※ 考生請注意：本試題 ☑可　□不可 使用計算機

A 卷：普通物理(20 題選擇題[1-20]，每題 1.5 分)、量子物理導論(10 題選擇題[21-30]，每題 3 分)、物理冶金(6 題非選擇題[31-36]，每題 5 分)。滿分 90 分。倒扣至零分為止。

一、 選擇題（請以 2B 鉛筆劃卡作答）

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. Two particles, X and Y, are 4m apart. X has a charge of 2Q and Y has a charge of Q. The force of X on Y: Ⓐ has twice the magnitude of the force of Y on X Ⓑ has half the magnitude of the force of Y on X Ⓒ has one-fourth the magnitude of the force of Y on X Ⓓ has the same magnitude as the force of Y on X

2. Let k denote $1/4\pi\varepsilon_0$. The magnitude of the electric field at a distance r from an isolated point particle with charge q is: Ⓐ kq/r Ⓑ kr/q Ⓒ kq/r^2 Ⓓ kq^2/r^2

3. A charged particle is placed in an electric field that varies with location. No force is exerted on this charge: Ⓐ at locations where the electric field is zero Ⓑ at locations where the electric field strength is $1/(1.6\times10^{-19})$N/C Ⓒ if the particle is moving along a field line Ⓓ if the field is caused by an equal amount of positive and negative charge

4 Charge Q is distributed uniformly throughout an insulating sphere of radius R. The magnitude of the electric field at a point R/2 from the center is: Ⓐ $Q/4\pi\varepsilon_0R^2$ Ⓑ $Q/8\pi\varepsilon_0R^2$ Ⓒ $3Q/4\pi\varepsilon_0R^2$ Ⓓ $Q/\pi\varepsilon_0R^2$

5. An electron volt is: Ⓐ the force acting on an electron in a field of 1N/C Ⓑ the force required to move an electron 1 meter Ⓒ the energy gained by an electron in moving through a potential difference of 1 volt Ⓓ the work done when 1 coulomb of charge is moved through a potential difference of 1 volt.

6. A charged capacitor stores 10C at 40V. Its stored energy is: Ⓐ 400 J Ⓑ 4 J Ⓒ 200 J Ⓓ 2.5J

7. Which one of the following quantities is correctly matched to its unit? Ⓐ Power – kW·h Ⓑ Energy – kW Ⓒ Potential difference – J/C Ⓓ Current – A/s

(背面仍有題目，請繼續作答)

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8. A 3-Ω and a 1.5-Ω resistor are wired in parallel and the combination is wired in series to a 4-Ω resistor and a 10-V emf device. The potential difference across the 3-Ω resistor is: Ⓐ 1.0V Ⓑ 2.0V Ⓒ 8.0V Ⓓ10V

9. When the outdoor emergency warning siren at school was tested, the sound from the siren took 7.9 s to reach her house located 2.40km from the school. What is the speed of sound in the air? Ⓐ 240 m/s Ⓑ 340 m/s Ⓒ 440 m/s Ⓓ 540 m/s

10. A landing airplane makes contact with the runway with a speed of 78.0m/s and moves toward the south. After 18.5 seconds, the airplane comes to rest. What is the average acceleration of the airplane during the landing? Ⓐ 14.3 m/s^2, north Ⓑ 14.3 m/s^2, south Ⓒ 4.22 m/s^2, north Ⓓ 4.22 m/s^2, south

11. In which of the following cases is the displacement of the object directly proportional to the elapsed time? Ⓐ A ball tolls with constant velocity Ⓑ A ball rolling with velocity v is given a constant acceleration Ⓒ A bead falling through oil experience a decreasing acceleration Ⓓ A rocket fired from the earth's surface experience an increasing acceleration

12. A ball is thrown vertically upward from the surface of the earth. Consider the following quantities: (1) the speed of the ball; (2) the velocity of the all; (3) the acceleration of the ball. Which of these is (are) zero when the ball has reached the maximum height? Ⓐ 1 only Ⓑ 2 only Ⓒ 1 and 2 Ⓓ 1, 2, and 3

13. Starting from rest, a particle that is confined to move along a straight line is accelerated at a rate of 5.9 m/s^2. Which statement concerning the slope of the position versus time graph for this particle is true? Ⓐ The slope has a constant value of 5.0m/s. Ⓑ The slope is both constant and negative. Ⓒ The slope is not constant and increases with increasing time. Ⓓ The slope is not constant and decreases with increasing time.

14. A train travels due south at 60 m/s. It reverses its direction and travels due north at 60 m/s. What is the change in velocity of the train? Ⓐ 120 m/s, due north Ⓑ 120 m/s, due south Ⓒ 60 m/s, due north Ⓓ 60 m/s, due south

15. Two slits are 0.158 mm apart. A mixture of red light (wavelength = 665 nm) and yellow-green light (wavelength = 565 nm) falls on the slits. A flat observation screen is located 2.24 m away. What is the distance on the screen between the third-order red fringe and the third-order yellow-green fringe? Ⓐ 0.42 Ⓑ 0.43 Ⓒ 0.44 Ⓓ 0.45 cm

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16. The pupil of an eagle's eye has a diameter of 6.0 mm. The refractive index in the eye is 1.36. Two field mice are separated by 0.010 m. From a distance of 175 m, the eagle sees them as one unresolved object and dives toward them at a speed of 17 m/s. Assume that the eagle's eye detects light that has a wavelength of 550 nm in a vacuum. How much time passes until the eagle sees the mice as separate objects? Ⓐ 3.0 Ⓑ 3.1 Ⓒ 3.2 Ⓓ 3.3 sec

17. A diffraction grating produces a first-order bright fringe that is 0.0894 m away from the central bright fringe on a flat screen. The separation between the slits of the grating is 4.17 x 10^{-6} m, and the distance between the grating and the screen is 0.625 m. What is the wavelength of the light shining on the grating? Ⓐ 5.90 x 10^{-7} Ⓑ 5.90 x 10^{-6} Ⓒ 6.90 x 10^{-7} Ⓓ 6.90 x 10^{-6} m

18. A single slit has a width of 2.1 x 10^{-6} m and is used to form a diffraction pattern. Find the angle that locates the second dark fringe when the wavelength of the light is 660 nm. Ⓐ 38 Ⓑ 39 Ⓒ 40 Ⓓ 41 degrees

19. The same diffraction grating is used with two different wavelengths of light, λ_A and λ_B. The fourth-order principal maximum of light A exactly overlaps the third-order principal maximum of light B. Find the ratio λ_A/λ_B. Ⓐ 3/4 Ⓑ 1/2 Ⓒ 3/8 Ⓓ 1/4

20. A charge of 12 μC, traveling with a speed of 9.0 x 10^6 m/s in a direction perpendicular to a magnetic field, experiences a magnetic force of 8.7 x 10^{-3} N. What is the magnitude of the field? Ⓐ 7.8 x 10^{-5} Ⓑ 7.9 x 10^{-5} Ⓒ 8.0 x 10^{-5} Ⓓ 8.1 x 10^{-5} T

科目名稱： 量子物理導論

每題為 4 選 1，每一題答對得 3 分，答錯倒扣 2 分。

Planck's constant h=6.626×10^{-34} J·s　　　Mass of an electron=9.110×10^{-31} Kg

Speed of light=2.998×10^8 m/sec　　　Charge of an electron=1.602×10^{-19} C

21. Spacecraft A is moving at 0.8 c with respect to the earth. If spacecraft B is to pass A at a relative speed of 0.6 c in the same direction, what speed must B have with respect to the earth? Ⓐ 0.98 c Ⓑ 0.89 c Ⓒ 0.92 c Ⓓ 0.95 c

22. A 80 MeV photon is elastically scattered by a proton that is at rest. What is the maximum possible energy loss for the photon? (The Compton wavelength of electron is 2.4*10^{-12} m) Ⓐ 68.5 MeV Ⓑ 72.8 MeV Ⓒ 54.5 MeV Ⓓ 58.8 MeV

(背面仍有題目，請繼續作答)

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23. How many spectral lines appear in the Zeeman splitting of the the $^2D_{3/2} \rightarrow {}^2P_{1/2}$? Ⓐ 4 Ⓑ 5 Ⓒ 6 Ⓓ 7

24. A $^{200}Hg^{35}Cl$ molecule emits a 4.4-cm photon when it undergoes a rotational transition from $J = 1$ to $J = 0$. Find the interatomic distance in the molecule. Ⓐ 0.22 nm Ⓑ 0.33 nm Ⓒ 0.44 nm Ⓓ 0.55nm

25. If a wavelength of 0.083 nm is needed for the electron diffraction experiment of a material, what is the potential difference required for the electrons to accelerate through in order to get the necessary kinetic energy? Ⓐ 0.216 kV Ⓑ 2.16 kV Ⓒ 21.6 kV Ⓓ 216 kV

26. If an electron of hydrogen atom is in the $4f$ state, what are the principle quantum number n and orbital quantum number l of this state? Ⓐ $n=5$ $l=4$ Ⓑ $n=4$ $l=3$ Ⓒ $n=3$ $l=3$ Ⓓ $n=3$ $l=2$

27. If an electron of hydrogen atom is in the $5d$ state, what is its angular momentum? Ⓐ $\sqrt{3}\hbar$ Ⓑ $\sqrt{4}\hbar$ Ⓒ $\sqrt{5}\hbar$ Ⓓ $\sqrt{6}\hbar$

28. Which one of the following is correct? Ⓐ Classical mechanics is an approximation of quantum mechanics. Ⓑ Classical mechanics is complimentary to quantum mechanics. Ⓒ Quantum mechanics proves that classical mechanics is wrong. Ⓓ Quantum mechanics cannot explain those that can be explained classical mechanics.

29. In many molecules, the bond is most likely to be Ⓐ purely covalent Ⓑ ones in which the atoms share electrons to an unequal extent Ⓒ purely ionic Ⓓ ones in which the atoms share electrons to an equal extent.

30. Identical particles of 0 or 1 integral spin that cannot be distinguished one from another are described the ⒶBose-Einstein ⒷFermi-Dirac Ⓒ Maxwell-Boltzmann Ⓓ any of the above distribution.

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二、非選擇題（請以原子筆在非選擇題答案紙上標明題號作答）

科目名稱：　物理冶金　（每題5分）

31. Please draw the [010] diffraction pattern of a FCC crystal.

32. Please discuss the difference between static recovery and dynamic recovery.

33. Sketch the unit cell of $BaTiO_3$. Answer the following questions.
    (a) What is the crystal system and the Bravais lattice?
    (b) How many atoms are there per unit cell?
    (c) Give the type and number of nearest neighbors for each atom and show that the structure obey Pauling's electrostatic valence rule.

34. Derive and discuss the relationships between the potential well and the elastic modulus of the crystalline materials.

35. Please explain the phenomenon of "dendritic growth" in pure metals. Draw the 2D schematic of liquid-solid interface for an FCC crystal having primary and secondary dendrite arms.

36. Aluminum-Lithium alloy, like certain precipitation-hardened aluminum alloys, has low ductility. Please explain one of its failure mechanisms that is due to the formation of precipitation-free zones in the grains.