MCQ 50 marks

1. **A. 3.3 g**

Explanation: $n = \frac{1.68}{22.4} = 0.075$ mol

$m = 0.075 \times 44 = 3.3$ g

2. **B.** N_2

Explanation: $n = \frac{PV}{RT} = \frac{0.5 \times 22.4}{0.0821 \times 546}$

$n = 0.250$ mol

$M = \frac{7}{0.250} = 28.0 \approx 28\ gmol^{-1}$

Among the options, only N_2 has $M = 28$

3. **C.** $1.41\ gL^{-1}$

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

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

$d_2 = 1.25 \times \frac{1140}{760} \times \frac{273}{364} = 1.41\ gL^{-1}$

4. **D. 557.73 kg**

Explanation: $V = 15 \times 8 \times 4 = 480\ m^3 = 4.8 \times 10^5$ L

$P = \frac{750}{760} = 0.9868$ atm

$n = \frac{PV}{RT} = \frac{0.9868 \times 4.8 \times 10^5}{0.0821 \times 300} = 19232.0$ mol

$m = 19232.0 \times 29 = 557728$ g $= 557.73$ kg

5. **B. 117°C**

Explanation: $V_2 = 1.3V_1$

$T_2 = T_1 \times \frac{V_2}{V_1} = 300 \times 1.3 = 390$ K

$\theta_2 = 390 - 273 = 117°C$

6. **A.** $25\ cm^3$

Explanation: Let the volume of the solid be x ; gas volumes are $V_1 = 150 - x$ and $V_2 = 100 - x$

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \Rightarrow \frac{150-x}{300} = \frac{2(100-x)}{360}$

$360(150 - x) = 600(100 - x)$

$54000 - 360x = 60000 - 600x$

$240x = 6000 \Rightarrow x = 25\ cm^3$

7. **C. will decrease 3 times**

Explanation: $d = \frac{PM}{RT}$

At constant T , $d \propto P$

$P_2 = \frac{P_1}{3} \Rightarrow d_2 = \frac{d_1}{3}$

8. **D.** $52.4\ gmol^{-1}$

Explanation: Mass of the empty flask = $24.6500 - 0.981 = 23.6688$ g

Mass of the vapour = $25.4420 - 23.6688 = 1.7732$ g

$n = \frac{PV}{RT} = \frac{1 \times 1}{0.0821 \times 360} = 0.03383$ mol

$M = \frac{1.7732}{0.03383} = 52.4\ gmol^{-1}$

9. **C.** $4.089 \times 10^{-23}\ dm^3$

Explanation: $V_m = \frac{RT}{P} = 0.0821 \times 300 = 24.63$ L $= 24.63\ dm^3$

Volume per molecule $= \frac{24.63}{6.023 \times 10^{23}} = 4.089 \times 10^{-23}\ dm^3$

10. **D.** 2.277×10^{-3}

Explanation: $p_{H_2O} = 5.901 \times e^{0.0506 \times 32} = 29.79$ mmHg

$P_{H_2} = 752 - 29.79 = 722.21$ mmHg $= 0.9503$ atm

$n = \frac{PV}{RT} = \frac{0.9503 \times 0.060}{0.0821 \times 305} = 2.277 \times 10^{-3}$ mol

11. **B. 6 : 3 : 2**

Explanation: $V = \left(\frac{nR}{P}\right) T \Rightarrow$ slope $= \frac{nR}{P} \propto \frac{1}{P}$

$P_1 : P_2 : P_3 = \frac{1}{m} : \frac{1}{2m} : \frac{1}{3m} = 6 : 3 : 2$

12. **C.** $\frac{3}{8}$

Explanation: In an open vessel P and V are constant $\Rightarrow n_1T_1 = n_2T_2$

$\frac{n_2}{n_1} = \frac{T_1}{T_2} = \frac{250}{400} = \frac{5}{8}$

Fraction escaped $= 1 - \frac{5}{8} = \frac{3}{8}$

13. **B. 4 L**

Explanation: $\frac{V_{He}}{V_{SO_2}} = \sqrt{\frac{M_{SO_2}}{M_{He}}} = \sqrt{\frac{64}{4}} = 4$

$V_{He} = 4 \times 1 = 4$ L

14. **A. 45**

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

$d_A = d_B \left(\frac{r_B}{r_A}\right)^2 = 20 \times \left(\frac{0.9}{0.6}\right)^2$

$d_A = 20 \times 2.25 = 45$

15. **B. 49.3**

Explanation: $r_u = \frac{400}{150} = 2.667$ mL/s; $r_{Cl_2} = \frac{300}{135} = 2.222$ mL/s

$M_u = M_{Cl_2} \left(\frac{r_{Cl_2}}{r_u}\right)^2$

$M_u = 71 \times \left(\frac{2.222}{2.667}\right)^2 = 49.3$

16. **D. 27.71 min**

Explanation: $M_{mix} = 0.4 \times 44 + 0.6 \times 28 = 34.4$

$\frac{t_{mix}}{t_{N_2}} = \sqrt{\frac{M_{mix}}{M_{N_2}}}$

$t_{mix} = 25 \times \sqrt{\frac{34.4}{28}} = 27.71\ \text{min}$

17. A. 1.0043

Explanation: $\frac{r_{235}}{r_{238}} = \sqrt{\frac{352}{349}}$

$= 1.0043$

18. D. 42%

Explanation: $M_{mix} = M_{O_2}\left(\frac{t_{mix}}{t_{O_2}}\right)^2 = 32 \times \left(\frac{66}{60}\right)^2$

$M_{mix} = 38.72$

$48x + 32(1 - x) = 38.72$

$16x = 6.72 \Rightarrow x = 0.42$

Ozone = 42%

19. B. H_2

Explanation: $p_i \propto n_i = \frac{w}{M_i}$

For equal masses, the gas with smaller M has more moles

$M_{H_2} = 2$ is the lowest $\Rightarrow p_{H_2}$ is the highest

20. C. 316.2 mmHg

Explanation: At 20°C: $P = \frac{300\times600+650\times400+760\times200}{2000}$

$P = \frac{592000}{2000} = 296.0\ \text{mmHg}$

At 40°C: $P' = 296.0 \times \frac{313}{293} = 316.2\ \text{mmHg}$

21. A. 82.3 cm from the NH_3 **end**

Explanation: $\frac{x}{120-x} = \frac{r_{NH_3}}{r_{HBr}} = \sqrt{\frac{81}{17}}$

$\sqrt{\frac{81}{17}} = 2.183$

$x = \frac{120\times2.183}{1+2.183} = 82.3\ \text{cm}$ (from the NH_3 end)

22. B. 6 atm

Explanation: $n_{N_2} = \frac{56}{28} = 2$; $n_{Cl_2} = \frac{71}{71} = 1$

$x_{N_2} = \frac{2}{3}$

$p_{N_2} = \frac{2}{3} \times 9 = 6\ \text{atm}$

23. D. 0.508 atm

Explanation: $n_{N_2} = \frac{5.6}{28} = 0.2$; $n_{O_2} = \frac{9.6}{32} = 0.3$

Total volume = 10 + 6 = 16 L; $T = 330\ \text{K}$

$p_{O_2} = \frac{n_{O_2}RT}{V} = \frac{0.3\times0.0821\times330}{16} = 0.508\ \text{atm}$

24. A. 20.50 kPa

Explanation: Pressure of dry air = 100 − 2.4 = 97.6 kPa

$p_{O_2} = 0.21 \times 97.6 = 20.50\ \text{kPa}$

25. C. $\frac{1}{9}$

Explanation: Let the mass of each gas be w

$n_{He} = \frac{w}{4}$; $n_{O_2} = \frac{w}{32}$

$x_{O_2} = \frac{w/32}{w/4+w/32} = \frac{1}{8+1} = \frac{1}{9}$

26. D. $P = \frac{1}{3}\varrho C^2$

Explanation: $PV = \frac{1}{3}mNC^2$

$\frac{mN}{V} = \varrho \Rightarrow P = \frac{1}{3}\varrho C^2$

27. A. CO_2

Explanation: $M = \frac{3RT}{C^2}$

$M = \frac{3\times8.314\times400}{(476.2)^2} = 0.044\ \text{kgmol}^{-1}$

$M = 44\ \text{gmol}^{-1} \Rightarrow CO_2$

28. D. 8729.7 J

Explanation: $n = \frac{56}{28} = 2\ \text{mol}$

$E_k = \frac{3}{2}nRT = \frac{3}{2} \times 2 \times 8.314 \times 350$

$E_k = 8729.7\ \text{J}$

29. C. 367°C

Explanation: $\frac{T_{SO_2}}{M_{SO_2}} = \frac{T_{O_2}}{M_{O_2}}$

$T_{SO_2} = 320 \times \frac{64}{32} = 640\ \text{K}$

$= 640 - 273 = 367°C$

30. A. 0.0476%

Explanation: $n_{air} = \frac{PV}{RT} = \frac{100\times200}{8.314\times300} = 8.019\ \text{mol}$

$M_{air} = 2 \times 14.4 = 28.8$

Mass of air = $8.019 \times 28.8 = 230.94$ g

Mass gained by the KOH solution = mass of $CO_2 = 0.11$ g

$CO_2\% = \frac{0.11}{230.94} \times 100 = 0.0476\%$

31. D. $451.8\ \text{ms}^{-1}$

Explanation: $M = d \times 22.4 = 1.964 \times 22.4 = 44.0 \approx 44\ \text{gmol}^{-1}$

C_{rms} does not depend on pressure, only on T and M

$C = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3\times8.314\times360}{0.044}} = 451.8\ \text{ms}^{-1}$

32. C. $6.84\ \text{ms}^{-1}$

Explanation: $C = \sqrt{\frac{3^2+5^2+6^2+8^2+10^2}{5}}$

$= \sqrt{\frac{234}{5}} = \sqrt{46.8}$

$= 6.84\ \text{ms}^{-1}$

33. A. 476.1 K and 404.1 K

Explanation: $\bar{c} = \sqrt{\frac{8RT_1}{\pi M}} \Rightarrow T_1 = \frac{\pi M \bar{c}^2}{8R}$

$T_1 = \frac{3.1416 \times 0.028 \times 600^2}{8 \times 8.314} = 476.1\ K$

$C = \sqrt{\frac{3RT_2}{M}} \Rightarrow T_2 = \frac{MC^2}{3R}$

$T_2 = \frac{0.028 \times 600^2}{3 \times 8.314} = 404.1\ K$

34. **C.** $8.312\ Jmol^{-1}K^{-1}$

Explanation: $E_k = \frac{3}{2}nRT \Rightarrow R = \frac{2E_k}{3nT}$

$R = \frac{2 \times 7980}{3 \times 2 \times 320} = 8.312\ Jmol^{-1}K^{-1}$

35. **B. High pressure and low temperature**

Explanation: At high pressure the intrinsic volume of the molecules is not negligible

At low temperature intermolecular attraction is strong

Hence the deviation is greatest at high pressure and low temperature

36. **A. 39.50 atm**

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

$\frac{0.0821 \times 300}{0.5 - 0.0427} = 53.86\ atm$

$\frac{3.59 \times 1^2}{(0.5)^2} = 14.36\ atm$

$P = 53.86 - 14.36 = 39.50\ atm$

37. **D.** SO_2

Explanation: Larger a ⇒ stronger intermolecular attraction

Stronger attraction makes liquefaction easier

$a_{SO_2} = 6.71$ is the highest

38. **A. 0.972**

Explanation: $Z = \frac{PV}{nRT}$

$Z = \frac{101.0 \times 12}{0.5 \times 8.314 \times 300} = \frac{1212}{1247.1}$

$Z = 0.972$

39. **B.** $\left(P + \frac{2.25a}{V^2}\right)(V - 1.5b) = 1.5RT$

Explanation: $n = \frac{66}{44} = 1.5\ mol$

$\left(P + \frac{n^2 a}{V^2}\right)(V - nb) = nRT$

Substituting $n = 1.5$ and $n^2 = 2.25$ gives this equation

40. **C.** NH_3

Explanation: A Lewis base donates a lone pair of electrons

The N atom in NH_3 has a lone pair

41. **A.** $HClO_4 > HClO_3$

Explanation: In oxoacids, acid strength increases as the oxidation state of the central atom increases: $HClO_4$ (+7) > $HClO_3$ (+5)

42. **C.** NH_4^+

Explanation: An amphoteric species can both donate and accept a proton

NH_4^+ can only donate a proton (it has no lone pair to accept one)

43. **B.** BF_3

Explanation: A Brønsted acid must be a proton (H^+) donor

BF_3 contains no H, so it cannot donate a proton; it is only a Lewis acid

44. **D.** HSO_4^-, SO_4^{2-}

Explanation: HSO_4^- donates a proton to become SO_4^{2-}

An acid and its conjugate base differ by one proton

45. **B.** H_2SO_4 **and** HNO_3

Explanation: H_2SO_4 forms from SO_2 and HNO_3 forms from NO_x

These two strong acids are the main cause of acid rain

46. **D.** $CaSO_4 \cdot 2H_2O$

Explanation: $CaCO_3 + SO_2 \rightarrow CaSO_3 + CO_2$

$2CaSO_3 + O_2 + 4H_2O \rightarrow 2CaSO_4 \cdot 2H_2O$ (gypsum)

47. **B. 4.2 ppm**

Explanation: $O_2 \equiv 2I_2 \equiv 4Na_2S_2O_3$

$n_{S_2O_3^{2-}} = 0.0125 \times 8.4 \times 10^{-3} = 1.05 \times 10^{-4}\ mol$

$n_{O_2} = \frac{1.05 \times 10^{-4}}{4} = 2.625 \times 10^{-5}\ mol$

$m_{O_2} = 2.625 \times 10^{-5} \times 32 = 8.4 \times 10^{-4}\ g = 0.84\ mg$ (in 200 mL)

$DO = \frac{0.84 \times 1000}{200} = 4.2\ mg/L$ or ppm

48. **C. 149.5 ppm**

Explanation: $MgCl_2 \equiv CaCO_3$ (mole ratio 1 : 1)

95 parts of $MgCl_2 \equiv$ 100 parts of $CaCO_3$

Hardness = $142 \times \frac{100}{95} = 149.5$ ppm

49. **D. 10 ppm**

Explanation: The maximum COD value of drinking water permitted by WHO is 10 ppm

50. **B.** $CaSO_4$ **and** $MgCl_2$

Explanation: Chlorides and sulphates of Ca and Mg cause permanent hardness

These are not removed on boiling