● 本 A 科目試題含普通物理（第 1～30 題）、物理冶金（第 31～60 題）、近代物理（第 61 ～90 題）三科目之試題，計 90 題，每一題為 4 選 1，每一題答對得 1 分，答錯倒扣 0.25 分，未作答者不給分亦不扣分，滿分為 90 分。

1. In 1977, Kitty O'Neil set a dragster record by reaching 392.54 mi/h in a sizzling time of 3.72s. In 1958, Eli Beeding Jr. rode a rocket sled from a standstill to a speed of 72.5 mi/h in an elapsed time of 0.04s. How can we compare these two rides to see which was more exciting (or more frightening)?

    (a) by final speeds   (b) by elapsed times

    (c) by acceleration speeds   (d) (a) and (b)

2. Which of the following atom is usually used for measuring the atomic mass?

    (a) C12   (b) O16   (c) C60   (d) H1

3. Two stones each travels in circle over a frictionless surface. Each stone is tied to a cord whose opposite end is anchored at the center of the circle. If the stones travel (1) at the same speed and (2) with the same period of motion, the tension in the longer cord is _____ than that in the shorter cord.

    (a) Both larger   (b) Less, larger   (c) Larger, less   (d) Both less

4. If c is the scalar product of a and b, where a= 2i+4j and b= 8i+16j what is c?

    (a) 16i + 64j   (b) 32i +32 j   (c) 80   (d) 0

5. A rescue plane is flying at a constant elevation of 1200 m with a speed of 430 km/h toward a point directly over a person struggling in the water. When calculating the angle of sight ϕ for the pilot to release a rescue capsule that is very close to the person in water what assumption should we made?

    (a)Vo= 430km/h   (b) Vo= 430km/h-1/2 gt^2 (c) θo=0   (d) (a) and (c)

6. If a spring was cut in half, the spring constant of either half is how many times that of the original spring? (*Hint*: Consider the amount by which each half stretches for a given value of force.)

    (a) 1/2   (b) 1   (c) 2   (d) 4

7. When a particle moves from *f* to *i* and from *j* to *i* along the paths shown in the figure, and in the indicated directions, a conservative force **F** does the indicated amounts of work on it. How much work does **F** do when the particle moves from *f* to *j*?

   (a) 0   (b) 40J   (c) -40J   (d) -20J
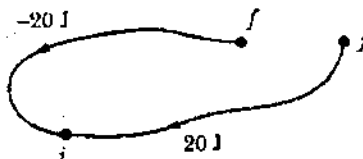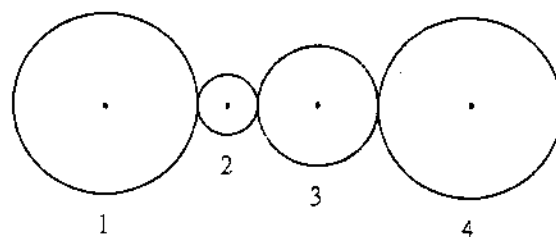
11. Figure (a) shows a meter stick which is half wood and half steel, that is pivoted at the wood end at O. A force F is applied to the steel end at a. Figure (b) shows the stick is reversed and pivoted at the steel end at O' and the same force F is applied to the wood end at a'. Is the resulting angular acceleration of meter stick arrangement in Figure (a) _____ that of the arrangement in figure (b)

　　（a）greater than 　（b）less than 　（c）the same 　（d）incomparable


(a)　　　　　　(b)
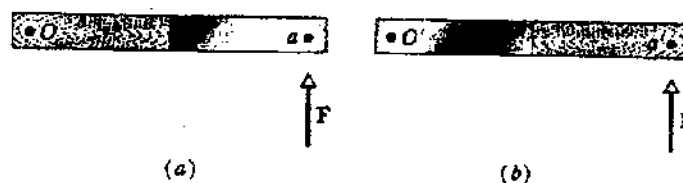
12. Wheel A and B in the following figure are connected by a belt that does not slip. The radius of wheel B is three times the radius of wheel A. What would be the ratio of the rotational inertias I_A/I_B if both wheels had the same angular momenta about their central axes?

　　（a）3　　（b）1/3　　（c）9　　（d）1/9
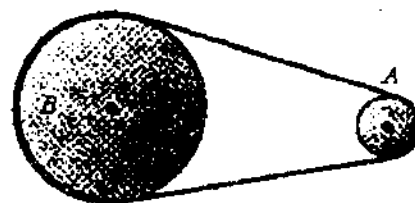
13. Figures below show four arrangements in which each painting is suspended from a wall with two identical lengths of wire. The angles between wires and the horizontal side of the painting in figure (b) and (c) are the same. Rank the four arrangements according to the tension in the wires, largest first.

　　（a）a > b = c > d　　（b）a < b = c < d
　　（c）a > c > d > b　　（d）a < c < d < b


(a)　　　　　(b)　　　　　(c)　　　　　(d)
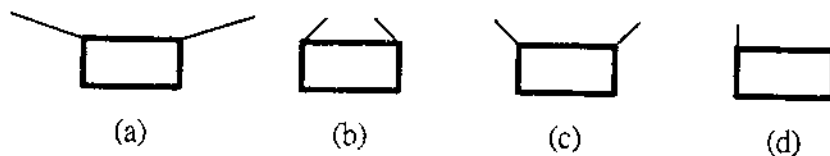
8. A horizontally moving block can take three frictionless routes, differing in elevation, to reach the dashed finish line.), rank the routes according to the speed of the block to the finish line, greatest first.

（a）321　　（b）123　　（c）132　　（d）231
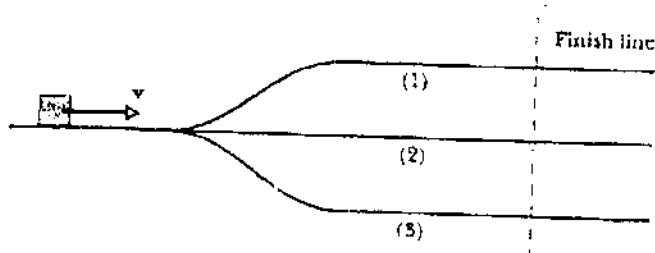
9. A stationary croquet ball with mass 0.50kg is struck by a mallet, receiving the impulse shown in the following figure. What is the ball's velocity just after the force has become zero?

（a）4m/s　　（b）8 m/s　　（c）1 m/s　　（d）2m/s
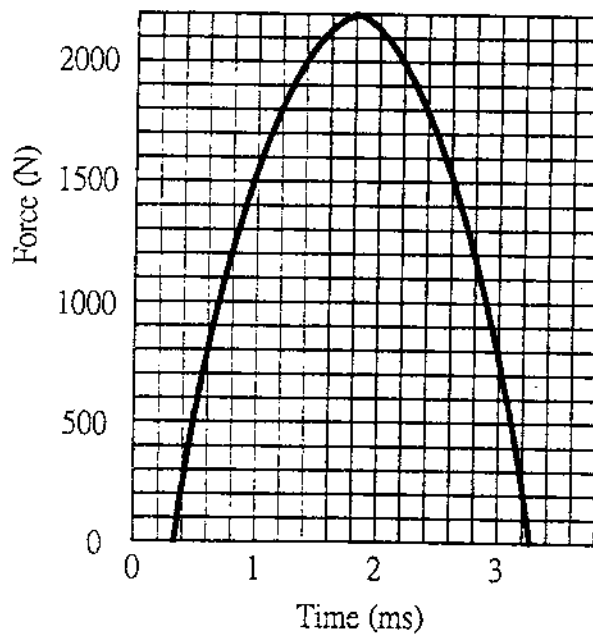
10. As shown in the following figure, four gears rotate because of friction between them. Gear 1 and Gear 4 has the same radius. Gear 2 is forced to rotate by a motor. Which gear has the same angular speed of rotation as Gear 1?

（a）Gear 2　　（b）Gear 3　　（c）Gear 4　　（d）Gear 2, 3 and 4

14. A mass M is split into two parts, m and M-m, which are then separated by a certain distance. What ratio of m/M maximizes the gravitational force between the parts?

    (a) 1   (b) 1/2   (c) 1/4   (d) 1/8

15. Figures below shown three physical pendulums consisting of identical uniform spheres of the same mass that are rigidly connected by identical rods of negligible mass. Each pendulum is vertical and can pivot about suspension point O. Rank the pendulums according to period of oscillation, greatest first.

    (a) a, b, c   (b) b, c, a   (c) b, a, c   (d) c, b, a
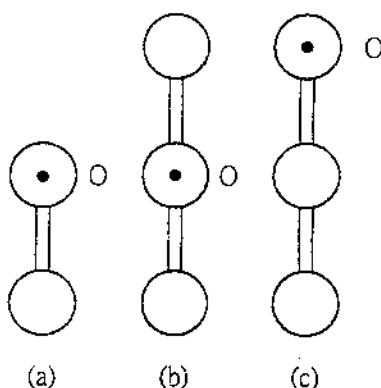
16. An electric field of 280,000 N/C points due south at a certain spot. What are the magnitude and direction of the force that acts on a charge of -4.0 μC at this spot? (a) 1.1N due north (b) 1.1N due south (c) 11N due north (d) 11N due south

17. An electric flux of 160 N.m^2/C passes through a flat horizontal surface that has an area of 0.70 m^2. The flux is due to a uniform electric field. What is the magnitude of the field if the field points vertically? (a) 2.3   (b) 23   (c) 230   (d) 2300 N/C.

18. There is an electric potential of +130 V at a spot that is 0.25 m away from a charge. Find the magnitude and sign of the charge. (a) +3.6 * 10^{-8} (b) -3.6 * 10^{-8} (c) +3.6 * 10^{-9} (d) -3.6 * 10^{-9} C

19. Consider the equipotential surfaces that surround a point charge of +1.50 * 10^{-8} C. How far from the 190-V surface is the 75-V surface? (a) 0.9m (b) 1.0m (c) 1.1m (d) 1.2m

20. A toaster has a resistance of 14 Ω and is plugged into a 120-V outlet. What is the current in the toaster? (a) 8.5 (b) 8.6 (c) 8.7 (d) 8.8 A

21. A wire has a resistance of 21.0 Ω. It is melted down, and from the same volume of metal a new wire is made that is three times longer than the original wire. What is the resistance of the new wire? (a) 159 (b) 169 (c) 179 (d) 189 Ω.

22. The current in a circuit is ac and has a peak value of 2.5 A. Determine the rms current. (a) 1.77 (b) 1.79 (c) 1.81 (d) 1.83 A

23. A battery has an emf of 12.0 V and an internal resistance of 0.15Ω. What is the terminal

voltage when the battery is connected to a 1.50 Ω resistor? (a) 10.8 (b) 10.9 (c) 11 (d) 11.1 V

24. A charge of 12 μC, traveling with a speed of $9.0 * 10^6$ m/s in a direction perpendicular to a magnetic field, experiences a magnetic force of $8.7 * 10^{-3}$ N. What is the magnitude of the field? (a) $8.1 *10^{-3}$ (b) $8.1 *10^{-4}$ (c) $8.1 *10^{-5}$ (d) $8.1 *10^{-6}$ T

25. A beam of protons moves in a circle of radius 0.25m. The protons move perpendicular to a 0.30 T magnetic field. What is the speed of each proton? (a) $7.2 *10^6$ (b) $7.2 *10^7$ (c) $3.6*10^6$ (d) $3.5*10^7$ m/s

26. A wire of length 0.655 m carries a current of 21.0 A. In the presence of a 0.470 T magnetic field, the wire experiences a force of 5.46 N. What is the angle between the wire and the magnetic field? (a) 45° (b) 90° (c) 37.6° (d) 57.6°

27. A long solenoid consists of 1400 turns of wire and has a length of 0.65 m. There is a current of 4.7 A in the wire. What is the magnitude of the magnetic field within the solenoid? (a) $1.3 *10^{-2}$ (b) $1.3 *10^{-1}$ (c) $2.6 *10^{-2}$ (d) $2.6 *10^{-1}$ T

28. A charged particle with a charge-to-mass ratio of $5.7 * 10^8$ C/kg travels on a circular path that is perpendicular to a magnetic field whose magnitude is 0.72 T. How much time does it take for the particle to complete one revolution? (a) $1.5 *10^{-4}$ (b) $1.5 *10^{-6}$ (c) $1.5 *10^{-8}$ (d) $1.5 *10^{-10}$ sec

29. Some of the X-rays produced in an X-ray machine have a wavelength of 2.1nm. What is the frequency of these electromagnetic waves? (a) $1.4*10^{15}$ (b) $1.4*10^{16}$ (c) $1.4*10^{17}$ (d) $1.4*10^{18}$ Hz

30. Two diverging light rays, originating from the same point, have an angle of 10° between them. After the rays reflect from a plane mirror, what is the angle between them? (a) 0 (b) 10 (c) 20 (d) 90

31. In two-component system, the maximum number of phases can co-exist at a fixed pressure is (a) 0, (b) 1, (c) 2, (d) 3.

32. For the reaction: liquid solution + solid solution = solid solution, please specify the type of phase transformation. (a) eutectic, (b) eutectoid, (c) peritectic, (d) monotectic.

33. Compare the free energy change for a homogeneous nucleation ($\triangle G_{hom}$) to that for a heterogeneous nucleation ($\triangle G_{het}$), which of the followings is true? (a) $\triangle G_{hom} > \triangle G_{het}$, (b) $\triangle G_{hom} < \triangle G_{het}$, (c) $\triangle G_{hom} = \triangle G_{het}$, (d) none of the above.

34. Which of the following transformations does not involve diffusion: (a) precipitation transformation, (b) martensitic transformation, (c) order-disorder transformation, (d) eutectoid transformation.

35. For diffusion-controlled gain growth behavior, which of the followings best describes the coarsening of precipitate particles (where r is the radius of the precipitate and t is time):

(a) $r^3 \propto t$, (b) $r^2 \propto t$, (c) $r \propto t$, (d) $r = $ constant.

36. The solubilities of carbon in ferrite and austenite at eutectoid temperature are 0.02 wt% and 0.8 wt%, respectively. What is the equilibrium ferrite content at eutectoid temperature for a steel containing 0.54 wt% of carbon. (a) 10%, (b) 25%, (c) 33,3%, (d) 66.7%.

37. A material is loaded in one of the following ways: (a) uniaxial tension, (b) biaxial tension, (c) triaxial tension, (d) uniaxial compression. Which one has the smallest shear stress?

38. A carbon steel is exposed in a $CO + CH_4$ gas mixture with a carbon activity (a_c) greater than 1. What kind of reaction may take place on the steel surface at high temperature? (a) decarburization, (b) carburization, (c) nitridation, (d) sulfidation.

39. The alloying of steel with (a) Au, (b) Ag, (c) Cu, (d) Cr can improve its corrosion resistance substantially.

40. There are two metals with different stacking fault energies. Which one can slip easily?
(a) The one with low stacking fault energy, (b) The one with high stacking fault energy, (c) Both have the same slip resistance, (d) Both can not slip.

41. The primary slip systems in NaCl are {110}<110>. For the (110) plane, a possible slip direction is therefore (a) [110], (b) [101], (c) [011], (d) [100].

42. Which of the following statements concerning the lack of ductility of ceramic polycrystals at room temperature is false? (a) They generally do not have the required 5 independent slip systems, (b) The dislocations are narrow and are thus difficult to move, (c) The dislocations are thermodynamically stable in ceramics, (d) The Peierl's stress in ceramics is high.

43. Which of the following is false about an edge dislocation? (a) The elastic energy is proportional to the square of the Burger's vector, (b) Below the extra half plane of atoms, the stress field is compressive, (c) It attracts other edge dislocations of the opposite sign on the same slip plane, (d) It is attracted to a free surface.

44. A very fine-grained material may have a mean grain intercept of the order of 1 micron. Assuming the grain boundary energy of the metal is 0.8 J/m^2, what would be the approximate value of its brain boundary energy per unit volume? (a) 0.71 cal/cm^3, (b) 0.47 cal/cm^3, (c) 0.38 cal/cm^3, (d) 0.92 cal/cm^3.

45. The surface energy of a film of soap and water is about 3×10^{-2} J/m2. Compute the increase in the pressure on the inside of a soap bubble with a diameter of 6 cm. (a) 8 Pa, (b) 7Pa, (c) 3 Pa, (d) 4Pa.

46. Determine, to a first approximation, the limiting grain size in a 2 cm thick plate of a metal containing a 1 percent volume fraction of a stable precipitate whose average diameter is 600 nm. (a) 80 μm, (b) 100 μm, (c) 35 μm, (d) 205 μm.

47. On the assumption that the self-diffusion coefficient of a simple cubic metal whose lattice constant, a, equals 0.300 nm is given by the equation $D = 10^{-4}e^{-200,000/RT}$ m^2/s, determine the mean time of an atom at a lattice site. (a) 1.78×10^{-8} s, (b) 9.56×10^{-8} s, (c) 7.61×10^{-8} s, (d) 3.24×10^{-8} s.

48. Determine the mean time of stay of an oxygen atom in an interstitial site in niobium at 300 K. The diffusion equation for oxygen in niobium is $D = 7.31 \times 10^{-7}e^{-110,000/RT}$ and the lattice parameter for niobium is 0.3301 nm. (a) 88,503 s, (b) 200,354 s, (c) 45,678 s, (d) 105,356 s.

49. How many equivalent {111}<1$\bar{1}$0> slip systems are there in the fcc lattice? (a) 24, (b) 12, (c) 8, (d) 11.

50. The total line length of the dislocations in a 4 cm by 4 cm TEM photograph, of a metal foil, taken at a magnification of 25,000 X is 400 cm. The foil imaged by the picture had a thickness of 300 nm. Determine the dislocation density in the foil. (a) 1.67×10^{14} m/m^2, (b) 3.56×10^{14} m/m^2, (c) 8.34×10^{14} m/m^2, (d) 4.78×10^{14} m/m^2.

51. For a diamond cubic lattice, give the extinct reflection indexes (hkl) when the structure factor, $F(hkl) = \sum f e^{-2\pi i(hx + ky + lz)}$, is zero, where f is the atomic scattering factor, and x, y, and z are the positions of the atoms in the unit cell. (a) (220), (b) (111), (c) (222), (d) (200).

52. Which one shows no barrier to nucleation ? (a) precipitation, (b) martensitic transformation, (c) eutectoid transformation, (d) spinodal decomposition.

53. For a FCC lattice, the stacking sequence of the closed-packed planes, (a) ABCACABC, (b) ABCACBACB, (c) ABABCABC, (d) ABCACBCABC, would form a twin.

54. Spinodal decomposition can occur for any alloy system under the condition of (a) $d^2G/dX^2 > 0$, (b) $d^2G/dX^2 < 0$, (c) $d^2G/dX^2 = 0$, (d) $dG/dX \leqq 0$. G, the free energy, X, the chemical composition.

55. Hume-Rothery found that the extent of primary solid solution is seriously hindered whenever the disparity in atomic radii exceeds (a) 5, (b) 10, (c) 15, (d) 20%.

56. In order to reduce the shape change in the crystal during FCC-HCP transformation (a) two, (b) three, (c) four, (d) five different Shockley partial dislocations should be used.

57. Which one shows the lowest activation energy barrier for heterogeneous nucleation ? (a) grain boundaries, (b) grain edges, (c) grain corners, (d) dislocations.

58. A continuous change in enthalpy H at the equilibrium transformation temperature indicates the transformation is (a) zero order, (b) first order, (c) second order, (d) third order.

59. When subjected to a stress the crystal exhibits electric polarity. This is called (a) pyroelectric effect, (b) piezoelectric effect, (c) ferrimagnetic effect, (d) ferroelectric effect.

60. Which dislocation can slip on (1,1,1) (a) 1/6 [-2,1,1], (b) 1/6 [-1,2,1], (c) 1/6 [-1,-1,0], (d) 1/2 [1,1,0].

61. Which of the following equation describe the angular moment (L) of an orbital electron circulating the nuclei? (m = mass of electron, v = velocity, r = radius,

    (a) mr/v, (b) mrv^2, (c) mrv, (d) mr^2v

62. Under what circumstances is an atomic electron's probability-density distribution spherically symmetric?

    (a) Principal quantum no. n = 0,   (b) Orbital quantum no. l = 0,

    (c) Magnetic quantum no. ml = 0,   (d) Spin magnetic quantum number ms = 0.

63. For a Hydrogen atom with its electron at p state, the electron angular momentum (L) is equal to (a) $\hbar = h/2\pi$, (b) $3\hbar$, (c) $6\hbar$, (d) $2\hbar$

64. You can find a colorful reflection from a CD surface (on its data storage side). The reason for this colorful pattern is due to which of the following effect.

    (a) Reflection   (b) Filter   (c) Diffraction   (d) Interference

65. A piece iron turns red hot at 1000 ºC, this phenomenon is due to which of the following effect.

    (a) Black body radiation effect   (b) Photoelectric effect

    (c) Phosphorescence effect   (d) Photodiode effect

66. The solid can be classified into insulator, semiconductor, and conductor based on its electrical conductivity. Which theory is used to bridge the quantized energy level of each electron and the large number of atoms in solid.

    (a) Bloch band theory   (b) Fermi energy

    (c) Bohr atomic model   (d) Einstein photoelectric effect

67. Which of the following experiment validate the space quantization ?

    (a) Photoelectric effect   (b) Compton effect

    (c) Stern-Gerlach's experiment   (d) Michelson-Morley experiment

68. The unit of Planck constant is same with which of the following physical property.

    (a) Energy   (b) Momentum   (c) Electrical Conductivity   (d) Angular momentum

69. For an atom with many electrons, the spin-orbit coupling effect is to be considered. Which of the following statement is not related to this spin-orbit coupling effect.

    (a) Zeeman effect   (b) Very fine-structure doubling of spectral lines

    (c) The total atomic angular momentum of the summation of all electrons are quantized

    (d) Energy Dispersion Spectrum (EDS) of X-ray spectra

70. Which of the following device is not based on a p-n junction of semiconductors.

    (a) Semiconductor laser   (b) Light emitting diode

    (c) Solar cell   (d) Scanning Tunneling Microscopy

71. At what temperature would the average kinetic energy of the molecules of hydrogen be equal to their binding energy?

(a) 100 K   (b) 1,000 K   (c) 10,000 K   (d) 100,000 K

72. Which of the following statement is called "Selection rule" for allowed transition?

(a) The change in total quantum number $n = \pm 1$

(b) The change in the orbital quantum number $l = \pm 1$

(c) The change in the magnetic quantum number m_l is not restricted.

(d) The change in the spin magnetic quantum number $m_s = \pm 1$

73. It is know that the x-ray spectra of elements of nearby atomic numbers are qualitatively very similar, although the optical spectra of these elements may differ considerably. Which of the following reasons are related to these phenomena.   (1) Optical spectra depend upon the possible transition involve states of outermost electrons, (2) X-ray spectra depend upon the possible transition involve only inner, closed-shell electrons, (3) X-ray diffraction is related to its lattice constant by Bragg's law

(a) both (1) and (2)   (b) both (1) and (3)   (c) only (3)   (d) only (2)

74. When germanium is doped with aluminum, which of the following statement is correct.

(a) a n-type semiconductor   (b) a p-type semiconductor

(c) an intrinsic semiconductor   (d) the charge carrier is electron

75. Who introduce the mathematic solution of wave function for an electron in Hydrogen atom?

(a) Einstein   (b) Born   (c) Rutherford   (d) Schrodinger

76. If W travels at a speed of 0.8c, then when your heart beats 5 times, how many times does W's heart beat?   (a) 5.   (b) 4.   (c) 3.   (d) 2.   (c is the speed of light.)

77. Take an educational guess.   How many times, roughly, is the electron-proton electric attraction greater than the electron-proton gravitational attraction?   (a) 10^{10}.   (b) 10^{20}. (c) 10^{30}.   (d) 10^{40}.

78. The Hubble's law (a) suggests that the universe is not expanding, (b) describes the relationship between the recession speed of a remote star and the distance between the earth and the star, (c) indicates the recession speed of a remote star is an exponential function of the distance between the earth and the star, or (d) does not support the big bang theory.

79. A material whose work function is 1.9 eV is exposed to a light having a wavelength of 198 nm.   What is the maximum kinetic energy of the photoelectrons?   (a) 4.3 eV.   (b) 3.6 eV.   (c) 3.9 eV.   (d) 4.7 eV.

80. In the Bragg's law of $2d\sin\theta = n\lambda$, n represents (a) the quantum number, (b) the order of the scattered beam, (c) the order of crystal planes, or (d) the order of the incident beam.

81. For electromagnetic waves A of wavelength 10 pm and electromagnetic waves B of wavelength 20 pm, which produces more pronounced Compton effect?   (a) A.   (b) B.

(c) Both are the same.   (d) Both cannot produce Compton effect.

82. The amplitude of a wave function of a moving particle (a) reflects the probability of finding the particle at a particular place and all the time, (b) reflects the probability of finding the particle at a particular place and a particular time, (c) reflects the probability of finding the particle at a particular time and all the places, or (d) means nothing as it is not measurable.

83. A hydrogen atom has a radius of about 5×10^{-11}.   What would be its minimum momentum?   (a) 1×10^{-20} kg·m/s, (b) 1×10^{-22} kg·m/s, (c) 1×10^{-24} kg·m/s, or (d) 1×10^{-26} kg·m/s.

84. In a wave function, the angular frequency ω and the wave number κ (a) are related, (b) are not related, (c) are not necessarily related, or (d) are inversely proportional to each other.

85. Who first described that an atom had a concentrated mass with positive charge in the center of the atom?   (a) J.J. Thomson, (b) E. Rutherford, (c) Bohr, or (d) A. Einstein.

86. Which of the following describes the Bohr's Correspondence Principle?   (a) The greater the quantum number, the closer quantum physics approaches classical physics.   (b) In the limit where classical and quantum theories agree, the quantum theory must reduce to the classical result.   (c) Quantum theory should agree with classical physics in the limit in which quantum effects become unimportant.   (d) All of the above are correct.

87. The wavelength for n = 3 to n = 2 electron transition in a hydrogen atom is (a) 673.19 nm, (b) 638.26 nm, (c) 639.36 nm, or (d) 656.47 nm.   (Proton = 1.007276 u)

88. A function satisfying the Schrodinger's equation (a) must be continuous, (b) must be single-valued, (c) may be single-valued, or (d) can always be normalized.

89. For a Schrodinger's steady-state equation, (a) the values of energy E_n are eigenvalues, (b) there is only one set of eignevalues, (c) each single eigenvalue gives a eigenfunction, (d) a non-trivial solution always exists.

90. A particle whose energy is smaller than its potential energy.   The particle has (a) a great possibility, (b) no possibility, (c) a very small possibility, or (d) 50% of possibility to penetrate the potential wall.