Engineering Daily 26 [Home Practice] EV - Answer Sheet

Environmental Chemistry

Total Marks: 50 **Negative Marks:** 0.25 **Time:** 1 Hour

MCQ 50 marks

1. **A. 5.6 L**

Explanation: $n = \frac{1.50575\times10^{23}}{6.023\times10^{23}} = 0.25$ mol

$V = 0.25 \times 22.4 = 5.6$ L

2. **B. 0.0933 mol**

Explanation: $n = \frac{PV}{RT} = \frac{0.95\times2.5}{0.0821\times310} =$ 0.0933 mol

3. **A. 282.2 g**

Explanation: $n = \frac{12.0\times20.0}{0.0821\times290} = 10.080$ mol

$m = 10.080 \times 28 = 282.2$ g

4. **D. 33°C**

Explanation: At constant volume $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

$T_2 = 255 \times \frac{1.92}{1.70} = 288.0$ K

Difference $= 288.0 - 255 = 33$ K or °C

5. **B. 5.197**

Explanation: $d = \frac{PM}{RT} = \frac{2.0\times64}{0.0821\times300} = 5.197$ g/L

6. **D.** 1.834×10^{22}

Explanation: $P = \frac{380}{760} = 0.5$ atm

$n = \frac{0.5\times1.25}{0.0821\times250} = 0.03045$ mol

Molecules $= 0.03045 \times 6.023 \times 10^{23} =$ 1.834×10^{22}

7. **B.** 2.445×10^{13}

Explanation: $V_m = 0.0821 \times 300 = 24.63$ L

$n = \frac{1.0\times10^{-9}}{24.63} = 4.060 \times 10^{-11}$ mol

Molecules $= 2.445 \times 10^{13}$

8. **D. 608 m**

Explanation: Maximum volume $= 4 \times \frac{3}{2} =$ $6\ m^3$

Bursting pressure $P_2 = \frac{1.2\times4}{6} = 0.8$ atm

Pressure drop $= (1.2 - 0.8) \times 760 =$ 304 mmHg

Height $= \frac{304}{0.5} = 608$ m

9. **B.** $2.408\ gL^{-1}$

Explanation: Under the given conditions

$d_1 = \frac{0.84}{0.420} = 2.0$ g/L

$d_2 = d_1 \times \frac{P_2}{P_1} \times \frac{T_1}{T_2}$

$d_2 = 2.0 \times \frac{760}{740} \times \frac{320}{273} = 2.408$ g/L

10. **A. 66.67**

Explanation: $n_{He} = \frac{0.42}{4} = 0.105$ mol

At the same P and V, nT is constant: $n_X = 0.105 \times \frac{280}{350} = 0.084$ mol

$M_X = \frac{5.6}{0.084} = 66.67$

11. **D. 6d**

Explanation: $d \propto \frac{P}{T}$

$d' = d \times \frac{3P}{P} \times \frac{T}{T/2} = 6d$

12. **C.** $67.2\ m^3$

Explanation: Moles of gas removed $= \frac{2\times90}{R\times300}$

Decrease in moles in the tank $= \frac{(150-147.5)V}{R\times280}$

$\frac{2.5V}{280} = \frac{180}{300}$

$V = \frac{180\times280}{300\times2.5} = 67.2\ m^3$

13. **B. 1 : 3**

Explanation: $\frac{r_A}{r_B} = \sqrt{\frac{d_B}{d_A}} = \sqrt{\frac{1}{9}} = \frac{1}{3}$

14. **C.** SO_2

Explanation: $d_Y = d_X \left(\frac{r_X}{r_Y}\right)^2 = 16 \times \left(\frac{0.420}{0.297}\right)^2$ $= 16 \times 2.0 = 32$

$M_Y = 2 \times 32 = 64 \Rightarrow SO_2$

15. **D. 49**

Explanation: $t_x = 1.75\ t_{CH_4}$

$M_x = 16 \times (1.75)^2 = 16 \times 3.0625 = 49$

16. **B.** $384\ cm^3$

Explanation: $r_{CH_4} = 24 \times \sqrt{\frac{64}{16}} = 48\ cm^3/s$

$V = 48 \times 8 = 384\ cm^3$

17. **C. 19.11 s**

Explanation: $r_{Cl_2} = \frac{150}{18} = 8.333\ cm^3/s$

$r_{air} = 8.333 \times \sqrt{\frac{35.5}{14.4}} = 13.084\ cm^3/s$

$t = \frac{250}{13.084} = 19.11$ s

18. **D.** $53.03\ dm^3$

Explanation: $r_{H_2S} = \frac{25}{6}\ dm^3/min$

$r_{NH_3} = \frac{25}{6}\sqrt{\frac{34}{17}}$

$V = \frac{25}{6} \times \sqrt{2} \times 9 = 53.03\ dm^3$

19. **B. 5**

Explanation: $\frac{r_{CH_4}}{r_{HC}} = \sqrt{\frac{M}{16}} = \sqrt{4.25}$

$M = 16 \times 4.25 = 68$

$14n - 2 = 68 \Rightarrow n = 5$ (C_5H_8)

20. **C.** $\frac{2P}{3}$

Explanation: $p_{O_2} = \frac{2}{6}P = \frac{P}{3}$

Remaining pressure $= P - \frac{P}{3} = \frac{2P}{3}$

21. **A. 1.642 atm**

Explanation: $n = \frac{7}{28} + \frac{1}{2} = 0.25 + 0.5 = 0.75$ mol

$P = \frac{0.75 \times 0.0821 \times 320}{12} = 1.642$ atm

22. **B. 75.32 kPa**

Explanation: 1.8 atm $= 1.8 \times 101.325 = 182.385$ kPa

In vessel C at 27°C: $P = \frac{120 \times 400 + 182.385 \times 300}{1500}$

$= \frac{48000 + 54715.5}{1500} = 68.48$ kPa

At 57°C: $P' = 68.48 \times \frac{330}{300} = 75.32$ kPa

23. **C. 0.40 atm**

Explanation: $n_{He} = 0.2$ mol; $n_{N_2} = 0.5$ mol

$x_{He} = \frac{0.2}{0.7} = \frac{2}{7}$

$p_{He} = \frac{2}{7} \times 1.4 = 0.40$ atm

24. **B.** 600 cm^3

Explanation: Required partial pressure of $N_2 = 105 - 60 = 45$ kPa

$150 \times V = 45 \times 2000$

$V = 600\ cm^3$

25. **C.** 22.5 mmHg

Explanation: Partial pressure of dry O_2:

$P_1 = \frac{P_0 V_0}{T_0} \times \frac{T_1}{V_1}$

$P_1 = \frac{1 \times 1.778}{273} \times \frac{298}{2.00} = 0.9704$ atm

$p_{H_2O} = 1.00 - 0.9704 = 0.0296$ atm

$= 0.0296 \times 760 = 22.5$ mmHg

26. **D. 1 : 1**

Explanation: $\bar{E} = \frac{3}{2}kT$ — depends only on temperature

At the same T the ratio = 1 : 1

27. **C.** 1321.3 ms^{-1}

Explanation: $C \propto \sqrt{\frac{T}{M}}$

$C_{He} = 558.4 \times \sqrt{\frac{280/4}{350/28}} = 558.4 \times \sqrt{5.6}$

$C_{He} = 1321.3\ ms^{-1}$

28. **B. 1.225 : 1**

Explanation: $\frac{C_{rms}}{C_{mp}} = \sqrt{\frac{3RT/M}{2RT/M}} = \sqrt{1.5} = 1.225$

29. **D. 16 g**

Explanation: $E_k = \frac{3}{2}nRT \Rightarrow n = \frac{2E_k}{3RT}$

$n = \frac{2 \times 997.7}{3 \times 8.314 \times 200} = 0.4$ mol

$m = 0.4 \times 40 = 16$ g

30. **A.** $T_{O_2} = 32\ T_{He}$

Explanation: $\frac{C_{O_2}}{C_{He}} = \sqrt{\frac{T_{O_2}}{32} \times \frac{4}{T_{He}}} = 2$

$\frac{T_{O_2}}{8T_{He}} = 4$

$T_{O_2} = 32\ T_{He}$

31. **A.** 8.28×10^{-14} erg

Explanation: $k = 1.38 \times 10^{-23}\ JK^{-1} = 1.38 \times 10^{-16}\ ergK^{-1}$

$\bar{E} = \frac{3}{2}kT = 1.5 \times 1.38 \times 10^{-16} \times 400 = 8.28 \times 10^{-14}$ erg

32. **B.** N_2

Explanation: $C = \sqrt{\frac{3 \times 8.314 \times 300}{M}}$

$C_{N_2} = \sqrt{\frac{3 \times 8.314 \times 300}{0.028}} = 516.9\ ms^{-1} > 500\ ms^{-1}$

33. **C. 1 and 5.73**

Explanation: $E = \frac{3}{2}RT$ per mole — independent of the nature of the gas $\Rightarrow E_1/E_2 = 1$

$\frac{C_1}{C_2} = \sqrt{\frac{131.3}{4}} = 5.73$

34. **D.** $\sqrt{\frac{16E}{3\pi M}}$

Explanation: $E = \frac{3}{2}RT \Rightarrow RT = \frac{2E}{3}$

$\bar{c} = \sqrt{\frac{8RT}{\pi M}} = \sqrt{\frac{8}{\pi M} \times \frac{2E}{3}} = \sqrt{\frac{16E}{3\pi M}}$

35. **C.** atm L^2mol^{-2}

Explanation: The unit of $\frac{an^2}{V^2}$ equals the unit of pressure

$a = \frac{PV^2}{n^2} \Rightarrow$ atm L^2mol^{-2}

36. **B. 99.53%**

Explanation: $n = 0.1$ mol

$P_{ideal} = \frac{0.1 \times 0.0821 \times 320}{2.0} = 1.3136$ atm

$P_{vdW} = \frac{2.6272}{1.99573} - \frac{3.59 \times 0.01}{4} = 1.3074$ atm

Percentage $= \frac{1.3074}{1.3136} \times 100 = 99.53\%$

37. **A.** 4.19 atm L^2mol^{-2}

Explanation: $P = \frac{nRT}{V - nb} - \frac{an^2}{V^2}$

$\frac{nRT}{V - nb} = \frac{2 \times 0.0821 \times 300}{4 - 0.0742} = 12.5478$ atm

$\frac{a \times 4}{16} = 12.5478 - 11.5 = 1.0478$

$a = 4.19$ atm L^2mol^{-2}

38. **C. He**

Explanation: a is a measure of intermolecular attraction
He is monoatomic, small and nonpolar ⇒ its attraction is the lowest

39. **A. 30.9°C**
Explanation: $T = \frac{PV}{ZnR}$
$T = \frac{600 \times 2.0}{0.95 \times 0.5 \times 8.314} = 303.9\,K$
$= 30.9°C$

40. **D.** NH_3
Explanation: Conjugate base = acid $-H^+$
$NH_4^+ - H^+ = NH_3$

41. **A.** BH_3
Explanation: A Lewis base has a lone pair of electrons
B in BH_3 is electron-deficient — it is a Lewis acid

42. **D. ZnO**
Explanation: ZnO reacts with both acids and bases

43. **A. Lewis acid**
Explanation: $B(OH)_3 + H_2O \rightarrow [B(OH)_4]^- + H^+$
It accepts an electron pair from OH^- ⇒ Lewis acid

44. **B.** $Cl^- < H_2O < CH_3COO^- < NH_3$
Explanation: The weaker the conjugate acid, the stronger the base
Conjugate acids: $HCl > H_3O^+ > CH_3COOH > NH_4^+$
Hence $Cl^- < H_2O < CH_3COO^- < NH_3$

45. **D.** O_3
Explanation: $NO_2 \xrightarrow{h\nu} NO + O$
$O + O_2 \rightarrow O_3$ — a secondary pollutant

46. **C. NO**
Explanation: $N_2 + O_2 \xrightarrow{\Delta} 2NO$ (at the very high temperature of lightning)

47. **A. Na**
Explanation: Na is an alkali metal — not a heavy metal pollutant

48. **C. i and iii**
Explanation: BOD = the O_2 required by microorganisms to oxidise organic matter
When organic pollutants and microbial activity increase, the O_2 demand increases (i and iii are correct)

49. **D. 60 ppm**
Explanation: $n_{Na_2CO_3} = 0.02 \times 7.5 \times 10^{-3} = 1.5 \times 10^{-4}$ mol $= n_{CaCO_3}$
$m_{CaCO_3} = 1.5 \times 10^{-4} \times 100 = 0.015$ g $= 15$ mg (in 250 mL)
Hardness $= \frac{15 \times 1000}{250} = 60$ ppm

50. **A. Poor pollution level**
Explanation: A BOD of 10 mg/L indicates a poor (bad) level of pollution