Note that the three questions below are representative of the type of essays that may appear on the Master Cicerone written exam. The exam includes a total of sixteen essays that will differ from those listed here. While we have no specific expectations on the length of a response to each essay question, candidates should provide detailed answers that fully address the prompt.

1. Carbonate, calcium, and chlorine are generally the most important factors that brewers must take into account when assessing their water supply. For each of these compounds found in water:
    a. Identify its impact, flavor or otherwise, on beer or the brewing process.
    b. Explain how a brewer might go about adjusting the amount found in his or her water.

2. Use commercial examples to discuss the full scope of the **Saison** style ranging from the classic Belgian commercial examples to modern and regional interpretations. Discuss the variations in ingredients/recipe that occur and what effect they have on the flavor of the finished beer. Give commercial examples to illustrate your discussion, naming the brewery and the beer in each case. Give examples brewed in Europe as well as examples brewed in other parts of the world, citing **at least six producers from at least three countries**.

3. A local restaurant is building a new bar and wants your help designing the draft system. The keg cooler will be located below the actual bar and the distance from the edge of the cooler to the faucet will be 9 feet (2.7 meters), although the total length of run (including the jumper hose and stainless steel faucet leads) from any coupler to any faucet will be at least 25 feet (7.6 meters). There are 14 feet (4.3 meters) of vertical lift from the bottom of a keg to the height of the faucet.

    a. The owners believe they can use an air-cooled conduit to carry the draft lines from the cooler to the draft tower. Do you believe this would be acceptable?

    b. Using line resistances shown on the attached page, balance a system to deliver properly carbonated beer with a flow rate of approximately 2 ounces (60 ml) per second at the faucet in this setting. Specify the operating temperature and pressure for the system as well as any other important assumptions or details. Avoid the use of mixed gas if possible. Assume that:

        All beers will be carbonated to 2.6 volumes (5.1 g/L) of CO_2.
        Each run will include 5 feet (1.5 meters) of 3/8” ID vinyl jumper hose
        The last 3.3 feet (1 meter) of line before each faucet will be 5/16” OD stainless steel.

    c. Please explain whether it might be financially attractive to include a FOB on each line in this system, assuming that one FOB costs $100 and that beer costs $0.05 per ounce. Assume that each line will have four keg changes per week.

Draught Beer Tubing Specifications

Type	Size	Restriction	Volume
Vinyl	3/16" ID	3.00 lbs/ft	1/6 oz/ft
Vinyl	1/4" ID	0.85 lbs/ft	1/3 oz/ft
Vinyl	5/16" ID	0.40 lbs/ft	1/2 oz/ft
Vinyl	3/8" ID	0.20 lbs/ft	3/4 oz/ft
Vinyl	1/2" ID	0.025 lbs/ft	1.33 oz/ft
Barrier	1/4" ID	0.30 lbs/ft	1/3 oz/ft
Stainless	1/4" OD	1.20 lbs/ft	1/6 oz/ft
Stainless	5/16" OD	0.30 lbs/ft	1/3 oz/ft
Stainless	3/8" OD	0.12 lbs/ft	1/2 oz/ft

Assume that the resistance for all other items is zero.

Volumes of CO_2 in beer at specific temperatures and CO_2 pressures

PSIG =>	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25.0	26.0	27.0	28.0	29.0	30.0
Deg F \/	The values below are volumes of CO2.																													
30°F	1.8	1.9	2.0	2.1	2.2	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.7	4.8	4.9	5.0	5.0
31°F	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.7	2.8	2.9	3.0	3.1	3.2	2.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.3	4.4	4.5	4.6	4.7	4.8	4.9
32°F	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.2	4.3	4.4	4.5	4.6	4.7	4.8
33°F	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7
34°F	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6
35°F	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5
36°F	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4
37°F	1.6	1.7	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.8	3.9	4.0	4.1	4.2	4.3
38°F	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.2
39°F	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2
40°F	1.5	1.6	1.7	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.6	3.7	3.8	3.9	4.0	4.1
41°F	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.0
42°F	1.4	1.5	1.6	1.7	1.8	1.9	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.4	3.5	3.6	3.7	3.8	3.9	4.0
43°F	1.4	1.5	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.7	3.8	3.9
44°F	1.4	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.6	2.7	2.8	2.9	3.0	3.1	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.8
45°F	1.3	1.4	1.5	1.6	1.7	1.8	1.8	1.9	2.0	2.1	2.2	2.3	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.5	3.6	3.7	3.8
46°F	1.3	1.4	1.5	1.5	1.6	1.7	1.8	1.9	2.0	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.2	3.3	3.4	3.5	3.6	3.7	3.7
47°F	1.3	1.3	1.4	1.5	1.6	1.7	1.8	1.8	1.9	2.0	2.1	2.2	2.3	2.3	2.4	2.5	2.6	2.7	2.8	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.4	3.5	3.6	3.7
48°F	1.2	1.3	1.4	1.5	1.6	1.7	1.7	1.8	1.9	2.0	2.1	2.1	2.2	2.3	2.4	2.5	2.5	2.6	2.7	2.8	2.9	3.0	3.0	3.1	3.2	3.3	3.4	3.5	3.5	3.6
49°F	1.2	1.3	1.4	1.5	1.5	1.6	1.7	1.8	1.9	1.9	2.0	2.1	2.2	2.3	2.3	2.4	2.5	2.6	2.7	2.8	2.8	2.9	3.0	3.1	3.2	3.2	3.3	3.4	3.5	3.6