

Homework 26

$$J = N \cdot m = Pa \cdot m^3$$

$$R = 8.31 \frac{Pa \cdot m^3}{mole \cdot K}$$

① $n = 1 \text{ mole}$

$$\boxed{pV = nRT} \Rightarrow V = \frac{nRT}{p}$$

$$V = 22.4 \cdot 10^{-3} m^3 = 22.4 L \approx 6 \text{ gal.}$$

$$1 \text{ liter} = 10^{-3} m^3 = 10^3 cm^3$$

② $\boxed{n = \frac{p \cdot V}{R \cdot T} = 44.7 \text{ moles}}$

$$T = 273 K$$

$$V = 1 m^3$$

$$p = 101.3 \text{ kPa}$$

③.

$$V_1 = 0.5 \frac{\text{m}^3}{\frac{60 \text{ sec.}}{5}} \cdot 12 \text{ sec.} = 0.1 \text{ m}^3$$

$$n = 4.47 \text{ moles}$$

$$P_2 V_2 = n \cdot R T_2$$

$$T_2 = 295 \text{ K}, V_2 = 0.105 \text{ m}^3$$

$$P_2 = \frac{n \cdot R T_2}{V_2}$$

$$| P_2 = 104.4 \text{ kPa} |$$

Or:

$$\left[\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \right]$$

Classwork

Molar mass

Work done by gas

Molar mass

How do we measure n ?

$$n = \frac{N}{N_A}, \quad N_A = 6.02 \cdot 10^{23} \frac{1}{\text{mole}}$$

$$\Rightarrow \boxed{[n] = \text{mole}}$$

through the ideal gas law.
What if it is a liquid?

Count N — the number of molecules

We have a homogeneous substance $\rightarrow$ all molecules are the same!

$\Rightarrow$ m_{molecule}

What is the mass of substance per mole if we know m_{molecule} ?

$$M = N_A \cdot m_{\text{molecule}}$$

molar mass.

$$[M] = \frac{\text{g}}{\text{mole}}$$

$\Rightarrow$

$$n = \frac{m_{\text{subst.}}}{M_{\text{subst.}}}$$

Let's show that these definitions agree:

$$h = \frac{m_{\text{subst.}}}{M_{\text{subst.}}} = \frac{N \cdot \cancel{m_{\text{molecule}}}}{N_A \cdot \cancel{m_{\text{molecule}}}}$$

$$\Rightarrow \boxed{h = \frac{N}{N_A}} \quad \text{Agreement}$$

But how do we know M ?

1

IA

1A

1

H

Hydrogen

1.008

2

IIA

2A

3

Li

Lithium

6.941

4

Be

Beryllium

9.012

11

Na

Sodium

22.990

12

Mg

Magnesium

24.305

3

IIIB

3B

4

IVB

4B

5

VB

5B

6

VIB

6B

7

VIIB

7B

8

VIII

8

9

VIII

9

10

VIII

10

11

IB

1B

12

IIB

2B

13

IIIA

3A

14

IVA

4A

15

VA

5A

16

VIA

6A

17

VIIA

7A

18

VIIIA

8A

2

He

Helium

4.003

5

B

Boron

10.811

6

C

Carbon

12.011

7

N

Nitrogen

14.007

8

O

Oxygen

15.999

9

F

Fluorine

18.998

10

Ne

Neon

20.180

17

Cl

Chlorine

35.453

18

Ar

Argon

39.948

19

K

Potassium

39.098

20

Ca

Calcium

40.078

21

Sc

Scandium

44.956

22

Ti

Titanium

47.88

23

V

Vanadium

50.942

24

Cr

Chromium

51.996

25

Mn

Manganese

54.938

26

Fe

Iron

55.845

27

Co

Cobalt

58.933

28

Ni

Nickel

58.693

29

Cu

Copper

63.546

30

Zn

Zinc

65.39

31

Ga

Gallium

69.723

32

Ge

Germanium

72.61

33

As

Arsenic

74.922

34

Se

Selenium

78.972

35

Br

Bromine

79.904

36

Kr

Krypton

83.80

37

Rb

Rubidium

84.468

38

Sr

Strontium

87.62

39

Y

Yttrium

88.906

40

Zr

Zirconium

91.224

41

Nb

Niobium

92.906

42

Mo

Molybdenum

95.94

43

Tc

Technetium

98.906

44

Ru

Ruthenium

101.07

45

Rh

Rhodium

102.905

46

Pd

Palladium

106.42

47

Ag

Silver

107.868

48

Cd

Cadmium

112.411

49

In

Indium

114.818

50

Sn

Tin

118.71

51

Sb

Antimony

121.757

52

Te

Tellurium

127.6

53

I

Iodine

126.905

54

Xe

Xenon

131.29

55

Cs

Cesium

132.905

56

Ba

Barium

137.327

57-71

$$M(H) = 1 \frac{g}{mole}$$

$$M_H = 1g \Rightarrow h = \frac{M_H}{M(H)} = \frac{1g}{1 \frac{g}{mole}}$$

$$h = 1 mole$$

$$M(C) = 12 \frac{g}{mole}$$

$$M(N_2) = M(N) + M(N) =$$

$$= 2 \cdot M(N)$$

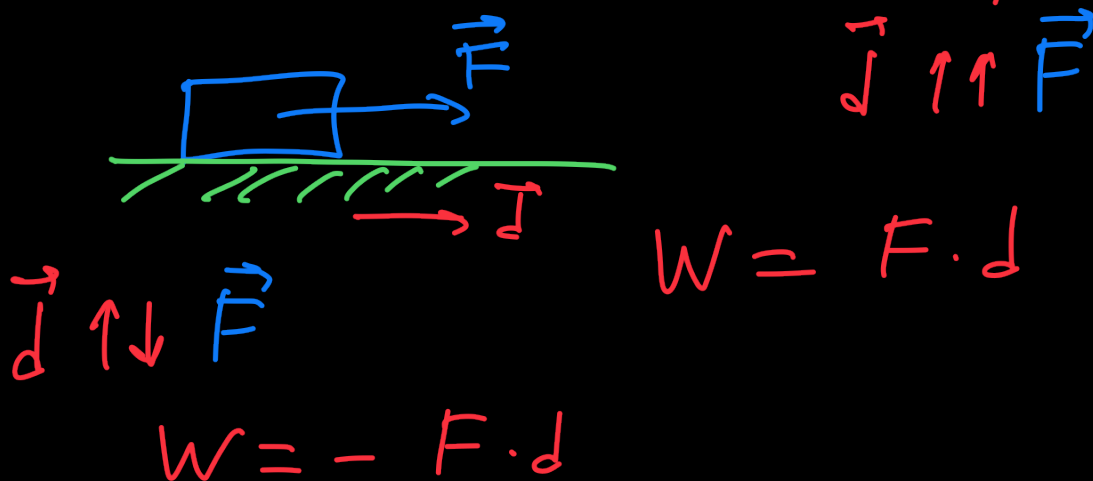
$$M(N_2) = 2 \cdot 14 \frac{g}{mole} = 28 \frac{g}{mole}$$

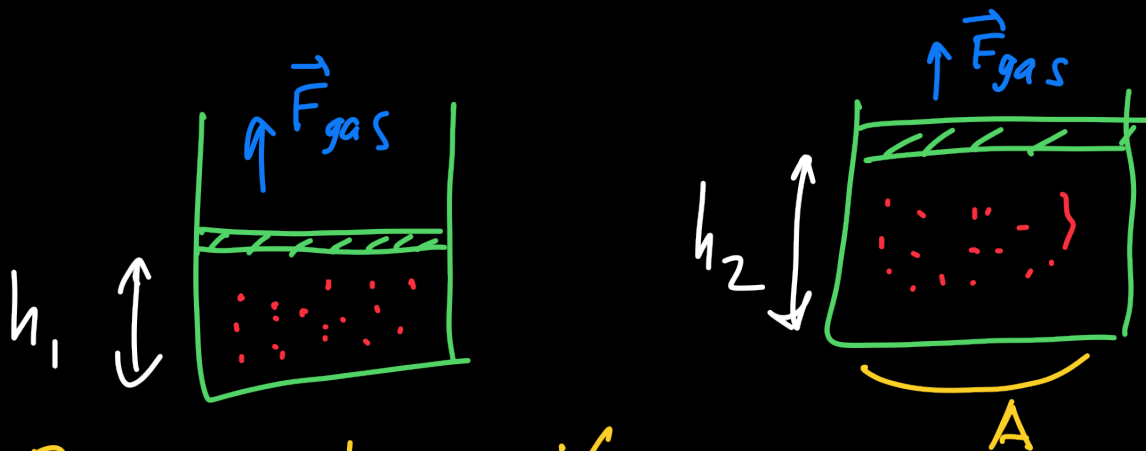
$$M(CO_2) = M(C) + 2 \cdot M(O)$$

$$M(CO_2) = 12 + 2 \cdot 16 \frac{g}{mole}$$

$$= 44 \frac{g}{mole}$$

Work done by gas





$$p = \text{const}$$

$$\frac{V}{T} = \text{const}$$

$$F_{\text{gas}} = p \cdot A$$

$$W_{\text{gas}} = F_{\text{gas}} \cdot (h_2 - h_1) =$$

$$= p \cdot A (h_2 - h_1) =$$

$$= p (A \cdot h_2 - A \cdot h_1) = p (V_2 - V_1)$$

$$\boxed{W_{\text{gas}} = p \cdot \Delta V}$$

when
 $p = \text{const.}$

$$\Delta V > 0 \Rightarrow W_{\text{gas}} > 0$$

$$\Delta V < 0 \Rightarrow W_{\text{gas}} < 0$$

