

**PENANG SANGAM HIGH SCHOOL**  
**P.O.BOX 44, RAKIRAKI**  
**LESSON NOTES**

**Year/Level: 12**

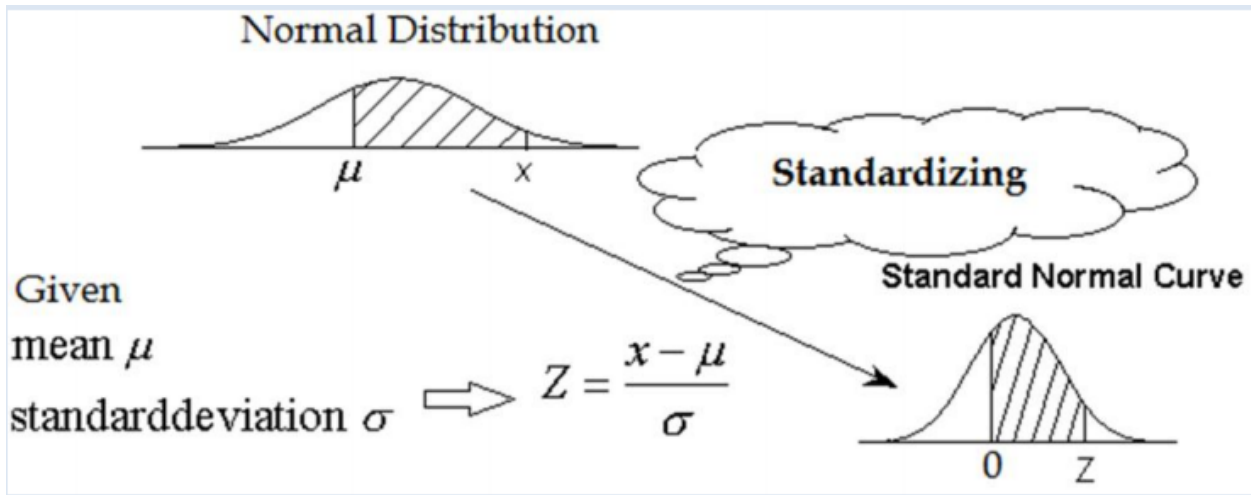
**Subjects: Mathematics**

|                                 |   |
|---------------------------------|---|
| <b>Content Learning Outcome</b> | Students should be able to: <ul style="list-style-type: none"> <li>• State characteristics of normal distribution</li> <li>• Define normal distribution terms.</li> </ul> |
|---------------------------------|---|

**Lesson notes**

**Strand 8: Probability**

- It is impossible to give probability for every situation such as large population size, therefore we convert ordinary normal measurements to what we call is standard normal distribution(z).



- Standard normal distribution are symmetric about the  $\bar{x} = 0$ .
- The units marked on the x axis are called z value or z scores.

$$z = \frac{x - \bar{x}}{\sigma}$$

- The z scores to the left of the mean are negative and the z scores to the right of the mean are positive.
- The total probability under the curve is equal to 1.
- The total probability to the right of the mean is 0.5.

**Examples**

For the following scores, convert it to z score and show the region on a normal distribution and find the probability.

a.  $\mu = 250$

b.  $\mu = 155$

$\sigma = 20$

$\sigma = 12$

$x = 230$

$x = 200$

## Example solutions

$$a) \mu = 250$$

$$\sigma = 20$$

$$x = 230$$

$$P(X > 230)$$

$$\text{Rewrite } P(X > 230)$$

$$= P(Z > -1)$$

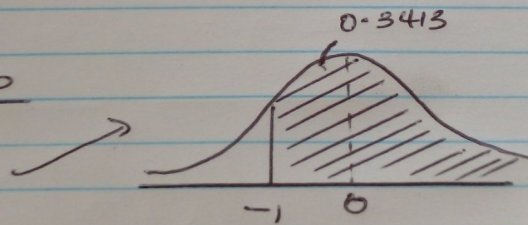
$$= 0.3413 + 0.5$$

$$= \underline{\underline{0.8413}}$$

$$z = \frac{x - \mu}{\sigma}$$

$$= \frac{230 - 250}{20}$$

$$= \underline{\underline{-1}}$$



$$b) \mu = 155$$

$$\sigma = 12$$

$$x = 200$$

$$P(X < 155)$$

$$P(X < 155)$$

$$= P(Z < -3.75)$$

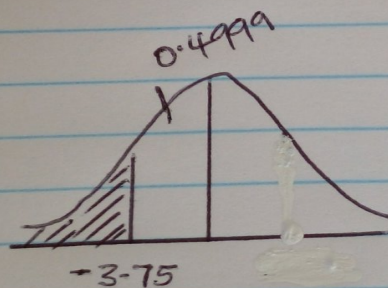
$$= 0.5 - 0.4999$$

$$= \underline{\underline{0.0001}}$$

$$z = \frac{x - \mu}{\sigma}$$

$$= \frac{155 - 200}{12}$$

$$= \underline{\underline{-3.75}}$$



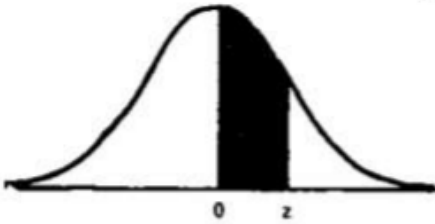
## Activity

1. X has a normal probability distribution with mean 50 and standard deviation 6.

Calculate

(a)  $P(X > 60)$

## AREAS UNDER NORMAL PROBABILITY CURVE



The tabulated value is the probability that the standardized normal variate  $Z$  (with  $\mu=0, \sigma=1$ ) lies between 0 and  $z$ ,  
 e.g.  $P(0 < Z < 1.43) = 42.36\%$

| z   |       |       |       |       |       |       |       |       |       |       |   |   |    |    |    |    |    |    |    |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---|---|----|----|----|----|----|----|----|
|     | 0     | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 1 | 2 | 3  | 4  | 5  | 6  | 7  | 8  | 9  |
| 0.0 | .0000 | .0040 | .0080 | .0120 | .0160 | .0199 | .0239 | .0279 | .0319 | .0359 | 4 | 8 | 12 | 16 | 20 | 24 | 28 | 32 | 36 |
| 0.1 | .0398 | .0438 | .0478 | .0517 | .0557 | .0596 | .0636 | .0675 | .0714 | .0754 | 4 | 8 | 12 | 16 | 20 | 24 | 28 | 32 | 36 |
| 0.2 | .0793 | .0832 | .0871 | .0910 | .0948 | .0987 | .1026 | .1064 | .1103 | .1141 | 4 | 8 | 12 | 15 | 19 | 22 | 27 | 31 | 35 |
| 0.3 | .1179 | .1217 | .1255 | .1293 | .1331 | .1368 | .1406 | .1443 | .1480 | .1517 | 4 | 8 | 11 | 15 | 19 | 22 | 26 | 30 | 34 |
| 0.4 | .1554 | .1591 | .1628 | .1664 | .1700 | .1736 | .1772 | .1808 | .1844 | .1879 | 4 | 7 | 11 | 14 | 18 | 22 | 25 | 29 | 32 |
| 0.5 | .1915 | .1950 | .1985 | .2019 | .2054 | .2088 | .2123 | .2157 | .2190 | .2224 | 3 | 7 | 10 | 14 | 17 | 21 | 24 | 27 | 31 |
| 0.6 | .2258 | .2291 | .2324 | .2357 | .2389 | .2422 | .2454 | .2486 | .2518 | .2549 | 3 | 6 | 10 | 13 | 16 | 19 | 23 | 26 | 29 |
| 0.7 | .2580 | .2612 | .2642 | .2673 | .2704 | .2734 | .2764 | .2794 | .2823 | .2852 | 3 | 6 | 9  | 12 | 15 | 18 | 21 | 24 | 27 |
| 0.8 | .2881 | .2910 | .2939 | .2967 | .2996 | .3023 | .3051 | .3078 | .3106 | .3133 | 3 | 6 | 8  | 11 | 14 | 17 | 19 | 22 | 25 |
| 0.9 | .3159 | .3186 | .3212 | .3238 | .3264 | .3289 | .3315 | .3340 | .3365 | .3389 | 3 | 5 | 8  | 10 | 13 | 15 | 18 | 20 | 23 |
| 1.0 | .3413 | .3438 | .3461 | .3485 | .3508 | .3531 | .3554 | .3577 | .3599 | .3621 | 2 | 5 | 7  | 9  | 12 | 14 | 16 | 18 | 21 |
| 1.1 | .3643 | .3665 | .3686 | .3708 | .3729 | .3749 | .3770 | .3790 | .3810 | .3830 | 2 | 4 | 6  | 8  | 10 | 12 | 14 | 16 | 19 |
| 1.2 | .3849 | .3869 | .3888 | .3907 | .3925 | .3944 | .3962 | .3980 | .3997 | .4015 | 2 | 4 | 5  | 7  | 9  | 11 | 13 | 15 | 16 |
| 1.3 | .4032 | .4049 | .4066 | .4082 | .4099 | .4115 | .4131 | .4147 | .4162 | .4177 | 2 | 3 | 5  | 6  | 8  | 10 | 11 | 13 | 14 |
| 1.4 | .4192 | .4207 | .4222 | .4236 | .4251 | .4265 | .4279 | .4292 | .4306 | .4319 | 1 | 3 | 4  | 6  | 7  | 8  | 10 | 11 | 13 |
| 1.5 | .4332 | .4345 | .4357 | .4370 | .4382 | .4394 | .4406 | .4418 | .4429 | .4441 | 1 | 2 | 4  | 5  | 6  | 7  | 8  | 10 | 11 |
| 1.6 | .4452 | .4463 | .4474 | .4484 | .4495 | .4505 | .4515 | .4525 | .4535 | .4545 | 1 | 2 | 3  | 4  | 5  | 6  | 7  | 8  | 9  |
| 1.7 | .4554 | .4564 | .4573 | .4582 | .4591 | .4599 | .4608 | .4616 | .4625 | .4633 | 1 | 2 | 3  | 3  | 4  | 5  | 6  | 7  | 8  |
| 1.8 | .4641 | .4649 | .4656 | .4664 | .4671 | .4678 | .4686 | .4693 | .4699 | .4706 | 1 | 1 | 2  | 3  | 4  | 4  | 5  | 6  | 6  |
| 1.9 | .4713 | .4719 | .4726 | .4732 | .4738 | .4744 | .4750 | .4756 | .4761 | .4767 | 1 | 1 | 2  | 2  | 3  | 4  | 4  | 5  | 5  |
| 2.0 | .4772 | .4778 | .4783 | .4788 | .4793 | .4798 | .4803 | .4808 | .4812 | .4817 | 0 | 1 | 1  | 2  | 2  | 3  | 3  | 4  | 4  |
| 2.1 | .4821 | .4826 | .4830 | .4834 | .4838 | .4842 | .4846 | .4850 | .4854 | .4857 | 0 | 1 | 1  | 2  | 2  | 2  | 3  | 3  | 4  |
| 2.2 | .4861 | .4864 | .4868 | .4871 | .4875 | .4878 | .4881 | .4884 | .4887 | .4890 | 0 | 1 | 1  | 1  | 2  | 2  | 2  | 3  | 3  |
| 2.3 | .4893 | .4896 | .4898 | .4901 | .4904 | .4906 | .4909 | .4911 | .4913 | .4916 | 0 | 0 | 1  | 1  | 1  | 2  | 2  | 2  | 2  |
| 2.4 | .4918 | .4920 | .4922 | .4925 | .4927 | .4929 | .4931 | .4932 | .4934 | .4936 | 0 | 0 | 1  | 1  | 1  | 1  | 1  | 2  | 2  |
| 2.5 | .4938 | .4940 | .4941 | .4943 | .4945 | .4946 | .4948 | .4949 | .4951 | .4952 | 0 | 0 | 0  | 1  | 1  | 1  | 1  | 1  | 1  |
| 2.6 | .4953 | .4955 | .4956 | .4957 | .4959 | .4960 | .4961 | .4962 | .4963 | .4964 | 0 | 0 | 0  | 0  | 1  | 1  | 1  | 1  | 1  |
| 2.7 | .4965 | .4966 | .4967 | .4968 | .4969 | .4970 | .4971 | .4972 | .4973 | .4974 | 0 | 0 | 0  | 0  | 0  | 1  | 1  | 1  | 1  |
| 2.8 | .4974 | .4975 | .4976 | .4977 | .4977 | .4978 | .4979 | .4979 | .4980 | .4981 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 1  |
| 2.9 | .4981 | .4982 | .4982 | .4983 | .4984 | .4984 | .4985 | .4985 | .4986 | .4986 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 1  |
| 3.0 | .4987 | .4987 | .4987 | .4988 | .4988 | .4989 | .4989 | .4989 | .4990 | .4990 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 3.1 | .4990 | .4991 | .4991 | .4991 | .4992 | .4992 | .4992 | .4992 | .4993 | .4993 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 3.2 | .4993 | .4993 | .4994 | .4994 | .4994 | .4994 | .4994 | .4994 | .4995 | .4995 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 3.3 | .4995 | .4995 | .4995 | .4996 | .4996 | .4996 | .4996 | .4996 | .4996 | .4997 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 3.4 | .4997 | .4997 | .4997 | .4997 | .4997 | .4997 | .4997 | .4997 | .4997 | .4998 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  |

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|                          |   |
|--------------------------|---|
| Content Learning Outcome | Students should be able to: <ul style="list-style-type: none"><li>• Find probabilities.</li></ul> |
|--------------------------|---|

Finding probabilities

**Note:** To find the probability of standard scores,  $z$  – value is not enough. You need to know how to use the table.

**Steps**

- Find the  $z$  – score with reference to question.
- Draw and shade the required region. } Done previously
- Use table to find the probability in relation to  $z$  –score
- Add 0.5 or Subtract from 0.5 or subtract from 1 etc. depending on shaded area.

Example

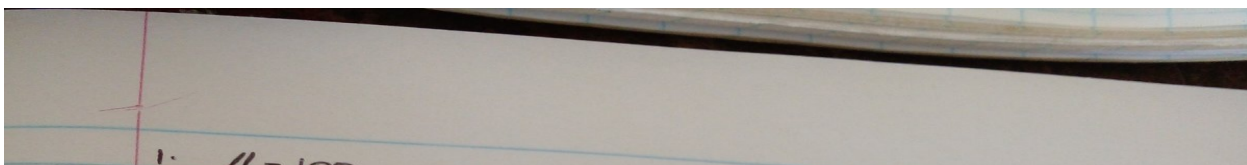
1.

IQ scores from a test are normally distributed with a mean of 100 standard deviation of 16.5. If 100 students sit the IQ test, how many will score between 67 and 133?

2.

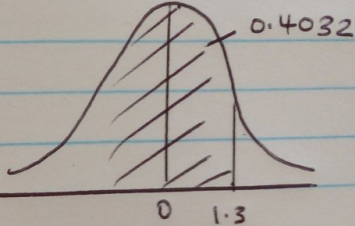
An average light bulb manufactured by the Acme Corporation lasts 300 days with a standard deviation of 50 days. Assuming that bulb life is normally distributed, what is the probability that an Acme light bulb will last less than 365 days?

E



2.

2.  $\mu = 300$   
 $\sigma = 50$   
 $P(X < 365)$   
 $P\left(Z < \frac{365 - 300}{50}\right)$   
 $P(Z < 1.3) = 0.5 + 0.4032$   
 $= \underline{\underline{0.9032}}$



Activity

Exercise 57 page 228 no 5 and 6