1. The check-in line at Alpha Airlines has two agents who serve all passengers during peak hours. Arrivals to the check-in counter are Poisson with a mean of 50 passengers per hour. Approximately, thirty percent of the arrivals are Priority Class (e.g., First Class, Gold members, etc) while the remainder holds coach tickets. The time that a passenger spends at the ticket check-in counter with an agent is exponentially distributed with a mean of 1.44 minutes. Alpha promises that if a passenger waits in line for more than 5 minutes, a coach passenger will be awarded 500 frequent flyer miles while a Priority Class passenger will be awarded 1000 miles. Currently, all passengers go through the same queue for check-in.
   1. How many total miles are awarded per hour on average currently?
   2. Management is considering the creation of two separate lines, one for each of the two classes of passengers. In this situation, each check-in line will have one agent who will serve their respective passengers; line switching will not be allowed. Find the average total miles awarded hourly under this configuration.
2. The Acme Vending Company services vending machines for a large university on the west coast. Because students kick the machines at every opportunity out of anger and frustration, Acme management has a constant repair problem. According to MBA students who studied the machines as part of their Operations Management course, vending machines on the campus break down on an average of four per hour, and the breakdowns are distributed in a Poisson manner. Downtime costs $45/hour per machine, and each maintenance worker earns $20 per hour. Acme owns one repair truck which can be staffed by one, two, or three workers. One worker can service machines at an average rate of five per hour, distributed exponentially; two workers, working together, can service seven per hour, distributed exponentially; and a team of three workers can service eight per hour. Acme earnings have not been strong in recent times and they cannot afford another repair truck at this time.

What is the optimal maintenance crew for servicing vending machines?

*Hint 1: No matter how many workers there are in a crew, they always work as one unit. Hence, the question is about how big the crew should be, not how many crews to have.*

*Hint 2: To calculate the total “waiting cost” (i.e. cost due to machine downtime), please refer to Examples 5, 6 and 7 in the “example problems and solution” posted on Blackboard alongside this assignment.*

1. *Stanley Cup Café* is a small mom-and-pop store in Seattle. Its store layout and process flow are shown below in Figure 1.

* During peak time, customers arrive to the shop according to a Poisson process with rate of 45 per hour.
* Upon arrival, all customers queue in front of the cashier station. There is only one cashier, who is responsible for answering questions on food or coffee taking orders, serving food, tea, and drip coffee, heating up food orders, and receiving payment. As a result, the service time is highly variable and is assumed to have an exponential distribution. On average, the cashier can process 1.25 customers per minute. After completing transaction at the cashier station, 30% will leave or sit down; 20% will go to the condiments station; and the rest 50% will go to the barista station.
* The arrival of all the people going to the barista station can be modeled as Poisson process again. Due to the variety of drinks (espresso, etc.) and the number of drinks ordered by each customer, the service time at the barista station is again modeled as exponential with an average of 2 minutes. There is only one barista. After completing service at the barista station, 20% will leave or sit down and the rest 80% will go to the condiments station.
* The arrival of all the people going to the condiments station can be modeled as Poisson and the service time is exponential with an average of 20 seconds. The condiments counter is wide enough to accommodate two customers at a time. After getting the condiments, all customers leave or sit down.

Figure 1

Assume that all customers follow the process above (i.e. they don’t go to the condiments first and then barista). Please perform the following analysis. Show all your work.

1. What is the total time spent in the system, from arrival to departure (or sit-down), for an *average* customer?
2. The owner is concerned about the service area being too crowded. Assume that customers in all three areas stand there until service is completed. What is the average total number of customers in all three areas?
3. To reduce congestion in the service area, the owner is considering adding a cashier or a barista during peak time. Which one will achieve a bigger reduction of the total number of people in the service area (as calculated in part b)?