BJCP STUDY GROUP - SESSION 4

> READ / STUDY - The appropriate / matching section of the new BJCP Study Guide that corresponds to the technical topics / off flavors / flavors / etc. listed below.

- Recipe Formulation
- Packaging and Conditioning

- Chocolate Malt (cocoa / bakers chocolate)
- Black Patent Malt (burnt / charred)
- Roast Barley (coffee-like)

- Cloudiness
- Phenolic (clove-like) (taste in Hefewweizens)
- Phenolic (spicey, peppery) (taste in Belgians)
- Musty
- Moldy
- Sour / Acidic (lactic AND acetic / vinegar) (taste in Berliner Weiss, Flanders Red and Lambics)
- Butyric (vomit-like)
- Isovaleric
- Infection (lactic sour and buttery)

> READ / STUDY - Style Guidelines - Introduction (all) and the Styles listed below.

12 Porter
- 12A. Bown Porter
- 12B. Robust Porter
- 12C. Baltic Porter

13. Stout
- 13A. Dry Stout
- 13B. Sweet Stout
- 13C. Oatmeal Stout
- 13D. Foreign Extra Stout
- 13E. American Stout
- 13F. Russian Imperial Stout

14. India Pale Ale
- 14A. English IPA
- 14B. American IPA
- 14C. Imperial IPA

19. Strong Ale
- 19A. Old Ale
- 19B. English Barleywine
- 19C. American Barleywine

22. Smoke-Flavored and Wood-Aged Beer
- 22A. Classic Rauchbier

SESSION 4

>> Technical Topic 1

- Recipe formulation, including the selection of appropriate hops, malt, water, yeast and brewing procedure for different beer styles.

Recipe Formulation
Compiled by Greg Christmas and Ron Smith

--- Old Recipe Formulation Question
The Question: Provide a complete ALL-GRAIN recipe for a <STYLE*>, listing ingredients and their quantities, procedure, and carbonation. Give volume, as well as original and final gravities. Explain how the recipe fits the style's characteristics for aroma, flavor, appearance, mouthfeel, and other significant aspects of the style.

*Styles may include:

Belgian Tripel	Oktoberfest	Classic American Pilsner
Doppelbock	American IPA	Bohemian Pilsner
Robust Porter	Weizen	German Pilsner
Dry Stout	English Pale Ale	

Graded as follows…

1 point	Target statistics (starting specific gravity, final specific gravity, and bitterness in IBUs or HBUs) and color (as SRM or a textual description of the color).
2 points	Batch size, ingredients (grist, hops, water, and yeast) and their quantities.
3.5 points	Mashing, boil, fermentation, packaging, and other relevant brewing procedures.
3.5 points	Explain how the recipe fits the style's characteristics for aroma, appearance, flavor, mouthfeel, and other significant aspects of the style; and describe how the ingredients and processes used impact this style.

Also / Alternative Graded as follows…

[Volume]
[Water – chemistry/strike volume/sparge volume]
[Grist – appropriate choices/appropriate volumes]
[Mash – appropriate choice/decoction traditional]
[Boil]
[Hops – appropriatevariety/AAU/weight/times]
[Chill]
[Yeast – appropriate variety]
[Ferment – primary/secondary/duration/temperatures/diacetyl]
[OG]
[FG]
[Carb Technique]
[Aroma]
[Appearance]
[Flavor]
[Mouthfeel]

All BJPC exam questions about recipe formulation are for 5 gallon batches. The guidelines here assume a 5-1/2 gallon batch size to make up for losses and 75% mash efficiency, which is about average. (Indicate your assumptions in your test response).

OG	Lbs Grain	OG	Lbs Grain
1.030	6.0	1.070	14.0
1.040	8.0	1.080	16.0
1.050	10.0	1.090	18.0
1.060	12.0	1.100	20.0

Look at the trend pattern - Double the gravity's first two decimal places to get the lbs of grain!

Base Malt will normally comprise of 80% to 100% of the grain bill.
- Pale ale malts are highly converted so they work well for single step infusion mashes.
- British pale ale malts tend to be a bit darker and have a nutty flavor.
- Pilsner malt is lighter in color and typically requires a protein rest.
- Others: Wheat malt, Munich & Vienna malt

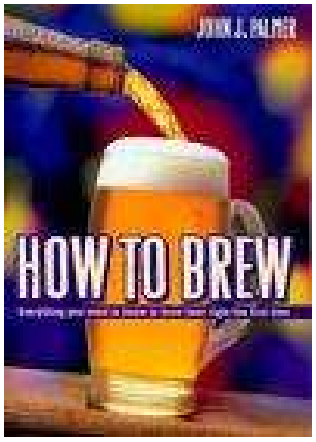
Specialty Malt will normally comprise 20% or less (usually 10% or so) of the grain bill.
- Toasted malts [victory, biscuit, aromatic, etc]
- Carmel malts [dextrin, carapils, caramel (British & American), crystal (Continental)]
- Roasted malt [Chocolate, Black Patent]
- Roasted Barley

Adjunct Grains normally comprise 20% or less of the grain bill.
Oats Barley Corn (maize) Wheat Rye

Sugars normally comprise 10% or less of fermentable (Belgian Strong Ales up to 30%)
Corn Table "Candi" Carmel Honey Molasses

Hops Assuming a 60 minute boil time, bittering hops yield approx 3 IBU per AAU (or HBU).
1 AAU (or HBU) = 1 ounce x 1% alpha acid
THUS ….. IBU / 3 = AAU ….. AAU / AA% = Ozs
EXAMPLE: 40 IBUs / 3 = 13 AAU ….. 13 AAU / 4.5% AA = 2.9 oz (call it 3 oz)
- Common IBU range is about 20 - 40
    - 1 - 2 oz of hops for a 5 gal batch is common (0.5 - 4 oz is a broader range)
        - Examples:
            - Red, Blond, Brown Ales = Approx 1.5 oz (about 25 - 30 IBUs)
            - American Pale = Approx 2.5 oz (approx 40 IBUs)
- Consider bittering vs finishing hops.
- Noble Hops = SHTS = Saaz, Hallertau, Tettnanger, Spalt
- Notes on Types of Hops:
    - American Citrusy Hops - Cascade, Centennial, Chinook, Columbus
        - Remember the "C" hops!
    - English Flowery Perfumey Hops - EKG, Fuggles
    - Northern Brewer - Woodsy, Minty, Earthy
    - Saaz - Spicey (Bo Pils)
    - Simcoe - Piney
- Bittering Hops:
    - High alpha acid / bitterness (8 - 10 % AA or so)
    - Magnum, Millenium, Brewers Gold, Newport
- Aroma Hops:
    - Low alpha acid / bitterness (4 - 5 % AA or so), high aroma
    - EKG, Fuggles, Styrian Goldings, Mt. Hood, Liberty

Yeast & Fermentation [Lager vs. Ale] [fruity or phenolic vs. clean]



Conditioning
Degree of carbonation for style [English ales low, many in the middle, Belgian ales & wheat's high]

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Extraction and Maximum Yield (partially an excerpt from a previous session)

--- All of these grains can be used to produce the fermentable sugars that make up the wort. But to brew the same beer recipe consistently, we need to be able to quantify how much yield we can expect from each type of grain. Under laboratory conditions, each grain will yield a typical amount of fermentable and non-fermentable sugars that is referred to as its percent extraction or maximum yield. This number ranges from 50 - 80% by weight, with some wheat malts hitting as high as 85%. This means that 80% (for example) of the malt's weight is soluble in the laboratory mash. (The other 20% represents the husk and insoluble starches.) In the real world, we brewers will never hit this target, but it is useful for comparison.

--- The reference for comparison is pure sugar (sucrose) because it yields 100% of its weight as soluble extract when dissolved in water. (One pound of sugar will yield a specific gravity of 1.046 when dissolved in 1 gallon of water.) To calculate the maximum yield for the malts and other adjuncts, the percent extraction for each is multiplied by the reference number for sucrose-46 points/pound/gallon (ppg).

--- For example, let's look at a typical pilsner base malt. Most light base malts have a maximum yield of 80% by weight of soluble materials. So, if we know that sugar will yield 100% of its weight as soluble sugar and that it raises the gravity of the wort by 46 ppg, then the maximum increase in gravity we can expect from pilsner base malt, at 80% solubility, is 80% of 46 or 37 ppg.

--- The typical maximum yields for the malts are listed in the Table below. You may be wondering how useful the maximum yield number of a malt can be if you can never expect to hit it. The answer is to apply a scaling factor to the maximum yield and derive a number we will usually achieve - a typical yield.

--- The maximum yield is just that, a value you might get if all the mash variables (e.g. pH, temperature, time, viscosity, grind, phase of the moon, etc.) lined up and 100% of the starches where converted to sugars. But most brewers, even commercial brewers, don't get that value in their mashes. Most brewers will approach 80 - 90% of the maximum yield (i.e. 90% of the maximum 80%).

--- This percentage is referred to as a brewer's extract efficiency and the resulting yield is the typical yield from our mash. The extract efficiency is dependent on the mash conditions and the lautering system.

--- For the purposes of our discussion of the typical yields for the various malts and adjuncts, we will assume an extract efficiency of 85%, which is considered to be very good for homebrewers. A few points less yield (i.e. 80 or 75% extraction efficiency), is still considered to be good extraction. A large commercial brewery would see the 10% reduction as significant because they are using thousands of

pounds of grain a day. For a homebrewer, adding 10% more grain per batch to make up for the difference in extraction is a pittance.

Typical Malt Yields in Points/Pound/Gallon

Malt Type	Max. Yield	Max. PPG	Typical PPG (75 - 85%)	PPG Steep
2 Row Lager Malt	80	37	28 - 31	--
6 Row Base Malt	76	35	26 - 30	--
2 Row Pale Ale Malt	81	38	29 - 32	--
Biscuit/Victory Malt	75	35	26 - 30	--
Vienna Malt	75	35	26 - 30	--
Munich Malt	75	35	26 - 30	--
Brown Malt	70	32	24 - 28	8*
Dextrin Malt	70	32	24 - 28	4*
Light Crystal (10 - 15L)	75	35	26 - 30	14*
Pale Crystal (25 - 40L)	74	34	26 - 29	22
Medium Crystal (60 - 75L)	74	34	26 - 29	18
Dark Crystal (120L)	72	33	25 - 28	16
Special B	68	31	23 - 27	16
Chocolate Malt	60	28	21 - 24	15
Roast Barley	55	25	19 - 22	21
Black Patent Malt	55	25	19 - 22	21
Wheat Malt	79	37	28 - 31	--
Rye Malt	63	29	22 - 25	--
Oatmeal (Flaked)	70	32	24 - 28	--
Corn (Flaked)	84	39	29 - 33	--
Barley (Flaked)	70	32	24 - 28	--
Wheat (Flaked)	77	36	27 - 30	--
Rice (Flaked)	82	38	29 - 32	--
Malto - Dextrin Powder	100	40	(40)	(40)
Sugar (Corn, Cane)	100	46	(46)	(46)

Malt % Yield data obtained and averaged from several sources. Steeping data is experimental and was obtained by steeping 1 lb. in 1 gal at 160°F for 30 minutes. All malts were crushed in a 2 roller mill at the same setting.
* The low extraction from steeping is attributed to unconverted, insoluble starches as revealed by an iodine test.

CALCULATION NOTES:
Base Malts are about 28 avg PPG (at 75% eff), so 28 / 5 = 5.6 avg PP'5'G,
so for a 1.045 beer, take 45 / 5.6 = 8 pounds of grain.

Specialty Malts have a little less avg PPG, so figure = 5.0 avg PP'5'G, and they may comprise 10% of the grain bill, so of the 1.045, 10% or 1.005 is from specialty and 1.040 is from base malt.
THUS, 5 / 5 = 1 pound of specialty and 40 / 5.6 = 7 pounds of base malt.

Calculating Grain Bill Needed - Example 1 - Doppelbock:

Step 1) Identify the parameters for this style:

- OG (total range and target OG) = _____ 1.090

- Brewery Efficiency Assumed = _____ % 75%

- Flavor Profile = _____ Malty

- Types of Grains Needed, their PPG and PP'5'G (divide by 5), and Percentages

  = _____ Pils Malt = 28 PPG = 5.6 PP5G

  = _____ Munich Malt = 26 PPG = 5.2 PP5G

  = _____ Vienna Malt = 26 PPG = 5.2 PP5G

Step 2) Calculate Grain Bill:

First, take the target OG and break into percentages of each grain (for the math, just use the decimal part of the OG):

Grain 1 = _____ % = _____ Portion of OG - 20% = 1.018

Grain 2 = _____ % = _____ Portion of OG - 40% = 1.036

Grain 3 = _____ % = _____ Portion of OG - 20% = 1.036

Next, take the Portion of OG from above and divide by the PP'5'G for each grain (again, for the math, just use the decimal part of the OG) :

Grain 1 = _____ Portion of OG / _____ PP'5'G = _____ Pounds - 18 / 5.6 = 3.2 lbs

Grain 2 = _____ Portion of OG / _____ PP'5'G = _____ Pounds - 36 / 5.2 = 6.9 lbs

Grain 3 = _____ Portion of OG / _____ PP'5'G = _____ Pounds - 36 / 5.2 = 6.9 lbs

TOTAL POUNDS = _____ Pounds - 17 lbs

----- OR -----

OG = 1.090, so 9 x 2 = 18 lbs
So at a 20% / 40% / 40% split = 3.6 lbs / 7.2 lbs / 7.2 lbs

Step 3) Don't forget to explain the brewing process, including mashing techniques and temps, boiling time and anything unique to this style. Also, show calculations for hop choices and amounts and details of hop additions. Also, discuss the water profile needed. Lastly, discuss the yeast strain used and why it is the proper choice.

IBU / 3 = AAU ….. AAU / AA% = Ozs
20 IBUs / 3 = 7 AAU ….. 7 AAU / 4.5% AA = 1.5 oz (Hallertau)

Calculating Grain Bill Needed - Example 2 - Dry Stout:

Step 1) Identify the parameters for this style:

- OG (total range and target OG) = _____ 1.045

- Brewery Efficiency Assumed = _____ % 75%

- Flavor Profile = _____ Roasty and Bitter

- Types of Grains Needed, their PPG and PP'5'G (divide by 5), and Percentages

  = _____ Pale Malt = 28 PPG = 5.6 PP5G

  = _____ Roasted Barley = 20 PPG = 4.0 PP5G

  = _____ Flaked Barley = 24 PPG = 4.8 PP5G

Step 2) Calculate Grain Bill:

First, take the target OG and break into percentages of each grain (for the math, just use the decimal part of the OG):

Grain 1 = _____ % = _____ Portion of OG - 90% = 1.041

Grain 2 = _____ % = _____ Portion of OG - 7% = 1.003

Grain 3 = _____ % = _____ Portion of OG - 3% = 1.001

Next, take the Portion of OG from above and divide by the PP'5'G for each grain (again, for the math, just use the decimal part of the OG) :

Grain 1 = _____ Portion of OG / _____ PP'5'G = _____ Pounds - 41 / 5.6 = 7.25 lbs

Grain 2 = _____ Portion of OG / _____ PP'5'G = _____ Pounds - 3 / 4.0 = 0.75 lbs

Grain 3 = _____ Portion of OG / _____ PP'5'G = _____ Pounds - 1 / 4.8 = 0.25 lbs

TOTAL POUNDS = _____ Pounds - 8.25 lbs

----- OR -----

OG = 1.045, so 4.5 x 2 = 9 lbs
So at a 90% / 7% / 3% split = 8 lbs / 0.75 lbs / 0.25 lbs

Step 3) Don't forget to explain the brewing process, including mashing techniques and temps, boiling time and anything unique to this style. Also, show calculations for hop choices and amounts and details of hop additions. Also, discuss the water profile needed. Lastly, discuss the yeast strain used and why it is the proper choice.

IBU / 3 = AAU ….. AAU / AA% = Ozs
40 IBUs / 3 = 13 AAU ….. 13 AAU / 4.5% AA = 2.75 oz (Hallertau or EKG)

Briefly Discuss the Other Possible Recipe Question Styles:

- Belgian Tripel
--- High Gravity
--- Pils and Sugar
--- Styrian Goldings Hops (low)
--- Phenolic (spicy), Fruity Ale Yeast

- Oktoberfest
--- Average Gravity
--- Malt Focused
--- Munich and Vienna Malt
--- Decoction Mash
--- German Hops (low)
--- Clean Lager Yeast

- Classic American Pilsner
--- Average Gravity
--- Pale Malt and Corn
--- German Hops (fairly bitter)
--- Clean Lager Yeast

- American IPA
--- High Gravity
--- Pale Malt
--- American Citrusy Hops (aroma, flavor and bitter)
--- Ale Yeast

- Bohemian Pilsner
--- Average Gravity
--- Pils Malt (original uses under-modified Moravian malt)
--- Decoction Mash (due to under-modified malt and low Ca and Mg water,
plus to get proper full, rounded malt profile)
--- Czech Saaz Hops (some flavor and aroma - fairly bitter - spicy Saaz)
--- Clean Lager Yeast

- Robust Porter
--- Average Gravity
--- Pale, Chocolate and Black Malts
--- Any Hops (can be sweet or bitter)
--- Ale Yeast

- Weizen
--- Average Gravity
--- Pilsner and Malted Wheat
--- Acid Rest (Step mash or Decoction - Need Ferulic acid as a precursor to clove character)
--- German Hops (low)
--- Penolic (clove), Fruity (banana) Ale Yeast

- German Pilsner
--- Average Gravity
--- Pils Malt
--- Light and Dry
--- German Hops (fairly bitter)
--- Clean Lager Yeast

- English Pale Ale
--- Specify ESB (if desired)
--- Slightly Higher Than Average Gravity
--- Pale and Crystal Malts
--- English Hops (fairly bitter)
--- Characterful, Fruity, Ale Yeast

Continued presentation from John Palmer's book…

To help get your creative juices flowing, here is a rough approximation of the recipes for the common ale styles:
> Pale Ale - base malt plus a half pound of caramel malt,
> Amber Ale - pale ale plus a half pound of dark caramel malt,
> Brown Ale - pale ale plus a half pound of chocolate malt
> Porter - amber ale plus a half pound of chocolate malt,
> Stout - porter plus a half pound of roast barley.

Yes, those recipes are pretty crude, but I want you to realize how little effort it takes to produce a different beer. When adding a new malt to a recipe, start out with a half pound or less for a five gallon batch. Brew the recipe and then adjust up or down depending on your tastes. Try commercial beers in each of the styles and use the recipes and guidelines in this book to develop a feel for the flavors the different ingredients contribute.

Read recipes listed in brewing magazines, even if they are all-grain and you are not a grain brewer. By reading an all-grain recipe and the descriptions of the malts they are using, you will gain a feel for what that beer would taste like. Use the principles given in Chapter 12 to duplicate the recipe using extract and the specialty grains in the recipe. You may need to use a partial mash for some recipes.

Look at yeast strain information and determine what flavors different strains would give to the recipe. Use the calculations in Chapters 5 and 12 to estimate the IBUs and the gravity of the beer. Plan a final gravity for the beer and decide what factors you would use to achieve it, i.e., extract brand, mash schedule, yeast strain, fermentation temperature, etc. You as the brewer have almost infinite control over the end result. Don't be afraid to experiment.

References

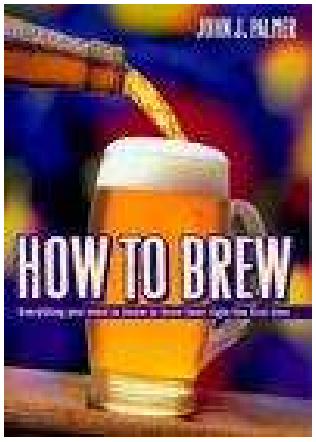
Mosher, R., *The Brewers Companion*, Alephenalia Publishing, Seattle Washington, 1995.
Chapter 21 - Is My Beer Ruined?
Papazian, C., *The Homebrewers Companion*, Brewers Publications, Boulder Colorado, 1994.
Gold, Elizabeth, ed. *Evaluating Beer*, Brewers Publications, Boulder Colorado, 1993.

> Technical Topic 2

- Packaging (bottling and kegging) and conditioning.

Packaging (bottling and kegging) and Conditioning

Compiled Ron Smith



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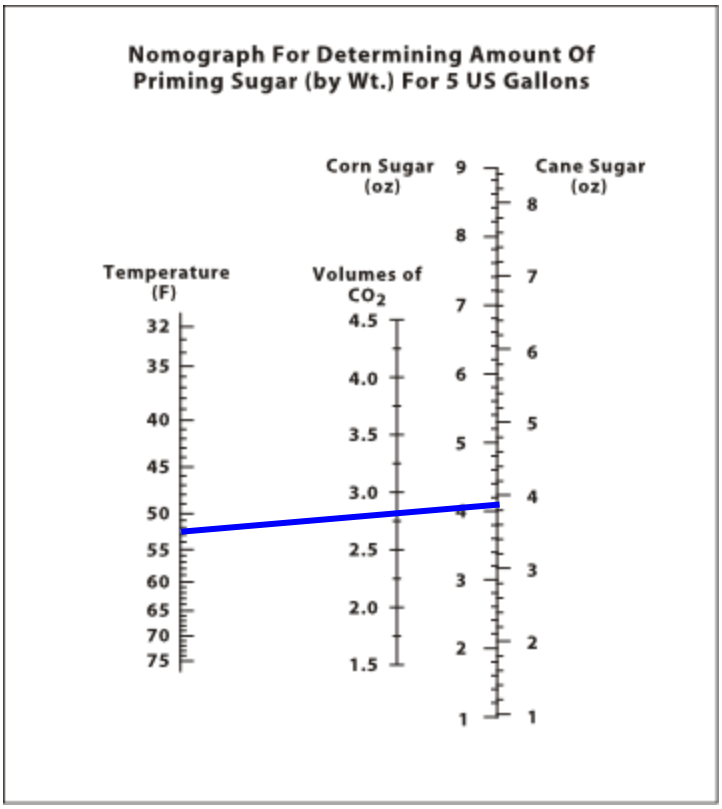
When to Bottle

Ales are usually ready to bottle in 2-3 weeks when fermentation has completely finished. There should be few, if any, bubbles coming through the airlock. Although 2-3 weeks may seem like a long time to wait, the flavor won't improve by bottling any earlier. Some books recommend bottling after the bubbling stops or in about 1 week; this is usually bad advice. It is not uncommon for fermentation to stop after 3-4 days and begin again a few days later due to a temperature change. If the beer is bottled before fermentation is complete, the beer will become over-carbonated and the pressure may exceed the bottle strength. Exploding bottles are a disaster (and messy to boot).

What Sugar Should I Prime With?

You can prime your beer with any fermentable that you want. Any sugar: white cane sugar, brown sugar, honey, molasses, even maple syrup can be used for priming. The darker sugars can contribute a subtle aftertaste (sometimes desired) and are more appropriate for heavier, darker beers. Simple sugars, like corn or cane sugar, are used most often though many brewers use dry malt extract too. Ounce for ounce, cane sugar generates a bit more carbon dioxide than corn sugar, and both pure sugars carbonate more than malt extract, so you will need to take that into account. Honey is difficult to prime with because there is no standard for concentration. The gravity of honey is different jar to jar. To use honey, you will need to dilute it and measure its gravity with a hydrometer. For all sugars in general, you want to add 2-3 gravity points per gallon of beer to prime.



Be aware that malt extract will generate break material when boiled, and that the fermentation of malt extract for priming purposes will often generate a krausen/protein ring around the waterline in the bottle, just like it does in your fermenter. Simple sugars don't have this cosmetic problem and the small amount used for priming will not affect the flavor of the beer.

Priming Solutions
The best way to prime your beer is to mix your priming sugar into the whole batch prior to bottling. This ensures that all the bottles will be carbonated the same. Some books recommend adding 1 tsp. of sugar directly to the bottle for priming. This is not a good idea because it is time consuming and imprecise. Bottles may carbonate unevenly and explode. Plus there is a greater risk of infection because the sugar has not been boiled. The exception to these rules is to use PrimeTabs'. (More on this product in a minute.)

Here's how to make and add priming solutions:
1. Boil 3/4 cup of corn sugar (4 oz by weight), or 2/3 cup of white sugar, or 1 and 1/4 cup dry malt extract in 2 cups of water and let it cool. Use the nomograph to determine a more precise amount of priming sugar if you wish.

You can add the priming solution in either of two ways, depending on your equipment;
I prefer the first (2a).

2a. If you have a bottling bucket gently pour the priming solution into it. Using a sanitized siphon, transfer the beer into the sanitized bottling bucket. Place the outlet beneath the surface of the priming solution. Do not allow the beer to splash because you don't want to add oxygen to your beer at this point. Keep the intake end of the racking tube an inch off the bottom of the fermenter to leave the yeast and sediment behind.

2b. If you don't have a bottling bucket, open the fermenter and gently pour the priming solution into the beer. Stir the beer gently with a sanitized spoon, trying to mix it in evenly while being careful not to stir up the sediment too much. Wait a half hour for the sediment to settle back down and to allow more diffusion of the priming solution to take place. Use a bottle filler attachment with the siphon to make the filling easier.

Nomograph for determining more precise amounts of priming sugar. To use the nomograph, draw a line from the temperature of your beer through the Volumes of CO2 that you want, to the scale for sugar. The intersection of your line and the sugar scale gives the weight of either corn or cane sugar in ounces to be added to five gallons of beer to achieve the desired carbonation level. Here is a list of typical volumes of CO2 for various beer styles:

British ales = 1.5 - 2.0
Porter, Stout = 1.7 - 2.3
Belgian ales = 1.9 - 2.4
American ales = 2.2 - 2.7
European lagers = 2.2 - 2.7
Belgian Lambic = 2.4 - 2.8
American wheat = 2.7 - 3.3
German wheat = 3.3 - 4.5

Using PrimeTabs
PrimeTabs (manufactured by Venezia & Company) are high quality, sanitized tablets of corn sugar that you can add directly to your bottles. There is no mixing or boiling required. The tablets are sized such that you can adjust the level of carbonation in your bottles depending on the style and your tastes. For a low carbonation level, typical of a British draught ale, use 2 PrimeTabs per 12 oz. bottle. Use 3 for a more average carbonation level and use 4-5 for a higher carbonation level like that of American lagers. PrimeTabs are sold in packages of 250 tablets, suitable for priming an entire 5 gallon batch. By using PrimeTabs, you can eliminate one siphoning step (from the fermenter to the bottling bucket) and reduce the risk of oxidation.

Bottling
Age the capped bottles at room temperature for two weeks, out of the light. Aging up to two months can improve the flavor considerably, but one week will often do the job of carbonation for the impatient, it depends on the type and viability of the yeast.

Priming and Bottling Lager Beer
Ninety five percent of the time there is no difference between priming for lager beer and priming ale. But once in a while you will need to add fresh yeast for priming and carbonation purposes. This is most common when the beer is given a long cold lagering for more than two months. If the beer is very clear at bottling time, then the majority of the yeast may have settled out and there may not be enough left to carbonate the beer in the bottle. Prepare some fresh yeast of the same strain and mix it with the priming solution when you rack the beer to the bottling bucket. You will not need as much as you originally pitched to the wort, only about 1/4 - 1/2 cup of slurry for 5 gallons.

Since the yeast is being added for carbonation during the storage phase of the beer, there are a couple of differences in procedure from that used to ferment the original wort. Grow the yeast at the temperature you will be carbonating and storing the beer at (usually room temperature) instead of the original pitching temperature. This will produce more esters than the yeast normally would, but the percentage of sugar that is being fermented for carbonation at this stage is so small that the added difference in taste is unnoticeable. The reason for doing it this way is to avoid thermally shocking the yeast and to speed up the carbonation time. It is not necessary to store the beer cold after lagering. The beer can be stored at room temperature without affecting the taste of the beer.

Storage
Two common questions are, "How long will a homebrewed beer keep?" and "Will it spoil?" The answer is that homebrewed beer has a fairly long storage life. Depending on the style and original gravity, the beer will keep for more than a year. I occasionally come across a year-old six pack of pale ale that I had forgotten about and it tastes great! Of course, there are other cases when that year-old six pack has gotten very oxidized in that time, tasting of cardboard or cooking sherry. It really depends on how careful you were with the bottling - Quality in, Quality out.

When cooled prior to serving, some batches will exhibit chill haze. It is caused by proteins left over from those taken out by the cold break. The proteins responsible for chill haze need to be thermally shocked into precipitating out of the wort. Slow cooling will not affect them. When a beer is chilled for drinking, these proteins partially precipitate forming a haze. As the beer warms up, the proteins re-dissolve. Chill haze is usually regarded as a cosmetic problem. You cannot taste it. However, chill haze indicates that there is an appreciable level of cold-break-type protein in the beer, which has been linked to long-term stability problems. Hazy beer tends to become stale sooner than non-hazy beer.

Finally, it is important to keep the beer out of direct sunlight, especially if you use clear or green bottles. Exposure to sunlight or fluorescent light will cause beer to develop a skunky character. It is the result of a photo-chemical reaction with hop compounds and sulfur compounds. Contrary to popular belief, this is not a character that Heineken, Grolsch, and Molson strive for in their beer. It is simply a result of poor handling by retailers, and storing them under fluorescent lighting. Other beers like Miller High Life™ don't boil hops with the wort but instead use a specially processed hop extract for bittering which lacks the compounds that cause skunking (and flavor). Brown bottles are best unless you make a point of keeping your beer in the dark.

References
Miller, D., *The Complete Handbook of Home Brewing*, Storey Publishing, Pownal, Vermont, 1988. - Noonen, G., *New Brewing Lager Beer*, Brewers Publications, Boulder Colorado, 1996. - Draper, D., personal communication, February, 1996. - Fix, G., Fix, L., *An Analysis of Brewing Techniques*, Brewers Publications, Boulder Colorado, 1997.

Bottling Issues:

Symptom: It won't carbonate.
Causes: Need More Time Time, temperature and yeast strain all combine to form a government committee with the charter to determine a range of times when they can expect to be 90% finished with the Carbonation/Residual Attenuation Project. This committee works best without distractions-- the meetings should be held in quiet, low light areas in a warm room. If the committee was given enough budget (priming sugar), then they should arrive at a consensus in about 2 weeks. If they don't get their act together within a month, then its time to rattle their cages and shake things up a bit.
Cure: The yeast may have settled out prematurely and the bottles need to be shaken to get the yeast back into suspension. Likewise if the temperature is too cool in the room, moving the bottles to a warmer room may do the trick.

Symptom: The bottles are overcarbonated.
Cause 1: Too much sugar You used too much priming sugar
Cure: Vent and re-cap all of the bottles.
Cause 2: Bottled too soon You bottled before fermentation was complete.
Cure: Vent and re-cap all of the bottles.
Cause 3: Wild yeast A gusher bug has gotten into the beer. Gusher bugs and wild yeasts are a real problem as they will keep on fermenting the beer until there is nothing left but fizzy bitter alcoholic water. The real danger with overcarbonation is exploding bottles. Bottle grenades can be very dangerous both from flying glass and from glass slivers left in the carpet.
Cures: Refrigerate the bottles and drink them while there is still some flavor left.
I recall one story I read on the Internet rec.crafts.brewing newsgroup where a brewer recounted how both he and his partner each added 3/4 cup of priming sugar to the batch, thinking that the other one had not. By venting and recapping all the remaining bottles after the initial explosions, they thought they had saved the batch. Then a massive cold front swept through and the corresponding drop in barometric pressure caused the rest of the bottles to explode. Be careful!

> Off Flavors / Problems / Other Flavors

- Chocolate Malt (cocoa / bakers chocolate)
- Black Patent Malt (burnt / charred)
- Roast Barley (coffee-like)

- Cloudiness
- Phenolic (clove-like) (taste in Hefewweizens)
- Phenolic (spicey, peppery) (taste in Belgians)
- Musty
- Moldy
- Sour / Acidic (lactic AND acetic / vinegar) (taste in Berliner Weiss, Flanders Red and Lambics)
- Butyric (vomit-like)
- Isovaleric
- Infection (lactic sour and buttery)

- Dark Malts / Grains

- For this discussion, we focused on the 3 malts / grains that the dark beer styles use. Each person received a few kernels of chocolate malt, black malt, and roasted barley, and tasted each one and discussed it. The purpose was to identify the…
    - Chocolate / Cocoa flavor of Chocolate Malt
    - Charcoal / Burnt flavor of Black Malt
    - Coffee flavor of Roasted Barley.

We then discussed how each of these flavors are important to the porters and stouts we tasted. Repeated below are the summaries of these grains as they were discussed in a prior session.

--- **Chocolate Malt** 400L Used in small amounts for brown ale and extensively in porters and stouts, this malt has a bittersweet chocolate flavor, pleasant roast character and contributes a deep ruby black color.

--- **Black Patent Malt** 580L This is the blackest of the black. It must be used sparingly, generally less than a half pound per 5 gallons. It contributes a roasted charcoal flavor that can actually be quite unpleasant if used in excess. It is useful for contributing color and/or setting a "limit" on the sweetness of other beer styles using a lot of caramel malt; one or two ounces is useful for this purpose.

--- **Roast Barley** 550L This is not actually a malt, but highly roasted plain barley. It has a dry, distinct coffee taste and is the signature flavor of Stouts. It has less of a charcoal "bite" to it than does Black Patent.

- Cloudiness

HowToBrew: Chill haze is the number one cause of cloudy homebrew. It is caused by an insufficient cold break during cooling after the boil. Use a wort chiller. If you made an all-grain beer and had incomplete conversion, or added/steeped a malt that needed to be mashed to an extract batch, then you can have residual starches in the beer that will also cause cloudiness. Watch the mash temperature and mash longer next time. Yeast strains that have low flocculation, such as German Hefeweizen, will also cause the beer to be cloudy. Use a different yeast strain if you want a clearer beer. In all cases, cloudiness can be combated by adding fining agents (e.g. isinglass, gelatin, Polyclar, bentonite) after fermentation. When all-grain brewing, the clarity can be enhanced by adding Irish Moss towards the end of the boil.

- Phenolic (clove-like)

Another type of phenolic flavor. This is desirable in wheat beers. It is derived from the yeast strain used.

- Phenolic (spicey, peppery)

See previous discussions on this topic.

- Musty

BJCP: This is a stale aroma and taste associated with the oxidation of malt compounds in the melanoidin family. This oxidation can occur in the mash or boil via hot side aeration or by exposure to air when racking or bottling. The responsible compounds may be later transformed to their reduced state by oxidizing alcohols into aldehydes. Musty flavors are generally not desirable, but may be found in some cellared beer styles such as biere de garde.

- Moldy

HowToBrew: Molds are quickly recognized by their smell and taste. Black bread molds and mildew can grow in both wort and beer. Contamination is likely if the wort or beer is exposed to musty or damp areas during fermentation. If the infection is caught early enough, it can often be removed by skimming

or cleaning of the surface before it significantly contaminates the batch. Chances are though that the spores have contaminated the batch and it could crop up again.

- Sour / Acidic (lactic AND acetic)
This is usually perceived as a taste on the sides of the tongue, towards the rear of the mouth. The two most common acids responsible for this flavor are lactic and acetic, which both have related esters that may be perceived in the aroma. Lactic acid is produced by Gram positive bacteria such as *Lactobacillus* and *Pediococcus*, which are present in dust and saliva. Acetic acid may be produced by several contaminants, including *Acetobacter*, *Zymomonas*, and yeast in the *Kloeckera* and *Brettanomyces* families. High levels of sour and acidic flavors generally indicate a sanitation problem, but they are an important part of the profile of the lambic, oud bruin and Berliner weiss styles, and to a lesser extent, Belgian white beers.

- Butryic
Rancid Butter / Putrid (also described as vomit-like). From bacterial contamination.

- Isovaleric
Cheesy / Old Hops / Sweaty Socks. From old, degraded hops.

- Infection
Sour and Buttery. A common infection from Bacterial Contamination

HowToBrew: Symptom: It smells like vinegar.
Cause 1: Bacteria In this case, it probably is. Aceto bacteria (vinegar producing) and Lacto bacteria (lactic acid producing) are common contaminates in breweries. Sometimes the infection will produce sweet smells like malt vinegar, other times they will produce cidery smells. It will depend on which bug is living in your wort. Aceto bacteria often produce ropy strands of jelly which can be a good visual indicator, as can excessive cloudiness, after several weeks in the fermentor (although some cloudiness is not unusual, especially in all-grain beers).
Cure: If you don't like the taste, then pour it out. Lactic infections are desired in some beer styles.
Cause 2: Wild Yeast/Bacteria Two other bugs are also common, Brettanomyces and Pediococcus. Brettanomyces is supposed to smell like horse sweat or a horse blanket. Raise your hand if you know what a horse smells like. From sweat, I mean. Anyone? I think Brettanomyces smells like leather, myself. Pediococcus can produce diacetyl and acidic aromas and flavors. One man's garbage can be another man's gold though. These two cultures and Lacto bacteria are actually essential to the Belgian Lambic beer styles. Under other circumstances and styles, beers that taste like Lambics would be discarded instead of being carefully nurtured and blended over a two year period. Lambic beers have a pronounced tartness with fruity overtones. This type of beer is very refreshing and is excellent with heavy food.
Cure: Be meticulous in your sanitation or investigate Lambic brewing.

FLAVORS & OFF-FLAVORS REVIEW: - Review

- DMS - Dimethyl Sulfide - Cooked corn or vegetables
- Produced during he boil, but evaporates off with the lid off
- Also scrubbed out during vigorous fermentation (ales)
- Some pils malt can also produce at low levels
- Slow cooling of wort may allow to dissolve back in

- Vegetal - More intense level of DMS - More like rotten vegetables
- Usually from bacterial contamination

- Oxidized - Stale, papery, cardboard flavor
- From O2 being introduced into the hot wort (hot side aeration) or during or after fermentation (cold side aeration)
- Both typically from mishandling, splashing, etc.
- Old beer will also become oxidized just from the O2 remaining in the bottle

- Sherry-Like - The smell and taste of sherry
- Occurs when high gravity beers get old and oxidize
- The oxidized melanoidins create a sherry-like or almond-like flavor
- This can be positive in barleywines, old ales, etc.

- Skunky - Smells like a skunk
- Occurs when UV rays meet the hop components remaining in the beer
- A variant on sulfury and some people confuse the two
- Common aroma and flavor in green bottle imports

- Sulfury - The smell of burning matches, old rubber, innertube air, or rotten eggs
- Produced by lager yeasts, but it should dissipate with proper conditioning time
- Autolysized yeast (old end of life yeast that is eating itself) can also create this
- May also be from bacterial contamination

- Yeasty - The smell and taste of yeast
- If used too much yeast or yeast didn't flocculate and settle out
- Can also be produced by autolysis

- Phenolic (Medicinal) - Band Aids, Chloraseptic, disinfectants, Listerine, etc.
- Almost always from bacterial contamination or wild yeast
- Can also be extracted from grain husks by over-crushing, over-sparging, or sparging with hot alkaline water

- Phenolic (Chlorophenols) - Chlorine-like
- Usually from not rinsing sanitizer residue or from highly chlorinated water
- Could also be from Chloramines, which are new to many water sources and are not removed as easily as chlorine - Requires Campden tablets

- Phenolic (Clove) - The smell and taste of cloves
- Produced from certain strains of yeast for German Weizens, where it is appropriate

- Phenolic (Spicy / Peppery) - The smell and taste of peppery spices
- Produced from certain strains of yeast for various Belgian styles, where it is appropriate

- Acetaldehyde - Green apple-like
- This compound is normally reduced to ethanol during secondary fermentation, but oxidation of the finished beer may reverse this process and re-create it
- Also, green or young beer that hasn't been given time to finish ("ripen" - my memorization helper term), where this compound would be removed naturally

- Diacetyl - Buttery or butterscotch like
- Produced during fermentation, but typically absorbed by the yeast if the beer is allowed to complete its fermentation process - If prematurely separated from the yeast, it will remain in the beer
- A diacetyl rest at the end of fermentation can help remove this (by increasing the ferm temp to speed up the absorption process)
- Can also be caused by bacterial contamination

- Esters / Fruity - Bananas, strawberries, pears, apples, plums, etc.
- Produced by Ale yeasts - Higher fermentation temps produce more esters
- Strong banana esters are produced by German Weizen yeasts
- Esters can have solventy notes at high levels

- Solventy - High fusel alcohols, acetone, laquer thinner, turpentine, etc.
- Harsher flavors than regular ethanol - Fusel alcohols and ethyl acetate can be produced by:
  - Underpitching
  - Low levels of dissolved oxygen prior to pitching or low levels of free available nitrogen /FAN (these deficiencies force the yeast to metabolize fatty acids in the trub as a source of oxygen and carbon, producing a greater fraction of long chain alcohols)
  - Excessive amounts of yeast (through increased yeast activity)
  - High gravity worts (through increased yeast activity)
  - Fermentation temps too high (above 80 F more fusels are created)
  - When the yeast sits too long on the trub (this is one reason to move the beer off of the hot and cold break when the beer is going to be spending a lot of time in the fermentor)
- Also, the solvents in some plastics like PVC can be leached by high temperatures.
- Contamination by wild yeast may produce elevated levels of both esters and fusel alcohols

- Astringent - This is a mouthfeel, not a flavor - Mouth-puckering, like chewing on a grape skin
- Often caused by the extraction of tannins from the grain husks due to over-crushing, over-sparging, boiling the grains, long mashes, or sparging with water that is too hot (boiling)
- Could also be from bacterial contamination or oxidation
- Over attenuation or low dextrin levels increase the perception of astringency

- Sour - Detected on the back sides of the tongue - A sour taste and sensation
- From lactic acid (lactobacillus bacteria) and/or acetic acid (pediococcus bacteria)
- Desired in sour ales, but typically a sanitation problem

- Metallic - Tinny, blood-like, like sucking on a coin
- Usually caused by unprotected metals dissolving into the wort (highly alkaline water with aluminum pots, cracks in ceramic coated pots, etc.)
- Can also be from improperly stored malts (from hydrolysis of lipids in those malts)

- Husky / Grainy - A grainy, cereal-like flavor
- Associated with astringency, with the same causes, etc.

- Grassy - Like freshly cut grass or grass leaves
- From poorly stored malt that picks up moisture and forms aldehydes
- Can be produced from hops as well if poorly stored or not properly dried
- Some hops used in large quantities, but shouldn't be a significant part of the beer's flavor

- Musty - A basement, musty character
- Oxidation of malt compounds, especially melanoidins (see Sherry-like)

- Poor Head Retention - It should take a beer 1 minute to lose half its head height
- Get good head retention from:
  - Proper hop isomerization
  - Dextrins and proteins in the beer
  - Proper carbonation level

- Use of adjuncts like flaked barley or wheat improve head retention
- Poor head retention can be caused by a lack of the above and/or by the fatty acids from the trub (hot break material)

- Light Body - Body is produced by the level of dextrins and proteins
- The lack of dextrins and proteins could be due to:
  - Recipe formulation
  - Highly attenuative yeast
  - Excessive use of adjuncts
  - Highly fermentable sugars
  - Mash temp too low, creating more fermentable sugars (hot body)

- Cloudiness - Normally due to chill haze, which is due to an insufficient cold break during cooling of the wort
  - Also, incomplete starch conversion during the mash due to temp or time
  - Low flocculating yeast and/or no fining agents used

>Beer Styles

12. Porter

12A. Brown Porter
- Fuller's London Porter

12B. Robust Porter
- Sierra Nevada Porter

12C. Baltic Porter
- Baltika Porter (# 6)

13. Stout

13A. Dry Stout
- Beamish Stout

13B. Sweet Stout
- Left Hand Milk Stout

13C. Oatmeal Stout
- Young's Oatmeal Stout

13D. Foreign Extra Stout
- Export: Guinness Foreign

13E. American Stout
- Mad River Steelhead Stout

13F. Russian Imperial Stout
- Thirsty Dog Siberian Night

14. India Pale Ale

14A. English IPA
- Samuel Smith's India Ale - AND - Goose Island IPA

14B. American IPA
- Bell's Two Hearted Ale

14C. Imperial IPA
- Bell's Hop Slam - AND -
- Avery Maharaja

19. Strong Ale

19A. Old Ale

19B. English Barleywine
- Thomas Hardy's Ale

19C. American Barleywine
- Sierra Nevada Bigfoot

22. Smoke-Flavored and Wood-Aged Beer

22A. Classic Rauchbier
- Schlenkerla Marzen Rauchbier

> HOMEWORK - Old Sample Exam Questions (complete on your own) - Review

S20. Describe and differentiate the tastes and aromas of Anchor Steam, Newcastle Brown, Dos Equis and Spaten Oktoberfest.

T2. Explain how the brewer gets the following characteristics in his/her beer:
a) good head retention
b) appropriate body/mouthfeel for style
c) appropriate clarity for style

T17. Describe and explain two different major enzymatic reactions in brewing.

T20. Provide a complete five gallon ALL-GRAIN recipe for an Oktoberfest listing ingredients and procedure. Give original and final gravities. Explain why the recipe fits the style.

T21. Provide a complete five gallon ALL-Grain recipe for a Czech Pilsner listing ingredients and procedure. Give original and final gravities. Explain why the recipe fits the style.

- ONE OF THESE LAGER RECIPE QUESTIONS ARE TYPICALLY ON THE EXAM !!!

S4. Identify, describe and differentiate all top fermenting beer styles with original gravities greater than 1.070. Give commercial examples of each style.

S17. Describe and differentiate the taste and aroma characteristics of the following beer styles. Give commercial examples of each style.
a) Porter b) Biere de Garde c) American Brown

S21. Identify, describe and give commercial examples of a major beer style associated with (three will be given):
a) Dusseldorf b) Berlin c) Einbeck
d) Cologne e) Edinburgh f) Bamberg
g) Burton-on-Trent h) Newcastle i) The Senne Valley
j) Dublin k) San Francisco l) Vienna

- THIS QUESTION IS ALWAYS ON THE EXAM !!!

S1. Explain the lambic style and describe each of the following: Faro, Framboise, Gueuze, and Kriek.

S9. Identify and describe all ale styles traditionally brewed in Germany.

S11. Describe and differentiate all distinct Belgian beer styles and give commercial examples of each style.

S16. Describe, differentiate and compare the taste and aroma characteristics of the following beer styles. Give commercial examples of each style:
a) Kolsch b) Cream Ale c) Munich Helles

S7. Describe and differentiate all distinctly different beer styles using wheat as a primary ingredient. Note that color and strength differences don't count as distinct styles. Give commercial examples of each style.

- ??? NOT CERTAIN, BUT THIS QUESTION IS POSSIBLY TYPICALLY ALWAYS ON THE EXAM ??? !!!

T1. Describe and discuss the following beer characteristics. How are they perceived? What causes them and how are they avoided and controlled? Are they ever appropriate and if so, in what styles? (three will be given)
a) cloudiness b) buttery/butterscotch c) poor head retention
d) mouthpuckering e) band-aid-like f) light body
g) fruitiness h) sour or acidic i) cooked corn
j) astringent k) cardboard l) sherry-like

END OF SESSION 4