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Normal Distribution Problems with Answers

Problems and applications on normal distributions are presented. The answers to these problems are at the bottom of the page. Also an online [normal distribution probability calculator](#) may be useful to check your answers.

1.

X is a normally normally distributed variable with mean $\mu = 30$ and standard deviation $\sigma = 4$. F

a) $P(x < 40)$

b) $P(x > 21)$

c) $P(30 < x < 35)$

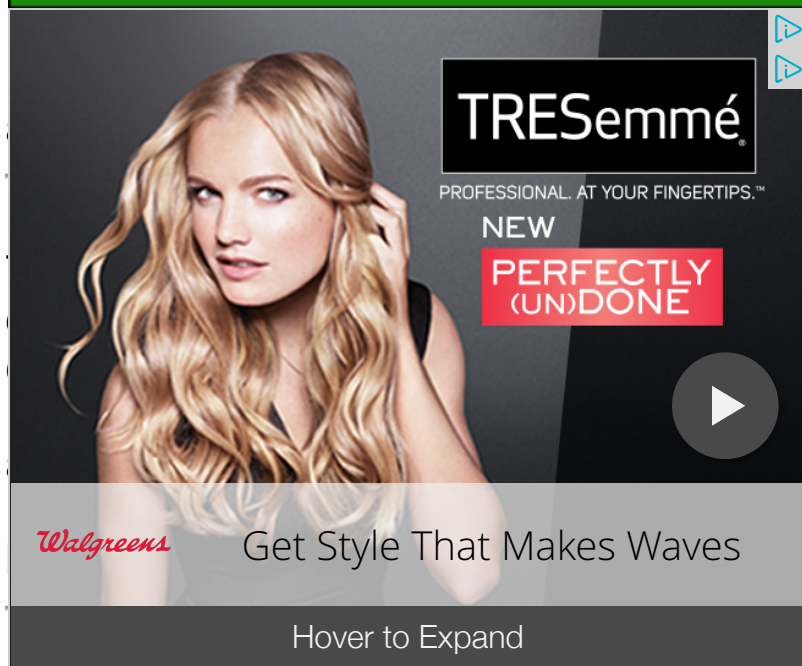
2. A radar unit is used to measure speeds of cars on a motorway. The speeds are normally distributed with a mean of 90 km/hr and a standard deviation of 10 km/hr. What is the probability that a car picked at random is travelling at more than 100 km/hr?



3. For a certain type of computers, the length of time between charges of the battery is normally distributed with a mean of 50 hours and a standard deviation of 15 hours. John owns one of these computers and wants to know the probability that the length of time will be between 50 and 70 hours.

4. Entry to a certain University is determined by a national test. The scores on this test are normally distributed with a mean of 500 and a standard deviation of 100. Tom wants to be admitted to this university and he knows that he must score better than at least 70% of the students who took the test. Tom takes the test and scores 585. Will he be admitted?

5.



5. The length of life of an instrument produced by a company are approximated by a normal distribution with a mean of 5.00 cm and a standard deviation of 0.02 cm. If a component is selected at random, find the probability that

a) this component is between 4.98 and 5.02 cm?

b) this component is between 4.96 and 5.04 cm?

6. The length of life of an instrument produced by a machine has a normal distribution with a mean of 12 months and standard deviation of 2 months. Find the probability that an instrument produced by this machine will last

a) less than 7 months.

b) between 7 and 12 months.

7. The time taken to assemble a car in a certain plant is a random variable having a normal distribution with a mean of 20 hours and a standard deviation of 2 hours. What is the probability that a car can be assembled at this plant in a period of time

a) less than 19.5 hours?

b) between 20 and 22 hours?

8. A large group of students took a test in Physics and the final grades have a mean of 70 and a standard deviation of 10. If we can approximate the distribution of these grades by a normal distribution, what percent of the students

a) scored higher than 80?

b) should pass the test (grades ≥ 60)?

c) should fail the test (grades < 60)?

9. The annual salaries of employees in a large company are approximately normally distributed with a mean of \$50,000 and a standard deviation of \$20,000.

a) What percent of people earn less than \$40,000?

b) What percent of people earn between \$45,000 and \$65,000?

c) What percent of people earn more than \$70,000?

Answers to the Above Problems

Answers to the Above Questions

1. **Note:** What is meant here by area is the area under the standard normal curve.

a) For $x = 40$, the z-value $z = (40 - 30) / 4 = 2.5$

Hence $P(x < 40) = P(z < 2.5) = [\text{area to the left of } 2.5] = 0.9938$

b) For $x = 21$, $z = (21 - 30) / 4 = -2.25$

Hence $P(x > 21) = P(z > -2.25) = [\text{total area}] - [\text{area to the left of } -2.25]$

$= 1 - 0.0122 = 0.9878$

c) For $x = 30$, $z = (30 - 30) / 4 = 0$ and for $x = 35$, $z = (35 - 30) / 4 = 1.25$

Hence $P(30 < x < 35) = P(0 < z < 1.25) = [\text{area to the left of } z = 1.25] - [\text{area to the left of } 0]$

$= 0.8944 - 0.5 = 0.3944$

2. Let x be the random variable that represents the speed of cars. x has $\mu = 90$ and $\sigma = 10$. We have to find the probability that x is higher than 100 or $P(x > 100)$

$$\text{For } x = 100, z = (100 - 90) / 10 = 1$$

$$P(x > 90) = P(z > 1) = [\text{total area}] - [\text{area to the left of } z = 1]$$

$$= 1 - 0.8413 = 0.1587$$

The probability that a car selected at a random has a speed greater than 100 km/hr is equal to 0.1587

3.



Let x be the random variable that represents the length of time. It has a mean of 50 and a standard deviation of 15. We have to find the probability that x is between 50 and 70 or $P(50 < x < 70)$

$$\text{For } x = 50, z = (50 - 50) / 15 = 0$$

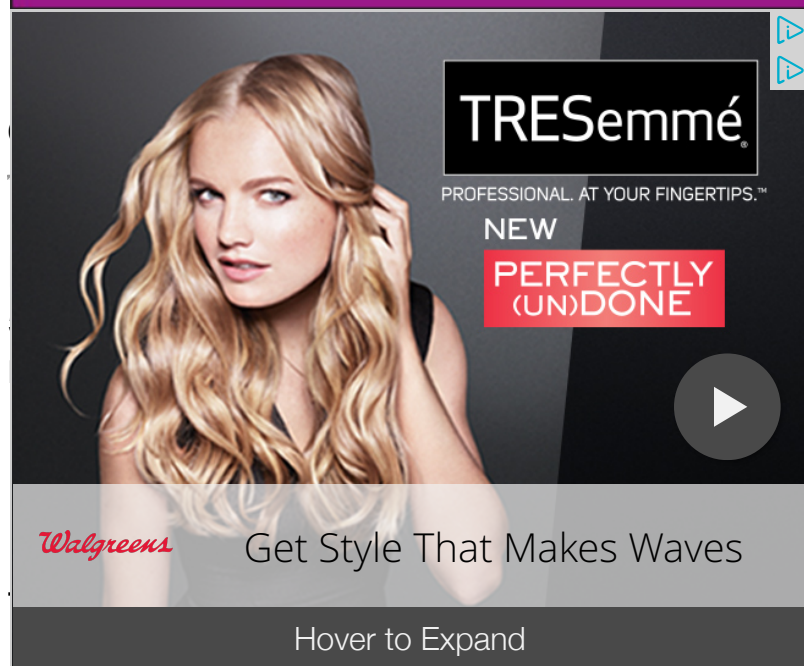
$$\text{For } x = 70, z = (70 - 50) / 15 = 1.33 \text{ (rounded to two decimal places)}$$

$$P(50 < x < 70) = P(0 < z < 1.33) = [\text{area to the left of } z = 1.33] - [\text{area to the left of } z = 0]$$

$$= 0.9082 - 0.5 = 0.4082$$

The probability that John's computer has a length of time between 50 and 70 is 0.4082.

4.



Let x be the scores. x is normally distributed with a mean of 585 and a standard deviation of 15. The total area under the normal curve represents the total probability. We multiply the values of the areas under the curve by 100 to get the percentage.

The probability that Tom's score is below 585 is given by

$$P = [\text{area to the left of } z = 0.85] = 0.8023 = 80.23\%$$

Tom scored better than 80.23% of the students who took the test and he will be admitted to the University.

5. a) $P(4.98 < x < 5.02) = P(-1 < z < 1)$

$$= 0.6826$$

$$\text{b) } P(4.96 < x < 5.04) = P(-2 < z < 2)$$

$$= 0.9544$$

6. $\text{a) } P(x < 7) = P(z < -2.5)$

$$= 0.0062$$

$$\text{b) } P(7 < x < 12) = P(-2.5 < z < 0)$$

$$= 0.4938$$

7. $\text{a) } P(x < 19.5) = P(z < -0.25)$

$$= 0.4013$$

$$\text{b) } P(20 < x < 22) = P(0 < z < 1)$$

$$= 0.3413$$

8. $\text{a) For } x = 80, z = 1$

Area to the right (higher than) $z = 1$ is equal to $0.1586 = 15.87\%$ scored more than 80.

$$\text{b) For } x = 60, z = -1$$

Area to the right of $z = -1$ is equal to $0.8413 = 84.13\%$ should pass the test.

$$\text{c) } 100\% - 84.13\% = 15.87\% \text{ should fail the test.}$$

9. $\text{a) For } x = 40000, z = -0.5$

Area to the left (less than) of $z = -0.5$ is equal to $0.3085 = 30.85\%$ earn less than \$40,000.

$$\text{b) For } x = 45000, z = -0.25 \text{ and for } x = 65000, z = 0.75$$

Area between $z = -0.25$ and $z = 0.75$ is equal to $0.3720 = 37.20\%$ earn between \$45,000 and \$65,000.

$$\text{c) For } x = 70000, z = 1$$

Area to the right (higher) of $z = 1$ is equal to $0.1586 = 15.86\%$ earn more than \$70,000.


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