

Name: \_\_\_\_\_

Date: \_\_\_\_\_

## Heating & Air Conditioning Work Example 1

**WorkKey Level: 3**

**NATEF Automotive Tasks: VII.A**

According to the following refrigerant oil capacities chart, how much oil should be added when you replace the accumulator and the evaporator?

Component	ml	fl. oz.
A/C system	240	8.1
Accumulator	120	4
Condenser	30	1
Evaporator	60	2

### Solution

Accumulator + Evaporator

$$120 \text{ ml} + 60 \text{ ml} = 180 \text{ ml}$$

or

$$4 \text{ oz} + 2 \text{ oz} = 6 \text{ oz}$$

## Heating & Air Conditioning Work Example 2

**WorkKey Level: 3**

**NATEF Automotive Tasks: VII.C.2**

For every pound per square inch of pressure (psi), the boiling point rises three-Fahrenheit degrees. What is the boiling point of a system with a 16-pound cap assuming the boiling point of the coolant is 228 degrees.

### Solution

Since 1 psi = 3-Fahrenheit degrees,

$$(16 \text{ lb})(3 \text{ degrees}) = 48^\circ$$

Boiling point:

$$228^\circ + 48^\circ = 276 \text{ degrees Fahrenheit}$$

### Heating & Air Conditioning Work Example 3

**WorkKey Level:** 4

**NATEF Automotive Tasks:** VII.C.5

When filling a 15-quart system with a solution that is 40% water and 60% coolant, how many quarts of coolant would be required?

**Solution**

$$(16 \text{ quarts})(60\% \text{ coolant}) = (16)(0.60) = 9.6 \text{ quarts}$$

You will need to add 9.6 quarts of coolant.

### Heating & Air Conditioning Work Example 4

**WorkKey Level:** 3

**NATEF Automotive Tasks:** VII.C.6

According to the following chart, if I have a 14-quart capacity cooling system and I want to obtain protection against freezing down to about -54 degrees Fahrenheit, how many quarts of antifreeze should I add to the system?

**Antifreeze and Coolant Means Maximum Severe Conditions Protection**

Cooling system capacity in quarts	3	4	5	6	7	8	9	10	11
8	-7	-34	-69						
9	0	21	-50	-70					
10	4	-12	-34	-62					
11	8	-6	-23	-47	-65				
12	10	0	-15	-34	-57				
13		3	-9	-25	-45	-64			
14		6	-5	-18	-34	-54	-68		
15		8	0	-12	-26	-43	-62		
16		10	2	-8	-19	-34	-52	-64	
17			5	-4	-14	-27	-42	-58	-69
18			7	0	-10	-21	-34	-58	-62
19			9	2	-7	-16	-28	-42	-56
20			10	4	-3	-12	-22	-34	-48

**Solution**

Reading from the chart:

Go down to 14 quarts and over to  $-54$  degrees.

The answer is 8 quarts.

**Heating & Air Conditioning Work Example 5**

**WorkKey Level:** 4

**NATEF Automotive Tasks:** VII.C.5

You have 12 quarts of antifreeze in a 20-quart system.

1. What would the boiling point be?
2. What would the freezing point be?

**Freeze/Boil Protection Chart**  
\* Using a 15-PSI Pressure Cap

% of cooling system capacity	Protects from freezing down to	Protects from boiling up to*
50	$-34^{\circ}$ F	$265^{\circ}$ F
60	$-62^{\circ}$ F	$270^{\circ}$ F
70	$-84^{\circ}$ F	$276^{\circ}$ F

**Solution**

12 quarts of antifreeze/20-quart system =  $12/20 = 3/5 = 60\%$

1. Reading off of the chart:  
60% of cooling system capacity has a boiling point up to 270 degrees Fahrenheit.
2. Reading off of the chart:  
60% of cooling system capacity has a freezing point down to  $-62$  degrees Fahrenheit.

## Heating & Air Conditioning Work Example 6

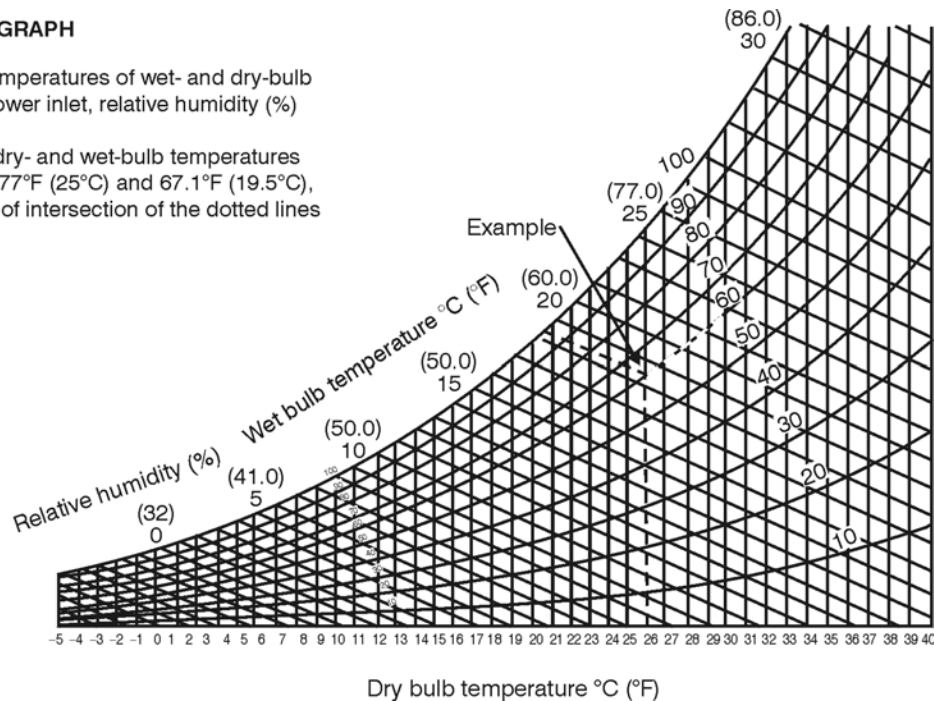
**WorkKey Level: 5**

**NATEF Automotive Tasks: VII.A.6**

### HOW TO READ THE GRAPH

After measuring the temperatures of wet- and dry-bulb thermometer at the blower inlet, relative humidity (%) can be obtained.

Example: Supposing dry- and wet-bulb temperatures at the blower inlet are 77°F (25°C) and 67.1°F (19.5°C), respectively, the point of intersection of the dotted lines in the graph is 60%.



Humidity plays a role in air conditioning. It is not just the outlet temperature that cools. Many customers will measure the outlet temperature on a 90% humidity day and complain that the system will not get cold enough.

If you tried a (23°C) wet Bulb and (25°C) dry bulb, the relative humidity would be \_\_\_\_\_ %.

### Solution

Reading off of the chart:

25 degrees Celsius on the bottom and 23 degrees Celsius on the top; they intersect at approximately 85%.

## Heating & Air Conditioning Work Example 7

**WorkKey Level: 4**

**NATEF Automotive Tasks: VII.C.5, VII.C.6**

Use the chart below to answer the following question. How many quarts of antifreeze coolant are needed for a 4-gallon system to -34°F? (1 gallon = 4 quarts)

**Quarts of Antifreeze Required for Protection to Temperatures (°F) Shown**

<b>Cooling system capacity in quarts</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>
5	-12	-62								
6	0	-34								
7	6	-17	-54							
8		-7	-34	-69						
9		0	-21	-50	-70					
10		4	-12	-34	-62					
11		8	-6	-23	-47	-65				
12		10	0	-15	-34	-57				
13			3	-9	-25	-45	-64			
14			6	-5	-18	-34	-54	-68		
15			8	0	-12	-26	-43	-62		
16			10	2	-8	-19	-34	-52	-64	
17				5	-4	-14	-27	-42	-58	-69
18				7	0	-10	-21	-34	-50	-62
19				9	2	-7	-16	-28	-42	-56
20				10	4	-3	-12	-22	-34	-48
21					6	0	-9	-17	-28	-41
22					3	2	-5	-14	-23	-34

**Solution**

Since one gallon is equal to four quarts, then four gallons equals 16 quarts.  $(4)(4) = 16$

Reading off of the chart, 16 quarts at -34 degrees Fahrenheit requires 8 quarts of antifreeze.

**Heating & Air Conditioning Work Example 8**

**WorkKey Level:** 7

**NATEF Automotive Tasks:** VII.C.5, VII.C.6

The chart below shows the relationship between the boiling point of coolant and the percent antifreeze coolant content of the coolant.

<b>Percent antifreeze in coolant</b>	<b>Boiling point of coolant (°F)</b>
0	212
10	213

20	214
30	217
40	223
50	228
60	236
70	245
80	258
90	270
100	330

You have tested a car's coolant system and found that the coolant is 20% antifreeze. The car will hold 12 liters of antifreeze when full.

- What is the boiling point of the coolant in the car with coolant containing 20% antifreeze?
- If you want the boiling point to increase to 245°F, what percent antifreeze should the coolant be?
- How many liters of coolant should you remove from the system so that replacing by 100% antifreeze will raise the boiling point to 245°F?

### Solution

- Reading off the chart, the boiling point is 214°F.
- Reading off the chart, the percent of antifreeze is 70%.
- Original amount = new amount  
 $0.20(12 - x) + x = (12)(0.70)$   
 $2.4 - 0.20x + x = 8.4$   
 $2.4 + 0.80x = 8.4$   
 $0.80x = 6$   
 $x = 6/0.80 = 7.5$  liters

## Heating & Air Conditioning Work Example 9

**WorkKey Level:** 3

**NATEF Automotive Tasks:**

A coolant system has a capacity of 7 1/2 quarts. If the ratio of antifreeze to water is 50:50, how much of each must be added after the system has been drained and cleaned?

### Solution

$$50:50 = 1/2$$

$$\frac{1}{2}\left(7\frac{1}{2}\right) = \frac{1}{2}\left(\frac{15}{2}\right) = \frac{15}{4} = 3.75 \text{ qts of water (and 3.75 qts of antifreeze)}$$