2018 Vapor pressure and Boiling Point Notes:

1. **Standard pressure** occurs only at sea level (0 ft elevation).
Here, pressure = 101.3 kPa = 1.00 atm = 760 torr = 760 mmHg = 14.7 psi

2. **Evaporation** happens at all temps below the boiling point when the molecules of the liquid can overcome the **attractive forces** holding them in the liquid phase and escape as a **vapor.**

3. **Boiling** occurs when the **vapor pressure** of the molecules escaping (leaving) the liquid phase equals the **atmosheric pressure** pushing down on the surface of the liquid.

4. **Normal Boiling point** occurs only at **Standard (sea level) pressure!**
(Same holds true for Normal melting point)

5. The **stronger** the **attractive forces** are between molecules in the solid or liquid phases the more energy is needed to make that solid melt or the liquid boil, so MP and BP temp will be higher!

** e.g. If you were comparing four different liquids at standard pressure (or any pressure) the one with the highest boiling point must have the strongest attractive forces!

6. As altitude increases, atmospheric pressure **decreases,** so the boiling point will also **decrease!** Implication?
Think of hard-boiling an egg on a mountain.
If the boiling point is LOWER the time it takes to cook that egg will
A. INCREASE
B. DECREASE
C. REMAIN THE SAME

Table 10.10 Boiling Point of Water at Various Locations

Location	Feet Above Sea Level	P_{atm} (torr)	Boiling Point (°C)
Top of Mt. Everest, Tibet	29,028	240	70
Top of Mt. McKinley, Alaska	20,320	340	79
Top of Mt. Whitney, Calif.	14,494	430	85
Leadville, Colo.	10,150	510	89
Top of Mt. Washington, N.H.	6293	590	93
Boulder, Colo.	5430	610	94
Madison, Wis.	900	730	99
New York City, N.Y.	10	760	100
Death Valley, Calif.	−282	770	100.3

Read and complete problems on Guided review book pages 146 – 147:

73. 1	77. 1
74. 2	78. 3
75. 1	79. 4
76. 4	80. 2

Set 1 — Vapor Pressure of Four Liquids

1. Which substance has the lowest vapor pressure at 75°C?

   (1) water
   (2) ethanoic acid
   (3) propanone
   (4) ethanol

   1 2

2. According to Reference Table H, what is the vapor pressure of propanone at 45°C?

   (1) 22 kPa (3) 70. kPa
   (2) 33 kPa (4) 98 kPa

   2 3

3. The boiling point of a liquid is the temperature at which the vapor pressure of the liquid is equal to the pressure on the surface of the liquid. What is the boiling point of propanone if the pressure on its surface is 48 kilopascals?

   (1) 25°C (3) 35°C
   (2) 30.°C (4) 40.°C

   3 3

4. At which temperature is the vapor pressure of ethanol equal to the vapor pressure of propanone at 35°C?

   (1) 35°C (3) 82°C
   (2) 60.°C (4) 95°C

   4 2

5. As the temperature of a liquid increases, its vapor pressure

   (1) decreases
   (2) increases
   (3) remains the same

   5 2

6. As the pressure on the surface of a liquid decreases, the temperature at which the liquid will boil

   (1) decreases
   (2) increases
   (3) remains the same

   6 1

7. Using your knowledge of chemistry and the information in Reference Table H, which statement concerning propanone and water at 50°C is true?

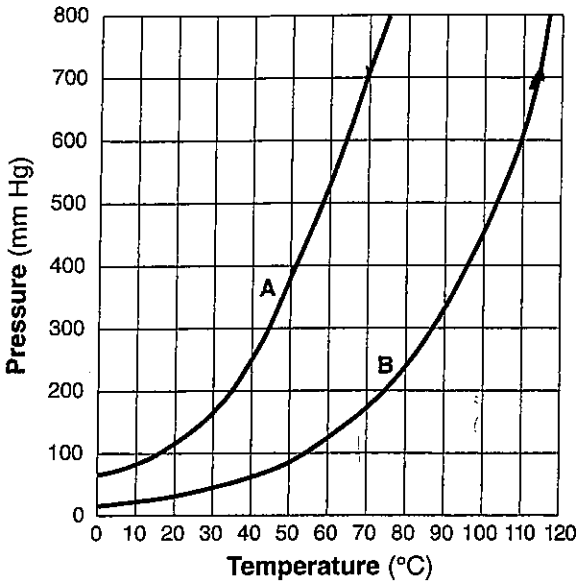
   (1) Propanone has a higher vapor pressure and stronger intermolecular forces than water.
   (2) Propanone has a higher vapor pressure and weaker intermolecular forces than water.
   (3) Propanone has a lower vapor pressure and stronger intermolecular forces than water.
   (4) Propanone has a lower vapor pressure and weaker intermolecular forces than water.

   7 2

8. A liquid boils when the vapor pressure of the liquid equals the atmospheric pressure on the surface of the liquid. Using Reference Table H, determine the boiling point of water when the atmospheric pressure is 90. kPa.

   ~97°C

Base your answers to question 9 using your knowledge of chemistry and on the graph below, which shows the vapor pressure curves for liquids *A* and *B*. **Note:** The pressure is given in mm Hg – millimeters of mercury.



9. *a*) What is the vapor pressure of liquid *A* at 70°C? Your answer must include correct units.

700 mm Hg

b) At what temperature does liquid *B* have the same vapor pressure as liquid *A* at 70°C? Your answer must include correct units.

112 - 113 °C

c) At 400 mm Hg, which liquid would reach its boiling point first? A

d) Which liquid will evaporate more rapidly? Explain your answer in terms of intermolecular forces.

"A" has higher vapor pressure at all Temps, so the particles in the Liquid phase are held together by weaker intermolecular Attractive Forces.

10. At 65°C, which compound has a vapor pressure of 58 kilopascals?

(1) ethanoic acid (3) propanone
(2) ethanol (4) water

10 2

11. Which liquid has the highest vapor pressure at 75°C?

(1) ethanoic acid (3) propanone
(2) ethanol (4) water

11 3

12. When the vapor pressure of water is 70 kPa the temperature of the water is

(1) 20°C (3) 60°C
(2) 40°C (4) 91°C

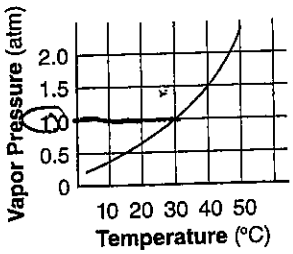
12 4

13. According to Reference Table H, what is the boiling point of ethanoic acid at 80 kPa?

(1) 28°C (3) 111°C
(2) 100°C (4) 125°C

13 3

14. The graph below shows the relationship between vapor pressure and temperature for substance **X**.



What is the normal boiling point for substance **X**?

(1) 50°C (3) 30°C
(2) 20°C (4) 40°C

14 3

15. The table below shows the normal boiling point of four compounds.

Compound	Normal Boiling Point (°C)
$HF(\ell)$	19.4
$CH_3Cl(\ell)$	–24.2
$CH_3F(\ell)$	–78.6
$HCl(\ell)$	–83.7

Which compound has the strongest intermolecular forces?

= the one with highest BP.

(1) $HF(\ell)$ (3) $CH_3F(\ell)$
(2) $CH_3Cl(\ell)$ (4) $HCl(\ell)$

15 1

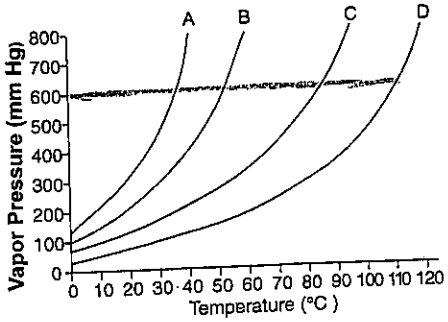
16. Based on Reference Table H, which subtance has the weakest intermolecular forces?

= the one with Highest vapor pressures

(1) ethanoic acid
(2) ethanol
(3) propanone
(4) water

16 3

17. The graph below represents the vapor pressure curves of four liquids.



Which liquid has the highest boiling point at 600 mm Hg?

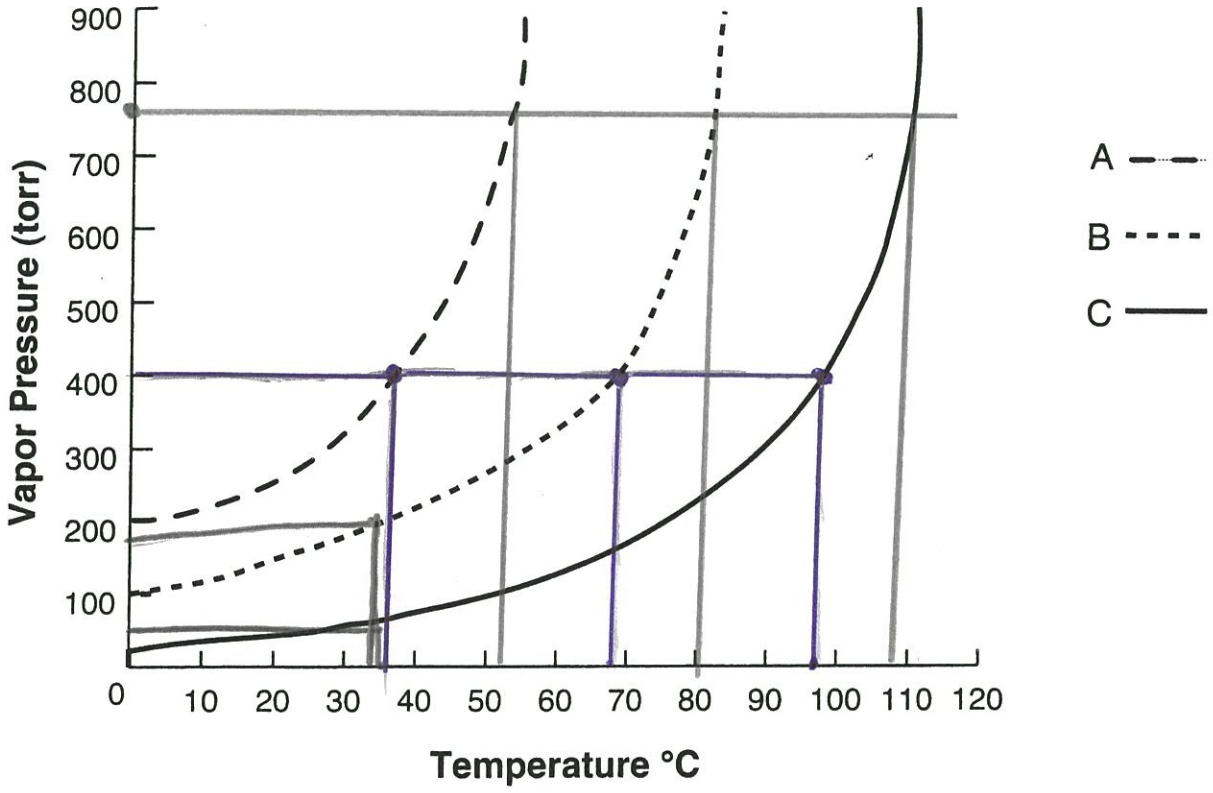
(1) *A* (3) *C*
(2) *B* (4) *D*

17 D

VAPOR PRESSURE AND BOILING

Name _____

A liquid will boil when its vapor pressure equals atmospheric pressure. Answer the questions following the graph.



1. At what temperature would Liquid A boil at an atmospheric pressure of 400 torr? 36°C ±1
2. Liquid B? 68 ± 1
3. Liquid C? 97 ± 1
4. How low must the atmospheric pressure be for Liquid A to boil at 35° C? ~400 torr
5. Liquid B? ~180 torr
6. Liquid C? ~50 torr
7. What is the normal boiling point of Liquid A? ~52
8. Liquid B? ~80
9. Liquid C? ~109
10. Which liquid has the strongest intermolecular forces? C