

本試題是否可以使用計算機： 可使用， 不可使用（請命題老師勾選）

A 卷：普通物理(20 題[1-20]，每題 1.5 分)、物理冶金(20 題[21-40]，每題 1.5 分)、量子物理導論(20 題[41-60]，每題 1.5 分)。滿分 90 分。倒扣至零分為止。

科目名稱：普通物理

每題為 4 選 1，每一題答對得 1.5 分，答錯倒扣 0.375 分。

- A Carnot engine whose high-temperature reservoir is at 500 K takes in 620 J of heat at this temperature in each cycle and gives up 335 J to the low-temperature reservoir. What is the temperature of the low-temperature reservoir?  
 (A) 340°C      (B) 170°C      (C) 340K      (D) 170 K
- Adjacent antinodes of a standing wave on a string are 12.0 cm apart. A particle at an anti-node oscillates in simple harmonic motion with amplitude 2.50 cm and period 0.500 s. The string lies along the + x-axis and is fixed at x=0. Find the speed of propagation of a transverse wave in the string.  
 (A) 0.48 m/s      (B) 0.96 m/s      (C) 48 m/s      (D) 96 m/s
- An electron is projected with an initial speed  $v=4.00 \times 10^6$  m/s into the uniform field between the parallel plates in Fig. 1. The direction of the field is vertically downward, and the field is zero except in the space between the plates. The electron enters the field at a point midway between the plates. If the electron just misses the upper plate as it emerges from the field, find the magnitude of the electric field.  
 (A)  $2.27 \times 10^2$  N/C      (B)  $2.27 \times 10^3$  N/C      (C)  $2.27 \times 10^{-2}$  N/C      (D)  $2.27 \times 10^{-3}$  N/C

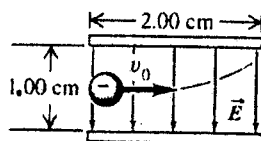


Figure 1 An electron in parallel plates

- The ammonia molecule ( $\text{NH}_3$ ) has a dipole moment of  $5.0 \times 10^{-30}$  C.m. Ammonia molecules in the gas phase are placed in a uniform electric field with magnitude  $E=2.0 \times 10^5$  N/C. What is the change in electrical potential energy when the dipole moment of a molecule changes its orientation with respect to the electric field from parallel to perpendicular?  
 (A)  $1.0 \times 10^{-22}$  J      (B)  $1.0 \times 10^{-23}$  J      (C)  $1.0 \times 10^{-24}$  J      (D)  $1.0 \times 10^{-25}$  J
- A cylindrical air capacitor of length 25.0 m stores  $5.40 \times 10^{-9}$  J of energy when the potential difference between the two conductors is 3.00 V. Calculate the magnitude of the charge on each conductor.

(背面仍有題目,請繼續作答)

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- (A)  $3.60 \times 10^{-6} \text{ C}$       (B)  $3.60 \times 10^{-7} \text{ C}$       (C)  $3.60 \times 10^{-8} \text{ C}$       (D)  $3.60 \times 10^{-9} \text{ C}$
6. A 1930s-vintage cyclotron has magnetic poles that produce a magnetic field with magnitude 1.5 T. The poles have a radius of 0.50 m, so that is the maximum radius of the orbits of the accelerated particles. What is the maximum energy to which protons ( $q=1.60 \times 10^{-19} \text{ C}$ ,  $m=1.67 \times 10^{-27} \text{ kg}$ ) can be accelerated by this cyclotron?
- (A)  $4.32 \times 10^{-12} \text{ J}$       (B)  $4.32 \times 10^{-11} \text{ J}$       (C)  $4.32 \times 10^{-10} \text{ J}$       (D)  $4.32 \times 10^{-9} \text{ J}$
7. Two long, parallel wires are separated by a distance of 5.0 cm. The force per unit length that each wire exerts on the other is  $6.0 \times 10^{-5} \text{ N/m}$ , and the wires repel each other. The current in one wire is 2.0 A. What is the current in the second wire?
- (A) 0.25 A      (B) 0.50 A      (C) 2.50 A      (D) 5.00 A
8. A converging lens has a focal length of 12.0 cm. For an object to the left of the lens, at distances of 20.0 cm, determine the image position?
- (A) 7.5 cm      (B) 15 cm      (C) 30 cm      (D) 60 cm
9. A proton traveling due east in a region that contains only a magnetic field experiences a vertically *upward force* away from the surface of the earth. What is the direction of the magnetic field?
- (A) north      (B) east      (C) south      (D) west
10. A 0.50-T magnetic field is directed perpendicular to the plane of a circular loop of radius 0.25 m. What is the magnitude of the magnetic flux through the loop?
- (A) 0.049 Wb      (B) 0.098 Wb      (C) 0.20 Wb      (D) 0.39 Wb
11. Which one of the following types of wave is intrinsically different from the other four?
- (A) radio waves      (B) sound waves      (C) gamma rays      (D) ultraviolet radiation
12. Which one of the following statements concerning the *proper time interval* between two events is true?
- (A) It is the longest time interval that any inertial observer can measure for the event.  
(B) It is the shortest time interval that any inertial observer can measure for the event.  
(C) It is the time measured by an observer who is in motion with respect to the event.  
(D) Its value depends upon the speed of the observer.
13. The view in figure 2 is from above a plane mirror suspended by a thread connected to the center of the mirror at point C. A scale is located 0.65 m (the distance from point C to point A) to the right of the center of the mirror. Initially, the plane of the mirror is parallel to the side of

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the scale; and the angle of incidence of a light ray which is directed at the center of the mirror is  $30^\circ$ . A small torque applied to the thread causes the mirror to turn  $12^\circ$  away from its initial position. The reflected ray then intersects the scale at point B. What is the distance from point A to point B on the scale?

- (A) 0.37 m      (B) 0.58 m      (C) 0.76 m      (D) 0.89 m

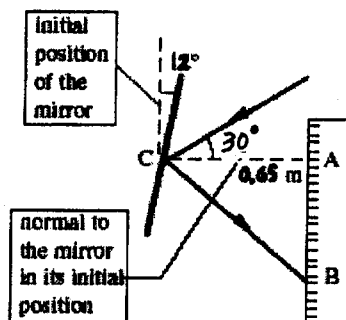


Figure 2

14. A laser emits a pulse of light with energy  $5.0 \times 10^3$  J. Determine the number of photons in the pulse if the wavelength of light is 480 nm.
- (A)  $5.2 \times 10^{16}$       (B)  $2.5 \times 10^{19}$       (C)  $1.2 \times 10^{22}$       (D)  $3.1 \times 10^{22}$
15. Each atom in the periodic table has a unique set of spectral lines. Which one of the following statements is the best explanation for this observation?
- (A) Each atom has a dense central nucleus.  
 (B) The electrons in atoms orbit the nucleus.  
 (C) Each atom has a unique set of energy levels.  
 (D) The electrons in atoms are in constant motion.
16. A transverse wave is traveling with a speed of 300 m/s on a horizontal string. If the tension in the string is increased by a factor of four, what is the speed of the wave?
- (A) 1200 m/s      (B) 600 m/s      (C) 300 m/s      (D) 150 m/s
17. A transverse wave is traveling on a string. The displacement  $y$  of a particle from its equilibrium position is given by  $y = (0.021\text{m}) \sin(25t - 2.0x)$ , where  $t$  is in seconds and  $x$  is in meters. The linear density of the string is  $1.6 \times 10^{-2}$  kg/m. What is the tension in the string?
- (A) 1.0 N      (B) 1.5 N      (C) 2.0 N      (D) 2.5 N
18. The width  $D$  of a diffraction horn loudspeaker is 0.05 m. The speed of sound is 343 m/s. At what frequency is the diffraction angle  $\theta$  equal to  $45^\circ$ ?
- (A) 3430 Hz      (B) 5400 Hz      (C) 7900 Hz      (D) 9700 Hz
19. A stretched rubber band has a length of 0.1 m and a fundamental frequency of 440 Hz. What is

(背面仍有題目,請繼續作答)

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the speed at which waves travel on the rubber band?

Ⓐ 55 m/s

Ⓑ 66 m/s

Ⓒ 77 m/s

Ⓓ 88 m/s

20. Two small charged objects are attached to a horizontal spring, one at each end. The magnitudes of the charges are equal, and the spring constant is 180 N/m. The spring is observed to be stretched by 0.020 m relative to its unstrained length of 0.40 m. Determine the magnitude of the charges.

Ⓐ  $8.4 \times 10^{-6} \text{ C}$ Ⓑ  $8.6 \times 10^{-6} \text{ C}$ Ⓒ  $8.8 \times 10^{-6} \text{ C}$ Ⓓ  $9.0 \times 10^{-6} \text{ C}$

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科目名稱: 物理冶金

每題為 4 選 1, 每一題答對得 1.5 分, 答錯倒扣 0.375 分。

21. A crystal of ferrous oxide  $\text{Fe}_{0.98}\text{O}$  is found to have a lattice parameter  $a = 0.43 \text{ nm}$  and a density of  $5.7 \text{ g/cm}^3$ . Calculate the number of iron vacancies per cubic centimeter.  
Ⓐ  $2.3 \times 10^{17}$       Ⓑ  $8.8 \times 10^{19}$       Ⓒ  $5 \times 10^{18}$       Ⓓ  $9.7 \times 10^{20}$
22. Which statement is correct for a normal spinel structure of  $\text{AB}_2\text{O}_4$ ?  
Ⓐ The  $\text{A}^{2+}$  ions exclusively occupy the tetrahedral sites.  
Ⓑ The  $\text{B}^{4+}$  ions exclusively occupy the tetrahedral sites.  
Ⓒ The  $\text{A}^{2+}$  ions occupy the tetrahedral and octahedral sites.  
Ⓓ The  $\text{B}^{4+}$  ions occupy the tetrahedral and octahedral sites
23. If we add Al ions in  $\text{BaTiO}_3$ , what do you expect?  
Ⓐ Increase the electron concentration,  
Ⓑ Decrease the barium-vacancy concentration,  
Ⓒ Decrease the titanium-vacancy concentration,  
Ⓓ Increase the hole concentration.
24. With the assumption of a constant chemical diffusivity and the same temperature, compute the length of time needed to obtain the same composition at twice the distance from the weld interface of a diffusion couple annealed for 40 hr.  
Ⓐ 100 hr,      Ⓑ 40 hr,      Ⓒ 80 hr,      Ⓓ 160 hr.
25. The following information for NaCl is given: At 600 K,  $K(\text{Schottky}) = 3.74 \times 10^{35} \text{ cm}^{-6}$  and  $K(\text{Frenkel}) = 5.8 \times 10^{34} \text{ cm}^{-6}$ . Calculate the equilibrium number of interstitial Na ions at 600 K.  
Ⓐ  $9.67 \times 10^{17} \text{ cm}^{-3}$       Ⓑ  $0.678 \times 10^{19} \text{ cm}^{-3}$       Ⓒ  $8.8 \times 10^{16} \text{ cm}^{-3}$       Ⓓ  $6.6 \times 10^{17} \text{ cm}^{-3}$
26. What ions lie along the  $\langle 310 \rangle$  directions of  $\text{BaTiO}_3$ ?  
Ⓐ Ba,      Ⓑ Ti,      Ⓒ Ti, O,      Ⓓ Ba, O.
27. Calculate the volume change for a material which transform from a simple cubic structure to a hexagonal close-packed structure. Assume the atoms as hard spheres.  
Ⓐ 12.6%,      Ⓑ 29.3%,      Ⓒ 35.4%      Ⓓ 5.8%.
28. What is the possible defect reaction when  $\text{Mg}^{2+}$  ions substitute the Al sites in  $\text{Al}_2\text{O}_3$ ?  
Ⓐ Oxygen vacancies are created.      Ⓑ Electrons are created.

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Ⓐ high  $G/R$       Ⓑ low  $G/R$       Ⓒ High  $G \times R$       Ⓓ Low  $G \times R$ ,  
where  $G$  is the temperature gradient in the liquid and  $R$  is the solidification rate.

38. The void sheet mechanism is associated with

- Ⓐ brittle fracture      Ⓑ ductile fracture  
Ⓒ intergranular fracture      Ⓓ transgranular fracture.

39. The persistent slip bands are associated with

- Ⓐ ductile fracture      Ⓑ brittle fracture      Ⓒ blue brittleness      Ⓓ fatigue.

40. Griffith criterion predicts that the strength of polycrystalline metals that fail by cleavage should vary as

- Ⓐ  $d^{1/2}$       Ⓑ  $d^{-1/2}$       Ⓒ  $d$       Ⓓ  $d^{-1}$ ,

where  $d$  is the average grain diameter.

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科目名稱：量子物理導論

每題為 4 選 1，每一題答對得 1.5 分，答錯倒扣 0.375 分。

Planck's constant  $h = 6.63 \times 10^{-34}$  J.s,Mass of an electron =  $9.1 \times 10^{-31}$  kg,Speed of light =  $3 \times 10^8$  m/sec,Charge of an electron =  $1.6 \times 10^{-19}$  CBoltzmann constant =  $1.381 \times 10^{-23}$  J/K

41. Are two spatially separated events simultaneous in one reference of frame also simultaneous in any other initial frame moving relative to the first one?
- Ⓐ No.  
Ⓑ Yes.  
Ⓒ Both cannot be compared.  
Ⓓ Depending on the relative motion between the two frames.
42. Time dilation is reciprocal
- Ⓐ under and circumstance.  
Ⓑ when an observer remains in his/her own inertial frame of reference all the time.  
Ⓒ when the clock remain in his/her own inertial frame of reference all the time.  
Ⓓ when an observer and the clock remain in his/her own inertial frame of reference all the time.
43. A 660-Hz tuning fork has a total energy of 0.04 J. What is the ratio of its quantized energy to its total energy?
- Ⓐ  $\sim 10^{-27}$ .      Ⓑ  $\sim 10^{-33}$ .      Ⓒ  $\sim 10^{-29}$ .      Ⓓ  $\sim 10^{-31}$ .
44. Fluorescence is a result of
- Ⓐ single emission      Ⓑ either single or multiple emissions  
Ⓒ multiple step emissions      Ⓓ no emission of photons.
45. In deriving statistical distributions a common assumption is
- Ⓐ each energy state has the different likelihood of being occupied.  
Ⓑ each energy state has the same or different likelihood of being occupied.  
Ⓒ each energy state has no likelihood of being occupied.  
Ⓓ each energy state has the same likelihood of being occupied.
46. An average energy of  $3/2$  kT can be obtained for a group of particles using which of the



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following statistical distribution.

- Ⓐ Maxwell-Boltzmann distribution.      Ⓑ Bose-Einstein distribution.  
Ⓒ Fermi-Dirac distribution.              Ⓓ Any of the above.

47. Ⓐ In a system of bosons, the presence of a particle in a certain state increases the probability of finding other particles in the same state.  
Ⓑ In a system of fermions, the presence of a particle in a certain state increases the probability of finding other particles in the same state.  
Ⓒ In a system of bosons, the presence of a particle in a certain state prevents the probability of finding other particles in the same state.  
Ⓓ All of the above are correct.
48. Which of the following statement is NOT correct as described in **Rutherford's experiment**  
Ⓐ a small fraction of  $\alpha$  particles deviate significantly  
Ⓑ this experiment confirms the existence of nuclei in an atom  
Ⓒ most  $\alpha$  particles did not go right through the thin metal foil  
Ⓓ Rutherford scattering formula shows that the number of alpha particle per unit area that reach the screen at a scattering angle
49. An isolator has  
Ⓐ a filled valance band  
Ⓑ a wide enough band gap  
Ⓒ can be tunneled through by a sufficiently high voltage  
Ⓓ a half filled valance band.
50. Which of the following statements is correct?  
Ⓐ Photons and electrons are both bosons.  
Ⓑ Photons and electrons are both fermions.  
Ⓒ Photons are fermions and electrons are bosons.  
Ⓓ Photons are bosons and electrons are fermions.
51. Schrodinger's Equation for the Hydrogen atom CAN NOT be used to describe the  
Ⓐ electron position,                      Ⓑ energy level of electron,  
Ⓒ probability of electron density      Ⓓ electron speed.
52. Heisenberg's uncertainty principle states that the position of an electron CAN NOT be measured accurately simultaneously with

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- (A) momentum, (B) wavelength, (C) energy levels, (D) quantum number.
53. Which of the following equation in quantum mechanics is equivalent to the Newton's three law of motions in classical mechanics.  
(A) Heisenberg's uncertainty principle, (B) Schrodinger's equation,  
(C) Einstein's relativity equation, (D) Maxwell equation.
54. Tunnel effect is the basic principle used to built which of the following devices:  
(A) Scanning Tunneling Microscope (B) Transmission Electron Microscope  
(C) Scanning Electron Microscope (D) X-ray Diffraction
55. What is the number of states in the hydrogen atom for a given quantum number  $n$ ?  
(A)  $n$  (B)  $n+1$  (C)  $n^2$  (D)  $2n^2$
56. If you double the temperature of a blackbody, by what factor is the peak wavelength emitted changed?  
(A) 2 (B) 1.5 (C) 0.5 (D) 0.1
57. An x-ray photon with a wavelength of 0.1000 nm makes an elastic collision with an electron and is scattered through an angle of  $90.0^\circ$ . What is the wavelength of the scattered photon?  
(A) 0.1124 nm (B) 0.1024 nm (C) 0.0924 nm (D) 0.0824 nm
58. An electron in a metal wire behaves like a free particle inside the wire. If the work function of the metal is 4 eV, what is the approximate distance that the electron wave function extends beyond the surface of the wire?  
(A) 10 nm (B) 1.0 nm (C) 0.1 nm (D) 0.01 nm
59. In which of the following cases are the energy levels evenly spaced?  
(A) A hydrogen atom (B) A helium atom  
(C) A particle in a box (D) A harmonic oscillator
60. If  $\Psi_1$  and  $\Psi_2$  are two solutions of Schrödinger's equation (that is two wave functions that satisfy the equation), which of the following functions must also be the solution of Schrödinger's equation? ( $a$  and  $b$  are constants)  
(A)  $a\Psi_1+b\Psi_2$  (B)  $a\Psi_1^2+b\Psi_2^2$  (C)  $a\Psi_1\Psi_2$  (D)  $a\Psi_1/b\Psi_2$