Chemistry 141 Name

Cary Willard

Quiz 9a (20 points) November 17, 2009

All work must be show to receive credit. Remember, significant figures are important!

$ln\frac{P\_{2}}{P\_{1}}=\frac{-∆H\_{vap}}{R}\left(\frac{T\_{1}-T\_{2}}{T\_{1}T\_{2}}\right)$, R=0.0821 L atm/mol K = 8.314 J/mol K

1. (12 points) Ethanol has a heat of vaporization of 38.56 kJ/mol and a normal boiling point of 78.4oC.
	1. What is the vapor pressure of ethanol at 25.0oC?

$$ln\frac{P\_{2}}{P\_{1}}=\frac{-∆H\_{vap}}{R}\left(\frac{T\_{1}-T\_{2}}{T\_{1}T\_{2}}\right)$$

$$ln\frac{\left(760 torr\right)}{P\_{1}}=\frac{-38560\frac{J}{mol}}{8.31\frac{J}{mol K}}\left(\frac{298.2 K-351.6K}{\left(351.6 K\right)\left(298.2 K\right)}\right)=2.363$$

$$\frac{\left(760 torr\right)}{P\_{1}}=e^{2.363}=10.63$$

$$P\\_1=(760 torr)/(10.63)=71.5 torr (0.0941 atm)$$

* 1. What is the boiling temperature of ethanol on Pikes Peak, where the atmospheric pressure is 540 torr?

$$ln\frac{\left(760 torr\right)}{\left(540 torr\right)}=\frac{-38560\frac{J}{mol}}{8.31\frac{J}{mol K}}\left(\frac{T\_{1}-351.6 K}{\left(T\_{1}\right)\left(351.6 K\right)}\right)$$

$$0.34=\frac{-38560\frac{J}{mol}}{8.31\frac{J}{mol K}}\left(\frac{T\_{1}-351.6 K}{\left(T\_{1}\right)\left(351.6 K\right)}\right)=\left(\frac{-4640 K}{351.6 K}\right)\left(\frac{T\_{1}-351.6 K}{\left(T\_{1}\right)}\right)$$

$$-0.0258=\frac{ \left(T\_{1}-351.6 K\right)}{T\_{1}}=\frac{T\_{1}-351.6 K}{T\_{1}}$$

$$-0.0258 T\_{1}= T\_{1}-351.6 K $$

$$1.0258 T\_{1}=-351.6 K$$

$$T\_{1}=343 K or 70℃$$

1. (8 points) A newly formulated substance has a normal boiling point of 314oC, a normal freezing point of 16oC, a triple point at 460 torr and 29oC, and a critical point at 7302 torr and 603oC. Draw a phase diagram for this substance, labeling the liquid, gas, and solid phases, the triple point, the critical point, and the supercritical fluid.

7302

Pressure (torr)

Which is more dense for this substance, the liquid or the solid state? Explain how you arrived at this answer.

Critical point

liquid

The liquid is more dense because the solid converts to a liquid when pressure is applied

solid

760

603

314

16 29

Temperature (oC)

gas

Triple point

460

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$ln\frac{P\_{2}}{P\_{1}}=\frac{-∆H\_{vap}}{R}\left(\frac{T\_{1}-T\_{2}}{T\_{1}T\_{2}}\right)$, R=0.0821 L atm/mol K = 8.314 J/mol K

1. (12 points) Ethanol has a heat of vaporization of 38.56 kJ/mol and a normal boiling point of 78.4oC.
	1. What is the vapor pressure of ethanol at 35.0oC?

$$ln\frac{P\_{2}}{P\_{1}}=\frac{-∆H\_{vap}}{R}\left(\frac{T\_{1}-T\_{2}}{T\_{1}T\_{2}}\right)$$

$$ln\frac{\left(760 torr\right)}{P\_{1}}=\frac{-38560\frac{J}{mol}}{8.31\frac{J}{mol K}}\left(\frac{308.2 K-351.6 K}{\left(351.6 K\right)\left(308.2 K\right)}\right)=1.858$$

$$\frac{\left(760 torr\right)}{P\_{1}}=e^{1.858}=6.414$$

$$P\\_1=(760 torr)/(6.414 )=118 torr (0.156 atm)$$

* 1. What is the boiling temperature of ethanol under the ocean, where the atmospheric pressure is 1577 torr?

$$ln\frac{\left(760 torr\right)}{\left(1577 torr\right)}=\frac{-38560\frac{J}{mol}}{8.31\frac{J}{mol K}}\left(\frac{T\_{1}-351.6 K}{\left(T\_{1}\right)\left(351.6 K\right)}\right)$$

$$-0.730=\frac{-38560\frac{J}{mol}}{8.31\frac{J}{mol K}}\left(\frac{T\_{1}-351.6 K}{\left(T\_{1}\right)\left(351.6 K\right)}\right)=\left(\frac{-4640 K}{351.6 K}\right)\left(\frac{T\_{1}-351.6 K}{\left(T\_{1}\right)}\right)$$

$$0.0553=\frac{ \left(T\_{1}-351.6 K\right)}{T\_{1}}=\frac{T\_{1}-351.6 K}{T\_{1}}$$

$$0.0553 T\_{1}= T\_{1}-351.6 K $$

$$-0.945 T\_{1}=-351.6 K$$

$$T\_{1}=372 K or 99℃$$

1. (8 points) A newly formulated substance has a normal boiling point of 531oC, a normal freezing point of 68oC, a triple point at 260 torr and 53oC, and a critical point at 8674 torr and 815oC. Draw a phase diagram for this substance, labeling the liquid, gas, and solid phases, the triple point, the critical point, and the supercritical fluid.

7302

Pressure (torr)

Which is more dense for this substance, the liquid or the solid state? Explain how you arrived at this answer.

liquid

Critical point

The liquid is less dense because the liquid converts to a solid when pressure is applied.

Temperature (oC)

53 68

solid

760

603

531

gas

Triple point

460