

單選題 (第 1-30 題, 每題 2 分; 第 31-40 題, 每題 4 分; 每個錯誤倒扣 1 分)
請於答案卷內之「選擇題作答區」依序作答。

- What answer should be reported if 4.560 is added to 2.6×10^{-3} ?
(a) 4.6 (b) 4.56 (c) 4.563 (d) 4.5626
- Give the number of protons (p), electron (e), and neutrons (n) in one atom of ${}_{17}^{37}\text{Cl}$.
(a) 37 p, 37 e, 17 n
(b) 17 p, 17 e, 37 n
(c) 17 p, 17 e, 20 n
(d) 20 p, 37 e, 17 n
- Which of the following are examples of transition metals:
(a) Fe and Zn
(b) Sb and I
(c) Pm and Gd
(d) Al and Ga
- Which of the following is a free radical?
(a) ICl_2^+ (b) O_2^{2-} (c) ClO_2 (d) I_3^-
- The average mass of an atom is determined by
(a) averaging the masses of each isotope
(b) taking a weighted average of all isotopic masses
(c) taking a weighted average of all stable isotopic masses
(d) adding the isotopic masses and dividing by the number of isotopes
- In quantum mechanics, an “l” value of 2 corresponds to a letter designation of orbital:
(a) s (b) p (c) d (d) f
- Which two electron configurations represent elements that would have similar chemical properties?
I. $1s^22s^22p^4$ II. $1s^22s^22p^5$ III. $[\text{Ar}]4s^23d^{10}4p^3$ IV. $[\text{Ar}]4s^23d^{10}4p^4$
(a) I, II (b) I, III (c) I, IV (d) III, IV
- Which of the following species is non-polar?
(a) PF_5 (b) NF_3 (c) IF_3 (d) SF_4
- CaCl_2 is an example of a:
(a) covalent compound
(b) formula unit
(c) molecular compound

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- (d) organic acid
10. The molecular formula of calcium phosphate is:
- Ca_3P_2
 - CaPO_3
 - $\text{Ca}_3(\text{PO}_4)_2$
 - $\text{Ca}_2(\text{PO}_4)_3$
11. The compound 2-chloro-1-pentene
- has the formula $\text{C}_5\text{H}_{11}\text{Cl}$.
 - cannot exist as *cis* and *trans* isomers.
 - can exist as *cis* and *trans* isomers.
 - has 3 structural isomers.
12. Which of the following substances has the highest boiling point?
- C_2H_6
 - Ar
 - CH_2Cl_2
 - HF
13. Which one of the following elements would have the lowest melting point?
- Kr
 - Ca
 - K
 - Br_2
14. Which one of the following is *not* a redox reaction?
- $\text{Al}(\text{OH})_4^-(aq) + 4\text{H}^+(aq) \rightarrow \text{Al}^{3+}(aq) + 4\text{H}_2\text{O}(l)$
 - $\text{C}_6\text{H}_{12}\text{O}_6(s) + 6\text{O}_2(g) \rightarrow 6\text{CO}_2(g) + 6\text{H}_2\text{O}(l)$
 - $\text{Na}_6\text{FeCl}_8(s) + 2\text{Na}(l) \rightarrow 8\text{NaCl}(s) + \text{Fe}(s)$
 - $2\text{H}_2\text{O}_2(aq) \rightarrow 2\text{H}_2\text{O}(l) + \text{O}_2(g)$
15. Complete and balance the following redox equation. What is the coefficient of H_2O when the equation is balanced with the set of smallest whole numbers?
 $\text{MnO}_4^- + \text{SO}_3^{2-} \rightarrow \text{Mn}^{2+} + \text{SO}_4^{2-}$ (acidic solution)
- 3
 - 4
 - 5
 - 8
16. The conjugate acid of sodium acetate ($\text{Na}^+\text{CH}_3\text{COO}^-$) is:
- NaOH
 - CH_3COOH
 - HCl
 - $\text{K}^+\text{CH}_3\text{COO}^-$
17. Which of the following aqueous solutions has the lowest freezing point?

- (a) 0.18 m KCl
(b) 0.15 m Na₂SO₄
(c) 0.12 m Ca(NO₃)₂
(d) 0.20 m C₆H₁₂O₆ (glucose)

18. If solutions of equal molarity concentration are prepared, the one with the highest electrical conductivity will be:

- (a) [Pt(NH₃)₂Cl₂]
(b) [Co(H₂O)₆]SO₄
(c) K₃[CoCl₆]
(d) [Co(NH₃)₅Cl]Cl₂

19. The ion [Co(NH₃)₆]²⁺ is octahedral and high spin. This complex is:

- (a) paramagnetic, with 1 unpaired electron.
(b) paramagnetic, with 3 unpaired electrons.
(c) paramagnetic, with 4 unpaired electrons.
(d) diamagnetic.

20. What is the maximum number of electrons in an atom that can have the following set of quantum numbers? $n = 4$ $l = 3$ $m_l = -2$ $m_s = +1/2$

- (a) 0 (b) 1 (c) 2 (d) 32

21. Which of the following substances exhibit optical isomers?

- (a) CH₃COOH (b) CH₃CH=CHBr
(c) [Pt(NH₃)₂Cl₂] (d) [Co(en)₃]Cl₃

22. Which species listed below is present in greatest concentration in a 1.0 M solution of NH₄NO₃?

- (a) NH₄⁺ (b) NO₃⁻ (c) HNO₃ (d) NH₃

23. The unit of first order rate constant is

- (a) M/s (b) 1/(M.s) (c) 1/s (d) 1/(M².s)

24. Which of the following statements is FALSE?

- (a) In a dynamic equilibrium the rates of the forward and reverse reactions go to zero once the equilibrium is reached.
(b) A catalyst will increase the rates of both the forward and reverse reactions.
(c) For a first-order reaction, a plot of natural log of concentration vs. time provides a line with a slope equal to -k.
(d) Radioactive decay is a first order reaction.

25. Band gaps tend to be largest for:

- (a) conductors
(b) semiconductors

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- (c) insulators
(d) modulators
26. "Doping" pure silicon with gallium results in a _____ material.
(a) p-type
(b) n-type
(c) s-type
(d) d-type
27. At equilibrium ΔG is:
(a) = 0
(b) > 0
(c) < 0
(d) can not be determined
28. A chemical reaction that transfers heat from the system (the reaction) to the surroundings is always:
(a) exothermic (b) endothermic (c) spontaneous (d) irreversible
29. Balance the following equation:
 $\text{CH}_3\text{OH} (\text{l}) + \text{O}_2 (\text{g}) \rightarrow \text{CO}_2 (\text{s}) + \text{H}_2\text{O} (\text{l})$
How many moles of water are produced in a reaction of 15 moles of methanol with 30 moles of oxygen?
(a) 20
(b) 30
(c) 40
(d) 50
30. Under constant volume conditions, the change in internal energy equals the:
(a) entropy
(b) insulation capacity
(c) transduction
(d) heat flow
31. What is the molar solubility of CaF_2 ($K_{\text{sp}} = 3.9 \times 10^{-11}$)?
(a) $6.24 \times 10^{-6} \text{ M}$ (b) $4.41 \times 10^{-6} \text{ M}$
(c) $2.14 \times 10^{-4} \text{ M}$ (d) $9.27 \times 10^{-5} \text{ M}$
32. A 2.0 L vessel is filled with 7.3×10^{-2} mol hydrogen at 1.55 atm. What is the temperature of this gas?
(a) 520 K
(b) 640 K
(c) 1200 K
(d) 2800 K

33. The Haber process is used to synthesize ammonia from hydrogen and nitrogen. How much hydrogen is required to produce 42.8 kg of ammonia?
- (a) 56.02 kg
(b) 42.8 kg
(c) 35.25 kg
(d) 7.60 kg
34. If silver atoms follow a face-centered cubic unit cell pattern, what is the length of this unit cell if the atomic radius is 144.4 pm?
- (a) 144 pm
(b) 179 pm
(c) 408 pm
(d) 635 pm
35. How many grams of silver are deposited at a platinum cathode in the electrolysis of $\text{AgNO}_3(\text{aq})$ by 5.30 amps of electric current in 4.0 hours?
- (a) 85.3 g
(b) 42.6 g
(c) 121 g
(d) 188 g
36. The production of nitric oxide is governed by the reaction:
 $4 \text{NH}_3(\text{g}) + 5 \text{O}_2(\text{g}) \rightarrow 4 \text{NO}(\text{g}) + 6 \text{H}_2\text{O}(\text{g})$
If the rate at which oxygen is consumed is $8.29 \times 10^{-3} \text{ mol L}^{-1} \text{ s}^{-1}$, at what rate is NO produced?
- (a) $8.29 \times 10^{-3} \text{ mol L}^{-1} \text{ s}^{-1}$
(b) $1.04 \times 10^{-2} \text{ mol L}^{-1} \text{ s}^{-1}$
(c) $6.63 \times 10^{-3} \text{ mol L}^{-1} \text{ s}^{-1}$
(d) $5.53 \times 10^{-3} \text{ mol L}^{-1} \text{ s}^{-1}$
37. A radioisotope decays at such a rate after 72.0 min only 1/16 of the original amount remains. Which of the following statements are TRUE?
- (a) The half-life of this nuclide is 9 min.
(b) After another 108 min, only 1/1024 of the original amount remains.
(c) The decay rate will change with the solvents used to dissolve the salts of radioisotope.
(d) The decay constant is 0.0385 min^{-1} .
38. Consider the reaction of carbon monoxide with oxygen to produce carbon dioxide.
 $2 \text{CO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{CO}_2(\text{g})$
At what temperature will this reaction be spontaneous according to Gibbs's Energy?
 ΔH_f in kJ/mol for: $\text{CO}(\text{g}) = -110.5$, $\text{CO}_2(\text{g}) = -393.5$
S in J/mol K for: $\text{CO}(\text{g}) = 197.6$, $\text{CO}_2(\text{g}) = 213.6$, $\text{O}_2(\text{g}) = 205.0$
- (a) temps above 63.1 K
(b) temps below 179.5 K
(c) temps above 415.8 K

(d) temps below 3273 K

39. Breaking the oxygen-oxygen bond in hydrogen peroxide requires 210 kJ/mol. What is the longest wavelength of light that can cause this bond to be broken?

- (a) 5.7×10^{-4} m
- (b) 9.5×10^{-31} m
- (c) 2.8×10^{-7} m
- (d) 9.5×10^{-28} m

40. In an electron microscope, electrons are accelerated to great velocities. Calculate the wavelength of an electron traveling with a velocity of 7.0×10^3 kilometers per second. The mass of an electron is 9.1×10^{-28} g.

- (a) 1.0×10^{-13} m
- (b) 1.0×10^{-7} m
- (c) 1.0 m
- (d) 1.0×10^{-10} m

Useful informations:

gas constant, $R = 0.08206 \text{ atm L mol}^{-1}\text{K}^{-1} = 8.314 \text{ J mol}^{-1}\text{K}^{-1}$

Faraday constant $F = 9.6485 \times 10^4 \text{ C.mol}^{-1}$

Planck's constant, $h = 6.626 \times 10^{-34} \text{ J.s} = 6.626 \times 10^{-27} \text{ erg.s}$

Speed of light, $c = 2.9979 \times 10^8 \text{ m s}^{-1}$

$m_e = 9.11 \times 10^{-28} \text{ g}$, $e = 1.60 \times 10^{-19} \text{ C}$

1 joule (J) = $1 \text{ kg m}^2 \text{ s}^{-2} = 1 \text{ C} \cdot \text{V}$ (coulomb-volt)

Atomic mass: H= 1.01 He = 4.00 C = 12.01 N = 14.01 O = 16.00 Ag =107.9