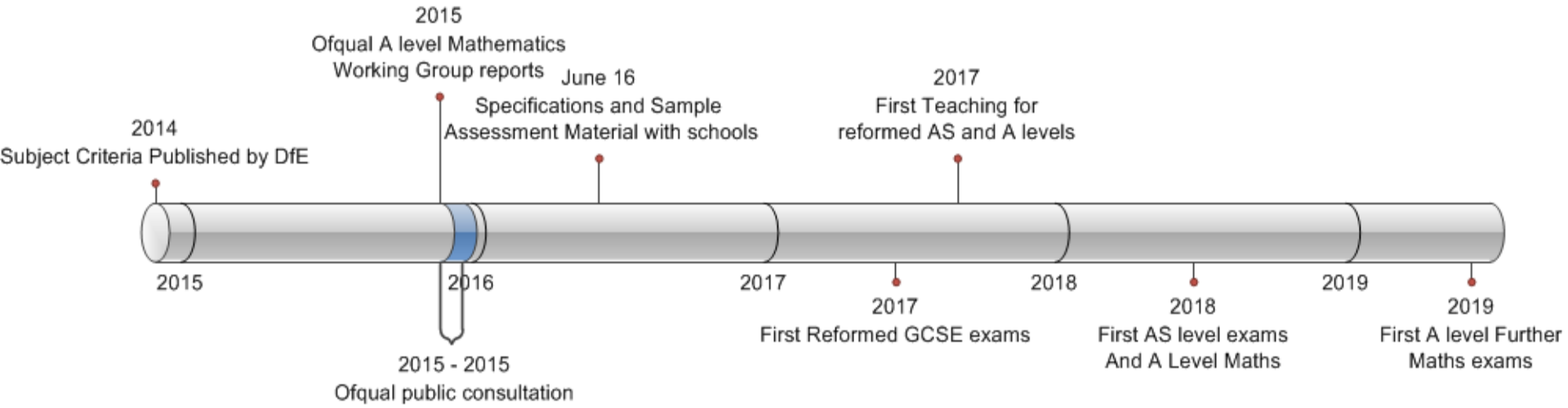
OCR
Oxford Cambridge and RSA

Statistics content and changes in the new mathematics AS and A Level

Development timeline



AS and A Level Maths

- A choice of specifications…
  - **Mathematics and Further Mathematics A**, developed by OCR
  - **Mathematics and Further Mathematics B (MEI)**, developed in collaboration with MEI.

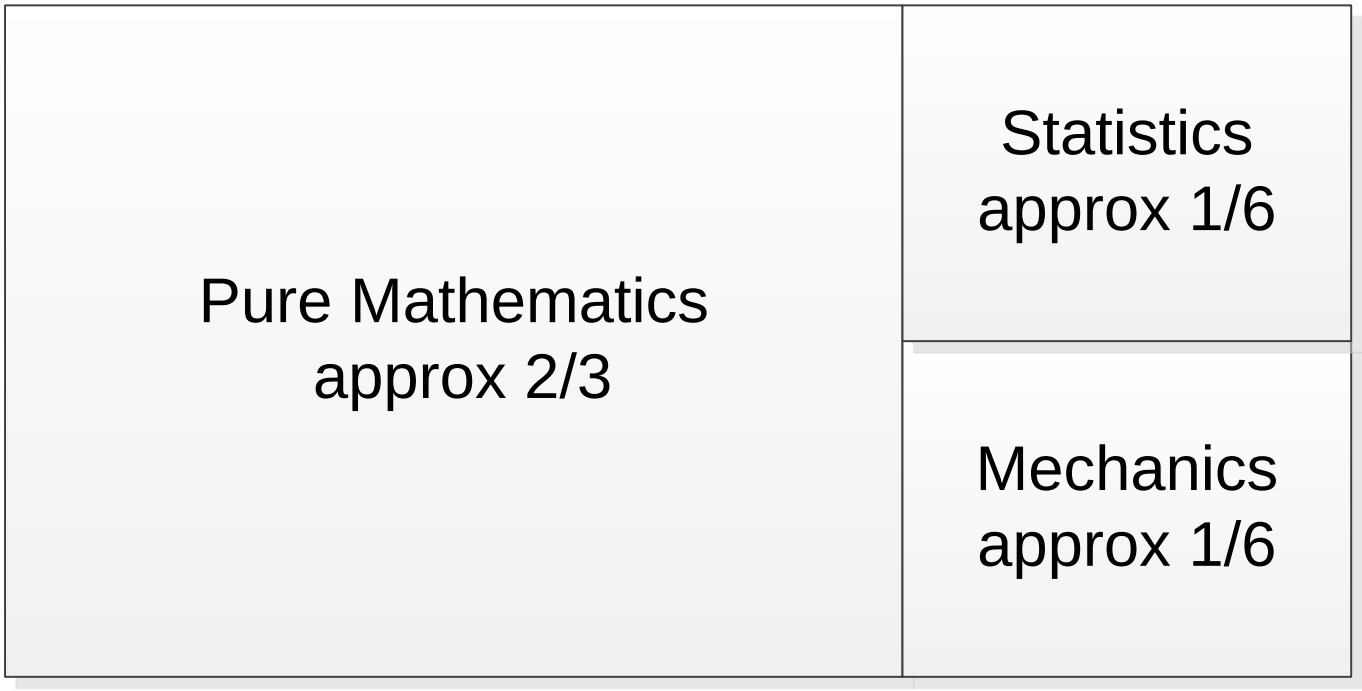
Overview

- The grade-set will stay the same: A* - E for A level and A - E for AS level.
- There will be no coursework in either Mathematics or Further Mathematics.
- The AS content will be a subset of the A level content. AS and A level qualifications must be co-teachable, so that AS and A level Mathematics can be taught together in year 12 and Further Mathematics can be studied in parallel with Mathematics.

Four Big Changes
(Maths)

- Moving to linear
- Large Data Set
- Technology
- Teaching Mechanics for the first time

AS and A Level Maths



OCR AS and A level Mathematics A

AS level

1 hour 30 mins
75 marks

ACCREDITED

Pure and **Statistics**

Pure and **Mechanics**

A Level

2 hours
100 marks

Pure

Pure and **Statistics**

Pure and **Mechanics**

OCR AS and A level Mathematics B (MEI)

AS level

1 hour 30 mins
75 marks

ACCREDITED

Pure and **Mechanics**

Pure And **Statistics**

A Level

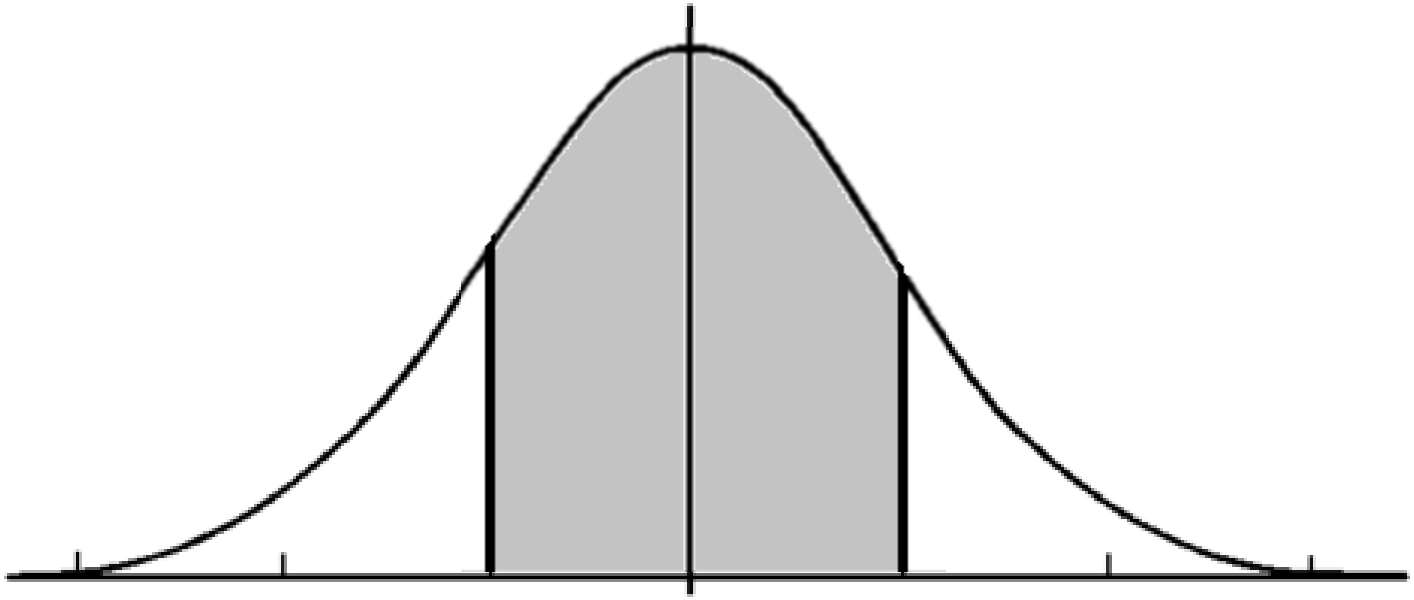
2 hours
P1+2 100 marks
P3 75 marks

Pure and **Mechanics**

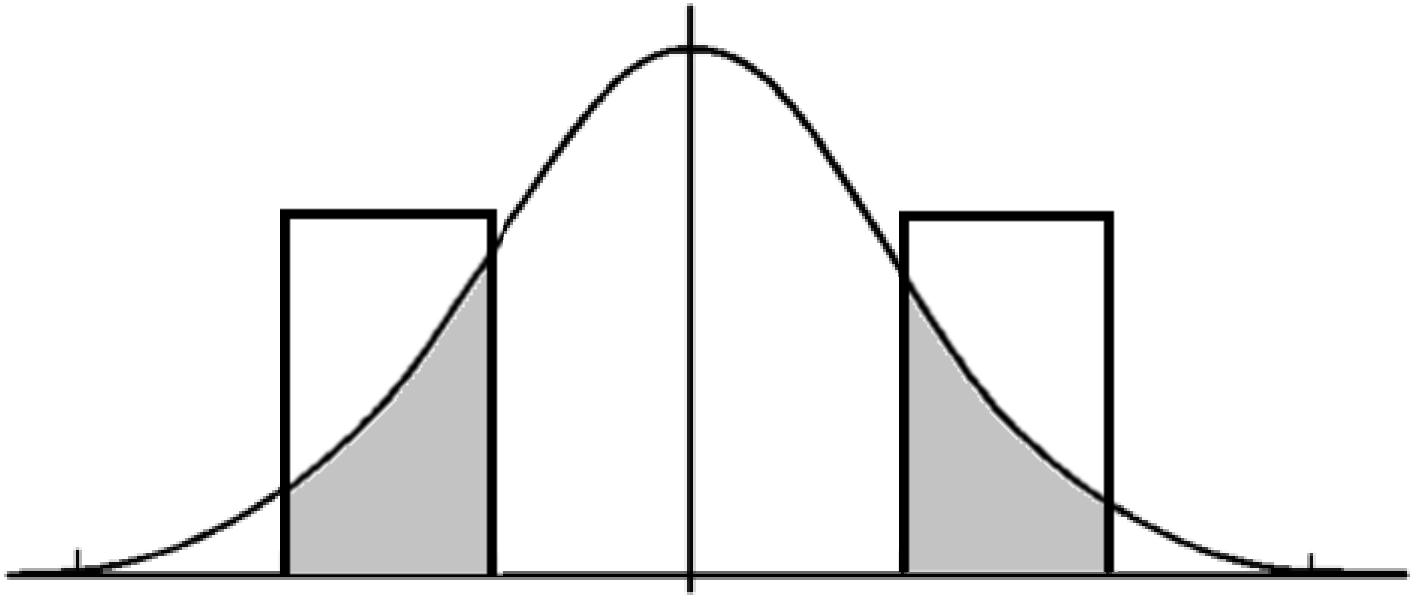
Pure and **Statistics**

Pure and **Comprehension**

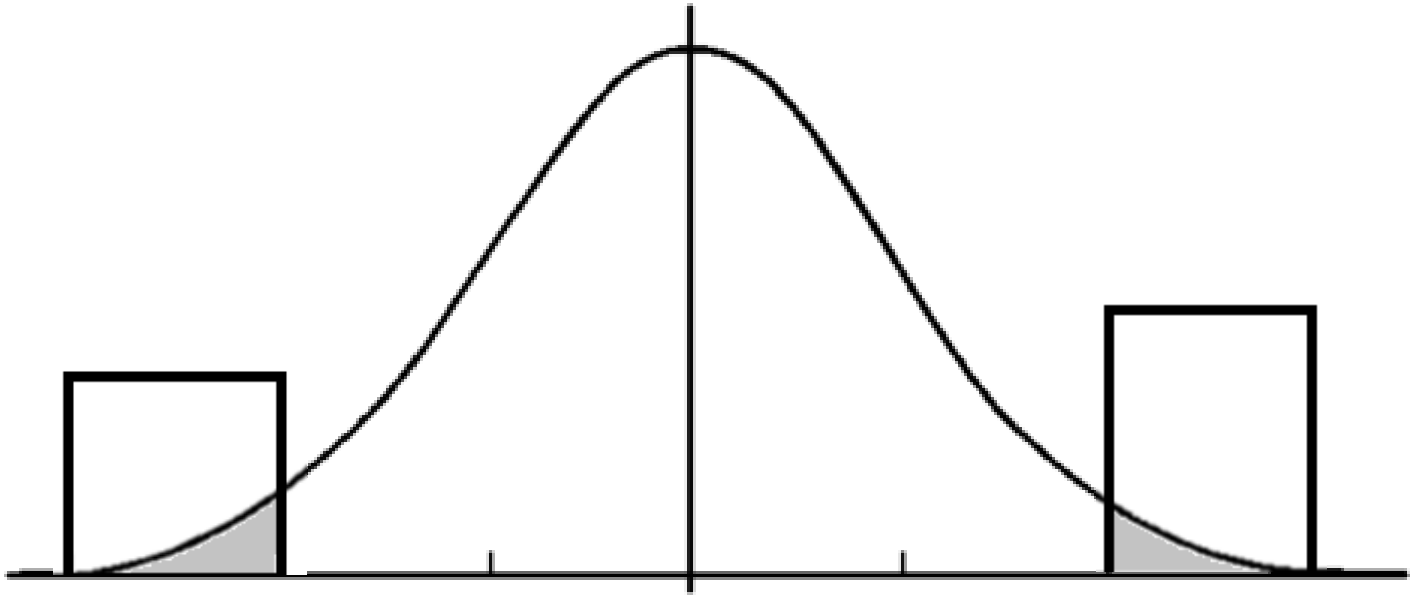
Hypothesis tests



Hypothesis tests



Hypothesis tests



Hypothesis tests

In the ideal hypothesis test, the following steps will be taken, in this order:

1. Establish the null and alternative hypotheses
2. Decide on the significance level
3. Collect suitable data using a random sampling procedure that ensures the items are independent
4. Conduct the test, doing the necessary calculations
5. Interpret the results in terms of the original claim, conjecture or problem

There are two types of hypothesis testing for the new qualifications

- Binomial (AS & A Level maths)
- Normal (A Level maths)

Hypothesis tests - H630/02 OCR B (MEI)

10 A company operates trains. The company claims that 92% of its trains arrive on time. You should assume that in a random sample of trains, they arrive on time independently of each other.

(i) Assuming that 92% of the company's trains arrive on time, find the probability that in a random sample of 30 trains operated by this company

(*A*) exactly 28 trains arrive on time, **[2]**

(*B*) more than 27 trains arrive on time. **[2]**

A journalist believes that the percentage of trains operated by this company which arrive on time is lower than 92%.

(ii) To investigate the journalist's belief a hypothesis test will be carried out at the 1% significance level. A random sample of 18 trains is selected. For this hypothesis test,

- state the hypotheses,
- find the critical region. **[5]**

Hypothesis tests - H630/02 OCR B (MEI)

10 A company operates trains. The company claims that 92% of its trains arrive on time. You should assume that in a random sample of trains, they arrive on time independently of each other.

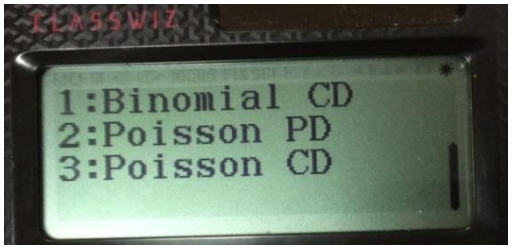
A journalist believes that the percentage of trains operated by this company which arrive on time is lower than 92%.

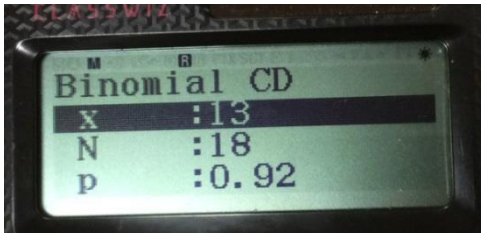
(ii) To investigate the journalist's belief a hypothesis test will be carried out at the 1% significance level. A random sample of 18 trains is selected. For this hypothesis test,

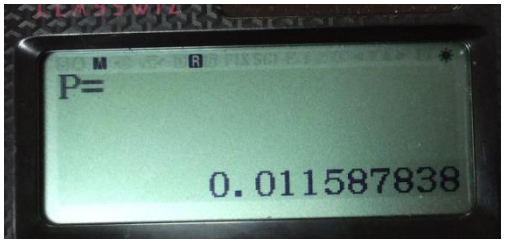
- state the hypotheses,
- find the critical region. **[5]**

Let p = probability that a train arrives on time	**B1**	**2.5**	For definition of p	
H_0: $p = 0.92$	**B1**	**1.1**	For H_0 and H_1	
H_1: $p < 0.92$				
Let $X \sim B(18, 0.92)$				
$P(X \leq 13) = 0.0116$ [> 1%]	**M1**	**1.1**	For probability $P(X \leq$ any whole number value 1 to 18),	Allow FT from H_1: $p < 0.92$ OR H_1: $p \neq 0.92$
$P(X \leq 12) = 0.0021$ [< 1%]	**M1**	**1.1**	Both $P(X \leq 13)$ and $P(X \leq 12)$	
The critical region is $X \leq 12$	**A1**	**2.2a**	For correct critical region stated	
	[5]			

Hypothesis tests - H630/02 OCR B (MEI)







Let p = probability that a train arrives on time	**B1**	**2.5**	For definition of p	
H_0: $p = 0.92$	**B1**	**1.1**	For H_0 and H_1	
H_1: $p < 0.92$				
Let $X \sim B(18, 0.92)$				
$P(X \leq 13) = 0.0116$ [> 1%]	**M1**	**1.1**	For probability $P(X \leq$ any whole number value 1 to 18),	Allow FT from H_1: $p < 0.92$ OR H_1: $p \neq 0.92$
$P(X \leq 12) = 0.0021$ [< 1%]	**M1**	**1.1**	Both $P(X \leq 13)$ and $P(X \leq 12)$	
The critical region is $X \leq 12$	**A1**	**2.2a**	For correct critical region stated	
	[5]			

Hypothesis tests - H640/02 OCR B (MEI)

The company also manufactures 'Ultrapower' batteries, which are stated to have a mean lifetime of 210 minutes.

(v) A random sample of 8 Ultrapower batteries is selected. The mean lifetime of these batteries is 207.3 minutes. Carry out a hypothesis test at the 5% level to investigate whether the mean lifetime is as high as stated. You should use the following hypotheses $H_0 : \mu = 210$, $H_1 : \mu < 210$, where μ represents the population mean for Ultrapower batteries. You should assume that the population is Normally distributed with standard deviation 3.4. **[5]**

Either			
Test statistic $= \dfrac{207.3-210}{3.4/\sqrt{8}} = -2.246$	**M1**	**3.4**	Must include $\sqrt{8}$
Lower 5% level 1 tailed critical value of $z = -1.645$	**A1**	**1.1**	
$-2.246 < -1.645$ so significant	**B1**	**1.1**	For comparison leading to correct conclusion
or			
Under H_0, $\overline{X} \sim N\left(210, \dfrac{3.4^2}{8}\right)$	**M1**	**3.4**	
$P\left(\overline{X} \leq 207.3\right) = 0.01235$	**A1**	**1.1**	**BC**
$0.01235 < 0.05$ so significant	**B1**	**1.1**	
There is sufficient evidence to reject H_0	**A1**	**2.2b**	
There is sufficient evidence to conclude that the mean lifetime is less than 210 minutes.	**E1**	**2.4**	
	[5]		

Formulae pages

OCR AS Mathematics A

The binomial distribution

If $X \sim \mathrm{B}(n, p)$ then $P(X = x) = \binom{n}{x} p^x (1-p)^{n-x}$, Mean of X is np, Variance of X is $np(1-p)$

OCR AS Mathematics B (MEI)

The binomial distribution

If $X \sim \mathrm{B}(n, p)$ then $P(X = r) = {}^{n}\mathrm{C}_{r} p^r q^{n-r}$ where $q = 1 - p$

Mean of X is np

OCR A Mathematics A

The binomial distribution

If $X \sim \mathrm{B}(n, p)$ then $P(X = x) = \binom{n}{x} p^x (1-p)^{n-x}$, Mean of X is np, Variance of X is $np(1-p)$

Hypothesis test for the mean of a normal distribution

If $X \sim \mathrm{N}(\mu, \sigma^2)$ then $\bar{X} \sim \mathrm{N}\left(\mu, \frac{\sigma^2}{n}\right)$ and $\frac{\bar{X} - \mu}{\sigma / \sqrt{n}} \sim \mathrm{N}(0, 1)$

Percentage points of the normal distribution

If Z has a normal distribution with mean 0 and variance 1 then, for each value of p, the table gives the value of z such that $P(Z \leq z) = p$.

p	0.75	0.90	0.95	0.975	0.99	0.995	0.9975	0.999	0.9995
z	0.674	1.282	1.645	1.960	2.326	2.575	2.807	3.090	3.291

OCR A Mathematics B (MEI)

The binomial distribution

If $X \sim \mathrm{B}(n, p)$ then $\mathrm{P}(X = r) = {}^{n}\mathrm{C}_{r} p^r q^{n-r}$ where $q = 1 - p$

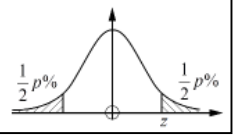
Mean of X is np

Hypothesis testing for the mean of a Normal distribution

If $X \sim \mathrm{N}(\mu, \sigma^2)$ then $\bar{X} \sim \mathrm{N}\left(\mu, \frac{\sigma^2}{n}\right)$ and $\frac{\bar{X} - \mu}{\sigma / \sqrt{n}} \sim \mathrm{N}(0, 1)$

Percentage points of the Normal distribution

p	10	5	2	1
z	1.645	1.960	2.326	2.575



Large Data Set

Teaching and Learning tasks
(a non-exhaustive list)

1. Exploratory data analysis
2. Modelling
3. Repeated sampling
4. Hypothesis testing

Large Data Set

In the exam…..

Questions will be set that give a material advantage to learners who have studied, and are familiar with, the large data set.

They might include questions/tasks which:

- assume familiarity with the terminology and contexts of the data,
- use summary statistics or selected data from, or statistical diagrams based on, the prescribed large data set
- are based on samples related to the contexts in the prescribed large data set,
- require learners to interpret data in ways which would be too demanding in an unfamiliar context.

ocr.org.uk/maths

ocr.org.uk/alevelmaths

maths@ocr.org.uk

01223 553998

OCR Maths podcast on iTunes

@OCR_Maths