) $2\frac{\mu_0 I_0}{\pi L}$ (D) $2\sqrt{2}\frac{\mu_0 I_0}{\pi L}$ (E) None of the above.

20. At a distance of 6m from a monochromatic (single wavelength) point source, the amplitude of the electric field is 10 V/m. What is the average power output of the source? (A) 30 W (B) 45 W (C) 60W (D) 90W (E) None of the above.