**Module D: Simulation**

**Practice Problems**

**MULTIPLE CHOICE**

Carter’s Clean Car Service specializes in hand-cleaning and hand-waxing cars. The owner plans on using simulation modeling to better understand her operations. She collected data on the interarrival rates of vehicles (in minutes); the time (in minutes) to hand wash cars, trucks, and vans; and the time (in minutes) to hand wax cars, trucks, and vans. The summary of her data is below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Interarrival** | **Probability** | **Wash** | **Probability** | **Wax** | **Probability** |
| 6 | 10% | 3 | 30% | 2 | 40% |
| 7 | 25% | 4 | 60% | 3 | 50% |
| 8 | 35% | 5 | 10% | 4 | 10% |
| 9 | 20% |  |  |  |  |
| 10 | 10% |  |  |  |  |

Use this table of random numbers if/as needed:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |
|  | **A** | **B** | **C** | **D** | **E** | **F** | **G** | **H** |
| 1 | 0.03 | 0.47 | 0.78 | 0.15 | 0.12 | 0.01 | 0.46 | 0.72 |
| 2 | 0.39 | 0.47 | 0.77 | 0.51 | 0.17 | 0.72 | 0.14 | 0.31 |
| 3 | 0.95 | 0.11 | 0.94 | 0.58 | 0.09 | 0.62 | 0.78 | 0.85 |
| 4 | 0.15 | 0.21 | 0.81 | 0.09 | 0.98 | 0.08 | 0.99 | 0.31 |
| 5 | 0.31 | 0.15 | 0.97 | 0.40 | 0.36 | 0.26 | 0.48 | 0.66 |
| 6 | 0.35 | 0.34 | 0.36 | 0.57 | 0.78 | 0.80 | 0.82 | 0.69 |
| 7 | 0.72 | 0.91 | 0.04 | 0.36 | 1.00 | 0.11 | 0.60 | 0.11 |
| 8 | 0.84 | 0.35 | 0.84 | 0.44 | 0.49 | 0.16 | 0.14 | 0.87 |
| 9 | 0.11 | 0.95 | 0.88 | 0.26 | 0.66 | 0.30 | 0.48 | 0.46 |
| 10 | 0.99 | 0.89 | 0.16 | 0.48 | 0.76 | 0.60 | 0.60 | 0.22 |
| 11 | 0.95 | 0.80 | 0.78 | 0.34 | 0.44 | 0.95 | 0.23 | 0.59 |
| 12 | 0.51 | 0.44 | 0.44 | 0.69 | 0.35 | 0.10 | 0.15 | 0.92 |
| 13 | 0.11 | 0.79 | 0.28 | 0.83 | 0.33 | 0.30 | 0.52 | 0.99 |
| 14 | 0.78 | 0.55 | 0.78 | 0.79 | 0.16 | 0.48 | 0.53 | 0.45 |
| 15 | 0.88 | 0.50 | 0.63 | 0.92 | 0.55 | 0.76 | 0.12 | 0.18 |
| 16 | 0.58 | 0.51 | 0.08 | 0.83 | 0.25 | 0.76 | 0.02 | 0.06 |
| 17 | 0.87 | 0.60 | 0.53 | 0.75 | 0.17 | 0.19 | 0.68 | 0.25 |
| 18 | 0.30 | 0.46 | 0.81 | 0.01 | 0.62 | 0.61 | 0.09 | 0.61 |
| 19 | 0.14 | 0.41 | 0.61 | 0.76 | 0.01 | 0.99 | 0.03 | 0.74 |
| 20 | 0.91 | 0.10 | 0.77 | 0.26 | 0.35 | 0.48 | 0.78 | 0.73 |
| 21 | 0.50 | 0.69 | 0.75 | 0.25 | 0.49 | 0.51 | 0.25 | 0.28 |
| 22 | 0.95 | 0.64 | 0.52 | 0.76 | 0.61 | 0.21 | 0.84 | 0.78 |
| 23 | 0.82 | 0.30 | 0.14 | 0.30 | 0.98 | 0.47 | 0.12 | 0.03 |
| 24 | 0.73 | 0.77 | 0.49 | 0.65 | 0.83 | 0.16 | 0.10 | 0.84 |
| 25 | 0.37 | 0.21 | 0.25 | 0.12 | 0.69 | 0.37 | 0.18 | 0.01 |
| 26 | 0.74 | 0.96 | 0.15 | 0.98 | 0.80 | 0.26 | 0.05 | 0.87 |
| 27 | 0.19 | 0.13 | 0.93 | 0.96 | 0.93 | 0.96 | 0.83 | 0.28 |
| 28 | 0.19 | 0.28 | 0.72 | 0.56 | 0.87 | 0.45 | 0.00 | 0.82 |
| 29 | 0.57 | 0.90 | 0.97 | 0.62 | 0.53 | 0.85 | 0.76 | 0.75 |
| 30 | 0.39 | 0.51 | 0.83 | 0.78 | 0.26 | 0.91 | 0.07 | 0.04 |
| 31 | 0.44 | 0.69 | 0.53 | 0.61 | 0.31 | 0.14 | 0.02 | 0.11 |
| 32 | 0.83 | 0.23 | 0.98 | 0.32 | 0.12 | 0.79 | 0.21 | 0.42 |
| 33 | 0.54 | 0.98 | 0.32 | 0.81 | 0.56 | 0.64 | 0.92 | 0.06 |
| 34 | 0.91 | 0.77 | 0.62 | 0.79 | 0.55 | 0.83 | 0.29 | 0.19 |
| 35 | 0.66 | 0.69 | 0.18 | 0.41 | 0.97 | 0.53 | 0.21 | 0.86 |
| 36 | 0.67 | 0.55 | 1.00 | 0.97 | 0.83 | 0.21 | 0.97 | 0.38 |
| 37 | 0.37 | 0.11 | 0.99 | 0.14 | 0.85 | 0.71 | 0.14 | 0.15 |
| 38 | 0.09 | 0.76 | 0.70 | 0.21 | 0.74 | 0.49 | 0.72 | 0.37 |
| 39 | 0.22 | 0.51 | 0.68 | 0.80 | 0.98 | 0.79 | 0.80 | 0.48 |
| 40 | 0.55 | 0.99 | 0.35 | 0.07 | 0.71 | 0.62 | 0.72 | 0.64 |

1. What range of random numbers (2 digits) would correspond with an interarrival time of 6 minutes?

|  |  |
| --- | --- |
| a. | 0.00–0.10 |
| b. | 0.00–0.09 |
| c. | 0.00–0.06 |
| d. | 0.10–0.16 |

ANS: B PTS: 1 DIF: Easy

2. What range of random numbers (2 digits) would correspond with an interarrival time of 8 minutes?

|  |  |
| --- | --- |
| a. | 0.00–0.35 |
| b. | 0.25–0.60 |
| c. | 0.35–0.69 |
| d. | 0.70–0.99 |

ANS: C PTS: 1 DIF: Easy

3. What range of random numbers (2 digits) would correspond with an interarrival time of 10 minutes?

|  |  |
| --- | --- |
| a. | 0.00–0.10 |
| b. | 0.00–0.09 |
| c. | 0.89–0.99 |
| d. | 0.90–0.99 |

ANS: D PTS: 1 DIF: Easy

4. What range of random numbers (2 digits) would correspond with a wash time of 3 minutes?

|  |  |
| --- | --- |
| a. | 0.00–0.29 |
| b. | 0.01–0.29 |
| c. | 0.01–0.39 |
| d. | 0.30–0.39 |

ANS: A PTS: 1 DIF: Easy

5. What range of random numbers (2 digits) would correspond with a wash time of 4 minutes?

|  |  |
| --- | --- |
| a. | 0.00–0.59 |
| b. | 0.30–0.89 |
| c. | 0.30–0.90 |
| d. | 0.30–0.99 |

ANS: B PTS: 1 DIF: Easy

6. What range of random numbers (2 digits) would correspond with a wash time of 5 minutes?

|  |  |
| --- | --- |
| a. | 0.00–0.10 |
| b. | 0.00–0.09 |
| c. | 0.89–0.99 |
| d. | 0.90–0.99 |

ANS: D PTS: 1 DIF: Easy

7. What range of random numbers (2 digits) would correspond with a wax time of 2 minutes?

|  |  |
| --- | --- |
| a. | 0.00–0.39 |
| b. | 0.01–0.39 |
| c. | 0.01–0.40 |
| d. | 0.01–0.41 |

ANS: A PTS: 1 DIF: Easy

8. What range of random numbers (2 digits) would correspond with a wax time of 4 minutes?

|  |  |
| --- | --- |
| a. | 0.00–0.10 |
| b. | 0.00–0.09 |
| c. | 0.89–0.99 |
| d. | 0.90–0.99 |

ANS: D PTS: 1 DIF: Easy

9. Based on the data collected, what would be the expected interarrival time?

|  |  |
| --- | --- |
| a. | 7.23 |
| b. | 7.95 |
| c. | 8.12 |
| d. | 8.35 |

ANS: B PTS: 1 DIF: Medium

10. Based on the data collected, what would be the expected wash time?

|  |  |
| --- | --- |
| a. | 3.5 |
| b. | 3.8 |
| c. | 4.0 |
| d. | 4.2 |

ANS: B PTS: 1 DIF: Medium

11. Based on the data collected, what would be the expected wax time?

|  |  |
| --- | --- |
| a. | 2.3 |
| b. | 2.5 |
| c. | 2.7 |
| d. | 3.3 |

ANS: C PTS: 1 DIF: Medium

12. The owner decided to run a simulation for the interarrival time. She ran it for five vehicles. She used the random number table provided and employed the first five numbers from Column A. What was the average interarrival time for these five simulations?

|  |  |
| --- | --- |
| a. | 6.0 |
| b. | 6.4 |
| c. | 7.2 |
| d. | 7.6 |

ANS: D PTS: 1 DIF: Hard

13. The owner decided to run a simulation for the wash time. She ran it for five vehicles. She used the random number table provided and employed the first five numbers from Column B. What was the average wash time for these five simulations?

|  |  |
| --- | --- |
| a. | 2.8 |
| b. | 3.0 |
| c. | 3.4 |
| d. | 4.0 |

ANS: C PTS: 1 DIF: Hard

14. The owner decided to run a simulation for the wax time. She ran it for five vehicles. She used the random number table provided and employed the first five numbers from Column C. What was the average wax time for these five simulations?

|  |  |
| --- | --- |
| a. | 2.8 |
| b. | 3.0 |
| c. | 3.4 |
| d. | 4.0 |

ANS: C PTS: 1 DIF: Hard

15. She mapped out these five arrivals, washes, and waxings. How long did it take for these five cars to completely go through the system?

|  |  |
| --- | --- |
| a. | 33 |
| b. | 45 |
| c. | 50 |
| d. | 54 |

ANS: B PTS: 1 DIF: Hard

16. How many of these first five cars had to wait for washing to begin?

|  |  |
| --- | --- |
| a. | 0 |
| b. | 1 |
| c. | 2 |
| d. | 4 |

ANS: A PTS: 1 DIF: Hard

Maklin Enterprises produces casings for hydraulic pumps. They produce on order, and therefore, demand for casings is variable. It can range from 100 units per month to 500 units per month. The machines that forge the casings are fairly reliable, but they can breakdown. The rate at which they breakdown is dependent on production volume. If the demand during any month is less than 300 units per month, breakdowns follow a particular distribution, but if demand rises above 300 units per month, the chance of breakdowns rises and follows another distribution. The data are provided below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Demand | Probability | Number of Breakdowns for Demand Less Than 300/Month | Probability | Number of Breakdowns for Demand Greater Than 300/Month | Probability |
| 100 | 10% | 0 | 80% | 0 | 55% |
| 200 | 50% | 1 | 15% | 1 | 25% |
| 300 | 20% | 2 | 5% | 2 | 15% |
| 400 | 15% |  |  | 3 | 5% |
| 500 | 5% |  |  |  |  |

Use this table of random numbers if/as needed:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **A** | **B** | **C** | **D** | **E** | **F** | **G** | **H** |
| 1 | 0.03 | 0.47 | 0.78 | 0.15 | 0.12 | 0.01 | 0.46 | 0.72 |
| 2 | 0.39 | 0.47 | 0.77 | 0.51 | 0.17 | 0.72 | 0.14 | 0.31 |
| 3 | 0.95 | 0.11 | 0.94 | 0.58 | 0.09 | 0.62 | 0.78 | 0.85 |
| 4 | 0.15 | 0.21 | 0.81 | 0.09 | 0.98 | 0.08 | 0.99 | 0.31 |
| 5 | 0.31 | 0.15 | 0.97 | 0.40 | 0.36 | 0.26 | 0.48 | 0.66 |
| 6 | 0.35 | 0.34 | 0.36 | 0.57 | 0.78 | 0.80 | 0.82 | 0.69 |
| 7 | 0.72 | 0.91 | 0.04 | 0.36 | 1.00 | 0.11 | 0.60 | 0.11 |
| 8 | 0.84 | 0.35 | 0.84 | 0.44 | 0.49 | 0.16 | 0.14 | 0.87 |
| 9 | 0.11 | 0.95 | 0.88 | 0.26 | 0.66 | 0.30 | 0.48 | 0.46 |
| 10 | 0.99 | 0.89 | 0.16 | 0.48 | 0.76 | 0.60 | 0.60 | 0.22 |
| 11 | 0.95 | 0.80 | 0.78 | 0.34 | 0.44 | 0.95 | 0.23 | 0.59 |
| 12 | 0.51 | 0.44 | 0.44 | 0.69 | 0.35 | 0.10 | 0.15 | 0.92 |
| 13 | 0.11 | 0.79 | 0.28 | 0.83 | 0.33 | 0.30 | 0.52 | 0.99 |
| 14 | 0.78 | 0.55 | 0.78 | 0.79 | 0.16 | 0.48 | 0.53 | 0.45 |
| 15 | 0.88 | 0.50 | 0.63 | 0.92 | 0.55 | 0.76 | 0.12 | 0.18 |
| 16 | 0.58 | 0.51 | 0.08 | 0.83 | 0.25 | 0.76 | 0.02 | 0.06 |
| 17 | 0.87 | 0.60 | 0.53 | 0.75 | 0.17 | 0.19 | 0.68 | 0.25 |
| 18 | 0.30 | 0.46 | 0.81 | 0.01 | 0.62 | 0.61 | 0.09 | 0.61 |
| 19 | 0.14 | 0.41 | 0.61 | 0.76 | 0.01 | 0.99 | 0.03 | 0.74 |
| 20 | 0.91 | 0.10 | 0.77 | 0.26 | 0.35 | 0.48 | 0.78 | 0.73 |
| 21 | 0.50 | 0.69 | 0.75 | 0.25 | 0.49 | 0.51 | 0.25 | 0.28 |
| 22 | 0.95 | 0.64 | 0.52 | 0.76 | 0.61 | 0.21 | 0.84 | 0.78 |
| 23 | 0.82 | 0.30 | 0.14 | 0.30 | 0.98 | 0.47 | 0.12 | 0.03 |
| 24 | 0.73 | 0.77 | 0.49 | 0.65 | 0.83 | 0.16 | 0.10 | 0.84 |
| 25 | 0.37 | 0.21 | 0.25 | 0.12 | 0.69 | 0.37 | 0.18 | 0.01 |
| 26 | 0.74 | 0.96 | 0.15 | 0.98 | 0.80 | 0.26 | 0.05 | 0.87 |
| 27 | 0.19 | 0.13 | 0.93 | 0.96 | 0.93 | 0.96 | 0.83 | 0.28 |
| 28 | 0.19 | 0.28 | 0.72 | 0.56 | 0.87 | 0.45 | 0.00 | 0.82 |
| 29 | 0.57 | 0.90 | 0.97 | 0.62 | 0.53 | 0.85 | 0.76 | 0.75 |
| 30 | 0.39 | 0.51 | 0.83 | 0.78 | 0.26 | 0.91 | 0.07 | 0.04 |
| 31 | 0.44 | 0.69 | 0.53 | 0.61 | 0.31 | 0.14 | 0.02 | 0.11 |
| 32 | 0.83 | 0.23 | 0.98 | 0.32 | 0.12 | 0.79 | 0.21 | 0.42 |
| 33 | 0.54 | 0.98 | 0.32 | 0.81 | 0.56 | 0.64 | 0.92 | 0.06 |
| 34 | 0.91 | 0.77 | 0.62 | 0.79 | 0.55 | 0.83 | 0.29 | 0.19 |
| 35 | 0.66 | 0.69 | 0.18 | 0.41 | 0.97 | 0.53 | 0.21 | 0.86 |
| 36 | 0.67 | 0.55 | 1.00 | 0.97 | 0.83 | 0.21 | 0.97 | 0.38 |
| 37 | 0.37 | 0.11 | 0.99 | 0.14 | 0.85 | 0.71 | 0.14 | 0.15 |
| 38 | 0.09 | 0.76 | 0.70 | 0.21 | 0.74 | 0.49 | 0.72 | 0.37 |
| 39 | 0.22 | 0.51 | 0.68 | 0.80 | 0.98 | 0.79 | 0.80 | 0.48 |
| 40 | 0.55 | 0.99 | 0.35 | 0.07 | 0.71 | 0.62 | 0.72 | 0.64 |

17. Based on these data, what would be the expected demand in any month?

|  |  |
| --- | --- |
| a. | 225 |
| b. | 240 |
| c. | 255 |
| d. | 275 |

ANS: C PTS: 1 DIF: Medium

18. Based on these data, what would be the expected number of breakdowns when demand is less than 300 units in any month?

|  |  |
| --- | --- |
| a. | 0.10 |
| b. | 0.17 |
| c. | 0.25 |
| d. | 0.30 |

ANS: C PTS: 1 DIF: Medium

19. Based on these data, what would be the expected number of breakdowns when demand is greater than 300 units in any month?

|  |  |
| --- | --- |
| a. | 0.0 |
| b. | 0.7 |
| c. | 1.0 |
| d. | 1.3 |

ANS: B PTS: 1 DIF: Medium

20. Maklin Enterprises wants to run a simulation of this setup. Conduct a simulation for 6 months (that would be 6 runs). What would be the average demand for this 6-run simulation. Use the random number table provided and the first 6 numbers from Column E. What was the average demand for these 6 runs?

|  |  |
| --- | --- |
| a. | 150 |
| b. | 175 |
| c. | 225 |
| d. | 250 |

ANS: D PTS: 1 DIF: Hard

21. Conduct a simulation for 6 months (that would be 6 runs). Based on the simulated demand levels from the prior question, what would be the average number of breakdowns if demand were less than 300 units for this 6-run simulation. Use the random number table provided and the first 6 numbers from Column F. What was the average number of breakdowns for these 6 runs?

|  |  |
| --- | --- |
| a. | 0.00 |
| b. | 0.17 |
| c. | 0.25 |
| d. | 0.31 |

ANS: B PTS: 1 DIF: Hard

22. Conduct a simulation for 6 months (that would be 6 runs). Based on the simulated demand levels from the prior question, what would be the average number of breakdowns if demand were greater than 300 units for this 6-run simulation. Use the random number table provided and the first 6 numbers from Column D. What was the average number of breakdowns for these 6 runs?

|  |  |
| --- | --- |
| a. | 0.00 |
| b. | 0.17 |
| c. | 0.25 |
| d. | 0.33 |

ANS: D PTS: 1 DIF: Hard

Maple Street Walk-In Clinic wants to evaluate its current operational procedures and possible changes to its procedures. They have gathered data on interarrival times and the times to perform certain procedures. They have discovered that the variability of interarrival times changes from day to day. They want to simulate Wednesday’s operations. Patients arrive at the clinic and check in. Some of the patients are there for the first time and must fill out forms (roughly 10% of the patients). After the check in (and/or filling out forms), patients then see the doctor (or wait to see the doctor). After the examination by the doctor, some patients have to have their blood drawn for tests. Data for a typical Wednesday are provided below.

|  |  |
| --- | --- |
| Interarrival Time (Min.) | Probability |
| 10 | 10% |
| 12 | 15% |
| 14 | 55% |
| 16 | 15% |
| 18 | 5% |

|  |  |
| --- | --- |
| Fill Out Forms | Probability |
| No | 90% |
| Yes | 10% |

|  |  |
| --- | --- |
| Fill Out Forms Time (Min.) | Probability |
| 6 | 60% |
| 8 | 30% |
| 10 | 10% |

|  |  |
| --- | --- |
| Blood Test | Probability |
| No | 80% |
| Yes | 20% |

|  |  |
| --- | --- |
| Blood Test Time (Min.) | Probability |
| 4 | 20% |
| 5 | 70% |
| 6 | 10% |

Use this table of random numbers if/as needed:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | A | B | C | D | E | F | G | H |
| 1 | 0.03 | 0.47 | 0.78 | 0.15 | 0.12 | 0.01 | 0.46 | 0.72 |
| 2 | 0.39 | 0.47 | 0.77 | 0.51 | 0.17 | 0.72 | 0.14 | 0.31 |
| 3 | 0.95 | 0.11 | 0.94 | 0.58 | 0.09 | 0.62 | 0.78 | 0.85 |
| 4 | 0.15 | 0.21 | 0.81 | 0.09 | 0.98 | 0.08 | 0.99 | 0.31 |
| 5 | 0.31 | 0.15 | 0.97 | 0.40 | 0.36 | 0.26 | 0.48 | 0.66 |
| 6 | 0.35 | 0.34 | 0.36 | 0.57 | 0.78 | 0.80 | 0.82 | 0.69 |
| 7 | 0.72 | 0.91 | 0.04 | 0.36 | 1.00 | 0.11 | 0.60 | 0.11 |
| 8 | 0.84 | 0.35 | 0.84 | 0.44 | 0.49 | 0.16 | 0.14 | 0.87 |
| 9 | 0.11 | 0.95 | 0.88 | 0.26 | 0.66 | 0.30 | 0.48 | 0.46 |
| 10 | 0.99 | 0.89 | 0.16 | 0.48 | 0.76 | 0.60 | 0.60 | 0.22 |
| 11 | 0.95 | 0.80 | 0.78 | 0.34 | 0.44 | 0.95 | 0.23 | 0.59 |
| 12 | 0.51 | 0.44 | 0.44 | 0.69 | 0.35 | 0.10 | 0.15 | 0.92 |
| 13 | 0.11 | 0.79 | 0.28 | 0.83 | 0.33 | 0.30 | 0.52 | 0.99 |
| 14 | 0.78 | 0.55 | 0.78 | 0.79 | 0.16 | 0.48 | 0.53 | 0.45 |
| 15 | 0.88 | 0.50 | 0.63 | 0.92 | 0.55 | 0.76 | 0.12 | 0.18 |
| 16 | 0.58 | 0.51 | 0.08 | 0.83 | 0.25 | 0.76 | 0.02 | 0.06 |
| 17 | 0.87 | 0.60 | 0.53 | 0.75 | 0.17 | 0.19 | 0.68 | 0.25 |
| 18 | 0.30 | 0.46 | 0.81 | 0.01 | 0.62 | 0.61 | 0.09 | 0.61 |
| 19 | 0.14 | 0.41 | 0.61 | 0.76 | 0.01 | 0.99 | 0.03 | 0.74 |
| 20 | 0.91 | 0.10 | 0.77 | 0.26 | 0.35 | 0.48 | 0.78 | 0.73 |
| 21 | 0.50 | 0.69 | 0.75 | 0.25 | 0.49 | 0.51 | 0.25 | 0.28 |
| 22 | 0.95 | 0.64 | 0.52 | 0.76 | 0.61 | 0.21 | 0.84 | 0.78 |
| 23 | 0.82 | 0.30 | 0.14 | 0.30 | 0.98 | 0.47 | 0.12 | 0.03 |
| 24 | 0.73 | 0.77 | 0.49 | 0.65 | 0.83 | 0.16 | 0.10 | 0.84 |
| 25 | 0.37 | 0.21 | 0.25 | 0.12 | 0.69 | 0.37 | 0.18 | 0.01 |
| 26 | 0.74 | 0.96 | 0.15 | 0.98 | 0.80 | 0.26 | 0.05 | 0.87 |
| 27 | 0.19 | 0.13 | 0.93 | 0.96 | 0.93 | 0.96 | 0.83 | 0.28 |
| 28 | 0.19 | 0.28 | 0.72 | 0.56 | 0.87 | 0.45 | 0.00 | 0.82 |
| 29 | 0.57 | 0.90 | 0.97 | 0.62 | 0.53 | 0.85 | 0.76 | 0.75 |
| 30 | 0.39 | 0.51 | 0.83 | 0.78 | 0.26 | 0.91 | 0.07 | 0.04 |
| 31 | 0.44 | 0.69 | 0.53 | 0.61 | 0.31 | 0.14 | 0.02 | 0.11 |
| 32 | 0.83 | 0.23 | 0.98 | 0.32 | 0.12 | 0.79 | 0.21 | 0.42 |
| 33 | 0.54 | 0.98 | 0.32 | 0.81 | 0.56 | 0.64 | 0.92 | 0.06 |
| 34 | 0.91 | 0.77 | 0.62 | 0.79 | 0.55 | 0.83 | 0.29 | 0.19 |
| 35 | 0.66 | 0.69 | 0.18 | 0.41 | 0.97 | 0.53 | 0.21 | 0.86 |
| 36 | 0.67 | 0.55 | 1.00 | 0.97 | 0.83 | 0.21 | 0.97 | 0.38 |
| 37 | 0.37 | 0.11 | 0.99 | 0.14 | 0.85 | 0.71 | 0.14 | 0.15 |
| 38 | 0.09 | 0.76 | 0.70 | 0.21 | 0.74 | 0.49 | 0.72 | 0.37 |
| 39 | 0.22 | 0.51 | 0.68 | 0.80 | 0.98 | 0.79 | 0.80 | 0.48 |
| 40 | 0.55 | 0.99 | 0.35 | 0.07 | 0.71 | 0.62 | 0.72 | 0.64 |

23. What would be the expected interarrival time in minutes?

|  |  |
| --- | --- |
| a. | 10.9 minutes |
| b. | 12.0 minutes |
| c. | 13.8 minutes |
| d. | 14.6 minutes |

ANS: C PTS: 1 DIF: Medium

24. What range of random numbers (2 digits) would correspond with a patient having to spend 8 minutes to fill out a form?

|  |  |
| --- | --- |
| a. | 0.00–0.50 |
| b. | 0.01–0.60 |
| c. | 0.60–0.89 |
| d. | 0.60–0.90 |

ANS: C PTS: 1 DIF: Easy

25. What range of random numbers (2 digits) would correspond with a patient having to spend 5 minutes for a blood test?

|  |  |
| --- | --- |
| a. | 0.00–0.19 |
| b. | 0.19–0.70 |
| c. | 0.20–0.89 |
| d. | 0.20–0.70 |

ANS: C PTS: 1 DIF: Easy

26. What would be the expected time for a patient to fill out a form (in minutes)?

|  |  |
| --- | --- |
| a. | 6 minutes |
| b. | 7 minutes |
| c. | 8 minutes |
| d. | 10 minutes |

ANS: B PTS: 1 DIF: Medium

27. What would be the expected time for blood to be drawn (in minutes)?

|  |  |
| --- | --- |
| a. | 4.9 minutes |
| b. | 5.5 minutes |
| c. | 6.2 minutes |
| d. | 6.9 minutes |

ANS: A PTS: 1 DIF: Medium

28. Run a simulation for 5 patients entering the system. Use Column A and Rows 6 to 10 in the supplied random number table. What was the average interarrival time for these first 5 patients?

|  |  |
| --- | --- |
| a. | 14.2 |
| b. | 14.8 |
| c. | 15.6 |
| d. | 16.6 |

ANS: B PTS: 1 DIF: Hard

29. Run a simulation for 5 patients entering the system. Use Column B and Rows 6 to 10 in the supplied random number table. What was the total number of patients, from the first 5, who had to fill out a form?

|  |  |
| --- | --- |
| a. | 0 |
| b. | 1 |
| c. | 2 |
| d. | 3 |

ANS: B PTS: 1 DIF: Hard

30. Run a simulation for 5 patients entering the system. Use Column C and Rows 10 to 14 in the supplied random number table. What was the average time for filling out forms for these first 5 patients?

|  |  |
| --- | --- |
| a. | 6.0 minutes |
| b. | 6.2 minutes |
| c. | 5.9 minutes |
| d. | 6.8 minutes |

ANS: D PTS: 1 DIF: Hard

31. Run a simulation for 5 patients entering the system. Use Column D and Rows 10 to 14 in the supplied random number table. What was the average time for these first 5 patients?

|  |  |
| --- | --- |
| a. | 10.6 minutes |
| b. | 11.2 minutes |
| c. | 12.8 minutes |
| d. | 14.0 minutes |

ANS: C PTS: 1 DIF: Hard

32. Run a simulation for 5 patients entering the system. Use Column E and Rows 10 to 14 in the supplied random number table. What was the total number of patients, from the first 5, who had to have a blood test?

|  |  |
| --- | --- |
| a. | 0 |
| b. | 1 |
| c. | 2 |
| d. | 3 |

ANS: B PTS: 1 DIF: Hard

33. Run a simulation for 5 patients entering the system. Use Column C and Rows 10 to 14 in the supplied random number table. What was the average time for the blood test for these first 5 patients?

|  |  |
| --- | --- |
| a. | 4.8 minutes |
| b. | 4.6 minutes |
| c. | 5.2 minutes |
| d. | 5.4 minutes |

ANS: A PTS: 1 DIF: Hard

34. Run a simulation for 5 patients entering the system. Map out the flow of these 5 patients. How long did it take these patients to completely go through the system?

|  |  |
| --- | --- |
| a. | 64 |
| b. | 78 |
| c. | 92 |
| d. | 99 |

ANS: C PTS: 1 DIF: Hard

35. Run a simulation for 5 patients entering the system. How many patients had to wait for ANY service?

|  |  |
| --- | --- |
| a. | 0 |
| b. | 1 |
| c. | 2 |
| d. | 3 |

ANS: C PTS: 1 DIF: Hard

36. What was the average waiting time for these 5 patients?

|  |  |
| --- | --- |
| a. | 0.0 minutes |
| b. | 0.5 minutes |
| c. | 1.5 minutes |
| d. | 3.5 minutes |

ANS: C PTS: 1 DIF: Hard

37. What would be the expected time for a patient to be examined?

|  |  |
| --- | --- |
| a. | 10.6 minutes |
| b. | 11.8 minutes |
| c. | 13.1 minutes |
| d. | 15.0 minutes |

ANS: B PTS: 1 DIF: Medium

Johnson Plumbing Supplies is the major plumbing supply company in a mid-sized town. The are planning on using a simulation to evaluate their inventory policies. One of their most popular items is a PVC U-pipe. Currently, they order these pipes in batches of 100 when the inventory level drops below 50 units. The cost of an order is $25, and the cost of holding a unit in inventory (average inventory) is $0.20/unit/day. When an order is placed, consider the following: If inventory drops below 50 units in, let us say, Day 2 and the lead time is 1 day, then inventory arrives at the beginning of Day 4. If inventory drops below 50 units in, let us say, Day 2 and the lead time is 2 days, then inventory arrives at the beginning of Day 5. Assume that the ending inventory on Day 0 is 54 units.

The probability distribution for demand and the probability distribution for the lead time are given below.

|  |  |
| --- | --- |
| Demand | Probability |
| 20 | 5% |
| 21 | 10% |
| 22 | 25% |
| 23 | 45% |
| 24 | 10% |
| 25 | 5% |

|  |  |
| --- | --- |
| Lead Time | Probability |
| 1 | 20% |
| 2 | 65% |
| 3 | 15% |

Use this table of random numbers if/as needed:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **A** | **B** | **C** | **D** | **E** | **F** | **G** | **H** |
| 1 | 0.03 | 0.47 | 0.78 | 0.15 | 0.12 | 0.01 | 0.46 | 0.72 |
| 2 | 0.39 | 0.47 | 0.77 | 0.51 | 0.17 | 0.72 | 0.14 | 0.31 |
| 3 | 0.95 | 0.11 | 0.94 | 0.58 | 0.09 | 0.62 | 0.78 | 0.85 |
| 4 | 0.15 | 0.21 | 0.81 | 0.09 | 0.98 | 0.08 | 0.99 | 0.31 |
| 5 | 0.31 | 0.15 | 0.97 | 0.40 | 0.36 | 0.26 | 0.48 | 0.66 |
| 6 | 0.35 | 0.34 | 0.36 | 0.57 | 0.78 | 0.80 | 0.82 | 0.69 |
| 7 | 0.72 | 0.91 | 0.04 | 0.36 | 1.00 | 0.11 | 0.60 | 0.11 |
| 8 | 0.84 | 0.35 | 0.84 | 0.44 | 0.49 | 0.16 | 0.14 | 0.87 |
| 9 | 0.11 | 0.95 | 0.88 | 0.26 | 0.66 | 0.30 | 0.48 | 0.46 |
| 10 | 0.99 | 0.89 | 0.16 | 0.48 | 0.76 | 0.60 | 0.60 | 0.22 |
| 11 | 0.95 | 0.80 | 0.78 | 0.34 | 0.44 | 0.95 | 0.23 | 0.59 |
| 12 | 0.51 | 0.44 | 0.44 | 0.69 | 0.35 | 0.10 | 0.15 | 0.92 |
| 13 | 0.11 | 0.79 | 0.28 | 0.83 | 0.33 | 0.30 | 0.52 | 0.99 |
| 14 | 0.78 | 0.55 | 0.78 | 0.79 | 0.16 | 0.48 | 0.53 | 0.45 |
| 15 | 0.88 | 0.50 | 0.63 | 0.92 | 0.55 | 0.76 | 0.12 | 0.18 |
| 16 | 0.58 | 0.51 | 0.08 | 0.83 | 0.25 | 0.76 | 0.02 | 0.06 |
| 17 | 0.87 | 0.60 | 0.53 | 0.75 | 0.17 | 0.19 | 0.68 | 0.25 |
| 18 | 0.30 | 0.46 | 0.81 | 0.01 | 0.62 | 0.61 | 0.09 | 0.61 |
| 19 | 0.14 | 0.41 | 0.61 | 0.76 | 0.01 | 0.99 | 0.03 | 0.74 |
| 20 | 0.91 | 0.10 | 0.77 | 0.26 | 0.35 | 0.48 | 0.78 | 0.73 |
| 21 | 0.50 | 0.69 | 0.75 | 0.25 | 0.49 | 0.51 | 0.25 | 0.28 |
| 22 | 0.95 | 0.64 | 0.52 | 0.76 | 0.61 | 0.21 | 0.84 | 0.78 |
| 23 | 0.82 | 0.30 | 0.14 | 0.30 | 0.98 | 0.47 | 0.12 | 0.03 |
| 24 | 0.73 | 0.77 | 0.49 | 0.65 | 0.83 | 0.16 | 0.10 | 0.84 |
| 25 | 0.37 | 0.21 | 0.25 | 0.12 | 0.69 | 0.37 | 0.18 | 0.01 |
| 26 | 0.74 | 0.96 | 0.15 | 0.98 | 0.80 | 0.26 | 0.05 | 0.87 |
| 27 | 0.19 | 0.13 | 0.93 | 0.96 | 0.93 | 0.96 | 0.83 | 0.28 |
| 28 | 0.19 | 0.28 | 0.72 | 0.56 | 0.87 | 0.45 | 0.00 | 0.82 |
| 29 | 0.57 | 0.90 | 0.97 | 0.62 | 0.53 | 0.85 | 0.76 | 0.75 |
| 30 | 0.39 | 0.51 | 0.83 | 0.78 | 0.26 | 0.91 | 0.07 | 0.04 |
| 31 | 0.44 | 0.69 | 0.53 | 0.61 | 0.31 | 0.14 | 0.02 | 0.11 |
| 32 | 0.83 | 0.23 | 0.98 | 0.32 | 0.12 | 0.79 | 0.21 | 0.42 |
| 33 | 0.54 | 0.98 | 0.32 | 0.81 | 0.56 | 0.64 | 0.92 | 0.06 |
| 34 | 0.91 | 0.77 | 0.62 | 0.79 | 0.55 | 0.83 | 0.29 | 0.19 |
| 35 | 0.66 | 0.69 | 0.18 | 0.41 | 0.97 | 0.53 | 0.21 | 0.86 |
| 36 | 0.67 | 0.55 | 1.00 | 0.97 | 0.83 | 0.21 | 0.97 | 0.38 |
| 37 | 0.37 | 0.11 | 0.99 | 0.14 | 0.85 | 0.71 | 0.14 | 0.15 |
| 38 | 0.09 | 0.76 | 0.70 | 0.21 | 0.74 | 0.49 | 0.72 | 0.37 |
| 39 | 0.22 | 0.51 | 0.68 | 0.80 | 0.98 | 0.79 | 0.80 | 0.48 |
| 40 | 0.55 | 0.99 | 0.35 | 0.07 | 0.71 | 0.62 | 0.72 | 0.64 |

38. What would be the expected value for daily demand?

|  |  |
| --- | --- |
| a. | 19.8 |
| b. | 21.5 |
| c. | 22.6 |
| d. | 23.2 |

ANS: C PTS: 1 DIF: Medium

39. What would be the expected value for the lead time?

|  |  |
| --- | --- |
| a. | 1.65 |
| b. | 1.95 |
| c. | 2.20 |
| d. | 2.34 |

ANS: B PTS: 1 DIF: Medium

40. What range of random numbers (2 digits) would correspond with a demand of 22 units?

|  |  |
| --- | --- |
| a. | 0.00–0.39 |
| b. | 0.15–0.39 |
| c. | 0.16–0.40 |
| d. | 0.19–0.44 |

ANS: B PTS: 1 DIF: Easy

41. What range of random numbers (2 digits) would correspond with a demand of 24 units?

|  |  |
| --- | --- |
| a. | 0.65–0.84 |
| b. | 0.70–0.84 |
| c. | 0.84–0.90 |
| d. | 0.84–0.95 |

ANS: D PTS: 1 DIF: Easy

42. What range of random numbers (2 digits) would correspond with a lead time of 1 day?

|  |  |
| --- | --- |
| a. | 0.00–0.19 |
| b. | 0.00–0.20 |
| c. | 0.01–0.19 |
| d. | 0.01–0.20 |

ANS: A PTS: 1 DIF: Easy

43. Run a simulation for 7 days. Use Column A and Rows 20 to 26 in the supplied random number table. What was the average demand for these first 7 days?

|  |  |
| --- | --- |
| a. | 22.2 |
| b. | 23.3 |
| c. | 23.9 |
| d. | 24.3 |

ANS: B PTS: 1 DIF: Hard

44. Run a simulation for 7 days. Use Column B and Rows 20 to 26 in the supplied random number table. What was the average lead time for these first 7 days (divide by 7 days)?

|  |  |
| --- | --- |
| a. | 0.4 |
| b. | 0.8 |
| c. | 2.0 |
| d. | 3.0 |

ANS: A PTS: 1 DIF: Hard

45. How many times were orders placed during these first 7 days?

|  |  |
| --- | --- |
| a. | 0 |
| b. | 1 |
| c. | 2 |
| d. | 3 |

ANS: C PTS: 1 DIF: Medium

46. Based on the number of orders, what was the average lead time?

|  |  |
| --- | --- |
| a. | 1.0 |
| b. | 1.5 |
| c. | 2.0 |
| d. | 2.3 |

ANS: B PTS: 1 DIF: Medium

47. Based on the simulation for 7 days, what was the cost of ordering parts?

|  |  |
| --- | --- |
| a. | $0.00 |
| b. | $25.00 |
| c. | $50.00 |
| d. | $75.00 |

ANS: C PTS: 1 DIF: Medium

48. Based on the simulation for 7 days, what was the cost of holding the average inventory?

|  |  |
| --- | --- |
| a. | $0 |
| b. | $52 |
| c. | $256 |
| d. | $1,435 |

ANS: B PTS: 1 DIF: Hard

49. Using the same numbers for simulating 7 days of operations, how would the ordering cost change if Johnson Plumbing Supplies ordered in batches of 200 instead of 100?

|  |  |
| --- | --- |
| a. | stay the same |
| b. | increase by 1 order |
| c. | decrease by 1 order |
| d. | decrease by 2 orders |

ANS: C PTS: 1 DIF: Medium

50. Using the same numbers for simulating 7 days of operations, how would the average inventory holding cost change if Johnson Plumbing Supplies ordered in batches of 200 instead of 100?

|  |  |
| --- | --- |
| a. | stay the same |
| b. | increase by less than $25 |
| c. | decrease by less than $25 |
| d. | increase by more than $25 |

ANS: D PTS: 1 DIF: Medium