

※ 考生請注意：本試題可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。物理與化學共 50 題選擇題，每題答對得 2 分，答錯倒扣 0.5 分；滿分 100 分，倒扣至 0 分為止。

- Which solvent is water-soluble?
(a) Tetrahydrofuran (b) Toluene (c) Chloroform (d) Benzene
- Which solvent has the highest density?
(a) CH_3Cl (b) CH_2Cl_2 (c) CHCl_3 (d) CCl_4
- Which molecule has the highest pK_a ?
(a) CH_3COOH (b) CH_2FCOOH (c) CHF_2COOH (d) CF_3COOH
- Which following abbreviation to the analytic techniques is CORRECT?
(a) FTIR (Fourier Transform Infrared) (b) NMR (Neutron Magnetic Resonance)
(c) XPS (X-Ray Phosphate Spectroscopy) (d) XRD (X-Ray Diffusion)
- Which one is NOT consisted of carbon?
(a) Buckminsterfullerene (b) Graphite (c) Sapphire (d) Graphene
- The mass of oxygen that combines with 1 g of carbon is 2.66 g. What is the compound formed after the reaction?
(a) CH_4 (b) C_2H_5 (c) CO (d) CO_2
- What is the atomic number of sulfur?
(a) 8 (b) 16 (c) 32 (d) 48
- What is the formula for cesium bromide?
(a) CaBr (b) CsB (c) CsBr (d) CdF
- One mole of C_3H_8 reacts with oxygen to produce CO_2 and H_2O . How many moles of CO_2 can be produced?
(a) 1 mole (b) 2 moles (c) 3 moles (d) 4 moles
- Which of the following samples would have the largest volume at 25°C and 75 mmHg?
(a) 100 g CO_2 (b) 100 g CH_4 (c) 100 g NO (d) 100 g SO_2
- How many grams of Na^+ (fw: 23) are contained in 25 g of Na_2SO_4 (fw: 142)?
(a) 8.1 g. (b) 16.2 g. (c) 4.05g. (d) 3 g.

12. Calculate the molar concentration of an aqueous solution of ethanol that contains 2.3 g of C_2H_5OH (fw:46.07) in 3.5 L of solution.
(a) 0.0143 M. (b) 0.143 M. (c) 0.0286 M. (d) 0.286 M.
13. What is the ionic strength of a solution that is 0.05 M in KNO_3 and 0.1 M in Na_2SO_4 ?
(a) 0.15. (b) 0.05. (c) 0.35. (d) 0.5.
14. Neglecting the dissociation of water, write a charge-balance equation for a solution that contains $NaCl$, $Mg(NO_3)_2$, and $Al_2(SO_4)_3$.
(a) $[Na^+] + [Mg^{2+}] + [Al^{3+}] = [Cl^-] + [NO_3^-] + [SO_4^{2-}]$.
(b) $2[Mg^{2+}] + 3[Al^{3+}] = [NO_3^-] + 2[SO_4^{2-}]$.
(c) $[Na^+] + 2[Mg^{2+}] + 3[Al^{3+}] = [Cl^-] + [NO_3^-] + 2[SO_4^{2-}]$.
(d) $3[Na^+] + [Mg^{2+}] + 2[Al^{3+}] = 3[Cl^-] + [NO_3^-] + 2[SO_4^{2-}]$.
15. How many glucose molecules are in 5.23 g of $C_6H_{12}O_6$?
(a) 5×10^{22} molecules. (b) 1.75×10^{22} molecules. (c) 6×10^{20} molecules. (d) 2×10^{21} molecules.
16. Which crystal has the least cohesive energy (energy required to evaporate crystal to gas)?
(a) $Li(s)$ (b) $Fe(s)$ (c) $CS_2(s)$ (d) $NaCl(s)$
17. Which has the biggest solubility product?
(a) $Be(OH)_2$ (b) $Sr(OH)_2$ (c) $Mg(OH)_2$ (d) $Ca(OH)_2$
18. Which has the greatest heat of hydration?
(a) Li^+ (b) Rb^+ (c) K^+ (d) Na^+
19. In the quantum-mechanical model, the general shape of an orbital is determined by quantum number(s)
(a) l (b) n (c) m_l (d) m_l and m_s
20. Which of the following is not an intensive property?
(a) density (b) heat content (c) temperature (d) physical state
21. Regarding the carbon atom,
(a) there are six electrons in the outermost electron shell.
(b) there are three electrons in the 2P orbital.
(c) there is only one electron in the 2s orbital.
(d) there are four electrons on the second shell.

22. Ethylene (C_2H_4) is an important starting material in the manufacture of plastics, and which of the following descriptions about ethylene is correct?
- (a) There are 8 valence electrons in this molecule.
 - (b) Only three of four sp^3 orbitals of carbon have been used to share electrons with hydrogens.
 - (c) The overlap of p orbitals of carbon atom is able to form a pi bond within this molecule.
 - (d) Carbon atoms use a set of sp^3 hybrid orbitals to establish covalent bonding with hydrogen atoms.
23. In a substitutional alloy,
- (a) some of the host metal atoms are replaced by other metal atoms of similar size.
 - (b) some interstices in the closet packed metal structure are occupied by small atoms.
 - (c) Steel is the best known substitutional alloy.
 - (d) it contains strong directional covalent bonds.
24. For the dipole-dipole forces,
- (a) they occur between molecules with temporary dipolar arrangement of charge, which is also known as dipole-dipole interactions.
 - (b) they are particularly strong among molecules in which hydrogen is bound to a highly electronegative atoms.
 - (c) they are stronger than ionic interactions.
 - (d) they are frequently found between nonpolar molecules.
25. The values of bond energy
- (a) can be used to calculate approximate change of enthalpy during the chemical reaction
$$H_{2(g)} + F_{2(g)} \rightarrow 2HF_{(g)}$$
 - (b) are related to the amount of gained energy by the formation of bonds.
 - (c) increase with the increase of bond length.
 - (d) can be used to estimate the polarity of an atom.
26. A certain string has a linear mass density of 0.25 kg.m^{-1} and is stretched with a tension of 25 N. One end is given a sinusoidal motion with frequency 5 Hz and amplitude 0.01 m. At time $t = 0$ the end has zero displacement and is moving in the + y-direction. Please find the wave number.
- (a) 1.57 m^{-1} (b) 3.14 m^{-1} (c) 4.71 m^{-1} (d) 6.28 m^{-1}
27. A certain string has a linear mass density of 0.25 kg.m^{-1} and is stretched with a tension of 25 N. One end is given a sinusoidal motion with frequency 5 Hz and amplitude 0.01 m. At time $t = 0$ the end has zero displacement and is moving in the + y-direction. Please find the transverse velocity of the point at $x = 0.25 \text{ m}$ at time $t = 0.1 \text{ s}$.
- (a) $+0.11 \text{ m.s}^{-1}$ (b) -0.11 m.s^{-1} (c) $+0.22 \text{ m.s}^{-1}$ (d) -0.22 m.s^{-1}

28. A steel piano wire 50 cm long, of mass 5 g, is stretched with a tension of 400 N. What is the frequency of its fundamental mode of vibration?
(a) 100 Hz (b) 150 Hz (c) 200 Hz (d) 250 Hz
29. What is the wavelength of the light of wavelength 500 nm (in vacuum) in the glass whose index at this wavelength is 1.5?
(a) 333 nm (b) 500 nm (c) 667 nm (d) 750 nm
30. In a thin lens ($n = 1.5$), let the absolute magnitude of the radii of curvature of the lens surfaces be respectively 20 cm and 5 cm. Assume the first surface is on the side of the outgoing light, please find out the focal length.
(a) 8 cm (b) 12.5 cm (c) 13.3 cm (d) 20 cm
31. A spacecraft is moving relative to the earth. An observer on the earth finds that, between 1 pm and 2 pm according to his clock, 3601 s elapse on the spacecraft's clock. What is the approximate spacecraft speed relative to the earth?
(a) 0.024C. (b) 0.366C. (c) 0.244C. (d) 0.066C. (C is the speed of light.)
32. If Mark travels at a speed of $0.8c$, then when your heart beats 15 times, how many times does Mark's heart beat?
(a) 15 (b) 12 (c) 9 (d) 6.
33. In order to see a red light becomes a green light, what can you do?
(a) Run toward to the red light at a speed of $0.55 C$.
(b) Run away from the red light at a speed of $0.55C$.
(c) Run toward to the red light at a speed of $0.75 C$.
(d) Run away from the red light at a speed of $0.75C$. (C is the speed of light.)
34. Electromagnetic waves A has a wavelength of 15 pm and B has 25 pm, which produces more pronounced Compton effect?
(a) Both cannot produce Compton effect. (b) A. (c) B. (d) Both are the same.
35. When the maximum kinetic energy of photoelectrons is 4.1 eV, what is the wavelength of the UV light (intensity of 1.00 W/m^2) that generates the photoelectric effect?
(a) 100 nm. (b) 200 nm. (c) 300 nm. (d) 400 nm.

36. A gravitational force,

- (a) can change the energy of a photon if the force is in the same direction of the photon's movement.
- (b) can change the energy of a photon.
- (c) cannot change the energy of a photon if the force is parallel to the direction of the photon's movement.
- (d) cannot change the energy of a photon.

37. Which lens aberration is caused by the variation of index with wavelength?

- (a) Spherical aberration
- (b) Chromatic aberration
- (c) Monochromatic aberration
- (d) Astigmatism

38. In the Young's experiment for light interference, with two slits spaced 0.2 mm apart, and a screen at a distance of 1 m, the third bright fringe is found to be displaced 7.5 mm from the central fringe. Find the wavelength of the light used.

- (a) 400 nm
- (b) 500 nm
- (c) 600 nm
- (d) 700 nm

39. A thin square steel plate, 10 cm on a side, is heated in a blacksmith's forge to a temperature of 1000K. If the emissivity is 0.8, and the Stefan-Boltzmann constant is σ (in MKS unit), what is the total rate of radiation of energy (W)?

- (a) 8000σ
- (b) 16000σ
- (c) 32000σ
- (d) 64000σ

40. A steel bar 10 cm long is welded end-to-end to a copper bar 20 cm. Each bar has a square cross section, 2cm on a side. The free end of the steel bar is placed in contact with steam at 100°C , and the free end of the copper bar with ice at 0°C . The thermal conductivities are 50.2 (in MKS unit) for steel and 385 (in MKS unit) for copper. Find the temperature at the junction of the two bars and the total rate of heat flow, when steady-state conditions have been reached.

- (a) 15.9°C
- (b) 20.9°C
- (c) 15.7°C
- (d) 20.7°C

41. C_p and C_v are the molar heat capacities at constant pressure and constant volume, respectively. What is the value of the ratio C_p/C_v for monatomic gases?

- (a) 1.00
- (b) 1.24
- (c) 1.40
- (d) 1.67

42. The compression ratio of a certain diesel engine is 15. This means that air in the cylinders is compressed to 1/15 of its initial volume. If the initial pressure is $1.0 \times 10^5 \text{ Pa}$ and the initial temperature is 27°C ($=300\text{K}$), find the final pressure and temperature after compression.

- (a) 613°C and 44atm
- (b) 414°C and 63 atm
- (c) 414°C and 44atm
- (d) 613°C and 63 atm

43. What is the total random kinetic energy of the molecules in 1 mole of a gas at a temperature of 300 K?
(a) 3471 cal (b) 3471 J (c) 894 J (d) 984J
44. Five gas molecules chosen at random are found to have speeds of 500, 600, 700, 800, and 900 ms^{-1} . Find the rms speed?
(a) 764m/s (b) 7641m/s (c) 714m/s (d) 7142m/s
45. A certain string has a linear mass density of 0.25 kg/m and is stretched with a tension of 25N. One end is giving a sinusoidal motion with frequency 5Hz and amplitude 0.01m. At time $t=0$ the end has zero displacement and is moving in the +y-direction. What is the wave speed of the string?
(a) 5 m/s (b) 10 m/s (c) 15 m/s (d) 20 m/s
46. A resistor is a cylinder with radius(5mm) and length (10mm). Its conductivity is $0.1 (\Omega\text{cm})^{-1}$. What is its resistance?
(a) 13Ω (b) 0.013Ω (c) 0.0013Ω (d) 0.13Ω
47. What is a requirement for diffraction?
(a) Nanostructure (b) Metal (c) Periodic (repeating) structure (d) powder
48. Two charges are separated by a distance x. How will their force change when the distance x is doubled?
(a) $\frac{1}{2}$ (b) 2 (c) $\frac{1}{4}$ (d) 3
49. Estimate the number of atoms in a nanoparticle of 10^{-9}m diameter
(a) ~ 1000 (b) $\sim 10^5$ (c) $\sim 10^{10}$ (d) ~ 10
50. Three capacitors with capacitance $C=1\text{nF}$ are arranged in series. What is the total capacitance of the arrangement?
(a) 1nF (b) 0.33nF (c) 0.5nF (d) 3nF