

Sample Questions – Mid-Session Test CHEM1011

(Note your test will consist of only 20 questions similar to these examples).

1. A 1.00 L gas sample at 705 Torr and 47 °C has a mass of 0.988 g. The gas is most likely:

- (A) CO (molar mass 28 g mol⁻¹)
- (B) CF₄ (molar mass 88 g mol⁻¹)
- (C) CH₄ (molar mass 16 g mol⁻¹)
- (D) CO₂ (molar mass 44 g mol⁻¹)
- (E) Cl₂ (molar mass 71 g mol⁻¹)

$$PV = nRT$$

$$\therefore n = \frac{PV}{RT} = \frac{(705)(1.00)}{(0.0821)(273 + 47)}$$

$$= 0.03531 \text{ mol} = 0.988 \text{ g}$$

$$\therefore 1 \text{ mol} = 0.988 / 0.03531 \text{ g} = 28 \text{ g}$$

2. The name of the compound BaCl₂·2H₂O is

- (A) barium dichloride
- (B) barium dichlorohydrate
- (C) barium chloride dihydrate ←
- (D) barium chloride
- (E) barium dichloride dihydrate

3. A binary compound of lead and oxygen was found to contain 90.66% Pb. What is the empirical formula for the compound?

- (A) PbO
- (B) Pb₃O₄ ←
- (C) PbO₉
- (D) Pb₉O
- (E) PbO₂

100g contains 90.66g Pb + 9.34g O

$$= \frac{90.66}{207.2} \text{ mol Pb} \& \frac{9.34}{16.00} \text{ mol O}$$

$$= 0.4375 \text{ mol Pb} \& 0.5838 \text{ mol O}$$

$$\equiv \text{Ratio } 1 : 1.334 \text{ mol ratios}$$

$$\equiv 3 : 4 \text{ atom ratios.}$$

4. The nucleus of the species F⁻ is made up of

- (A) 9 protons, 19 neutrons and 0 electrons
- (B) 9 protons, 10 neutrons and 0 electrons
- (C) 10 protons, 9 neutrons and 0 electrons
- (D) 10 protons, 9 neutrons and 10 electrons
- (E) 9 protons, 10 neutrons and 9 electrons

5. What amount of iron is contained in 125 g of it?

(The atomic mass of iron is 55.85 g mol⁻¹).

- (A) 1.12 mol
- (B) 0.447 mol
- (C) 3.49 mol
- (D) 6.98 mol
- (E) 2.24 mol ←

$$\text{Mol} = \frac{\text{mass}}{\text{molar mass}} = \frac{125}{55.85}$$

$$= 2.24 \text{ mol}$$

6. The charge on a halide ion is

- (A) always -2
- (B) may be -1, +1, +3, +5, or +7
- (C) always +1
- (D) always -1 ←
- (E) -1 or +7



7. Given the unbalanced equation:



The balanced equation shows that for every mole of Cl_2 used that the number of mole of PCl_3 formed is

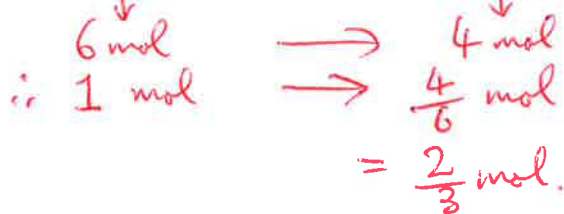
(A) 3

(B) 2

(C) $3/2$

(D) $2/3$ ←

(E) 6



8. A gas mixture contains four times as many CH_4 molecules as C_2H_4 molecules. The partial pressure of CH_4 is 100 mmHg. What is the partial pressure of C_2H_4 in the mixture?

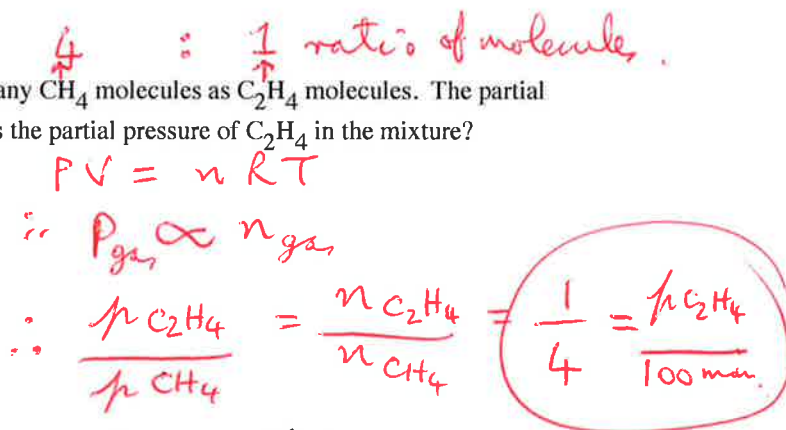
(A) 400 mmHg

(B) 25 mmHg ←

(C) 20 mmHg

(D) 500 mmHg

(E) 100 mmHg



9. The molar mass of dinitrogen oxide (laughing gas) is $44.02 \text{ g} \cdot \text{mol}^{-1}$. A sample contains 4.00×10^{24} dinitrogen oxide molecules. What is the mass of the sample in grams?

(A) $2.92 \times 10^2 \text{ g}$ ←

(B) 29.2 g

(C) $1.51 \times 10^2 \text{ g}$

(D) $3.42 \times 10^2 \text{ g}$

(E) $1.51 \times 10^{-2} \text{ g}$

$$\begin{array}{l} \text{Mass} = \left(\frac{4.00 \times 10^{24}}{6.022 \times 10^{23}} \right) \times 44.02 \text{ g} \\ = 292 \text{ g.} \end{array}$$

10. What volume of 0.202 M NaCl(aq) should be used to prepare 125 mL of $3.20 \times 10^{-3} \text{ M NaCl(aq)}$?

(A) 25.3 mL

(B) 0.0808 mL

(C) 1.98 mL ←

(D) 7.89 mL

(E) 0.400 mL

$$\begin{array}{l} C_1 V_1 = C_2 V_2 \\ (0.202)(V_1) = (3.20 \times 10^{-3})(0.125 \text{ L}) \\ V_1 = 0.00198 \text{ L} \\ = 1.98 \text{ mL.} \end{array}$$

11. Calculate the number of moles of $\text{Ca(OH)}_2(\text{aq})$ needed to react completely with 125 mL of 6.00 M HCl(aq) .

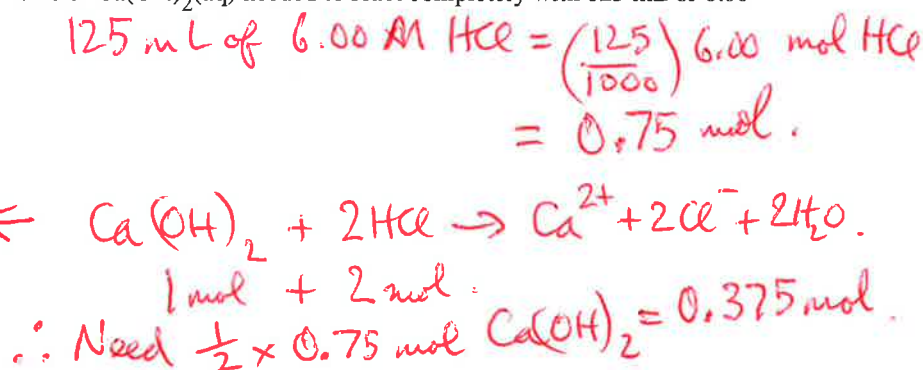
(A) 0.0416 mol

(B) 0.750 mol

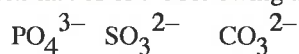
(C) 3.00 mol

(D) 0.375 mol ←

(E) 1.50 mol

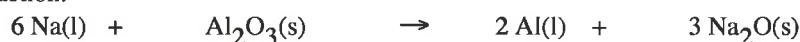


12. The names of the following three anions are respectively,



- (A) phosphide ion, sulfite ion, carbonate ion
 (B) phosphate ion, sulfate ion, carbonate ion
 (C) phosphite ion, sulfite ion, carbonite ion
 (D) phosphite ion, sulfate ion, carbonate ion
 (E) phosphate ion, sulfite ion, carbonate ion ←

13. For the reaction:



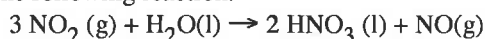
When 5.52 grams of Na (molar mass 23.0 g.mol^{-1}) is reacted with excess $\text{Al}_2\text{O}_3\text{(s)}$ (molar mass 102 g.mol^{-1}), 1.00 g of Al(l) (molar mass 27.0 g.mol^{-1}) is produced. The percent yield of Al is:

- (A) 46.3% ←
 (B) 18.1%
 (C) 11.1%
 (D) 39.1%
 (E) 15.4%
- Handwritten calculation:
 $6\text{Na} + \text{Al}_2\text{O}_3 \rightarrow 2\text{Al} + 3\text{Na}_2\text{O}$
 $6(23) + 102 \rightarrow 2(27)$
 $138\text{g} + 102\text{g} \rightarrow 54\text{g at } 100\% \text{ yield.}$
 $5.52\text{g} + \text{x.s.} \rightarrow 2.16\text{g at } 100\% \text{ yield.}$
 $\therefore \% \text{ yield} = \frac{1.00}{2.16} \times 100 = 46.3\%$

14. The formula for sulfurous acid is

- (A) HSO_3
 (B) H_2SO_3 ←
 (C) H_2S
 (D) HSO_4
 (E) H_2SO_4

15. Consider the following reaction:



How many mole of the excess reactant remain after the reaction is complete if 2.00 moles of $\text{H}_2\text{O(l)}$ and 5.00 moles of $\text{NO}_2\text{(g)}$ are used?

- (A) 0.33 mol $\text{H}_2\text{O(l)}$ ←
 (B) 4.00 mol $\text{NO}_2\text{(g)}$
 (C) 1.67 mol $\text{H}_2\text{O(l)}$
 (D) 3.00 mol $\text{NO}_2\text{(g)}$
 (E) 1.00 mol $\text{NO}_2\text{(g)}$
- Handwritten calculation:
 $3 \text{NO}_2 + \text{H}_2\text{O} \rightarrow 2 \text{HNO}_3 + \text{NO}$
 $3 \text{ mol} + 1 \text{ mol}$
 $\therefore 5 \text{ mol} + \frac{5}{3} \text{ mol}$
 $\therefore \text{Excess H}_2\text{O} = 2 \text{ mol} - \frac{5}{3} \text{ mol}$
 $= 0.33 \text{ mol.}$

16. The dye, Bismark brown, has a molar mass of 228.3 g.mol^{-1} . Analysis shows that it is 30.68% N. How many nitrogen atoms are in each Bismark brown molecule?

- (A) 5 ←
 (B) 0.5
 (C) 1
 (D) 4
 (E) 3
- Handwritten calculation:
 $1 \text{ mol BB} = 228.3 \text{ g}$
 $30.68\% \text{ of } 228.3 \text{ g} = 70.04 \text{ g of N in 1 mol.}$
 $\therefore 1 \text{ mol BB contains } 70.04 / 14.01 \text{ mol of N.}$
 $= 4.999 \text{ mol N.}$
 $\therefore 1 \text{ molecule BB contains 5 molecules N.}$

17. What energy is required to excite a hydrogen atom in its $n = 2$ state to the $n = 3$ state?

(A) $1.303 \times 10^{-25} \text{ J}$

(B) $8.235 \times 10^6 \text{ J}$

(C) $1.818 \times 10^{-19} \text{ J}$

(D) $3.635 \times 10^{-19} \text{ J}$

(E) $3.029 \times 10^{-19} \text{ J}$

$$\frac{1}{\lambda} = R_H \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

$$= (1.098 \times 10^7) \left(\frac{1}{2^2} - \frac{1}{3^2} \right)$$

$$\frac{1}{\lambda} = 1525000 \text{ m}^{-1}$$

$$E = h\nu = hc \left(\frac{1}{\lambda} \right) = (6.626 \times 10^{-34}) (2.998 \times 10^8) (1525000)$$

$$= 3.029 \times 10^{-19} \text{ J}$$

18. Electromagnetic radiation with a frequency of 10.4 MHz has a wavelength of:

(A) $6.89 \times 10^{-27} \text{ m}$

(B) $9.61 \times 10^{-8} \text{ m}$

(C) 0.035 m

(D) 2.88 m

(E) 28.8 m

$$c = \nu \lambda$$

$$\therefore \lambda = \frac{c}{\nu} = \frac{2.998 \times 10^8}{10.4 \times 10^6} \text{ m}$$

$$= 28.8 \text{ m}$$

19. The energy per photon for visible light with a wavelength of 700 nm is:

(A) $3.31 \times 10^{-31} \text{ J}$

(B) $2.84 \times 10^{-19} \text{ J}$

(C) $3.71 \times 10^{-19} \text{ J}$

(D) $3.97 \times 10^{-16} \text{ J}$

(E) $9.96 \times 10^{-10} \text{ J}$

$$E = h\nu = \frac{hc}{\lambda} = \frac{(6.626 \times 10^{-34}) (2.998 \times 10^8)}{700 \times 10^{-9} \text{ m}}$$

$$= 2.84 \times 10^{-19} \text{ J}$$

20. An atom undergoes a transition from a higher to a lower state where the energy difference is $3.03 \times 10^{-19} \text{ J}$. The frequency of the photon emitted is:

(A) $4.57 \times 10^{-14} \text{ Hz}$

(B) $4.57 \times 10^{14} \text{ Hz}$

(C) $2.99 \times 10^{13} \text{ Hz}$

(D) $9.08 \times 10^{11} \text{ Hz}$

(E) $4.57 \times 10^8 \text{ Hz}$

$$E = h\nu$$

$$\therefore \nu = \frac{E}{h} = \frac{3.03 \times 10^{-19}}{6.626 \times 10^{-34}} \text{ s}^{-1}$$

$$= 4.57 \times 10^{14} \text{ s}^{-1} \text{ (or Hz)}$$

21. Which one of the following statements is true?

(A) A 2p orbital has two nodal planes

(B) A 2p orbital has one nodal plane

(C) There are exactly three d orbitals in the 4d sublevel

(D) A 2s orbital has the quantum number m_l equal to 1

(E) There are exactly three p orbitals in the 4p sublevel

22. An unknown gas effuses at 1.05 times the rate of Cl_2 molecules, measured using the same apparatus under the same conditions of temperature and pressure. What is the probable identity of the unknown gas?

(A) NH_3 (molar mass = 17.0 g mol^{-1})

(B) H_2 (molar mass = 2.0 g mol^{-1})

(C) Xe (molar mass = 131.3 g mol^{-1})

(D) SO_2 (molar mass = 64.1 g mol^{-1})

(E) I_2 (molar mass = 253.8 g mol^{-1})

$$\frac{\text{rate}_X}{\text{rate}_{\text{Cl}_2}} = \sqrt{\frac{MM_{\text{Cl}_2}}{MM_X}}$$

$$\frac{1.05}{1} = \sqrt{\frac{71}{MM_X}}$$

$$\frac{1.1025}{1} = \frac{71}{MM_X}$$

$$\therefore MM_X = 64.4 \text{ g mol}^{-1}$$

23. Which of the following groups of elements are arranged in order of decreasing atomic radius (that is, from largest to smallest)?

(A) Na, K, Rb

(B) Ne, Na, Mg

(C) Cl, Ar, K

(D) Be, C, O ←

(E) Ar, Kr, Ne

24. For which of the following atoms or ions is the electronic configuration given NOT the ground state configuration for that atom or ion?

(A) N $1s^2 2s^2 2p^3$

(B) S $1s^2 2s^2 2p^6 3s^2 3p^4$

(C) Cr $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^4$ ←

(D) Cl^- $1s^2 2s^2 2p^6 3s^2 3p^6$

(E) Ca^{2+} $1s^2 2s^2 2p^6 3s^2 3p^6$

... $4s^1 3d^5$
↑
SPECIAL STABILITY OF
 $\frac{1}{2}$ -FILLED SET OF d ORBITALS

25. Which one of the following statements is TRUE?

(A) Silicon has 12 core electrons and 2 valence electrons

(B) Isolated atoms of zinc are diamagnetic ←

(C) Cl^+ is isoelectronic with Ar

(D) The ionic radius of Fe^{3+} is larger than the ionic radius of Fe^{2+}

(E) Isolated atoms of silicon are diamagnetic

26. The first five successive ionisation energies of an element are 0.807, 2.433, 3.666, 25.033, 32.834 MJ mol^{-1} . Which one element from those listed below could this element be?

(A) B ←

(B) C

(C) N

(D) O

(E) F

27. In which one of the following species is the central atom (the first atom in the formula) unlikely to have an octet of valence electrons?

(A) BF_4^-

(B) XeO_3 ←

(C) SiCl_4

(D) NH_3

(E) CH_2Cl_2

28. How many lone pairs of electrons are there in TOTAL in the Lewis structure of XeF_4 ?

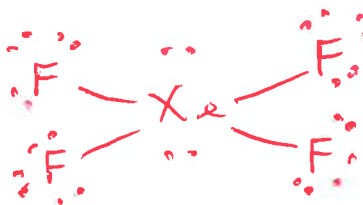
(A) 14 ←

(B) 6

(C) 4

(D) 12

(E) 2

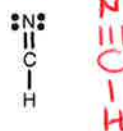


29. Which of the following formulae has, pictured below it, the least realistic Lewis diagram?

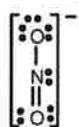
(A) NO



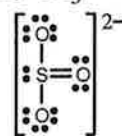
(B) HCN



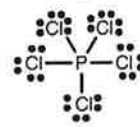
(C) NO_2^-



(D) SO_3^{2-}



(E) PCl_5



30. Which of the following elements has the lowest first ionisation energy?

(A) Cl

(B) K

(C) Br

(D) F

(E) Mg

31. The correct ground state electronic configuration for the isolated iron(III) ion is:

