※ 考生請注意：本試題 ☑可 □不可 使用計算機

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。

1. A particle of mass $4M$ is at the origin while a particle of mass $9M$ is at $x = 1\text{m}$. Where would the net force on a third particle be zero?
   Ⓐ $0.4cm$ Ⓑ $4.0cm$ Ⓒ $40.0cm$ Ⓓ $400.0cm$

2. A 200-g ball of putty falls vertically into a 2.5-kg cart that is rolling freely at 2m/s on a horizontal surface. What is the final speed of the cart?
   Ⓐ 1.85 *m/sec* Ⓑ 2.25 *m/sec* Ⓒ 3.50 *m/sec* Ⓓ 21.25 *m/sec*

3. An object of mass 1kg makes a completely inelastic collision with an object of unknown mass at rest. If 60% of the kinetic energy is lost, what is the unknown mass?
   Ⓐ 150 kg Ⓑ 50 kg Ⓒ 5.0 kg Ⓓ 1.5 kg

4. When 8mJ of work are done on a spring, its extension increases from 4cm to 6cm. What is the spring constant?
   Ⓐ 8 N/m Ⓑ 16 N/m Ⓒ 32 N/m Ⓓ 48 N/m

5. A pump has to raise water from a depth of 50m and eject it at 10m/s. If the flow rate is 2kg/s, what horsepower is needed?
   Ⓐ 1.45 Hp Ⓑ 9.8Hp Ⓒ 21.4Hp Ⓓ 98Hp

6. What is the work needed to lift 15kg of water from a well 12m deep? Assume the water has a constant upward acceleration of $0.7 m/sec^2$.
   Ⓐ 1.89 kJ Ⓑ 21.34 kJ Ⓒ 134 kJ Ⓓ 980 kJ

7. The velocity of a 2-kg particle changes from $(2\mathbf{i} - 3\mathbf{j}) m/s$ to $(-5\mathbf{i} + 2\mathbf{j}) m/s$. What is the change in its kinetic energy?
   Ⓐ 128 J Ⓑ 84 J Ⓒ 42 J Ⓓ 16 J

8. A net force **F** is required to give an object with mass m an acceleration **a**. If a net force 6 **F** is applied to an object with mass $2m$, what is the acceleration on this object?
   Ⓐ **a** Ⓑ 3**a** Ⓒ 6**a** Ⓓ 2**a**

(背面仍有題目,請繼續作答)

※ 考生請注意：本試題 ☑可 □不可 使用計算機

9. A 810-kg car accelerates from rest to 27 m/s in a distance of 120 m. What is the magnitude of the average net force acting on the car?
   Ⓐ 740 N Ⓑ 91 N Ⓒ 7900 N Ⓓ 2500 N

10. A physics student in a hot air balloon ascends vertically at constant speed. Consider the following four forces that arise in this situation:
    F1 = the weight of the hot air balloon; **F2** = the weight of the student; **F3** = the force of the student pulling on the earth; **F4** = the force of the hot air balloon pulling on the student.
    Which two forces form an "action-reaction" pair that obeys Newton's third law?
    Ⓐ **F1** and **F2** Ⓑ **F1** and **F3** Ⓒ **F3** and **F4** Ⓓ **F2** and **F3**

11. An astronaut orbits the earth in a space capsule whose height above the earth is equal to the earth's radius. How does the weight of the astronaut in the capsule compare to her weight on the earth?
    Ⓐ It is equal to her weight on earth.
    Ⓑ It is one-fourth her weight on earth.
    Ⓒ It is equal to one-half of her weight on earth.
    Ⓓ It is equal to one-third of her weight on earth.

12. Two point masses m and M are separated by a distance d. If the separation d remains fixed and the masses are increased to the values $3m$ and $3M$ respectively, how does the gravitational force between them change?
    Ⓐ The force will be one-third as great.
    Ⓑ The force will be one-ninth as great.
    Ⓒ The force will be three times as great.
    Ⓓ The force will be nine times as great.

13. A rock is suspended from a string; and it moves downward at constant speed. Which one of the following statements is true concerning the tension in the string *if air resistance is not ignored?*
    Ⓐ The tension is zero newtons.
    Ⓑ The tension points downward.
    Ⓒ The tension is equal to the weight of the rock.
    Ⓓ The tension is less than the weight of the rock.

14. A concave shaving mirror is designed so the virtual image is twice the size of the object, when the distance between the object and the mirror is 15cm. Determine the radius of

※ 考生請注意：本試題 ☑可 ☐不可 使用計算機

curvature of the mirror.

Ⓐ 15 cm Ⓑ 30 cm Ⓒ 60 cm Ⓓ 90 cm

15. An object is placed 20.0 cm to the left of a diverging lens (f = -8.0 cm). A concave mirror (f =12.0 cm) is placed 30.0 cm to the right of the lens. Find the final image distance, measured relative to the mirror

Ⓐ 18.1 cm Ⓑ 18.2 cm Ⓒ 18.3 cm Ⓓ 18.4 cm

16. In a Young's double-slit experiment the separation y between the first-order bright fringe and the central bright fringe on a flat screen is 0.0240 m, when light is used that has a wavelength of 475 nm. Assume that the angles that locate the fringes on the screen are small enough so that $\sin\theta \sim \tan\theta$. Find the separation y when the light has a wavelength of 611 nm.

Ⓐ 0.036 m Ⓑ 0.037 m Ⓒ 0.038 m Ⓓ 0.039 m

17. A diffraction pattern forms when light passes through a single slit. The wavelength of the light is 675 nm. Determine the angle that locates the first dark fringe when the width of the slit is 1.8×10^{-6} m.

Ⓐ 12° Ⓑ 16° Ⓒ 20° Ⓓ 22°

18. The width of a slit is 2.0×10^{-5} m. Light with a wavelength of 480 nm passes through this slit and falls on a screen that is located 0.50 m away. In the diffraction pattern, find the width of the bright fringe that is next to the central bright fringe.

Ⓐ 0.012 m Ⓑ 0.015 m Ⓒ 0.018 m Ⓓ 0.021 m

19. A capacitor has a capacitance of 2.5×10^{-8} F. In the charging process, electrons are removed from one plate and placed on the other plate. When the potential difference between the plates is 450 V, how many electrons have been transferred?

Ⓐ 7.0×10^{13} Ⓑ 7.0×10^{14} Ⓒ 7.0×10^{15} Ⓓ 7.0×10^{16}

20. A commercial resistor can safely dissipate power only up to a certain rated value. Beyond this value, the resistor becomes excessively hot and often cracks apart. What is the largest voltage that can be applied across a 680-Ω resistor, when the resistor is rated at 0.25 W.

Ⓐ 13 V Ⓑ 14 V Ⓒ 15 V Ⓓ 16 V

※ 考生請注意：本試題 ☑可 ☐不可 使用計算機

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 lattice is:
    Ⓐ A three-dimensional ordered array of points
    Ⓑ A three-dimensional ordered array of atoms
    Ⓒ A three-dimensional ordered array of unit cell
    Ⓓ A three-dimensional ordered array of ions

22. The activation energy for diffusion can be determined by a plot of: (D: diffusivity; c: concentration)
    Ⓐ lnD vs. 1/T Ⓑ lnc vs. 1/T Ⓒ lnD vs. T Ⓓ lnc vs. T

23. The driving energy for sintering is:
    Ⓐ Reduction in surface area of pores
    Ⓑ Reduction in total volume
    Ⓒ Reduction in Gibbs energy of reaction
    Ⓓ Reduction in grain-boundary area

24. The counter-diffusion of ions is sometimes called:
    Ⓐ Reaction diffusion Ⓑ Ambipolar diffusion
    Ⓒ Solid-state diffusion Ⓓ Self-diffusion

25. Oxidation is equivalent to:
    Ⓐ Electron gain Ⓑ Electron loss Ⓒ Electron transfer Ⓓ Electron excitation

26. Both Coble creep and Herring-Nabarro creep describe:
    Ⓐ Power law creep Ⓑ Creep due to dislocation movement
    Ⓒ Creep due to atomic diffusion Ⓓ Creep due to grain-boundary sliding

27. Solid lubricants often have:
    Ⓐ Layer structures Ⓑ Amorphous structures
    Ⓒ Liquid crystal structures Ⓓ Any kinds of structures

28. Which of the following is false about the theoretical shear strength of a particular set of crystal planes?

※ 考生請注意：本試題 ☑可 □不可 使用計算機

Ⓐ It increases as the shear modulus increases.
Ⓑ It increases as the interplanar distance increases.
Ⓒ It depends on temperature.
Ⓓ It depends on the interatomic potential of material.

29. An array of etch pits reveals the movement of a dislocation, therefore, among them the etch pit with the
Ⓐ largest Ⓑ middle Ⓒ smallest Ⓓ unchanged
size reveals the newest position of this dislocation.

30. The magnitude of the shear stress at a distance of 50 b(b = 0.248 nm) on the slip plane from the boundary, which is consisted of many edge dislocations, due to a single edge dislocation in the boundary is
Ⓐ negligible Ⓑ equal to Ⓒ smaller than Ⓓ larger than
that due to the whole dislocations in the boundary.

31. Secondary recrystallization occurs as a result of
Ⓐ the strain energy of cold work Ⓑ recovery
Ⓒ nucleation Ⓓ surface-energy
considerations.

32. For a FCC crystal the stacking faults associated with the partials can be formed by inserting an extra layer of atoms on the (1,-1,1) plane, thus the displacement vector of the stacking faults could be
Ⓐ 1/6[1,1,0] Ⓑ 1/3[1,-1,1] Ⓒ 1/6[1,2,1] Ⓓ 1/3[-1,1,1]

33. For the x-ray diffraction data, the wide peaks reveal that
Ⓐ the sample is well crystallized Ⓑ the grain size of the sample is large
Ⓒ the grain size of the sample is small Ⓓ the sample is amorphous

34. In order to precisely measure the lattice constant of a sample from x-ray diffraction, the diffraction angle (2θ) is taken preferably at around
Ⓐ 10-50° Ⓑ 50-100° Ⓒ 100-150° Ⓓ 150-180°

35. The growth of chain-like wires via the vapor-liquid-solid mechanism is due to the periodic instability drived by the vapor supersaturation. There has a spheroid on the tops of nanowires. During growth, as the size of the liquid droplet decreases, the required vapor

※ 考生請注意：本試題 ☑可 □不可 使用計算機

supersaturation at the vapor-liquid interface can

Ⓐ be unchanged Ⓑ increase Ⓒ decrease Ⓓ be equal to

the surface tension of the droplet.

36. The volume of an FCC unit cell in terms of the atomic radius R is:

Ⓐ $14R^3\sqrt{2}$ Ⓑ $16R^3\sqrt{2}$ Ⓒ $18R^3\sqrt{2}$ Ⓓ $20R^3\sqrt{2}$

37. An edge dislocation lies

Ⓐ at 90 degree to its Burgers vector Ⓑ at 60 degree to its Burgers vector

Ⓒ at 45 degree to its Burgers vector Ⓓ at 0 degree to its Burgers vector

38. The criterion for the stability of a planar interface during steady-state solidification in terms of the temperature gradient in the liquid (G), the solidification rate (R), the slope of the liquidus (m), the alloy composition (C), the redistribution coefficient (k), and the liquid diffusivity (D) is

Ⓐ $G/R = m\,C\,(1-k) / D$ Ⓑ $G/R = m\,C\,(1+k) / kD$

Ⓒ $G/R = m\,C\,(1+k) / 2kD$ Ⓓ $G/R = m\,C\,(1-k) / kD$

39. Shear strain rate is proportional to

Ⓐ $\rho^{1/2}bv$ Ⓑ $\rho b^2 v$ Ⓒ $\rho b^{1/2} v$ Ⓓ ρbv

where ρ is dislocation density, b is Burgers vector, and v is average dislocation density.

40. Number of vacancy equals to

Ⓐ $n\times\exp(-H_f/2RT)$ Ⓑ $n\times\exp(-H_f/RT)$ Ⓒ $n^2\times\exp(-H_f/2RT)$ Ⓓ $n^2\times\exp(-H_f/RT)$

where n=number of atoms, R=gas constant, and H_f = activation enthalpy for the formation of vacancies.

※ 考生請注意：本試題 ☑可 ☐不可 使用計算機

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 x 10^{-34} J-s,
Mass of an electron = 9.1 x 10^{-31} kg,
Speed of light = 3 x10^{8} m/sec,
Charge of an electron = 1.6 x 10^{-19} C
Boltzmann constant = 1.381 x 10^{-23} J/K

41. Bohr's atomic model applies
   Ⓐ only to atoms having low atomic numbers
   Ⓑ to all atoms
   Ⓒ only to one-electron atoms
   Ⓓ only to two-electron atoms

42. A particle limited to the x axis is described by $\Psi = (3x^2)^{1/2}$ for $0 \le x \le 1$ and $\Psi = 0$ elsewhere. What is the expectation value <x> of the particle's position?
   Ⓐ 0.75 Ⓑ 1.00 Ⓒ 0.50 Ⓓ 0.60

43. What is information that can be obtained from the wave functions?
   Ⓐ Only quantized information.
   Ⓑ All the particle information permitted by the uncertainty principle.
   Ⓒ Only information on probability.
   Ⓓ All the quantized and probability information.

44. According to the selection rule, which of the following is true?
   Ⓐ Δn = any number Ⓑ $\Delta l = \pm 1$
   Ⓒ $\Delta m_l = 0, \pm 1$ Ⓓ All of the above are correct.

45. An eigenfunction of the operator d^2/dx^2 is $\Psi = 2e^{2x}$. What is the corresponding eigenvalue?
   Ⓐ 16 Ⓑ 8 Ⓒ 4 Ⓓ 2

46. Is a 1s electron in a hydrogen more likely to be at a_0 from the nucleus than at $a_0/2$?
   Ⓐ No.
   Ⓑ Yes and it is at least 50% more likely.
   Ⓒ It cannot be determined.
   Ⓓ Yes and it is at least 30% more likely.

※ 考生請注意：本試題 ☑可 □不可 使用計算機

47. An element is placed in a magnetic field and excited. If the Zeeman components of the 450-nm spectral line are separated by 0.00283 nm, then what is the magnitude of the magnetic field?
Ⓐ 0.30 T Ⓑ 0.20 T Ⓒ 0.15 T Ⓓ 0.10 T

48. For a particle to behave as a de Broglie wave, what is the following is required?
Ⓐ with spin Ⓑ carry charge Ⓒ with momentum Ⓓ massless

49. A tungsten filament in light bulb turns red hot at 2000 ^{o}C, this phenomenon is due to which of the following effect.
Ⓐ Black body radiation effect Ⓑ Photoelectric effect
Ⓒ Phosphorescence effect Ⓓ Photodiode effect

50. In the experiment conducted by Compton, part of the X-ray energy will transfer to the electron. What scattering angle will the electron have the minimum kinetic energy?
Ⓐ 0° Ⓑ 45° Ⓒ 90° Ⓓ 180°

51. The synchrotron radiation facility is a
Ⓐ high precision STM Ⓑ high energy electron source
Ⓒ high intensity XRD source Ⓓ high resolution TEM

52. With knowing the ionization energy of a hydrogen atom, which of the following theory can be used to estimate the radius of a hydrogen atom?
Ⓐ Heisenberg uncertainty principle Ⓑ de Broglie wave
Ⓒ Compton effect Ⓓ Special relativity

53. A static electron was accelerated by a dc voltage of 10 kV, what is the kinetic energy of the accelerated electron?
Ⓐ 6.626×10^{-31} J Ⓑ 9.11×10^{-8} J Ⓒ 1.6×10^{-15} J Ⓓ 1.6×10^{-20} J

54. If an atomic shell is denoted as M, what is its principle quantum number?
Ⓐ 1 Ⓑ 2 Ⓒ 3 Ⓓ 4

55. Which of the following states is impossible to exist?
Ⓐ $^{3}F_{1}$ Ⓑ $^{3}F_{2}$ Ⓒ $^{3}F_{3}$ Ⓓ $^{3}F_{4}$

※ 考生請注意：本試題 ☑可 □不可 使用計算機

56. Phosphorescent radiation lasts for much longer time than fluorescent radiation. This is because phosphorescent radiations come from the transitions between:
   Ⓐ different vibrational states
   Ⓑ different rotational states
   Ⓒ electronic states of different orbital quantum number
   Ⓓ electronic states of different spin quantum number

57. In an ideal gas, the number of energy states, g(E), is proportional to:
   Ⓐ E^2 Ⓑ $E^{3/2}$ Ⓒ E Ⓓ $E^{1/2}$

58. If the average energy of a free electron in a metal is denoted as E_A, and the Fermi energy of the metal is E_F, which of the following relations is right at T=0 K?
   Ⓐ $E_A = E_F/2$ Ⓑ $E_A = 2E_F/3$ Ⓒ $E_A = 3E_F/4$ Ⓓ $E_A = 3E_F/5$

59. Space quantization of spin orientations was demonstrated explicitly by:
   Ⓐ Zeeman Effect Ⓑ Stern-Gerlach Experiment
   Ⓒ Rutherford Scattering Ⓓ Franck-Hertz Experiment

60. X-rays arise from the electronic transitions from the outer shells to the inner shells. Which is the starting shell of the transition for the $\mathbf{K}_\gamma$ line?
   Ⓐ N Ⓑ M Ⓒ L Ⓓ K