Answer the following questions on the answer sheet. Give your answer to the number of significant figures requested. **Missing units = 1/3 OFF**

$(P + an^2/V^2)(V - bn) = nRT$ $v_1/v_2 = (\mathcal{M}_2 / \mathcal{M}_1)^{1/2}$ $T_{/K} = t_{/^\circ C} + 273.15$

$R = 0.08206$ L atm K^{-1} mol^{-1} $V_{STP} = 22.4$ L mol^{-1} 760 torr = 1 atm
$N_A = 6.022 \times 10^{23}$ mol^{-1}

Water vapour pressure (P_{vapor}) as a function of temperature ($t_{^\circ C}$).

$t_{^\circ C}$	P_{vapor}	$t_{^\circ C}$	P_{vapor}	$t_{^\circ C}$	P_{vapor}	$t_{^\circ C}$	P_{vapor}
0 °C	4.6 torr	15 °C	12.8 torr	30 °C	31.8 torr	45 °C	71.9 torr
1 °C	4.9 torr	16 °C	13.6 torr	31 °C	33.7 torr	46 °C	75.7 torr
2 °C	5.3 torr	17 °C	14.5 torr	32 °C	35.7 torr	47 °C	79.6 torr
3 °C	5.7 torr	18 °C	15.5 torr	33 °C	37.7 torr	48 °C	83.7 torr
4 °C	6.1 torr	19 °C	16.5 torr	34 °C	39.9 torr	49 °C	88.0 torr
5 °C	6.5 torr	20 °C	17.6 torr	35 °C	42.2 torr	50 °C	92.5 torr
6 °C	7.0 torr	21 °C	18.7 torr	36 °C	44.6 torr	51 °C	97.2 torr
7 °C	7.5 torr	22 °C	19.8 torr	37 °C	47.1 torr	52 °C	102.1 torr
8 °C	8.0 torr	23 °C	21.1 torr	38 °C	49.7 torr	53 °C	107.2 torr
9 °C	8.6 torr	24 °C	22.4 torr	39 °C	52.4 torr	54 °C	112.5 torr
10 °C	9.2 torr	25 °C	23.8 torr	40 °C	55.3 torr	55 °C	118.0 torr
11 °C	9.8 torr	26 °C	26.2 torr	41 °C	58.3 torr	56 °C	123.8 torr
12 °C	10.5 torr	27 °C	26.7 torr	42 °C	61.5 torr	57 °C	129.8 torr
13 °C	11.2 torr	28 °C	28.3 torr	43 °C	64.8 torr	58 °C	136.0 torr
14 °C	12.0 torr	29 °C	30.0 torr	44 °C	68.3 torr	59 °C	142.6 torr
15 °C	12.8 torr	30 °C	31.8 torr	45 °C	71.9 torr	60 °C	149.4 torr

1) 25.00 mL of H_3PO_4 is neutralized with 42.27 mL of 0.02736 M $Ca(OH)_2$. What is the molarity of the H_3PO_4? Give the answer to 4 significant figures.

The reaction is: $2H_3PO_4 + 3Ca(OH)_2 \rightarrow Ca_3(PO_4)_2 + 3H_2O$

2) 25.00 mL of $H_2C_2O_2$ with a molarity of 0.3374 M is titrated with 6.63 mL of $KMnO_4$ used to reach the endpoint. What is the molarity of the $KMnO_4$? Give the answer to 3 significant figures.

The reaction is: $4H_2SO_4 + 2KMnO_4 + 5H_2C_2O_4 \rightarrow 2MnSO_4 + 10CO_2 + 8H_2O + 2K_2SO_4$

3) Calculate the pressure of 3.29 moles of an ideal gas contained in 30.8 liters at 74.6°C. Give the answer to 3 significant figures.

4) 1.32 mole of hydrogen gas is contained in a metal cylinder at 85.7 atm pressure. An additional 5.17 mole of hydrogen is pumped into this cylinder at the same temperature. What is the resultant pressure inside the cylinder? Give the answer to 3 significant figures.

5) A flexible container contains 17.8 L of air at 422 °C. The temperature is dropped to 25°C. What is the required volume to maintain the same pressure? Give the answer to 3 significant figures.

6) Calculate the volume required to contain 54.3 mol of N_2 gas at STP. Give the answer to 3 significant figures.

7) The Dumas method was performed on an unknown volatile liquid. The difference between the flask used before the experiment and at the end was 0.8886 g. The volume of the flask was 211.1 mL. The temperature at the time when the liquid was vaporized was 100.0°C and the pressure was 768.7 torr. What is the molar mass of the liquid? Give the answer to 4 significant figures.

8) Oxygen is collected over water at 17°C at a barometric pressure of 759.5 torr. What is the pressure of the dry oxygen? Give your answer to the nearest 0.1 torr.

9) A gas mixture consists of methane, nitrogen, argon and hydrogen. The total pressure is 98.8 torr. The partial pressure of methane is 33.7 torr. The pressure of nitrogen is 47.2 torr. The partial pressure of argon is 5.4 torr. What is the partial pressure of hydrogen? Give your answer to the nearest 0.1 torr.

10) What is the ratio of the diffusion rate of hydrogen–1 (molar mass of 1.00813 g mol^{-1}) to hydrogen–3 (molar mass of 3.01695 g mol^{-1})? Give the answer to 4 significant figures.

11) The following reaction is carried out in a closed chamber and the temperature returned to the starting temperature of 300°C.

$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

If the total pressure in the chamber was 15.9 atm at the beginning and the two reactants were in exactly the proper stoichiometric ratio, what would be the pressure at the end of the reaction. (Assume the reaction goes entirely to completion.) Give the answer to 3 significant figures.

12) Argon effuses at a rate that is 2.056 times faster than an unknown. What is the molar mass of the unknown? The molar mass of Argon is 39.9756 g mol^{-1}.

13) In the following reaction: $SiO_2(s) + 4HF_2(aq) \rightarrow SiF_4(g) + 2H_2O$ 6.339 g of SiO_2 is reacted with and excess of HF. What volume of SiF_4 is produced at 33.1 °C at a pressure of 1.062 atm? Give the answer to 3 significant figures.

14) Calculate the pressure of 21.4 mol of CO_2 contained in a volume of 3.14 L at 34.7 °C using the van der Waal equation. The van der Waal constants for CO_2 are:
a = 3.592 atm L^2 mol^{-2} b = 0.04267 L mol^{-2}

15) Using the data from question 14, what is the error that one would make if one were to use the ideal gas equation to calculate the pressure?

$$\%\ \text{error} = \frac{(\text{ideal pressure}) - (\text{pressure from van der Waal equation})}{(\text{pressure from van der Waal equation})} \times 100\%$$

16) To derive the ideal gas law from physics principles the follow assumptions are made.

A The gas molecules have no volume but interact strongly with each other.
B The gas molecules have no volume and do not interact with each other.
C The liquid density is a correction to yield the ideal gas law.
D Gas molecules repel each other very strongly.
E Gas molecules attract each other very strongly.
F Stoichiometry in gas reactions differs from that in solutions.

17) Which of the following phases retains its shape and volume

A) A solid B) A liquid C) A gas D) A solution E) A mixture

18) The van der Waal equation corrects for:

A the volume of the gas molecules and the interactions between them.
B the solid density and the repulsion energies.
C the molecular geometry and the attractive forces.
D only the attractive forces between molecules.
E only the repulsive forces between molecules.
F the condensation energy to form a liquid.

19) A mole of an ideal gas is contained in a volume at 350°C and 3.06 atm of pressure. The pressure is lowered to 1.00 atm and the temperature to 0°C, what volume does this gas occupy?

20) $4.31 \times 10^{+24}$ molecules confined in a container at STP. What is the volume of this container? Give the answer to 3 significant figures.

ANSWER SHEET

NAME _____

Missing units = 1/3 OFF

1) _____

2) _____

3) _____

4) _____

5) _____

6) _____

7) _____

8) _____

9) _____

10) _____

11) _____

12) _____

13) _____

14) _____

15) _____%

16) **A** **B** **C** **D** **E** **F**

17) **A** **B** **C** **D** **E**

18) **A** **B** **C** **D** **E** **F**

19) _____

20) _____

KEY

1) 0.03084 M

2) 0.5089 M

3) $3.048 \times 10^{+0}$ atm (3.048)

4) 421.4 atm

5) $7.63 \times 10^{+0}$ L (7.63)

6) $1.22 \times 10^{+3}$ L (1216.320)

7) 127.44g mol^{-1}

8) 745.0 torr

9) 12.5 torr

10) 1.730

11) 18.6 atm

12) 169 g mol^{-1}

13) $2.50 \times 10^{+0}$ L (2.497)

14) 75.9 atm (VDW) answer 172.2 atm ideal 96.2 difference 540.6= *nRT*

15) 127%

16) B

17) A

18) A

19) 22.4 L

20) $1.60 \times 10^{+2}$ L (1.60E+02)