The normal distribution

Skills sheet · SL AA 4.9 · 4.12

KEY FACTS

$X \sim N(\mu, \sigma^2)$: a probability is an area D1

Symmetry: $P(X < \mu - k) = P(X > \mu + k)$; 68, 95, 99.7 % P1

Inverse normal: the area to the **left** P2

$z = \dfrac{x - \mu}{\sigma}$; μ or σ unknown: z first D2 P3

The GDC takes σ, not σ^2.

"Top 10 %": area 0.9 to the left W2.

$P(X = a) = 0$ W1.

WHAT UNLOCKS

- a value → a probability normal cdf.
- a probability → a value inverse normal, area to the left.
- no GDC → symmetry about μ and the total 1.
- an unknown μ or σ → z from $N(0, 1)$, then solve.

WORKED EXAMPLE ①

$X \sim N(50, 4^2)$. **Find** $P(X > 55)$. with GDC

$P(X > 55)$, normal cdf (M1)

0.106 A1

Method

A probability

① Write $X \sim N(\mu, \sigma^2)$.
② The probability statement.
③ The GDC, to 3 s.f.

WORKED EXAMPLE ②

$X \sim N(50, 4^2)$. **Find the standardised value of** 62. no GDC

$\frac{62-50}{4}$ (M1)

3 A1

Method

A z-score

① Subtract the mean.
② Divide by σ.
③ Read: how many σ from μ.

Divide by σ, not σ^2.

FLUENCY

●○○ **1.** $X \sim N(30, 5^2)$: $P(X < 30)$ no GDC

●○○ **2.** $X \sim N(30, 5^2)$: z for $x = 40$ no GDC

●○○ **3.** $\mu = 30$, $P(X > 38) = 0.06$: $P(X < 22)$ no GDC

●○○ **4.** Same: $P(22 < X < 38)$ no GDC

●○○ **5.** $N(30, 5^2)$: about 95 % lie between? no GDC

●○○ **6.** "Top 5 %": the area to the left no GDC

REASONING

●●● **Question 1.** $X \sim N(65, 10^2)$. [with GDC]

(a) Find $P(50 < X < 80)$. [2]

(b) Find k such that $P(X > k) = 0.25$. [2]

●●● **Question 2.** $Z \sim N(0, 1)$. [with GDC]

(a) Find a such that $P(Z < a) = 0.3$. [1]

●●● **Question 3.** $X \sim N(30, 5^2)$ and $P(X < c) = 0.5$. [no GDC]

(a) Write down c. [1]

PROBLEMS

●●● **Question 4.** $X \sim N(\mu, 5^2)$ and $P(X < 40) = 0.9$. [with GDC]

(a) Find μ. [3]

●●● **Question 5.** $X \sim N(80, \sigma^2)$ and $P(X > 90) = 0.2$. [with GDC]

(a) Find σ. [3]

ANSWERS

1 0.5

2 2

3 0.06

4 0.88

5 20 and 40

6 0.95

Q1 (a) 0.866 (b) 71.7

Q2 -0.524

Q3 30

Q4 $\frac{40-\mu}{5} = 1.28155,\ \mu = 33.6$

Q5 $\frac{10}{\sigma} = 0.841621,\ \sigma = 11.9$

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