# Solutionbank S2
## Edexcel AS and A Level Modular Mathematics

**Exercise A, Question 1**

**Question:**

The discrete random variable $X$ takes integer values and is to be approximated by a normal distribution. Apply a continuity correction to the following probabilities.

**a** $P(X \leq 7)$

**b** $P(X < 10)$

**c** $P(X > 5)$

**d** $P(X \geq 3)$

**e** $P(17 \leq X \leq 20)$

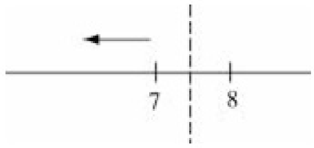
**f** $P(18 < X < 30)$

**g** $P(28 < X \leq 40)$

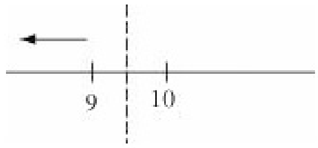
**h** $P(23 \leq X < 35)$

**Solution:**

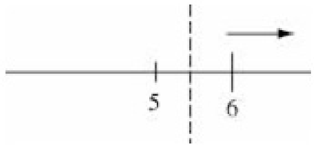
**a** $P(X \leq 7) = P(X \leq 7.5)$



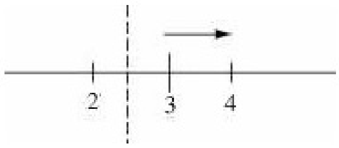

**b** $P(X < 10) = P(X \leq 9.5)$



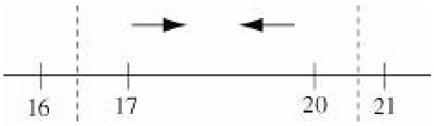

**c** $P(X > 5) = P(X \geq 5.5)$



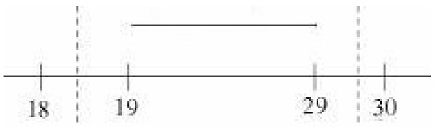

**d** $P(X \geq 3) = P(X \geq 2.5)$



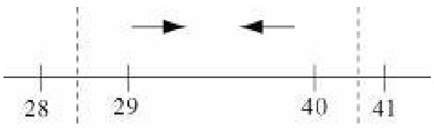

**e** $P(17 \leq X \leq 20) = P(16.5 \leq X < 20.5)$



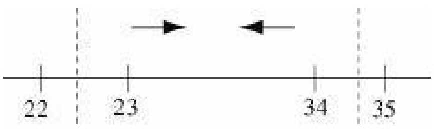

**f** $P(18 < X < 30) = P(18.5 \leq X < 29.5)$




**g** $P(28 < X \leq 40) = P(28.5 \leq X < 40.5)$




**h** $P(23 \leq X < 35) = P(22.5 \leq X < 34.5)$



# Solutionbank S2

## Edexcel AS and A Level Modular Mathematics

**Exercise B, Question 1**

**Question:**

The random variable $X \sim B(150, \frac{1}{3})$. Use a suitable approximation to estimate

**a** $P(X \leq 40)$,

**b** $P(X > 60)$,

**c** $P(45 \leq X \leq 60)$.

**Solution:**

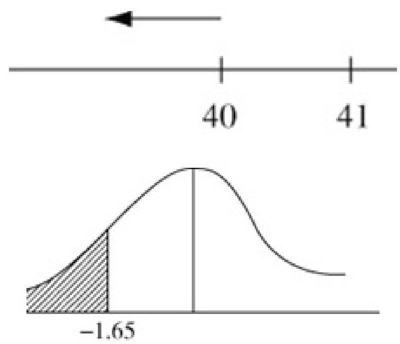
$X \sim B(150, \frac{1}{3})$

$Y \sim N(50, \sqrt{\frac{100}{3}}^2)$

$X \approx Y$

**a**

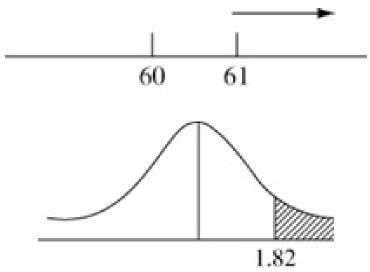
$$\begin{aligned} P(X \leq 40) &\approx P(Y < 40.5) \\ &= P\left(Z < \frac{40.5 - 50}{\sqrt{\frac{100}{3}}}\right) \\ &= P(Z < -1.645\ldots) \\ &= 1 - 0.9505 \\ &= 0.0495 \end{aligned}$$




$(\text{calc} = 0.0499\ldots)$

**b**

$$\begin{aligned} P(X > 60) &\approx P(Y > 60.5) \\ &= P(Z > 1.818\ldots) \\ &= 1 - 0.9656 \\ &= 0.0344 \end{aligned}$$




$(\text{calc} = 0.03448\ldots)$

So accept awrt 0.0340 (3 s.f.)

**c**

$$\begin{aligned} P(45 \leq X \leq 60) &\approx P(44.5 \leq Y < 60.5) \\ &= P(-0.95 \leq Z < 1.82) \\ &= 0.9656 - (1 - 0.8289) \\ &= 0.7945 \end{aligned}$$

$(\text{calc} = 0.79512\ldots)$

accept awrt 0.795

# Solutionbank S2

## Edexcel AS and A Level Modular Mathematics

**Exercise B, Question 2**

**Question:**

The random variable $X \sim \text{B}(200, 0.2)$. Use a suitable approximation to estimate

**a** $\text{P}(X < 45)$,

**b** $\text{P}(25 \le X < 35)$,

**c** $\text{P}(X = 42)$.

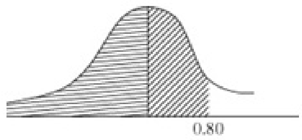
**Solution:**

$X \sim \text{B}(200, 0.2)$

$Y \sim \text{N}(40, \sqrt{32}^2)$ $\quad\quad X \approx Y$

**a**

$$\begin{aligned} \text{P}(X < 45) &\approx \text{P}(Y \le 44.5) \\ &= \text{P}\left(Z < \frac{44.5 - 40}{\sqrt{32}}\right) \\ &= \text{P}(Z < 0.7954\ldots) \\ &= 0.7881 \end{aligned}$$

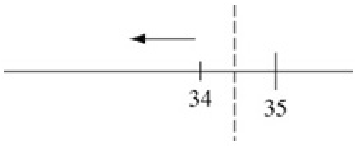


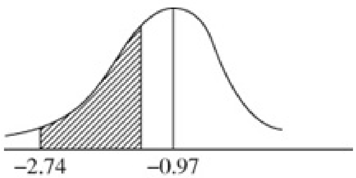

$(\text{calc} = 0.7868\ldots)$

So accept awrt $0.788 \sim 0.787$

**b**

$$\begin{aligned} \text{P}(25 \le X < 35) &= \text{P}(24.5 \le Y < 34.5) \\ &= \text{P}(-2.74 \le Z < -0.97\ldots) \\ &= [1 - 0.8340] - [1 - 0.9970] \\ &= 0.163 \end{aligned}$$



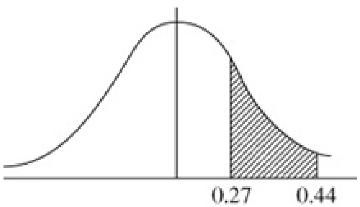




$(\text{calc} = 0.162386\ldots)$

so accept awrt $0.162 \sim 0.163$

**c**

$$\begin{aligned} \text{P}(X = 42) &= \text{P}(41.5 \le Y < 42.5) \\ &= \text{P}(0.265\ldots \le Z < 0.4419\ldots) \\ &= 0.6700 - 0.6064 \\ &= 0.0636 \end{aligned}$$




$(\text{calc} = 0.066175\ldots)$

so accept awrt $0.0640 \sim 0.0660$

# Solutionbank S2

## Edexcel AS and A Level Modular Mathematics

**Exercise B, Question 3**

**Question:**

The random variable $X \sim \mathrm{B}(100, 0.65)$. Use a suitable approximation to estimate

**a** $\mathrm{P}(X > 58)$,

**b** $\mathrm{P}(60 < X \leq 72)$,

**c** $\mathrm{P}(X = 70)$.

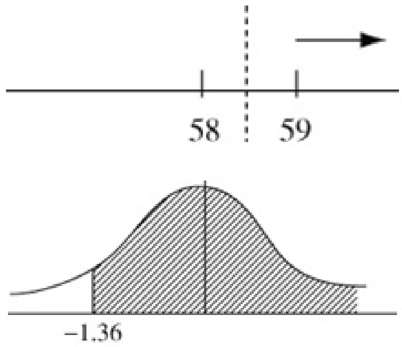
**Solution:**

$X \sim \mathrm{B}(100, 0.65)$

$Y \sim \mathrm{N}(65, \sqrt{22.75}^2)$ $\qquad X \approx Y$

**a**

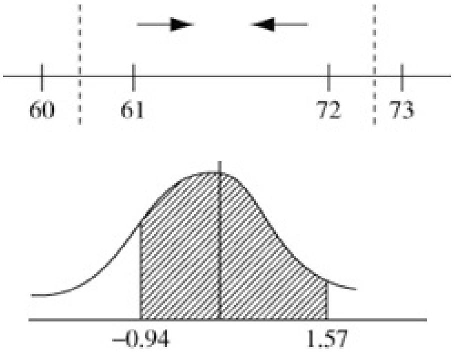
$$\begin{aligned} \mathrm{P}(X > 58) &\approx \mathrm{P}(Y > 58.5) \\ &= \mathrm{P}(Z > -1.36\ldots) \\ &= 0.9131 \end{aligned}$$




(calc $= 0.9135\ldots$)
So accept awrt $0.913 \sim 0.914$

**b**

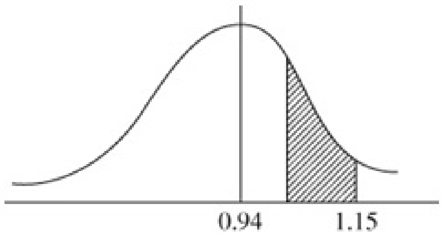
$$\begin{aligned} \mathrm{P}(60 < X \leq 72) &\approx \mathrm{P}(60.5 \leq Y < 72.5) \\ &= \mathrm{P}(-0.94 \leq Z < 1.57\ldots) \\ &= 0.9418 - (1 - 0.8264) \\ &= 0.7682 \end{aligned}$$




(calc $= 0.76935\ldots$)
So accept awrt $0.768 \sim 0.769$

**c**

$$\begin{aligned} \mathrm{P}(X = 70) &\approx \mathrm{P}(69.5 \leq Y < 70.5) \\ &= \mathrm{P}(0.943 \leq Z < 1.153\ldots) \\ &= 0.8749 - 0.8264 \\ &= 0.0485 \end{aligned}$$




(calc $= 0.04829\ldots$)
So accept awrt $0.0483 \sim 0.0485$

# Solutionbank S2
## Edexcel AS and A Level Modular Mathematics

**Exercise B, Question 4**

**Question:**

Sarah rolls a fair die 90 times. Use a suitable approximation to estimate the probability that the number of sizes she obtains is over 20.

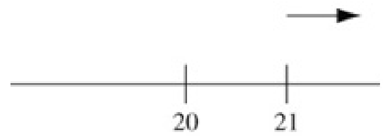
**Solution:**

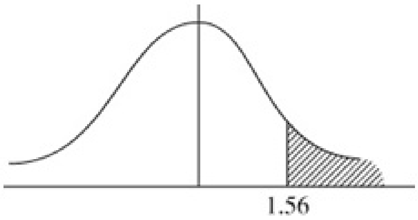
$X =$ number of sixes in 90 rolls

$X \sim B(90, \frac{1}{6})$

$Y \sim N(15, \sqrt{12.5}^2)$ $X \approx Y$

$$\begin{aligned} P(X > 20) &\approx P(Y \geq 20.5) \\ &= P\left(Z \geq \frac{20.5-15}{\sqrt{12.5}}\right) \\ &= P(Z \geq 1.555\ldots) \\ &= 1-0.9406 \\ &= 0.0594 \end{aligned}$$




(calc $= 0.059897\ldots$)

So accept awrt $0.059 \sim 0.060$

# Solutionbank S2
## Edexcel AS and A Level Modular Mathematics

**Exercise B, Question 5**

**Question:**

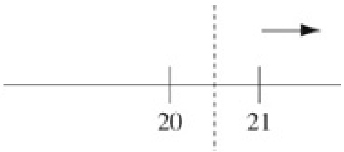
In a multiple choice test there are 4 possible answers to each question. Given that there are 60 questions on the paper, use a suitable approximation to estimate the probability of getting more than 20 questions correct if the answer to each question is chosen at random from the 4 available choices for each question.

**Solution:**

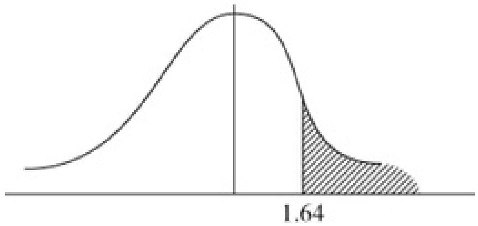
$X =$ number of correct answers

$X \sim \mathrm{B}(60, \frac{1}{4})$

$Y \sim \mathrm{N}(15, \sqrt{11.25}^2)$ $\qquad X \approx Y$




$$\begin{aligned} \mathrm{P}(X > 20) &\approx \mathrm{P}(Y \geq 20.5) \\ &= \mathrm{P}\left(Z \geq \frac{20.5 - 15}{\sqrt{11.25}}\right) \\ &= \mathrm{P}(Z \geq 1.639\ldots) \\ &= 1 - 0.9495 \\ &= 0.0505 \end{aligned}$$




(calc gives 0.050525…)
So accept awrt 0.0505

# Solutionbank S2
## Edexcel AS and A Level Modular Mathematics

**Exercise B, Question 6**

**Question:**

A fair coin is tossed 70 times. Use a suitable approximation to estimate the probability of obtaining more than 45 heads.

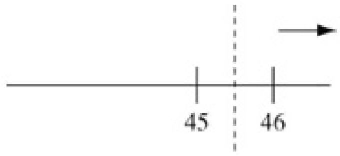
**Solution:**

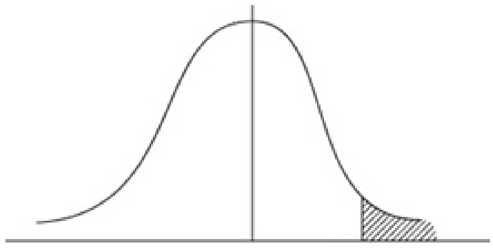
$X =$ number of heads in 70 tosses of a fair coin

$X \sim B(70, 0.5)$

$Y \sim N(35, \sqrt{17.5}^2)$ $\quad X \approx Y$

$$
\begin{aligned}
P(X > 45) &= P(Y \geq 45.5) \\
&= P\left(Z > \frac{45.5 - 35}{\sqrt{17.5}}\right) \\
&= P(Z > 2.5099\ldots) \\
&= 1 - 0.9940 \\
&= 0.0060
\end{aligned}
$$




(calc gives $0.006036\ldots$)

So accept awrt 0.006

# Solutionbank S2

## Edexcel AS and A Level Modular Mathematics

**Exercise C, Question 1**

**Question:**

The random variable $X \sim \text{Po}(30)$. Use a suitable approximation to estimate

**a** $\text{P}(X \leq 20)$,

**b** $\text{P}(X > 43)$,

**c** $\text{P}(25 \leq X \leq 35)$.

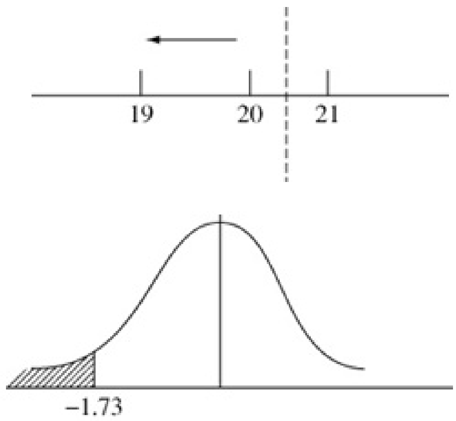
**Solution:**

$X \sim \text{Po}(30)$

$Y \sim \text{N}(30, \sqrt{30})$ $\quad\quad X \approx Y$

**a**

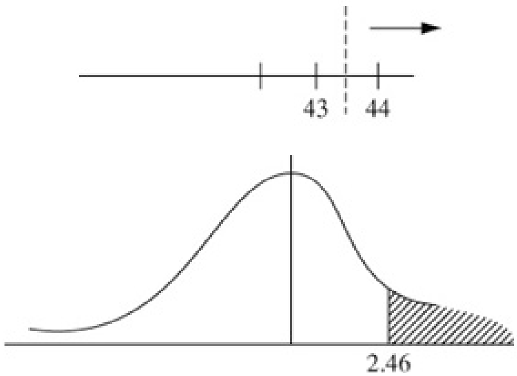
$$\begin{aligned} \text{P}(X \leq 20) &\approx \text{P}(Y \leq 20.5) \\ &= \text{P}\left(Z < \frac{20.5-30}{\sqrt{30}}\right) \\ &= \text{P}(Z < -1.7344\ldots) \\ &= 1-0.9582 \\ &= 0.0418 \end{aligned}$$




(calc gives 0.041418…)
So accept awrt 0.0410 ~ 0.0420

**b**

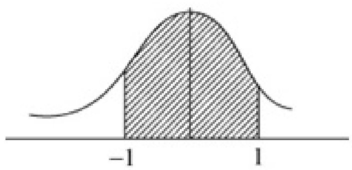
$$\begin{aligned} \text{P}(X > 43) &\approx \text{P}(Y > 43.5) \\ &= \text{P}\left(Z > \frac{43.5-30}{\sqrt{30}}\right) \\ &= \text{P}(Z > 2.46\ldots) \\ &= 1-0.9931 \\ &= 0.0069 \end{aligned}$$




(calc gives 0.006855…)
accept awrt 0.0069

**c**

$$\begin{aligned} \text{P}(25 \leq X \leq 35) &\approx \text{P}(24.5 \leq Y < 35.5) \\ &= \text{P}(-1.00 < Z < 1.00\ldots) \\ &= 2 \times 0.3413 \\ &= 0.6826 \end{aligned}$$




(calc gives 0.68469…)
accept awrt 0.683 ~ 0.685

# Solutionbank S2
## Edexcel AS and A Level Modular Mathematics

**Exercise C, Question 2**

**Question:**

The random variable $X \sim \text{Po}(45)$. Use a suitable approximation to estimate

**a** $\text{P}(X < 40)$,

**b** $\text{P}(X \geq 50)$,

**c** $\text{P}(43 < X \leq 52)$.

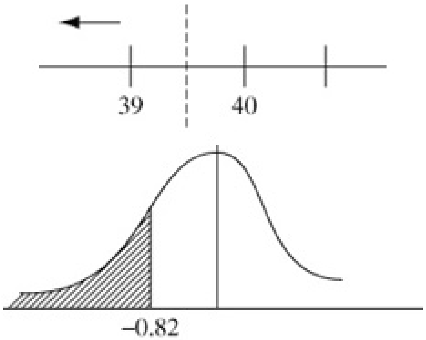
**Solution:**

$X \sim \mathrm{Po}(45)$

$Y \sim \mathrm{N}(45, \sqrt{45})$ $\quad\quad\quad\quad X \approx Y$

**a**

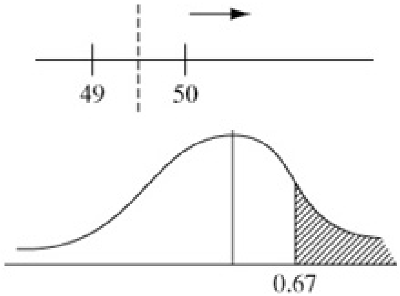
$$\begin{aligned} \mathrm{P}(X < 40) &\approx \mathrm{P}(Y \leq 39.5) \\ &= \mathrm{P}\left(Z < \frac{39.5-45}{\sqrt{45}}\right) \\ &= \mathrm{P}(Z < -0.819\ldots) \\ &= 1-0.7939 \\ &= 0.2061 \end{aligned}$$




(calc gives 0.20613…)
So accept awrt 0.206

**b**

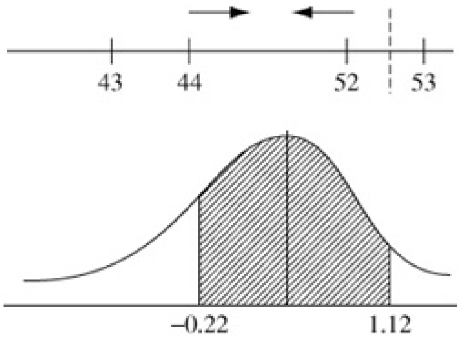
$$\begin{aligned} \mathrm{P}(X \geq 50) &\approx \mathrm{P}(Y \geq 49.5) \\ &= \mathrm{P}(Z \geq 0.6708\ldots) \\ &= 1-0.7486 \\ &= 0.2514 \end{aligned}$$




(calc gives 0.25116…)
So accept awrt 0.251

**c**

$$\begin{aligned} \mathrm{P}(43 < X \leq 52) &\approx \mathrm{P}(43.5 \leq Y < 52.5) \\ &= \mathrm{P}(-0.22\ldots \leq Z < 1.12\ldots) \\ &= 0.8686-(1-0.5871) \\ &= 0.4557 \end{aligned}$$




(calc gives 0.45669…)
So accept awrt 0.456 ~ 0.457

# Solutionbank S2
## Edexcel AS and A Level Modular Mathematics

**Exercise C, Question 3**

**Question:**

The random variable $X \sim \text{Po}(60)$. Use a suitable approximation to estimate

**a** $\text{P}(X \leq 62)$,

**b** $\text{P}(X = 63)$,

**c** $\text{P}(55 \leq X < 65)$.

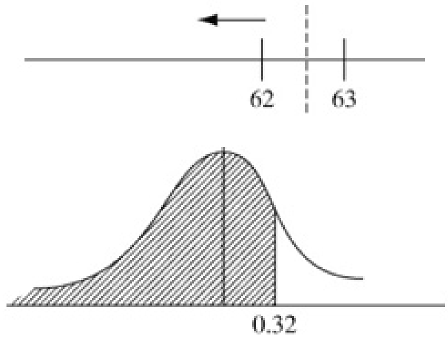
**Solution:**

$X \sim \text{Po}(60)$ $X \approx Y$

$Y \sim \text{N}(60, \sqrt{60}^2)$

**a**

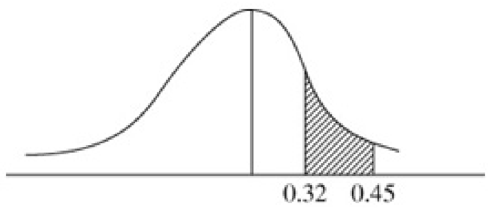
$$\begin{aligned} P(X \le 62) &\approx P(Y < 62.5) \\ &= P\left(Z < \frac{62.5 - 60}{\sqrt{60}}\right) \\ &= P(Z < 0.3227\ldots) \\ &= 0.6255 \end{aligned}$$




(calc gives 0.62655…)
So accept awrt 0.626 ~ 0.627

**b**

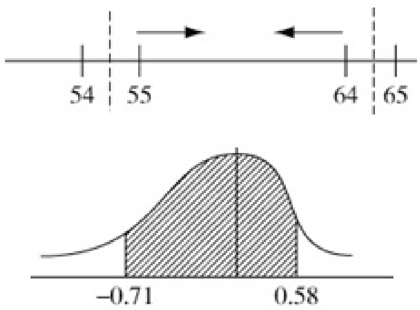
$$\begin{aligned} P(X = 63) &\approx P(62.5 \le Y < 63.5) \\ &= P(0.32\ldots \le Z < 0.45\ldots) \\ &= 0.6736 - 0.6255 \\ &= 0.0481 \end{aligned}$$




(calc gives 0.04775…)
So accept awrt 0.0480

**c**

$$\begin{aligned} P(55 \le X < 65) &= P(54.5 \le Y < 64.5) \\ &= P(-0.71\ldots \le Z < 0.58\ldots) \\ &= 0.7190 - (1 - 0.7611) \\ &= 0.4801 \end{aligned}$$




(Calc gives 0.48052…)
So accept awrt 0.480 ~ 0.481

# Solutionbank S2
## Edexcel AS and A Level Modular Mathematics

**Exercise C, Question 4**

**Question:**

The disintegration of a radioactive specimen is known to be at the rate of 14 counts per second. Using a normal approximation for a Poisson distribution, determine the probability that in any given second the counts will be

**a** 20, 21 or 22,

**b** greater than 10,

**c** above 12 but less than 16.

**Solution:**

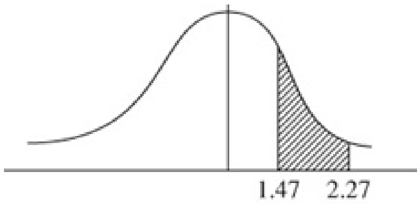
$X$ = number of counts in one second

$X \sim \text{Po}(14)$

$Y \sim \text{N}(14, \sqrt{14}^2)$ $\qquad X \approx Y$

**a**

$$\begin{aligned} \text{P}(20 \le X \le 22) &\approx \text{P}(19.5 \le Y < 22.5) \\ &= \text{P}(1.47 \le Z < 2.27\ldots) \\ &= 0.9884 - 0.9292 \\ &= 0.0592 \end{aligned}$$

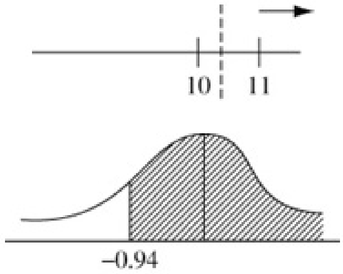



(calc gives 0.059237…)

So accept awrt 0.0590 ~ 0.0600

**b**

$$\begin{aligned} \text{P}(X > 10) &\approx \text{P}(Y \ge 10.5) \\ &= \text{P}(Z \ge -0.935\ldots) \\ &= 0.8264 \end{aligned}$$

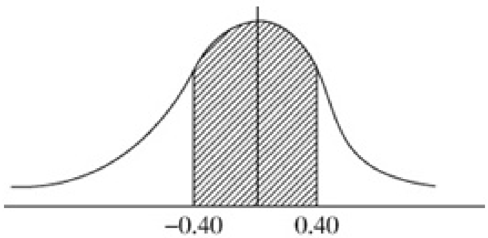



(calc gives 0.8252…)

So accept awrt 0.825 ~ 0.826

**c**

$$\begin{aligned} \text{P}(12 < X < 16) &\approx \text{P}(12.5 \le Y \le 15.5) \\ &= \text{P}(-0.40\ldots \le Z < 0.40\ldots) \\ &= 2 \times 0.1554 \\ &= 0.3108 \end{aligned}$$




(calc gives 0.311500…)

So accept awrt 0.311 ~ 0.312

# Solutionbank S2
## Edexcel AS and A Level Modular Mathematics

**Exercise C, Question 5**

**Question:**

A marina hires out boats on a daily basis. The mean number of boats hired per day is 15. Using the normal approximation for a Poisson distribution, find, for a period of 100 days

**a** how often 5 or fewer boats are hired,

**b** how often exactly 10 boats are hired,

**c** on how many days they will have to turn customers away if the marina owns 20 boats.

**Solution:**

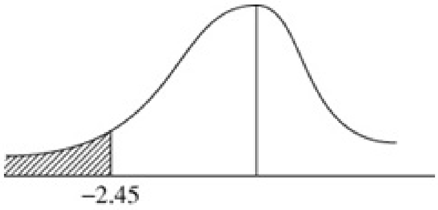
$X =$ number of boats hired per day

$X \sim \text{Po}(15)$

$Y \sim \text{N}(15, \sqrt{15}^2)$ $\quad\quad X \approx Y$

**a**

$$\begin{aligned} \text{P}(X \le 5) &\approx \text{P}(Y < 5.5) \\ &= \text{P}(Z < -2.452\ldots) \\ &= 1 - 0.9929 \\ &= 0.0071 \end{aligned}$$




(calc gives 0.00708…)

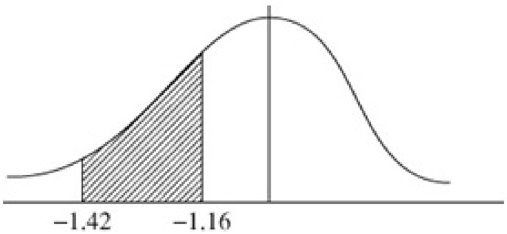
So accept awrt 0.0070 to 0.0071

i.e. in 100 days $\approx$ 0.7 times

i.e. 1 day

**b**

$$\begin{aligned} \text{P}(X = 10) &\approx \text{P}(9.5 \le Y < 10.5) \\ &= \text{P}(-1.42 \le Z < -1.16) \\ &= [1 - 0.8770] - [1 - 0.9222] \\ &= 0.0452 \end{aligned}$$




(calc gives 0.04484…)

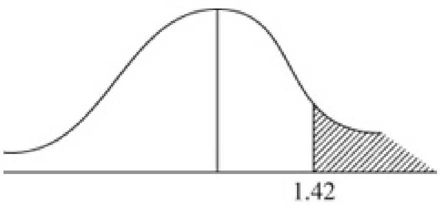
So accept awrt 0.045

i.e. in 100 days $\approx$ 4.5 days

i.e. 4 or 5 days

**c**

$$\begin{aligned} \text{P}(X > 20) &\approx \text{P}(Y > 20.5) \\ &= \text{P}(Z > 1.42\ldots) \\ &= 1 - 0.9222 \\ &= 0.0778 \end{aligned}$$




(calc gives 0.07779…)

So accept 0.078

i.e. in 100 days $\approx$ 7.8 days

i.e. 8 days

# Solutionbank S2
## Edexcel AS and A Level Modular Mathematics

**Exercise D, Question 1**

**Question:**

A fair die is rolled and the number of sixes obtained is recorded.
Using suitable approximations, find the probability of

**a** no more than 10 sixes in 48 rolls of the die,

**b** at least 25 sixes in 120 rolls of the die.

**Solution:**

**a** $X =$ number of sixes in 48 rolls of a die

$X \sim \mathrm{B}(48, \frac{1}{6})$

$Y \sim \mathrm{Po}(8)$ $\mu = 8$

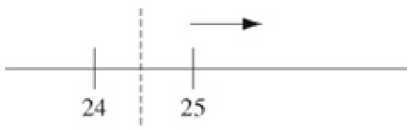
$$\begin{aligned} \mathrm{P}(X \le 10) &\approx \mathrm{P}(Y \le 10) \\ &= 0.8159 \quad \text{(Poisson tables)} \end{aligned}$$

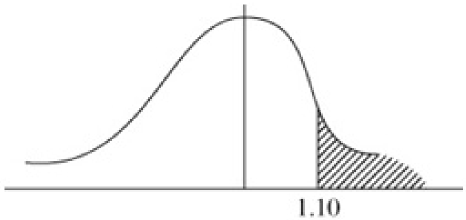
**b** $X =$ number of sixes in 120 rolls of a die

$X \sim \mathrm{B}(120, \frac{1}{6})$

$Y \sim \mathrm{N}(20, \sqrt{\frac{100}{6}}^2)$ or $Y \sim \mathrm{N}(20, \sqrt{\frac{50}{3}}^2)$ $\mu = 20$

$$\begin{aligned} \mathrm{P}(X \ge 25) &\approx \mathrm{P}(Y \ge 24.5) \\ &= \mathrm{P}(Z \ge 1.10\ldots) \\ &= 1 - 0.8643 \\ &= 0.1357 \end{aligned}$$




(calc gives 0.135172…)
So accept awrt $0.135 \sim 0.136$

# Solutionbank S2

## Edexcel AS and A Level Modular Mathematics

**Exercise D, Question 2**

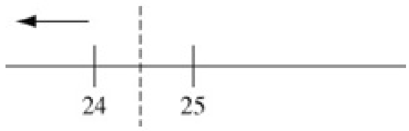
**Question:**

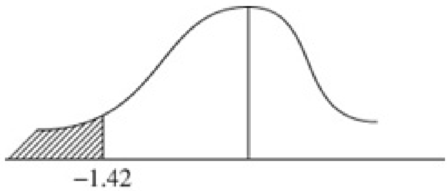
A fair coin is spun 60 times.
Use a suitable approximation to estimate the probability of obtaining fewer than 25 heads.

**Solution:**

$X =$ number of heads in 60 spins of a coin
$X \sim \mathrm{B}(60, 0.5)$
$Y \sim \mathrm{N}(30, \sqrt{15}^2)$ $X \approx Y$

$$\begin{aligned} \mathrm{P}(X < 25) &\approx \mathrm{P}(Y < 24.5) \\ &= \mathrm{P}(Z < -1.42\ldots) \\ &= 1 - 0.9222 \\ &= 0.0778 \end{aligned}$$




(calc gives 0.07779022…)
So accept awrt 0.0778

# Solutionbank S2

## Edexcel AS and A Level Modular Mathematics

**Exercise D, Question 3**

**Question:**

The owner of a local corner shop calculates that the probability of a customer buying a newspaper is 0.40 but the proportion of customers who spend over £10 is 0.04.
A random sample of 100 customer's shopping is recorded. Use suitable approximations to estimate the probability that in this sample

**a** at least half of the customers bought a newspaper,

**b** more than 5 of them spent over £10.

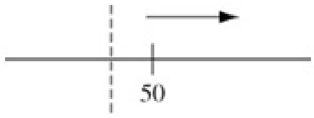
**Solution:**

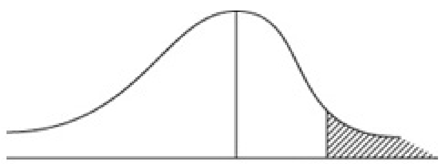
**a** $X =$ number of customers who bought a newspaper

$X \sim \text{B}(100, 0.40)$

$Y \sim \text{N}(40, \sqrt{24}^2)$ $\qquad X \approx Y$

$$\begin{aligned}
\text{P}(X \geq 50) &\approx \text{P}(Y \geq 49.5) \\
&= \text{P}\left(Z \geq \frac{49.5-40}{\sqrt{24}}\right) \\
&= \text{P}(Z \geq 1.939\ldots) \\
&= 1-0.9738 \\
&= 0.0262
\end{aligned}$$




calc gives 0.026239...
So accept awrt 0.0262

**b** $T =$ number of customers who spent over £10

$T \sim \text{B}(100, 0.04)$ $\qquad \mu = 4$

$S \approx \text{Po}(4)$

$T \approx S$

$$\begin{aligned}
\text{P}(T > 5) &\approx \text{P}(S \geq 6) && \text{(No continuity correction)} \\
&= 1-\text{P}(S \leq 5) \\
&= 1-0.7851 && \text{(Poisson tables)} \\
&= 0.2149
\end{aligned}$$

# Solutionbank S2

## Edexcel AS and A Level Modular Mathematics

**Exercise D, Question 4**

**Question:**

Street light failures in a town occur at a rate of one every two days. Assuming that $X$, the number of street light failures per week, has a Poisson distribution, find the probabilities that the number of street lights that will fail in a given week is

**a** exactly 2,

**b** less than 6.

Using a suitable approximation estimate the probability that

**c** there will be fewer than 45 street light failures in a 10-week period.

**Solution:**

$X \sim \text{Po}(3.5)$ ← $\lambda = 7 \times \frac{1}{2}$

**a**

$$\begin{aligned} P(X = 2) &= P(X \le 2) - P(X \le 1) \\ &= 0.3208 - 0.1359 \\ &= 0.1849 \end{aligned}$$

**b**

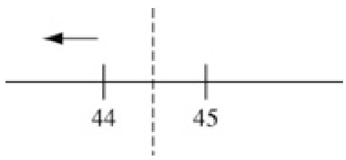
$$\begin{aligned} P(X < 6) &= P(X \le 5) \\ &= 0.8576 \end{aligned}$$

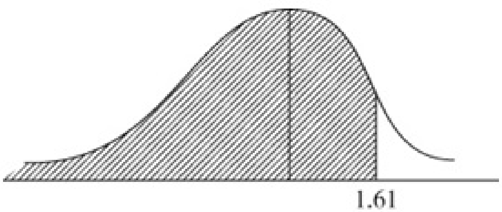
Let $Y =$ number of failures in 10-week period

$$\begin{aligned} Y &\sim \text{Po}(35) \\ W &\sim \text{N}(35, \sqrt{35}^2) \end{aligned}$$

**c**

$$\begin{aligned} P(Y < 45) &\approx P(W \le 44.5) \\ &= P\left(Z \le \frac{44.5 - 35}{\sqrt{35}}\right) \\ &= P(Z \le 1.605\ldots) \\ &= 0.9463 \end{aligned}$$




calc gives 0.945840…

So accept awrt 0.946

# Solutionbank S2

## Edexcel AS and A Level Modular Mathematics

**Exercise D, Question 5**

**Question:**

Past records from a supermarket show that 20% of people who buy chocolate bars buy the family size bar. A random sample of 80 people is taken from those who had bought chocolate bars.

**a** Use a suitable approximation to estimate the probability that more than 20 of these 80 bought family size bars.

The probability of a customer buying a gigantic chocolate bar is 0.02.

**b** Using a suitable approximation estimate the probability that fewer than 5 customers in a sample of 150 buy a gigantic chocolate bar.

**Solution:**

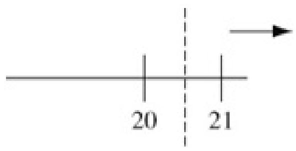
$X =$ number of people out of 80 who buy family size chocolate bars

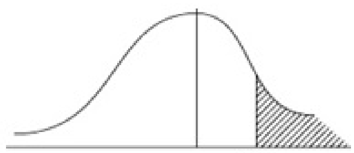
$X \sim \text{B}(80, 0.20)$

$Y \sim \text{N}(16, \sqrt{12.8}^2)$

**a**

$$\begin{aligned} \text{P}(X > 20) &\approx \text{P}(Y \geq 20.5) \\ &= \text{P}\left(Z \geq \frac{20.5 - 16}{\sqrt{12.8}}\right) \\ &= \text{P}(Z \geq 1.2577\ldots) \\ &= 1 - 0.8962 \\ &= 0.1038 \end{aligned}$$




calc gives 0.104234…

So accept awrt 0.104

**b** $G =$ number who buy a gigantic bar of chocolate

$G \sim \text{B}(150, 0.02)$ ← $\mu = 150 \times 0.02 = 3$

$H \sim \text{Po}(3)$ $G \approx H$

$$\begin{aligned} \text{P}(G < 5) &\approx \text{P}(H < 5) && \text{(No continuity correction)} \\ &= \text{P}(H \leq 4) \\ &= 0.8153 && \text{(Poisson tables)} \end{aligned}$$