Take-Home Quiz
Topic 07: Intermolecular Forces, States or Matter, and Energy

Objective:

This is to assess your comprehension of the material we have covered so far and to help prepare you for the exam.

Instructions and Notes:

- Most of the quiz problems are from or adapted from "Exercises" at the end of the chapters in the Chemistry: Atoms First 2e Online Textbook (OpenStax)
- You must *CLEARLY LABEL* all problems and *SHOW ALL WORK* neatly and legibly to receive credit. If the problems do not require calculations/work then you must explain how you got the answer. (can be a few words up to a few sentences or even a few arrows)
- If the problem requires calculations, the answers should be highlighted or boxed.
- Book sections covered: 10.1, 10.2, 10.3 (heating/cooling curves only), 10.4, 9.1

Submission:

The quiz is usually due ~1 week after we start this section (see our due date schedule). Summer session is due sooner. This should be scanned as a single PDF and submitted online through Canvas. The file cannot be larger than 20 Mb (20,000 kB).

Helpful Tips:

- Start as soon as we're done with the lecture.
- Refer to the lecture and/or videos (if available).
- Use the corresponding chapter in the book to help you through difficult problems/concepts.
- There are answers and solutions available to the odd numbered problems (book number not quiz number) on the OpenStax website under "Student Resources". It is not advised to rely on the solutions because you will not have access to the solutions during the exam. Only use the solutions as a last resort. Struggling is good and that is when you are learning the most!
- Work together with your classmates.
- Go to tutoring in the ASTC or MESA, ask your classmates in our Discord room, watch YouTube Videos, come to office hours, etc.
- To ensure your mastery of the material, do the quiz multiple times.

10.1 Intermolecular Forces

1) (From Chapter 10.1 #1) In terms of their bulk properties, how do liquids and solids differ? How are they similar?

2) (From Chapter 10.1 #4) Explain why liquids assume the shape of any container into which they are poured, whereas solids are rigid and retain their shape.

3) (From Chapter 10.1 #5) What is the evidence that all neutral atoms and molecules exert attractive forces on each other?

(From Chapter 10.1 #7) Define the following and give an example of each:

4) dispersion force 5) dipole-dipole attraction 6) hydrogen bond

7) (Not in book) Rank the IMF from weakest to strongest.

8) (Not in book) What types of molecules or atoms can have dispersion forces?

9) (Not in book) What types of molecules or atoms can have dipole-dipole attractions?

10) (Not in book) What types of molecules or atoms can have hydrogen bonds?

(From Chapter 10.1 #11) Arrange each of the following sets of compounds in order of increasing boiling point temperature:

11) HCl, H_2O, SiH_4

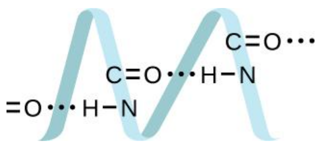
Skip this one) F_2, Cl_2, Br_2

Skip this one) CH_4, C_2H_6, C_3H_8

Skip this one) O_2, NO, N_2

12) (From Chapter 10.1 #17) Explain why a hydrogen bond between two water molecules is weaker than a hydrogen bond between two hydrogen fluoride molecules.

13) (From Chapter 10.1 #19)Proteins are chains of amino acids that can form in a variety of arrangements, one of which is a helix. What kind of IMF is responsible for holding the protein strand in this shape? On the protein image, show the locations of the IMFs that hold the protein together:



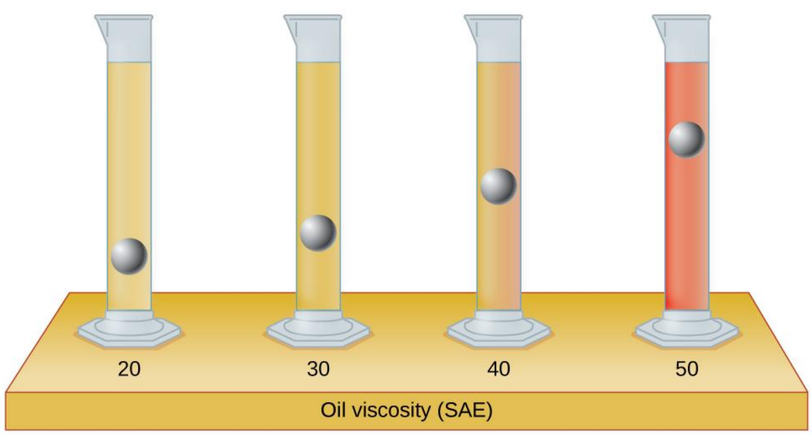
(From Chapter 10.1 #21) Identify the intermolecular forces present in the following solids:

14) CH_3CH_2OH 15) $CH_3CH_2CH_3$ 16) CH_3CH_2Cl

10.2 Properties of Liquids

17) (From Chapter 10.2 #22) The test tubes shown here contain equal amounts of the specified motor oils. Identical metal spheres were dropped at the same time into each of the tubes, and a brief moment later, the spheres had fallen to the heights indicated in the illustration.

Rank the motor oils in order of increasing viscosity, and explain your reasoning:



18) (From Chapter 10.2 #23) Although steel is denser than water, a steel needle or paper clip placed carefully lengthwise on the surface of still water can be made to float. Explain at a molecular level how this is possible.

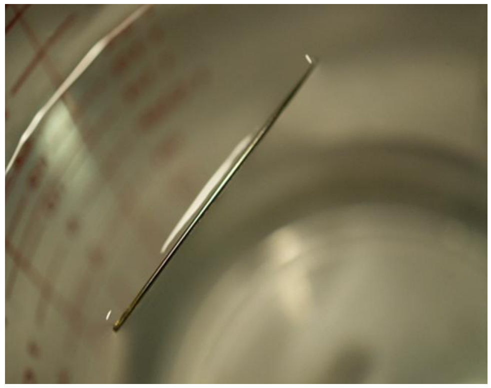


Figure 10.67 (credit: Cory Zanker)

The surface tension and viscosity of water at several different temperatures are given in this table.

Water	Surface Tension (mN/m)	Viscosity (mPa s)
0 °C	75.6	1.79
20 °C	72.8	1.00
60 °C	66.2	0.47
100 °C	58.9	0.28

19) (From Chapter 10.2 #27a) As temperature increases, what happens to the surface tension of water? Explain why this occurs, in terms of molecular interactions and the effect of changing temperature.

20) (From Chapter 10.2 #27b) As temperature increases, what happens to the viscosity of water? Explain why this occurs, in terms of molecular interactions and the effect of changing temperature.

10.3 Phase Transitions

21) (From Chapter 10.3 #30) Heat is added to boiling water. Explain why the temperature of the boiling water does not change. What does change?

22) (From Chapter 10.3 #31) Heat is added to ice at 0 °C. Explain why the temperature of the ice does not change. What does change?

23) (From Chapter 10.3 #37) Why does spilled gasoline evaporate more rapidly on a hot day than on a cold day?

10.4 Phase Diagrams

(From Chapter 10.4 #54) From the phase diagram for water (Figure 10.31), determine the state of water at:

24) 35 °C and 85 kPa

25) −15 °C and 40 kPa

26) −15 °C and 0.1 kPa

27) 75 °C and 3 kPa

28) 40 °C and 0.1 kPa

29) 60 °C and 50 kPa

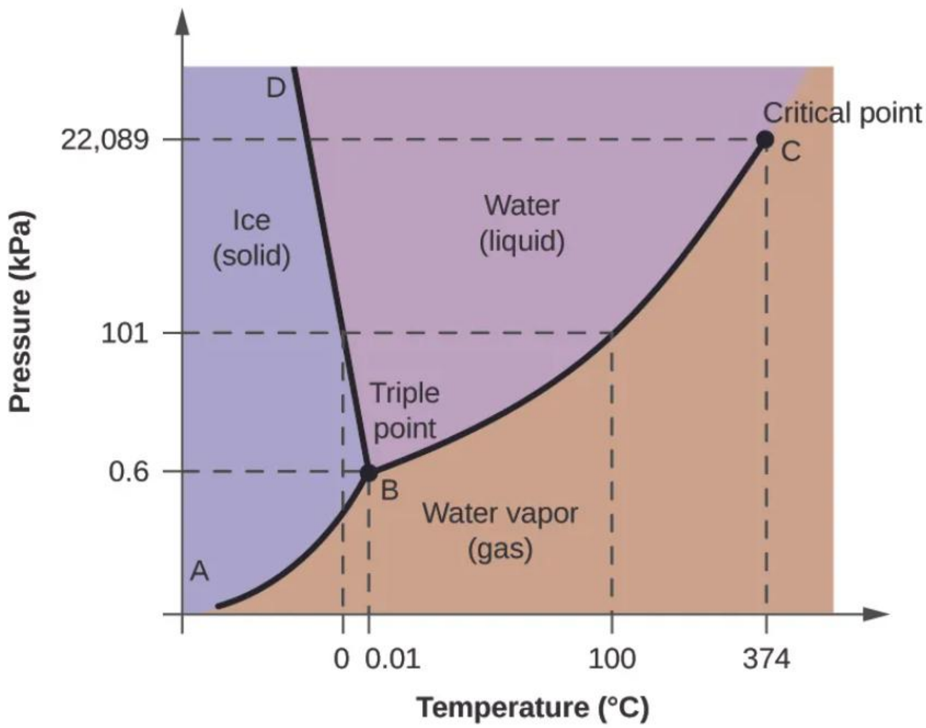


Figure 10.31 The pressure and temperature axes on this phase diagram of water are not drawn to constant scale in order to illustrate several important properties.

30) (From Chapter 10.4 #55) What phase changes will take place when water is subjected to varying pressure at a constant temperature of 0.

(From Chapter 10.4 #57) From the phase diagram for carbon dioxide in Figure 10.34, determine the state of CO_2 at:

31) 20 °C and 1000 kPa

32) 10 °C and 2000 kPa

33) 10 °C and 100 kPa

34) −40 °C and 500 kPa

35) −80 °C and 1500 kPa

36) −80 °C and 10 kPa

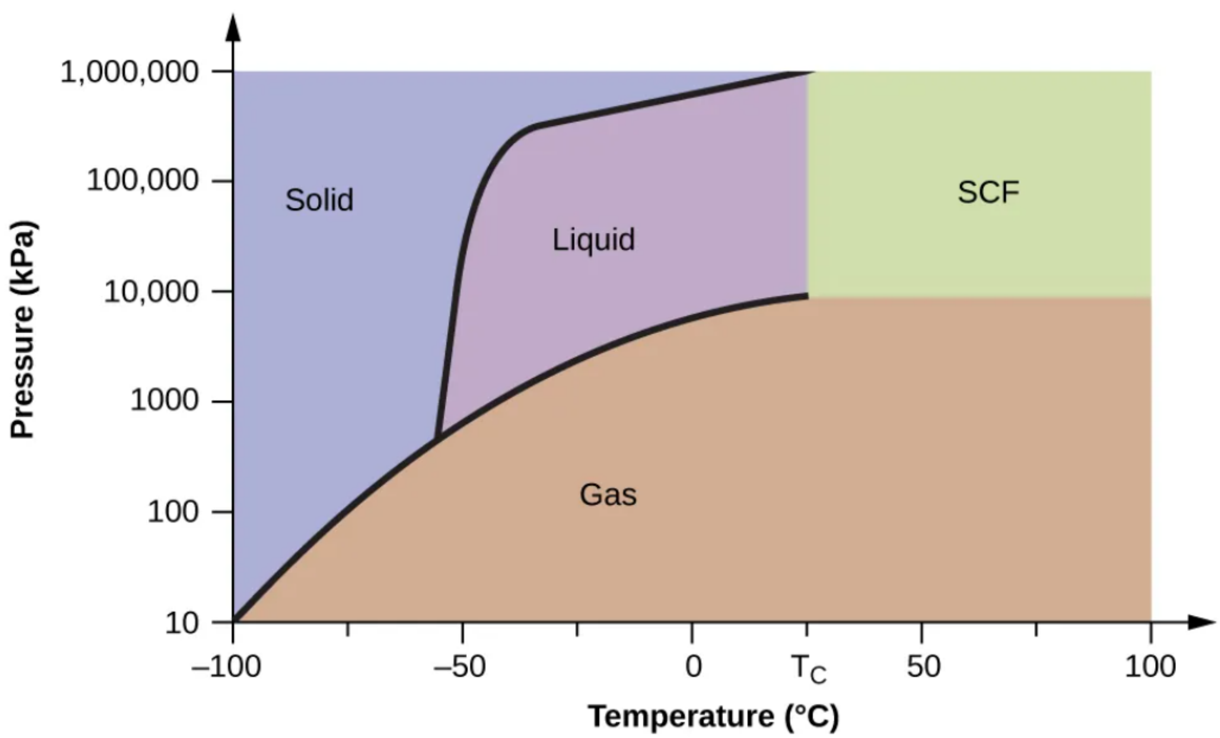


Figure 10.34 A phase diagram for carbon dioxide is shown. The pressure axis is plotted on a logarithmic scale to accommodate the large range of values.

9.1 Energy Basics

37) (From Chapter 9.1 #1) A burning match and a bonfire may have the same temperature, yet you would not sit around a burning match on a fall evening to stay warm. Why not?

38) (From Chapter 9.1 #6) How much heat, in joules and in calories, must be added to a 75.0–g iron block with a specific heat of 0.449 J/g °C to increase its temperature from 25 °C to its melting temperature of 1535 °C?

39) (From Chapter 9.1 #7) How much heat, in joules and in calories, is required to heat a 28.4-g (1-oz) ice cube from −23.0 °C to −1.0 °C?

Specific Heats of Common Substances at 25 °C and 1 bar

Substance	Symbol (*state*)	Specific Heat (J/g °C)
helium	$He(g)$	5.193
water	$H_2O(l)$	4.184
ethanol	$C_2H_6O(l)$	2.376
ice	$H_2O(s)$	2.093 (at −10 °C)
water vapor	$H_2O(g)$	1.864
nitrogen	$N_2(g)$	1.040
air		1.007
oxygen	$O_2(g)$	0.918
aluminum	$Al(s)$	0.897
carbon dioxide	$CO_2(g)$	0.853
argon	$Ar(g)$	0.522
iron	$Fe(s)$	0.449
copper	$Cu(s)$	0.385
lead	$Pb(s)$	0.130
gold	$Au(s)$	0.129
silicon	$Si(s)$	0.712

Table 9.1

40) (From Chapter 9.1 #9) If 14.5 kJ of heat were added to 485 g of liquid water, how much would its temperature increase? (remember to convert to J first)

41) (From Chapter 9.1 #11) A piece of unknown solid substance weighs 437.2 g, and requires 8460 J to increase its temperature from 19.3 °C to 68.9 °C.

(a) What is the specific heat of the substance?

(b) If it is one of the substances found in Table 9.1, what is its likely identity?

42) (Not in book) Describe the differences between exothermic and endothermic reactions