Pearson Edexcel

Additional Assessment Materials

Summer 2021

Pearson Edexcel GCE in As Mathematics

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Resource Set 1: Topic 5

Statistical hypothesis

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Additional Assessment Materials, Summer 2021

General guidance to Additional Assessment Materials for use in 2021

Context

- Additional Assessment Materials are being produced for GCSE, AS and A levels (with the exception of Art and Design).
- The Additional Assessment Materials presented in this booklet are an optional part of the range of evidence teachers may use when deciding on a candidate's grade.
- 2021 Additional Assessment Materials have been drawn from previous examination materials, namely past papers.
- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.

Purpose

- The purpose of this resource to provide qualification-specific sets/groups of questions covering the knowledge, skills and understanding relevant to this Pearson qualification.
- This document should be used in conjunction with the mapping guidance which will map content and/or skills covered within each set of questions.
- These materials are only intended to support the summer 2021 series.

1. Naasir is playing a game with two friends. The game is designed to be a game of chance so that the probability of Naasir winning each game is $\frac{1}{3}$.

Naasir and his friends play the game 15 times.

(a) Find the probability that Naasir wins

(i) exactly 2 games,

$X \sim B(15, 1/3)$

(3)

$P(X = 2) = 0.0599460 2934$

$= 0.0599 \; (3sf)$

(ii) more than 5 games.

$P(X > 5) = 1 - P(X \leq 5)$

$1 - 6183718414$

$= 0.3816281586$

$= 0.382 \; (3sf)$

Naasir claims he has a method to help him win more than $\frac{1}{3}$ of the games. To test this claim, the three of them played the game again 32 times and Naasir won 16 of these games.

(b) Stating your hypotheses clearly, test Naasir's claim at the 5% level of significance.

(4)

$H_0: p = 1/3$

$H_1: p > 1/3$

p is the probabuly of Naasir winming a game.

x = number of games won

$X \sim B(32, 1/3)$

$P(X \geq 16) = 1 - P(X \leq 15)$

$= 1 - 0.9623466642$

$= 0.03765... = 0.0377 \; (3sf)$

$0.0377 < 0.05$

the nesult is significant

There is suffcient evidence to reject Ho, would suggest that the probabuly of Naasir winning a game is more than 1/3.

(Total for Question 1 is 7 marks)

2. The discrete random variable $X \sim B(40, 0.27)$.

(*a*) Find $P(X \geq 16)$. **(2)**

$P(x \geq 16) = 1 - P(x \leq 15)$

$= 1 - 0.9490771841$

$= 0.0509228159$

$\approx \underline{0.0509}$ (3sf)

Past records suggest that 30% of customers who buy baked beans from a large supermarket buy them in single tins. A new manager suspects that there has been a change in the proportion of customers who buy baked beans in single tins. A random sample of 20 customers who had bought baked beans was taken.

(*b*) Write down the hypotheses that should be used to test the manager's suspicion. **(1)**

$H_0 : p = 0.3$, $H_1 : p \neq 0.3$

(*c*) Using a 10% level of significance, find the critical region for a two-tailed test to answer the manager's suspicion. You should state the probability of rejection in each tail, which should be less than 0.05 **(3)**

$X \sim B(20, 0.3)$

(TRIAL + IMPROVEMENT)

LOWER TAIL:

$P(x \leq 2) = 0.0354881323 = 0.0355$ (3sf) ✓

$P(x \leq 1) = 0.00763\ldots$ ×

$P(x \leq 8) = 0.1070\ldots$ ×

$\therefore$ Region is

$x \leq 2$ or $x \geq 10$

UPPER TAIL

$P(x \leq 8) = 0.8866685372$ ×

$P(x \leq 9) = 0.9820381021$ ✓ → $P(x \leq 9) = P(x \geq 10$

$P(x \leq 10) = 0.9828551083S$ × **(3)**

(*d*) Find the actual significance level of a test based on your critical region from part (*c*). **(1)**

$1 - P(x \leq 9) = 0.04796\ldots = 0.0480$ (3sf)

$0.0355 + 0.0480 = 0.0885$

One afternoon the manager observes that 12 of the 20 customers who bought baked beans, bought their beans in single tins.

(*e*) Comment on the manager's suspicion in the light of this observation. **(1)**

12 is in the critical region, therefore sufficient evidence to reject Ho, would suggest the manager is correct and the number of customers who buy baked beans in single tins has changed

Later it was discovered that the local scout group visited the supermarket that afternoon to buy food for their camping trip.

(*f*) Comment on the validity of the model used to obtain the answer to part (*e*), giving a reason for your answer. **(1)**

The validity is questionable as the sample of shoppers should be random but a group coming in changes that, as they are not representative of all the shoppers.

(Total for Question 2 is 9 marks)

3. Past records show that 15% of customers at a shop buy chocolate. The shopkeeper believes that moving the chocolate closer to the till will increase the proportion of customers buying chocolate.

After moving the chocolate closer to the till, a random sample of 30 customers is taken and 8 of them are found to have bought chocolate.

Julie carries out a hypothesis test, at the 5% level of significance, to test the shopkeeper's belief.

Julie's hypothesis test is shown below.

$H_0 : p = 0.15$

$H_1 : p \geqslant 0.15$

Let X = the number of customers who buy chocolate.

$X \sim B(30, 0.15)$

$P(X = 8) = 0.0420$

$0.0420 < 0.05$ so reject H_0

There is sufficient evidence to suggest that the proportion of customers buying chocolate has increased.

(*a*) Identify the first two errors that Julie has made in her hypothesis test.

(2)

$H_1 : p \geqslant 0.15$ should be $H_1 : p > 0.15$

The test statistic should be $P(X \geq 8)$ not $P(X = 8)$

(*b*) Explain whether or not these errors will affect the conclusion of her hypothesis test. Give a reason for your answer.

(1)

$P(X \geq 8) = 1 - P(X \leq 7) = 0.06978$, the error will affect the conclusion is $0.069 > 0.05$ so the null hypothesis shouldn't be rejected

(*c*) Find, using a 5% level of significance, the critical region for a one-tailed test of the shopkeeper's belief. The probability in the tail should be less than 0.05

(2)

TRIAL + IMPROVEMENT

$P(X \leq 7) = 0.9302 < 0.95$ ✗

$P(X \leq 8) = 0.9722 > 0.95$ ✓

$P(X \geq 9) = 1 - P(X \leq 8) = 0.0278 < 0.05$ ✓

$\therefore$ critical region is $\{X \geqslant 9\}$

(*d*) Find the actual level of significance of this test.

(1)

0.0278 (3 sf)

(Total for Question 3 is 6 marks)