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Gas Laws: PV=nRT, Dalton, Graham & Tricks

Printable Flashcards — Pre-Med Chemistry

Ideal gas law (PV=nRT), units, R values, STP, Boyle's/Charles'/Gay-Lussac's/Combined/Avogadro's laws, Dalton's law, mole fractions, gas over water, gas density, gas stoichiometry, kinetic theory, Graham's law, and ideal vs real gases.

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160 cards — Printable Flashcards

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1

Ideal gas law in one line:

2

In PV=nRT, what are the units that match R = 0.0821?

3

Trap: temperature in PV=nRT can be in °C as long as you're consistent. True or false?

4

Kelvin conversion: K = °C + _____

5

Quick sanity check: if temperature goes up (P constant), volume should...

6

Quick sanity check: if volume goes down (T constant), pressure should...

7

What does 'ideal gas' secretly assume?

8

When does real gas behavior matter most?

2

P in atm, V in L, n in mol, T in K.

1

PV = nRT.

4

273

3

False.

6

Go up.

5

Go up.

8

High pressure and low temperature.

7

Gas particles have negligible volume and no intermolecular forces.

9

Trap: gas laws apply only to oxygen and nitrogen. True or false?

10

If a problem gives you grams of a gas, what extra step do you need before PV=nRT?

11

Ideal gas law: {{c1::P}}{{c2::V}} = {{c3::n}}{{c4::R}}{{c5::T}}.

12

One atm equals...

13

1 atm = _____ mmHg

14

1 atm _____ kPa

15

R value if you use atm and liters:

16

R value if you use kPa and liters:

10

Convert grams -> moles ($n = m/M$).

9

False.

12

760 mmHg (torr) and about 101.3 kPa.

11

Ideal gas law: $PV = nRT$.

14

101.3

13

760

16

$R = 8.314\ \text{L} \cdot \text{kPa}/(\text{mol} \cdot \text{K})$.

15

$R = 0.0821\ \text{L} \cdot \text{atm}/(\text{mol} \cdot \text{K})$.

17

R value in energy units (thermo):

18

Trap: you can use R=0.0821 even if pressure is in kPa. True or false?

19

Volume unit trap: PV=nRT expects volume in liters (if R=0.0821). So 250 mL =

20

Temperature quick: 25°C in Kelvin is about...

21

Temperature quick: 0°C in Kelvin is...

22

Pressure quick: 1520 mmHg is how many atm?

23

Pressure quick: 380 mmHg is how many atm?

24

Key conversions: 1 atm = {{c1::760}} mmHg = {{c2::101.3}} kPa.

18

False.

17

$R = 8.314\ \text{J/(mol} \cdot \text{K)}$.

20

298 K.

19

0.250 L.

22

2 atm.

21

273 K.

24

Key conversions: 1 atm = 760 mmHg = 101.3 kPa.

23

0.5 atm.

25

At STP (0°C, 1 atm), 1 mol of an ideal gas occupies about...

26

At room temperature (~25°C) and 1 atm, 1 mol of gas is closer to...

27

Trap: STP always means 25°C. True or false?

28

Quick STP: 11.2 L of any ideal gas at STP is how many moles?

29

Quick STP: 44.8 L of gas at STP is how many moles?

30

Quick STP: 5.6 L of gas at STP is how many moles?

31

Quick STP: 0.10 mol of any gas at STP occupies...

32

Molar volume at STP (L/mol):

26

24 L (about 24.5 L).

25

22.4 L.

28

0.50 mol.

27

False.

30

0.25 mol.

29

2.00 mol.

32

22.4

31

2.24 L.

33

Boyle's law is used when _____ is constant.

34

Boyle's law formula:

35

Quick: if you cut the volume in half (T constant), pressure becomes...

36

Quick: P1=1 atm, V1=2.0 L. If V2=0.50 L (T constant), P2=

37

Trap: in Boyle's law, pressure and volume change in the same direction. True or false?

38

Boyle's law (T constant): {{c1::P1V1}} = {{c2::P2V2}}.

39

Charles' law is used when _____ is constant.

40

Charles' law formula:

34

P1V1 = P2V2.

33

Temperature (and moles).

36

4.0 atm.

35

Double.

38

Boyle's law (T constant): P1V1 = P2V2.

37

False.

40

V1/T1 = V2/T2 (T in Kelvin).

39

Pressure (and moles).

41

Quick: if temperature (K) doubles at constant pressure, volume becomes...

42

Quick: a gas is 3.0 L at 300 K. What volume at 600 K (same pressure)?

43

Trap: Charles' law works with Celsius if you add 273 at the end. True or false?

44

Charles' law (P constant): {{c1::V1/T1}} = {{c2::V2/T2}} (T in K).

45

Gay-Lussac's law is used when _____ is constant.

46

Gay-Lussac's law formula:

47

Quick: a gas is 1.0 atm at 300 K in a rigid container. At 600 K, pressure is...

48

Trap: heating a gas in a rigid container lowers pressure because gas expands. True or false?

42

6.0 L.

41

Double.

44

Charles' law (P constant):
$V1/T1 = V2/T2$ (T in K).

43

False.

46

$P1/T1 = P2/T2$ (T in Kelvin).

45

Volume (and moles).

48

False.

47

2.0 atm.

49

Gay-Lussac (V constant):
{{c1::P1/T1}} = {{c2::P2/T2}}.

50

Combined gas law is basically Boyle + Charles + Gay-Lussac together, when _____ is constant.

51

Combined gas law formula:

52

Quick: a gas at 1 atm, 2.0 L, 300 K. If it goes to 2 atm and 600 K, new volume is...

53

Trap: in combined gas law, you can keep temperature in Celsius because it cancels. True or false?

54

Combined gas law: {{c1::P1V1/T1}} = {{c2::P2V2/T2}} (n constant).

55

Avogadro's law applies when P and T are constant. It says...

56

Quick: at constant P and T, if moles triple, volume becomes...

50

Number of moles (n).

49

Gay-Lussac (V constant): P1/T1 = P2/T2.

52

2.0 L.

51

P1V1/T1 = P2V2/T2.

54

Combined gas law: P1V1/T1 = P2V2/T2 (n constant).

53

False.

56

Triple.

55

Volume is proportional to moles: V1/n1 = V2/n2.

57

Trap: if two gases have the same volume at the same T and P, they must have the same mass. True or false?

58

Avogadro's law (P,T constant): {{c1::V1/n1}} = {{c2::V2/n2}}.

59

Dalton's law in one line:

60

Partial pressure formula using mole fraction:

61

Trap: in a gas mixture, heavier gases have higher partial pressure. True or false?

62

If a container has 2 mol N2 and 1 mol O2, mole fraction of O2 is...

63

Same mixture: if $P_{total} = 0.90$ atm, partial pressure of O2 is...

64

Trap: partial pressures depend on volume each gas 'takes'. True or false?

58

Avogadro's law (P,T constant): $V1/n1 = V2/n2$.

57

False.

60

$P_i = x_i * P_{total}$, where $x_i = n_i / n_{total}$.

59

$P_{total} = P1 + P2 + P3 + ...$

62

1/3.

61

False.

64

False (for ideal gases).

63

0.30 atm.

65

Dalton's law: P_{total} = {{c1::sum of partial pressures}}.

66

If $x_C O2 = 0.20$ and total pressure is 2.0 atm, $P_C O2$ =

67

Gas collected over water: what pressure is measured?

68

So the correction is:

69

Trap: when collecting gas over water, you add water vapor pressure to get gas pressure. True or false?

70

If P_{total} = 760 mmHg and $P_{H2}O$ = 20 mmHg, dry gas pressure is...

71

Why does warmer water make this correction bigger?

72

Collected over water: P_{gas} = P_{total} - {{c1::P_{water} vapor}}.

66

0.40 atm

65

Dalton's law: P_{total} = sum of partial pressures.

68

$P_{gas} = P_{total}$ - $P_{water\ vapor}$.

67

Total pressure = $P_{gas} + P_{water\ vapor}$.

70

740 mmHg.

69

False.

72

Collected over water: $P_{gas} = P_{total}$ - $P_{water\ vapor}$.

71

Water vapor pressure increases with temperature.

73

If you know P, V, and T, the fastest way to get moles is:

74

If you know moles and want volume:

75

Example: 1.0 mol gas at 1.0 atm and 273 K. Volume is about...

76

Example: 0.50 mol gas at 2.0 atm and 273 K. Volume is about...

77

Example: 1.0 mol at 0.50 atm and 273 K. Volume is about...

78

Example: 1.0 mol at 1 atm and 546 K. Volume is about...

79

Trap: if T increases, P must increase. True or false?

80

Exam habit: before doing any gas calculation, always check these 3 things:

74

$V = nRT / P$.

73

$n = PV / (RT)$.

76

5.6 L.

75

22.4 L.

78

44.8 L.

77

44.8 L.

80

Kelvin? Pressure units? Volume units?

79

Depends.

81

Gas density trick: from PV=nRT you can get...

82

So if they give gas density and conditions, molar mass is:

83

Trap: gas density is usually given in g/mL. True or false?

84

Concept: at the same T and P, which gas is denser?

85

Quick: at the same T and P, CO2 vs O2: which is denser?

86

Quick: at the same T and P, He vs Ar: which is denser?

87

Quick numeric: A gas has density 1.25 g/L at 1 atm and 273 K. What's molar mass (approx)?

88

Gas density formula: d = {{c1::PM}}/{{c2::RT}}.

82

$M = dRT / P$.

81

$d = PM / (RT)$.

84

The one with bigger molar mass (M).

83

False (usually).

86

Ar is much denser.

85

CO_2 (44 g/mol) is denser than O_2 (32 g/mol).

88

Gas density formula: $d = PM/RT$.

87

About 28 g/mol.

89

At same T and P, the denser gas has the _____ molar mass.

90

Gas stoichiometry shortcut: at the same T and P, gas volumes are proportional to...

91

Example: 2H2(g) + O2(g) -> 2H2O(g). At same T,P, the volume ratio H2:O2 needed is...

92

Example: N2(g) + 3H2(g) -> 2NH3(g). If you have 30 L of H2 (same T,P), max NH3 volume you can make is...

93

Trap: volume ratios only work if gases are at the same temperature and pressure. True or false?

94

If a stoichiometry question gives volumes of gases at STP, you can convert volume to moles using...

95

Trap: in gas stoichiometry, coefficients compare liters directly even if it's not STP. True or false?

96

At constant T and P: volume ratio = {{c1::mole ratio}} (use coefficients).

90

Moles (and the coefficients in the balanced equation).

89

larger

92

20 L (if N2 is excess).

91

2:1.

94

$n = V/22.4$.

93

True.

96

At constant T and P: volume ratio = mole ratio (use coefficients).

95

False.

97

Average kinetic energy of a gas depends on...

98

Trap: at the same temperature, heavier gas molecules move faster. True or false?

99

At the same temperature, which moves faster on average: He or O2?

100

Root-mean-square speed relationship (you don't need to memorize the full formula):

101

Gas pressure comes from...

102

If you increase temperature, pressure increases (at fixed volume) because...

103

At the same temperature, all gases have the same average {{c1::kinetic energy}}.

104

Graham's law compares effusion/diffusion rates:

98

False.

97

Temperature only (in Kelvin).

100

u_{rms} sqrt(T/M).

99

He.

102

Molecules hit the walls more often and with more energy.

101

Collisions of gas particles with the container walls.

104

rate1/rate2 = sqrt(M2/M1).

103

At the same temperature, all gases have the same average kinetic energy.

105

Trap: if molar mass doubles, diffusion rate halves. True or false?

106

Quick: Compare rates of H2 (2 g/mol) and O2 (32 g/mol): H2 is faster by factor...

107

Quick: Which diffuses faster: NH3 (17) or HCl (36.5)?

108

Classic demo logic: why does the NH3/HCl ring form closer to the HCl side?

109

Graham's law: rate1/rate2 = sqrt({{c1::M2/M1}}).

110

Which diffuses faster (same T): He or CO2?

111

Question gives P1,V1 and P2,V2 only, and says T constant. Use:

112

Question gives V1,T1 and V2,T2 only, pressure constant. Use:

106

4 times.

105

False.

108

NH3 diffuses faster, so it travels farther in the same time.

107

NH3 diffuses faster.

110

He

109

Graham's law: rate1/rate2 = sqrt(M2/M1).

112

Charles' law (V1/T1=V2/T2).

111

Boyle's law (P1V1=P2V2).

113

Question gives P1,T1 and P2,T2 only, volume constant. Use:

114

Question changes P,V,T but same amount of gas. Use:

115

Question asks about mixtures and 'partial pressure'. Use:

116

Question gives density of a gas and asks molar mass. Use:

117

Question asks how diffusion/effusion speed changes with molar mass. Use:

118

Trap: PV=nRT only works at STP. True or false?

119

Trap: 'n' in PV=nRT is number of molecules. True or false?

120

If the number of moles doubles at constant T and V, pressure becomes...

114

Combined gas law (P1V1/T1 = P2V2/T2).

113

Gay-Lussac's law (P1/T1=P2/T2).

116

M = dRT/P.

115

Dalton's law.

118

False.

117

Graham's law (rate 1/sqrt(M)).

120

Double.

119

False.

121

If the number of moles doubles at constant T and P, volume becomes...

122

At constant P and T, equal volumes of different gases contain equal...

123

Trap: if two gases have the same pressure in the same container, they must have the same number of moles. True or false?

124

If you are solving for n using PV=nRT, the 'V' is the volume of...

125

If a problem says 'at constant pressure', your brain should immediately think:

126

If a problem says 'rigid container', your brain should immediately think:

127

Unit check trick: if you used PV=nRT and got moles in 'atm', what does that tell you?

128

A gas has P=1.0 atm, V=24.6 L, T=300 K. n is about...

122

Moles (same number of molecules).

121

Double.

124

The gas sample (or container) at those conditions.

123

False.

126

Volume constant -> Gay-Lussac (P/T) or PV=nRT with V fixed.

125

Charles' law or PV=nRT with P fixed.

128

1.0 mol.

127

Your units didn't match or you rearranged wrong.

129

A gas has P=2.0 atm, V=12.3 L, T=300 K. n is about...

130

At 1 atm and 273 K, what volume does 0.25 mol occupy?

131

At 1 atm, 273 K, 11.2 L of gas contains how many molecules?

132

How many moles of gas are in 2.24 L at STP?

133

A sample is 1.0 L at 1.0 atm. If pressure increases to 4.0 atm (T constant), V becomes...

134

A sample is 2.0 L at 300 K. If cooled to 150 K (P constant), V becomes...

135

A sample is 1.0 atm at 300 K in a rigid container. If cooled to 150 K, P becomes...

136

Combined gas law drill: P1=1 atm, V1=2 L, T1=300 K -> P2=2 atm, T2=600 K. V2 =

130

5.6 L.

129

1.0 mol.

132

0.10 mol.

131

About 3.01×10^{23} molecules.

134

1.0 L.

133

0.25 L.

136

2 L.

135

0.50 atm.

137

If a real gas shows LOWER pressure than ideal prediction at moderate pressure, that's usually because...

138

If a real gas shows HIGHER pressure than ideal prediction at very high pressure, that's usually because...

139

Trap: real gases behave most ideally at high pressure. True or false?

140

Best conditions for ideal-gas behavior:

141

You heat a sealed RIGID container. What changes for the gas?

142

You heat a gas in a cylinder with a moveable piston (pressure constant). What changes?

143

You add more gas (more moles) to a rigid container at constant temperature. What changes?

144

You add more gas to a piston-cylinder at constant T and constant external pressure. What happens?

138

Molecules take up real volume (crowding), so collisions are more intense.

137

Attractive forces pull molecules together, reducing wall collisions.

140

Low pressure and high temperature.

139

False.

142

Volume increases (pressure stays the same).

141

Pressure increases (volume stays the same).

144

Volume increases.

143

Pressure increases.

145

Trap: partial pressure depends on temperature but not volume. True or false?

146

If you double the volume of a gas mixture at constant T, each partial pressure...

147

If you keep the same container and temperature, doubling the moles of ONE gas in a mixture makes its partial pressure...

148

Ideal gas law:

149

Boyle's law:

150

Charles' law:

151

Gay-Lussac's law:

152

Combined gas law:

146

Halves.

145

False.

148

$PV = nRT$

147

Double.

150

$V1/T1 = V2/T2$

149

$P1V1 = P2V2$

152

$P1V1/T1 = P2V2/T2$

151

$P1/T1 = P2/T2$

153

Avogadro's law:

154

Dalton's law:

155

Mole fraction definition:

156

Partial pressure formula:

157

Gas collected over water:

158

Gas density formula:

159

Molar mass from density:

160

Graham's law:

154

$P_{total} = \Sigma P_i$

153

$V1/n1 = V2/n2$

156

$P_i = x_i\ P_{total}$

155

$x_i = n_i/n_{total}$

158

$d = PM/RT$

157

$P_{gas} = P_{total}$ - P_{H2O}

160

$rate1/rate2 = \sqrt{}(M2/M1)$

159

$M = dRT/P$