國立中興大學114學年度

學士後醫學系公費生招生考試

物理科試題

考試時間：100分鐘

考試開始鈴響前，不得翻閱試題，且不得書寫、劃記、作答!
本考試不得使用計算機

考生請注意：

一、考生應確實關閉行動電話(或取出電池)及手錶之鬧鈴設定；除准考證及考試必需用品外，所有物品(含行動電話、穿戴式裝置等)均應立即放置於臨時置物區，不得發出聲響或有影響試場秩序之情形。

二、請確認抽屜中、桌椅下、座位旁均無其他非必要用品。如有任何問題請立即舉手反映。

三、坐定後，雙手離開桌面，請核對並確認准考證、座位標籤、及答案卡上之准考證號碼是否完全相同。如有錯誤，應立即舉手請監試人員處理。

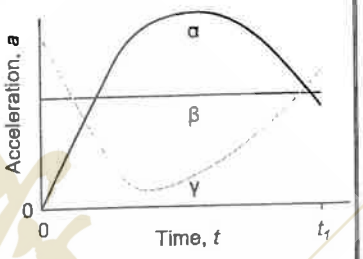
四、考生應試時不得飲食、飲水、抽菸、嚼食口香糖。

五、答案卡劃記以2B鉛筆為佳，劃記時要粗黑、清晰，劃滿作答格，不可出格，不得折損答案卡，修正作答以軟性橡皮擦擦拭乾淨，且不得使用修正液(帶)修正，未遵照正確作答方式而致機器無法正確辨識答案者，考生自行負責，不得以任何理由補救。答案寫在試題紙上者不予計分。

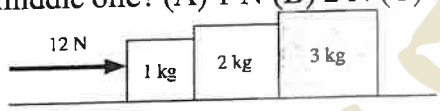
六、本試題必須與答案卡一併繳回，不得攜出試場。

選擇題(單選題，共 50 題，一題 2 分，答錯不扣分，請選擇最適切答案)

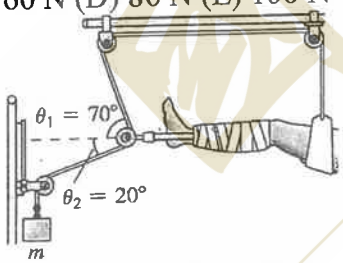
1. The graph shows acceleration versus time for three different objects, α, β, and γ, all of which start at rest from the same position. Which object is going fastest at the time t_1? (A) object α (B) object β (C) object γ (D) objects α and γ (E) objects α, β, and γ



2. Consider a projectile launched upward near the surface of Earth from the origin at some angle θ_0 to the horizontal, with initial speed v_0. The horizontal position x can be calculated as $x = v_0 cos\theta_0 t$. On the other hand, under the influence of gravity with gravitational acceleration g, the height y can be expressed by a function of x as (A) $y = xtan\theta_0 + \frac{g}{2v_0^2 sin^2\theta_0}x^2$ (B) $y = xcot\theta_0 + \frac{g}{2v_0^2 cos^2\theta_0}x^2$ (C) $y = xcot\theta_0 - \frac{g}{2v_0^2 cos^2\theta_0}x^2$ (D) $y = xtan\theta_0 + \frac{g}{2v_0^2 cos^2\theta_0}x^2$ (E) $y = xtan\theta_0 - \frac{g}{2v_0^2 cos^2\theta_0}x^2$
3. A 740-kg elevator accelerates upward at 0.2 m/s^2, pulled by a cable of negligible mass. Note that the acceleration due to gravity $g = 9.8$ m/s^2. What is the tension force in the cable? (A) 74 N (B) 740 N (C) 7400 N (D) 74000 N (E) None of the above
4. Blocks of 1, 2, and 3 kg are lined up on a frictionless table, as shown in the figure, with a 12-N force applied to the leftmost block. What's the magnitude of the force that the rightmost block exerts on the middle one? (A) 1 N (B) 2 N (C) 3 N (D) 6 N (E) 12 N



5. Patients with severe leg breaks are often placed in traction, with an external force countering muscles that would pull too hard on the broken bones. In the arrangement shown in the figure, the mass m is 5 kg, and the pulleys can be considered massless and frictionless. Note that $sin20° \approx 0.34$ and $sin70° \approx 0.94$. What is the horizontal traction force applied to the leg? About (A) 20 N (B) 40 N (C) 60 N (D) 80 N (E) 100 N



6. An elastic cord used in bungee jumping is normally 10 m long and has spring constant $k = 250$ N/m. At the lowest point in a jump, the cord length has doubled. How much work has been done on the cord? (A) 2.5 kJ (B) 12.5 kJ (C) 25 kJ (D) 125 kJ (E) 250 kJ
7. A 1.5-tonne car accelerates from 10 to 20 m/s in 10 s on a flat road. How much work is done on the car? (A) 225 J (B) 2.25 kJ (C) 22.5 kJ (D) 225 kJ (E) 2.25 MJ
8. Based on Newton's law of universal gravitation and Newton's second law of motion, Kepler's third law $\frac{r^3}{T^2} = \text{constant}$, where r is the radius of the circular path and T is the orbital period, can be derived. The constant, $\frac{r^3}{T^2}$, should be (A) $\frac{2GM}{\pi^2}$ (B) $\frac{GM}{2\pi^2}$ (C) $\frac{GM}{4\pi^2}$ (D) $\frac{GM}{4\pi}$ (E) $\frac{GM}{2\pi}$.
9. A rocket is launched vertically upward at velocity v around the surface of Earth. The constant of universal gravitation, the radius of Earth, and the mass of Earth are G, R_E, and M_E, respectively.

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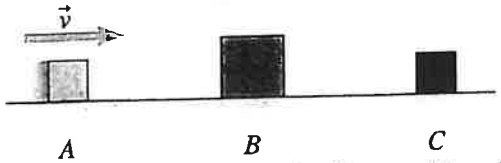
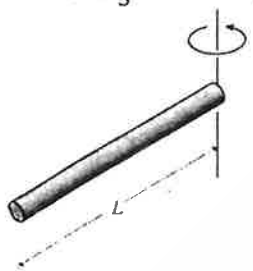
Neglect the air resistance and friction. What is the maximum height it can reach?(A) $\left(\frac{v^2}{2GM_E}-\frac{1}{R_E}\right)^{-2}$ (B) $\left(\frac{v^2}{GM_E}-\frac{1}{R_E}\right)^{-1}$ (C) $\left(\frac{1}{R_E}-\frac{v^2}{2GM_E}\right)^{-2}$ (D) $\left(\frac{1}{R_E}-\frac{v^2}{GM_E}\right)^{-1}$ (E) $\left(\frac{1}{R_E}-\frac{v^2}{2GM_E}\right)^{-1}$

10. In the figure, blocks B and C have masses $2m$ and m, respectively, and are at rest on a frictionless surface. Block A, also of mass m, is heading at speed v toward block B. Assume all collisions are elastic. After all subsequent collisions are over, which of the following final velocity is necessarily true? (A) $v_{Af}=\frac{1}{3}v$ (B) $v_{Af}=-\frac{1}{3}v$ (C) $v_{Bf}=\frac{2}{3}v$ (D) $v_{Bf}=-\frac{2}{3}v$ (E) $v_{Cf}=\frac{1}{3}v$



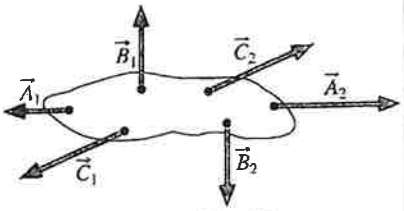
11. A uniform, narrow rod of mass M and length L rotates freely about an axis through one of its ends and perpendicular to the rod, as shown below. The rotational inertia of the rod about this axis is (A) $\frac{1}{2}ML^2$ (B) $\frac{1}{3}ML^2$ (C) $\frac{1}{4}ML^2$ (D) $\frac{1}{5}ML^2$ (E) $\frac{1}{12}ML^2$.



12. A solid ball of mass M and radius R starts from rest and rolls down a hill. Its center of mass drops a total distance h. What is the ball's speed at the bottom of the hill under the influence of gravity with gravitational acceleration g? (A) $\sqrt{2gh}$ (B) $\sqrt{\frac{1}{2}gh}$ (C) $\sqrt{\frac{1}{3}gh}$ (D) $\sqrt{\frac{5}{3}gh}$ (E) $\sqrt{\frac{10}{7}gh}$

13. For a simple pendulum with length L swinging back and forth through a small angle, under the influence of gravity with gravitational acceleration g, the angular frequency ω is approximately equal to (A) $\sqrt{\frac{g}{L}}$ (B) $\sqrt{\frac{L}{g}}$ (C) $\sqrt{\frac{g}{2L}}$ (D) $\sqrt{\frac{2L}{g}}$ (E) $2\pi\sqrt{\frac{L}{g}}$.

14. The figure shows three pairs of forces acting on an object. Which pair, acting as the only forces on the object, results in static equilibrium? (A) Pair A, forces $\vec{A}_1$ and $\vec{A}_2$ (B) Pair B, forces $\vec{B}_1$ and $\vec{B}_2$ (C) Pair C, forces $\vec{C}_1$ and $\vec{C}_2$ (D) Pairs A and B (E) All of the above

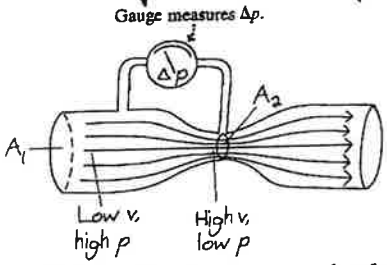


15. The density of a rubber ball is three-fifths that of water. When placed in water, the ball will (A) float with less than one-third of it out of the water (B) float with less than one-fifth of it out of the water (C) float with less than half of it out of the water (D) float with more than half of it out of the water (E) sink.

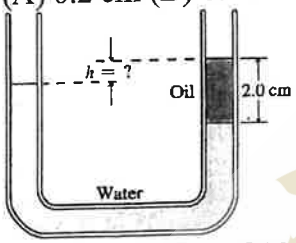
16. Two identical stars are different distances from Earth, and the intensity of the light from the more distant star as received at Earth is only 1% that of the closer star. The more distant star should be (A) twice (B) $\sqrt{10}$ times (C) 10 times as far away (D) 100 times (E) 1000 times as far away.

17. A string 1 m long is clamped tightly at one end and is free to slide up and down at the other. Which of the following is a possible wavelength for standing waves on this string? (A) 1 m (B) $\frac{4}{3}$ m (C) $\frac{5}{4}$ m (D) 2 m (E) 3 m

18. An incompressible fluid of density ρ flows through a horizontal pipe of cross-sectional area A_1. The pipe has a venturi constriction of area A_2, and a gauge measures the pressure difference Δp between the unconstructed pipe and the venturi. What is the expression for the flow speed in the unconstructed pipe? (A) $\sqrt{\frac{\Delta p}{\rho(A_2^2/A_1^2-1)}}$ (B) $\sqrt{\frac{\Delta p}{\rho(A_1^2/A_2^2-1)}}$ (C) $\sqrt{\frac{2\Delta p}{\rho(A_2^2/A_1^2-1)}}$ (D) $\sqrt{\frac{2\Delta p}{\rho(A_1^2/A_2^2-1)}}$ (E) $\sqrt{\frac{4\Delta p}{\rho(A_2^2/A_1^2-1)}}$



19. A U-shaped tube open at both ends contains water and a quantity of oil occupying a 2.0-cm length of the tube as shown in the figure. If the oil's density is 80% of water's, what's the height difference h? (A) 0.2 cm (B) 0.4 cm (C) 0.6 cm (D) 0.8 cm (E) 1.6 cm



20. You draw 200 g of 10 °C water from the tap and pop it into an 800-W microwave oven to heat. The specific heat capacity of water is 1 cal·g^{-1}·°C^{-1} or 4.184 J·g^{-1}·°C^{-1}. How long should you microwave the water so it just reaches the boiling point of water, 100 °C at 1 atm? Approximately (A) 30 s (B) 60 s (C) 90 s (D) 120 s (E) 150 s

21. C_v and C_p are defined as the molar specific heat at constant volume and the molar specific heat at constant pressure, respectively. For an ideal gas, which one is larger, C_v or C_p? What is the difference between C_v and C_p? Note that R is the universal gas constant. (A) C_v, R (B) C_v, $1.5R$ (C) C_v, $2R$ (D) C_p, R (E) C_p, $2R$

22. Based on the first law of thermodynamics, in isothermal ideal-gas processes, which one should be zero? Note that ΔE_{int}, Q, W, V, and p are the change in the system's internal energy, the heat supplied to the system, the work done on the system, the gas volume, and the gas pressure, respectively. (A) ΔE_{int} (B) Q (C) W (D) V (E) p

23. Based on the first law of thermodynamics, in adiabatic ideal-gas processes, which one should be a nonzero constant? Note that ΔE_{int}, Q, W, p, V, γ, and T are the change in the system's internal energy, the heat supplied to the system, the work done on the system, the gas pressure, the gas volume, the ratio of the specific heats at constant pressure and at constant volume ($= C_p/C_v$), and the gas temperature, respectively. (A) ΔE_{int} (B) Q (C) W (D) $pV^{\gamma-1}$ (E) $TV^{\gamma-1}$

24. Which of the following atom or molecule has three rotational degrees of freedom? (A) Ar (B) H_2 (C) O_2 (D) CO_2 (E) NO_2

25. "The entropy of the universe can never decrease." is a statement related to (A) the zeroth law (B) the first law (C) the second law (D) the third law (E) the fourth law of thermodynamics.

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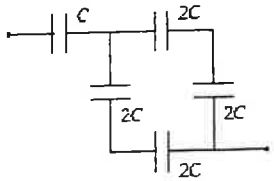
26. A 16-nC charge is distributed uniformly along the x axis from $x = 0$ to $x = 4\,m$. Which of the following integrals is correct for the magnitude (in N/C) of the electric field at $x = +10$ m on the x axis? The Coulomb constant is 9.0×10^9 N·m^2/C^2. (A) $\int_0^4 \frac{36}{(10-x)^2}dx$ (B) $\int_0^4 \frac{154}{(10-x)}dx$ (C) $\int_0^4 \frac{154}{x^2}dx$ (D) $\int_0^4 \frac{36}{x}dx$ (E) none of these.

27. Charges q and Q are placed on the x axis at $x = 0$ and $x = 2.0$ m, respectively. If $q = -40$ pC and $Q = +30$ pC, determine the net flux through a spherical surface (radius = 1.0 m) centered on the origin. The permittivity of free space is 8.85×10^{-12} C^2 / N·m^2. (A) -9.8 N · m^2/C (B) -7.8 N · m^2/C (C) -4.5 N · m^2/C (D) -1.3 N · m^2/C (E) $+2.0$ N · m^2/C.

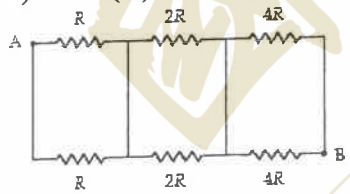
28. For the potential $V = 3x^2z - 2yz^3$, what is the corresponding electric field at the point (2,2,2)? Note that $\hat{\imath}, \hat{\jmath}$, and $\hat{k}$ are unit vectors along x, y, and z directions, respectively. (A) $-24\hat{\imath} + 16\hat{\jmath} + 36\hat{k}$ (B) $+24\hat{\imath} - 16\hat{\jmath} - 36\hat{k}$ (C) $-12\hat{\imath} + 16\hat{\jmath} + 16\hat{k}$ (D) $+12\hat{\imath} - 16\hat{\jmath} - 16\hat{k}$ (E) none of these.

29. Determine the equivalent capacitance of the combination shown when C = 24 μF. (A) 24 μF (B) 16 μF (C) 36 μF (D) 27 μF (E) 12 μF.



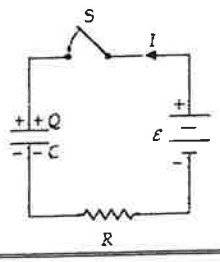
30. Light bulb A is rated at 60 W and light bulb B is rated at 100 W. Both are designed to operate at 110 V. Which statement is correct? (A) The 60 W bulb has a greater resistance and greater current than the 100 W bulb. (B) The 60 W bulb has a greater resistance and smaller current than the 100 W bulb. (C) The 60 W bulb has a smaller resistance and smaller current than the 100 W bulb (D) The 60 W bulb has a smaller resistance and greater current than the 100 W bulb. (E) We need to know the resistivities of the filaments to answer this question.

31. What is the equivalent resistance between points A and B in the figure when $R = 20\ \Omega$? (A) 20 Ω (B) 40 Ω (C) 70 Ω (D) 90 Ω (E) 84 Ω



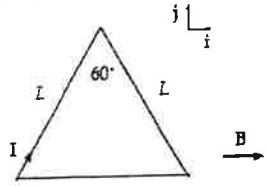
32. A 2.0-m wire carries a current of 15 A directed along the positive x axis in a region where the magnetic field is uniform and given by $\boldsymbol{B}=(30\hat{\imath} - 40\hat{\jmath})$ mT. What is the resulting magnetic force on the wire? (A) $(1.2\hat{k})$ N (B) $(-1.2\hat{k})$ N (C) $(-1.5\hat{k})$ N (D) $(+1.5\hat{k})$ N (E) $(+0.9\hat{k})$ N

33. At $t = 0$ the switch S is closed with the capacitor uncharged. If $C = 30\ \mu F$, $\varepsilon = 30\ V$, and $R = 5.0\ k\Omega$, at what rate is energy being stored in the capacitor when $I = 2.0\ mA$? (A) 15 mW (B) 40 mW (C) 45 mW (D) 70 mW (E) 90 mW

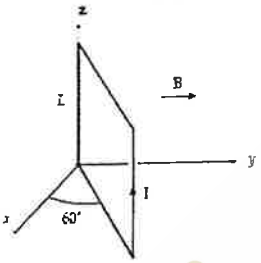


34. We find that N current loops are coplanar and coaxial. The first has radius a and current I. The second has radius $2a$ and current $2I$, and the pattern is repeated up to the Nth, which has radius Na and current NI. The current in each loop is counterclockwise as seen from above. The magnitude of the magnetic field at the center of the loops is (A) $\mu_0 I/2Na$ (B) $\mu_0 I/Na$ (C) $\mu_0 I/2a$ (D) $\mu_0 NI/2a$ (E) $\mu_0 NI/a$

35. A wire with current I is bent into the shape in a uniform magnetic field **B** as shown in the figure. Determine the net magnetic force on the wire. (A) IBL in the $+z$ direction (B) IBL in the $-z$ direction (C) $\sqrt{3}IBL$ in the $+z$ direction (D) $\sqrt{2}IBL$ in the $-z$ direction (E) Zero

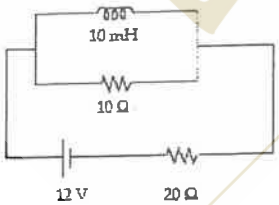


36. A square loop ($L = 0.20$ m) consists of 50 closely wrapped turns, each carrying a current of 0.50 A. The loop is oriented as shown in a uniform magnetic field of 0.40 T directed in the positive y direction. What is the magnitude of the torque on the loop? (A) 0.15 N · m (B) 0.35 N · m (C) 0.55 N · m (D) 0.75 N · m (E) 1.73 N · m



37. Coaxial Cable A has twice the length, twice the radius of the inner solid conductor, and twice the radius of the outer cylindrical conducting shell of coaxial Cable B. What is the ratio of the inductance of Cable A to that of Cable B? (A) 4 ln 2 (B) 2 ln 2 (C) ln 2 (D) 4 ln 4 (E) 2

38. For the circuit shown, what is the rate of change of the current in the inductor when the current in the battery is 0.50 A? (A) 200 A/s (B) 300 A/s (C) 400 A/s (D) 500 A/s (E) 600 A/s



39. A flat coil of wire consisting of 20 turns, each with an area of 50 cm^2, is positioned perpendicularly to a uniform magnetic field that increases its magnitude at a constant rate from 2.0 T to 6.0 T in 2.0 s. If the coil has a total resistance of 0.40 Ω, what is the magnitude of the induced current? (A) 0.2 A (B) 0.5 A (C) 0.7 A (D) 0.9 A (E) 1.0 A

40. An open circuit consists of a 12 μF parallel plate capacitor charged to 200 V and a 10 Ω resistor. At the instant when a switch closes the circuit (with no battery in it) the displacement current between the plates of the capacitor is (A) 1.2 μA (B) 2.4×10^{-4} A (C) 2.4 mA (D) 10 A (E) 20 A

41. If the maximum E-component of an electromagnetic wave in free space is 600 V/m, what is the maximum B-component? (A) 1.4 T (B) 1.6×10^{-5} T (C) 2.0×10^{-6} T (D) 1.0×10^{-3} T (E) 1.8×10^{-9} T

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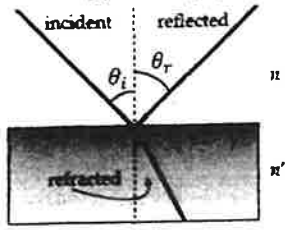
42. What is the average value of the magnitude of the Poynting vector at 1 meter from a 100-watt lightbulb radiating uniformly in all directions? (A) 1 W/m^2 (B) 2 W/m^2 (C) 4 W/m^2 (D) 8 W/m^2 (E) 16 W/m^2

43. A light ray is partially reflected and partially refracted at a boundary between two media. The upper (lower) medium has index of refraction n (n'). The angle of incidence (reflection) is θ_i (θ_r). The reflected ray is perpendicular to the refracted ray when (A) $n' = n \tan\theta_i$ (B) $n' = n \cot\theta_i$ (C) $n' = n \sin\theta_i / \sin\theta_r$ (D) $n' = n \sin\theta_i / \cos\theta_r$ (E) $n' = n \sec\theta_r$



44. When light is refracted, the quantity that does not change in either process is its (A) direction of travel (B) dispersion (C) frequency (D) speed (E) wavelength

45. An optical fiber has a refractive index of $n = 2.0$, while the surrounding air has a refractive index of 1.00. If light propagates inside the fiber and is incident on the interface between the fiber and air, at what minimum angle (the critical angle) will total internal reflection occur? (A) 15° (B) 30° (C) 45° (D) 60° (E) 89°

46. To create a nonreflective coating for a camera lens, a film of index of refraction $n_1 = 2.0$ coats the surface of the lens, which has an index of refraction $n_2 = 1.5$. This coating leads to destructive interference for reflected monochromatic light of wavelength 600 nm in air. Assuming the light ray is incident on the film at nearly normal incidence, what could be the possible thickness of the coating film? (A) 200 nm (B) 300 nm (C) 400 nm (D) 500 nm (E) 800 nm

47. White light is spread out into spectral hues by a diffraction grating. If the grating has 1000 lines per cm, at what angle will red light ($\lambda = 640$ nm) appear in first order? (A) 14.7° (B) 7.35° (C) 17.7° (D) 3.67° (E) 0.80°

48. The light intensity incident on a metallic surface produces photoelectrons with a maximum kinetic energy of 2 eV. The light intensity is doubled. Determine the maximum kinetic energy of the photoelectrons. (A) 4 eV (B) 2 eV (C) $\sqrt{2}$ eV (D) 3 eV (E) 16 eV

49. When a photon collides with a free electron at rest and the direction of motion of the photon changes, (A) the magnitude of the momentum of the photon does not change. (B) the momentum of the electron does not change. (C) the kinetic energy of the electron does not change. (D) the total energy of the photon does not change. (E) both the magnitude of the momentum and the total energy of the photon decrease.

50. A baseball (1 kg) has an energy of 100 joules. If its uncertainty in position is 1.0 m, what is the minimum percentage uncertainty in the momentum ($\frac{\Delta p}{p} \times 100\ \%$) of the baseball? Here, p (Δp) is the momentum (momentum uncertainty) of the baseball. (A) $\ll 1\%$ (B) 1% (C) 2% (D) 5% (E) 10%