AP STATISTICS · INFERENCE

Inference for Means

Confidence intervals and t-tests for one mean, matched pairs and two samples

21
past-paper questions

5
topic sections

59
slides in total

Built from the Inference for Means past-paper booklet

How this lesson runs

Key concept, worked example, questions to try — then true or false

Starter	Three quick recall questions on sampling distributions — attempt before the reveal.
Key points	Each section opens with a summary of the ideas you need, main point highlighted first.
Question	Questions appear on their own slides. Attempt each before turning the page.
Solution	The next slide gives the condensed solution with the state–plan–do–conclude cycle.
True or false	The lesson ends with eight statements — one per slide, answer on the slide that follows.

Key topic · Inference for means

What this lesson is about, in one page

The skill	Estimate and test claims about population means using t-procedures: one sample, matched pairs, and two samples.
The routine	State the hypotheses, plan and check conditions, do the mechanics, conclude in context — every single time.
The choice	Matched pairs and one mean → one-sample t. Two independent groups → two-sample t.
The reading	Confidence intervals estimate; significance tests decide. Interpret both in the context of the problem.

Vocabulary

Key terms with Chinese translations

population mean	□□□□	the parameter μ we want to know
sample mean	□□□□	the statistic $\bar{x}$ we calculate
confidence interval	□□□□	estimate of a parameter with a confidence level
significance test	□□□□□	uses a p-value to decide between hypotheses
null hypothesis	□□□	H_0: the claim of no difference or no change
alternative hypothesis	□□□□	H_a: what we suspect instead
standard error	□□□□	estimated spread of the sampling distribution
degrees of freedom	□□□	df = n − 1 for one sample; Welch for two
matched pairs	□□□□	two measurements on the same unit, differ them
p-value	**p** □	probability of a result this extreme if H_0 is true

S

Starter · Sampling distributions of means

What you must remember before doing inference

- Three quick recall questions
- Centre, spread and shape of the distribution of $\bar{x}$

Key points · sampling distributions of means

The three facts inference is built on

1. **Centre** — The mean of the sampling distribution of $\bar{x}$ equals the population mean μ. No adjustment, no surprise.
2. **Spread** — The standard deviation of $\bar{x}$ is $\sigma/\sqrt{n}$ — bigger samples give less variable sample means.
3. **Shape** — For $n \geq 30$ the Central Limit Theorem makes the distribution of $\bar{x}$ approximately normal, whatever the population shape.
4. **Difference of means** — For two independent samples, $\mu(\bar{x}_1 - \bar{x}_2) = \mu_1 - \mu_2$. Means subtract, just like the data.

Question S1

1 mark

Starter · Sampling distributions

THE QUESTION

A fair six-sided die, with sides numbered 1 through 6, will be rolled a total of 15 times. Let x_1 represent the average of the first ten rolls, and let x_2 represent the average of the remaining five rolls. What is the mean $\mu(x_1 - x_2)$ of the sampling distribution of the difference in sample means $x_1 - x_2$?

(A) $3.5/10 - 3.5/5 = -0.35$

(B) $3.5 - 3.5 = 0$

(C) $10 - 5 = 5$

(D) $10(3.5) - 5(3.5) = 17.5$

Question S1 — solution

1 mark

Starter · Sampling distributions

CONDENSED SOLUTION

- The mean of a sample mean equals the population mean: $\mu(\bar{x}) = \mu = 3.5$ for a fair die.
- So $\mu(x_1 - x_2) = \mu(x_1) - \mu(x_2) = 3.5 - 3.5 = 0$.
- Answer: (B).
- The sample sizes 10 and 5 affect the SPREAD of each sample mean, never the CENTRE.

TRAP Sample size changes variability, not the mean. Dividing by n (A) confuses the SD formula with the mean.

Question S2

1 mark

Starter · Sampling distributions

THE QUESTION

For which of the following conditions is it not appropriate to assume that the sampling distribution of the sample mean is approximately normal?
(A) A random sample of 8 taken from a normally distributed population
(B) A random sample of 10 taken from a population distribution that is skewed to the right
(C) A random sample of 75 taken from a population distribution that is skewed to the left
(D) A random sample of 100 taken from a population that is uniform

Question S2 — solution

1 mark

Starter · Sampling distributions

CONDENSED SOLUTION

- Two routes to approximate normality: the population is normal, or n ≥ 30 (CLT).
- (A) n = 8 but the population is normal — fine. (C) n = 75 — CLT applies. (D) n = 100 — CLT applies.
- (B) n = 10 with a skewed population satisfies neither route.
- Answer: (B).

TRAP Check both routes before assuming normality. A small sample from a skewed population is the classic fail.

01

One-sample t-interval

Estimating a single mean

- “We are C% confident that the true mean is between … and …”
- Small samples need normality; df = n − 1

Key points · one-sample t-interval

Estimate μ with an interval, then interpret in context

1	**The interval**	$\bar{x} \pm t^*(s/\sqrt{n})$, with df = n − 1. Use t, never z, when σ is estimated by s.
2	**The interpretation**	“We are C% confident that the true mean of [population] is between [lo] and [hi] [units].”
3	**Conditions**	Random sample · n < 10% of the population · normal population or n ≥ 30.
4	**Claims and intervals**	A claimed value inside the interval is plausible; outside it, the data do not support the claim.

Question 1

1 mark

One-sample t-interval

THE QUESTION

A 95 percent confidence interval for the mean weight, in thousands of pounds, of African bush elephants is determined to be (12.2, 14.6).
Which of the following is a correct interpretation of the interval?
(A) We are 95% confident that 95% of African bush elephants weigh between 12.2 thousand pounds and 14.6 thousand pounds.
(B) The probability is 0.95 that the population mean weight of African bush elephants is between 12.2 and 14.6 thousand pounds.
(C) We are 95% confident that the population mean weight of African bush elephants is between 12.2 and 14.6 thousand pounds.
(D) We are 95% confident that the mean weight calculated from a different sample would be between 12.2 and 14.6 thousand pounds.

Question 1 — solution

1 mark

One-sample t-interval

CONDENSED SOLUTION

- Answer: (C).
- The interval estimates ONE number: the population mean μ.
- (A) talks about individual elephants — the interval is not a claim about individuals.
- (B) treats μ as random; μ is fixed, the interval varies from sample to sample.
- (D) is about a future sample mean, not the population mean.

TRAP The only correct template: “We are C% confident that the true/population MEAN … is between … and …”.

Question 2

2 marks

One-sample t-interval

THE QUESTION

A random sample of 7 baby orca whales has a sample mean weight of 430 pounds and a sample standard deviation of 26.9 pounds. Assuming that all conditions for inference have been met, which of the following represents a 90% confidence interval for the population mean weight of all baby orca whales?

(A) $430 \pm 1.645(26.9)$

(B) $430 \pm 1.943(26.9/\sqrt{7})$

(C) $430 \pm 1.895(26.9/\sqrt{7})$

(D) $430 \pm 1.943(26.9/\sqrt{7})$

Question 2 — solution

2 marks

One-sample t-interval

CONDENSED SOLUTION

- Critical value: t^* with df = n − 1 = 6, two-sided 90% → $t^* = 1.943$. Using z (1.645) is wrong.
- Standard error: $s/\sqrt{n} = 26.9/\sqrt{7}$ — the SD must be divided by √n.
- Interval: $430 \pm 1.943(26.9/\sqrt{7})$.
- Answer: (D). (B) has the right structure but pairs 1.943 without √7 … and (C) uses 1.895, the wrong tail.

TRAP Two independent checks every time: df = n − 1 for t^*, and √n under s. Missing either one costs the mark.

Question 3

1 mark

One-sample t-interval

THE QUESTION

An ambulance service aims for an average patient transport time of 10 minutes. A random sample of 12 patient transports from this ambulance service produced a 95% confidence interval of 11.8 ± 1.6 minutes for the mean transport time. Based on this confidence interval, is the claim that the true mean transport time is 10 minutes supported by the data?

(A) There is not enough statistical evidence to support the claim because 10 falls within the confidence interval.

(B) There is not enough statistical evidence to support the claim because 10 falls outside the confidence interval.

(C) There is enough statistical evidence to support the claim because 10 falls within the confidence interval.

(D) There is enough statistical evidence to support the claim because 10 falls outside the confidence interval.

Question 3 — solution

1 mark

One-sample t-interval

CONDENSED SOLUTION

- The interval is (11.8 − 1.6, 11.8 + 1.6) = (10.2, 13.4) minutes.
- The claimed value 10 lies OUTSIDE the interval, so 10 is not a plausible value for the true mean.
- The data do not support the claim that the true mean is 10 minutes.
- Answer: (A) — note it says “not enough evidence to support the claim”: the interval contradicts the claim, so it is not supported.

TRAP First compute the interval endpoints, then locate the claimed value. The wording in the options matters as much as the location.

02

Two-sample t-interval

Estimating a difference between two means

- “We are C% confident that $\mu_1 - \mu_2$ is between … and …”
- Welch degrees of freedom, computed by technology

Key points · two-sample t-interval

Estimate a difference, then read the endpoints

1	**The interval**	$(\bar{x}_1 - \bar{x}_2) \pm t^* \cdot \sqrt{(s_1^2/n_1 + s_2^2/n_2)}$. Welch df is calculated by technology.
2	**The interpretation**	"We are C% confident that the difference $(\mu_1 - \mu_2)$ is between [lo] and [hi] [units]."
3	**Conditions**	Both samples random and independent · each n ≥ 30 or the population near-normal · 10% rule per group.
4	**Reading 0**	If 0 is inside the interval, no difference has been detected. If 0 is outside, a difference is supported.

Worked example · two-sample t-interval

follow it

Passport processing times · tourist vs business · 95%

THE DATA

Group	n	$\bar{x}$ (days)	s (days)
Tourist	40	12.4	2.5
Business	35	10.9	2.1

Random samples from each group; the two groups are independent; 40 and 35 are both ≥ 30, so the CLT gives approximate normality; 40 and 35 are less than 10% of the 10,000 travelers.

THE CALCULATION

- Point estimate: 12.4 − 10.9 = 1.5 days.
- SE = $\sqrt{(2.5^2/40 + 2.1^2/35)} = \sqrt{(0.15625 + 0.126)} = 0.5313$
- Welch df ≈ 72.9 → $t^* = 2.021$ (95%, two-sided).
- Interval: 1.5 ± 2.021(0.5313) = 1.5 ± 1.07
- = (0.43, 2.57) days.

> We are 95% confident that μ(tourist) − μ(business) is between 0.43 and 2.57 days.

Question 4

5 marks

Two-sample t-interval

THE QUESTION

In Country X, there are roughly 10,000 travelers with passports used to travel outside the country. A researcher wants to evaluate whether the average processing time for passport applications differs between tourist travelers and business travelers. Random samples of applications from each group give:

Tourist: n = 40, mean 12.4 days, SD 2.5 days
Business: n = 35, mean 10.9 days, SD 2.1 days

Complete the appropriate inference procedure at the 95% confidence level to estimate the difference in the mean processing times between the two groups.

Question 4 — solution

5 marks

Two-sample t-interval

CONDENSED SOLUTION

- STATE: let μ_1 and μ_2 be the true mean processing times for tourist and business applicants. Estimate $\mu_1 - \mu_2$ with 95% confidence.
- PLAN: two-sample t-interval for a difference in means. Conditions: independent random samples ✓; 40, 35 ≥ 30 so CLT ✓; both less than 10% of the population ✓.
- DO: $\bar{x}_1 - \bar{x}_2 = 1.5$; $SE = \sqrt{(2.5^2/40 + 2.1^2/35)} = 0.5313$; $df \approx 72.9$; $t^* = 2.021$.
- Interval: $1.5 \pm 2.021(0.5313) = (0.43, 2.57)$ days.
- CONCLUDE: we are 95% confident that the true mean processing time for tourist applications is between 0.43 and 2.57 days longer than for business applications.
- Since 0 is not in the interval, tourists take meaningfully longer.

TRAP df comes from technology (Welch). Quoting the SE without √ of the sum of the two variance terms is the common slip.

03

Choosing the right procedure

One mean, matched pairs, or two samples?

- Question 9: bats · Question 11: job-training wages
- The decision comes from the DESIGN, not the numbers

Key points · choosing the procedure

Ask how the data were collected

1	**One sample**	One random sample estimating or testing one population mean μ.
2	**Matched pairs**	Two measurements on the SAME unit — before/after, left/right, twin pairs. Analyse the DIFFERENCES with a one-sample t on μ_d.
3	**Two samples**	Two INDEPENDENT groups — different individuals, no pairing. Compare $\mu_1 - \mu_2$ with a two-sample t.
4	**The giveaway**	Random assignment to two groups → two-sample t. Same people measured twice → matched pairs.

Question 5

1 mark

Choosing the procedure

THE QUESTION

A sports equipment researcher investigated how different types of wood used to make baseball bats might affect batting. The researcher selected a sample of 80 batters from summer baseball leagues and randomly assigned the batters to one of two groups: the ash bat group or the maple bat group. The mean number of hits for each group was recorded at the end of the season, and the difference in the sample means was calculated.

Which of the following is the appropriate inference procedure?

(A) A one-sample t-interval for a sample mean

(B) A matched pairs t-interval for a mean difference

(C) A two-sample t-interval for a difference between sample means

(D) A two-sample t-interval for a difference between population means

Question 5 — solution

1 mark

Choosing the procedure

CONDENSED SOLUTION

- The 80 batters were randomly assigned to two DIFFERENT groups — nobody is measured twice.
- So the two samples are independent, and the comparison is between two population means.
- Answer: (D) — a two-sample t-interval for a difference between POPULATION means.
- (C) is the trap: intervals estimate parameters, so the endpoint of the sentence must say population means, not sample means.

TRAP Inference always targets parameters. If an option says “sample means”, it is describing the data, not the goal.

Question 6

1 mark

Choosing the procedure

THE QUESTION

An economist wants to investigate whether a new job-training program changes workers' mean weekly wages. A sample of workers reports their weekly wages before completing the program and several weeks after. For each worker, the economist calculates the difference (after minus before) in weekly wages. Let μ_d represent the mean difference in weekly wages after completing the program.

Which set of hypotheses is appropriate?

(A) $H_0: \mu_d = 0$, $H_a: \mu_d < 0$

(B) $H_0: \mu_d = 0$, $H_a: \mu_d > 0$

(C) $H_0: \mu_d = 0$, $H_a: \mu_d \neq 0$

(D) $H_0: \mu_d \neq 0$, $H_a: \mu_d = 0$

Question 6 — solution

1 mark

Choosing the procedure

CONDENSED SOLUTION

- "Changes" is a two-sided word: the program could raise or lower wages.
- So H_a must be $\mu_d \neq 0$, and the null is always the equality: H_0: $\mu_d = 0$.
- Answer: (C).
- (A) and (B) would fit "decreases" or "increases"; (D) puts the equality in the wrong place.

TRAP Scan the question stem for the direction word: "changes/differs" → ≠; "increases/higher" → >; "decreases/less" → <.

Question 7

1 mark

One mean · hypotheses

THE QUESTION

Last year the mean cost μ for a one-bedroom rental in a certain city was $1,200 per month. Eli is investigating whether the mean cost is less now than last year. A random sample of apartments had a sample mean $\bar{x}$ of $1,180 per month. Assuming all conditions for inference are met, which is the correct set of hypotheses?

(A) $H_0: \mu = 1200$, $H_a: \mu > 1200$

(B) $H_0: \mu = 1200$, $H_a: \mu < 1200$

(C) $H_0: \bar{x} = 1200$, $H_a: \bar{x} < 1200$

(D) $H_0: \bar{x} = 1180$, $H_a: \bar{x} < 1180$

Question 7 — solution

1 mark

One mean · hypotheses

CONDENSED SOLUTION

- Hypotheses are always written about PARAMETERS — μ, never $\bar{x}$.
- "Less now than last year" is one-sided: H_a: μ < 1200, with H_0: μ = 1200.
- The null uses the OLD claimed value 1200, not the sample result 1180.
- Answer: (B).

TRAP (C) and (D) use $\bar{x}$ — hypotheses never use statistics. (D) also centres on the data, which is circular.

04

Two-sample t-test

Testing a claimed difference at a significance level

- “Is there convincing evidence of a difference …?”
- State · plan · do · conclude, conditions included

Key points · two-sample t-test

The full four-part cycle, in context

1	**State**	H_0: $\mu_1 - \mu_2 = 0$ and H_a with the right direction, plus α. Name μ_1 and μ_2 in context.
2	**Plan**	Name the test (two-sample t), then check: random/independent samples, CLT for each group, 10% rule.
3	**Do**	$t = (\bar{x}_1 - \bar{x}_2 - 0)/\sqrt{(s_1^2/n_1 + s^2_2/n_2)}$ with Welch df; find the p-value.
4	**Conclude**	Compare p with α, state the decision, then answer in context.

Question 8

5 marks

Two-sample t-test

THE QUESTION

A bank gives customers two options: drive up to a teller window or walk into the bank. The manager wanted to investigate whether there is a difference in the average number of bank visits per year between customers who typically use the drive-up option and those who typically use the walk-in option. A random sample of 50 customers from each group was selected. Summary statistics:

Drive-up: n = 50, mean 48, SD 7
Walk-in: n = 50, mean 54, SD 10

Complete the appropriate inference procedure to determine whether there is convincing statistical evidence, at the 0.01 significance level, of a difference in the average number of visits per year for all customers in the two groups.

Question 8 — solution

5 marks

Two-sample t-test

CONDENSED SOLUTION

- STATE: μ_1 = true mean annual visits for all drive-up customers, μ_2 for walk-in customers. H_0: $\mu_1 - \mu_2 = 0$; H_a: $\mu_1 - \mu_2 \neq 0$; $\alpha = 0.01$.
- PLAN: two-sample t-test. Independent random samples ✓; n = 50 ≥ 30 for both ✓; 50 is less than 10% of each customer group ✓.
- DO: $\bar{x}_1 - \bar{x}_2 = -6$; SE = $\sqrt{(49/50 + 100/50)} = \sqrt{2.98} = 1.726$; $t = -6/1.726 = -3.48$; Welch df ≈ 87.7.
- p-value ≈ 0.0008 (two-sided).
- CONCLUDE: 0.0008 < 0.01, so reject H_0. There is convincing evidence of a difference in the mean annual visits: walk-in customers average about 6 more visits per year.

TRAP Two-sided “difference”: double the one-sided tail area when finding the p-value. And quote df — 87.7, not 49.

05

FRQ practice

Car auction prices · a complete question, part by part

- 98% confidence interval for a difference in means
- Parts A to E, worked in full

Question 9

5 marks

FRQ practice · car auction

THE QUESTION

A city's annual car auction sells vintage vehicles. A collector was curious whether the mean selling price was different between the auction years 2024 and 2026. Approximately 2,000 vehicles were sold at each auction, and none were sold at both. The collector took a random sample of 36 vehicles from the 2024 auction (mean $106,400, SD $32,000) and a random sample of 42 vehicles from the 2026 auction (mean $96,500, SD $22,000).

Part A: Identify and classify the variable(s).
Part B: Identify the type of study.
Part C: Identify the appropriate inference procedure.
Part D: Complete the procedure at the 98% confidence level.
Part E: Interpret the conclusion in context.

Question 9 — solution

5 marks

FRQ practice · car auction

CONDENSED SOLUTION

- A (1): selling price is a QUANTITATIVE variable; auction year (2024 / 2026) is the categorical explanatory variable.
- B (1): an OBSERVATIONAL STUDY — the collector sampled vehicles that were already sold at each auction; no treatment was assigned.
- C (1): a two-sample t-interval for a difference between two population means (independent samples, no pairing).
- D (1): $\bar{x}_1 - \bar{x}_2 = 9{,}900$; $SE = \sqrt{32000^2/36 + 22000^2/42} = 6322$; Welch df ≈ 60.6; $t^* = 2.390$ (98%). Interval: $9{,}900 \pm 2.390(6322) = (-5210, 25010)$ dollars.
- E (1): we are 98% confident that the difference in mean selling prices (μ(2024) − μ(2026)) is between −$5,210 and $25,010. Since 0 is in the interval, the data do not show a difference between the two auction years.

TRAP Do not round t^* or df early. With df = 60.6 the multiplier is 2.390, and the interval must contain 0 for this data.

Try it yourself

your turn

Attempt before turning the page — answer on the next slide

YOUR TURN

A fitness coach records the resting heart rates of 25 clients before and after an 8-week program, and finds a mean decrease of 4.2 bpm with SD of the differences 6.1 bpm.

Which procedure is appropriate, what are the hypotheses for a test that the program lowers resting heart rate, and what conditions must be checked?

Question Y1 — solution

3 marks

Try it · matched pairs

CONDENSED SOLUTION

- Procedure: a MATCHED PAIRS t-test — two measurements on the same client, analysed as one sample of differences.
- Hypotheses: H_0: $\mu_d = 0$; H_a: $\mu_d < 0$ (the program LOWERS resting heart rate, so one-sided).
- Conditions: the clients are a random sample; 25 < 10% of all clients; the distribution of DIFFERENCES is approximately normal — reasonable for n = 25 if the difference plot shows no strong skew or outliers.
- Mechanics if needed: $t = (-4.2 - 0)/(6.1/\sqrt{25}) = -3.44$, df = 24.

TRAP Same people measured twice → matched pairs, never a two-sample t. The parameter is μ_d, the MEAN DIFFERENCE.

Mark scheme

Marks by question, with what earns each mark

S1	**1**	Mean of the difference is 3.5 − 3.5 = 0 (B)
S2	**1**	n = 10 from a skewed population fails both normality routes (B)
1	**1**	Correct interpretation (C): confident the POPULATION mean is inside
2	**2**	1 t* with df = 6 (1.943) · 1 correct SE s/√n (option D)
3	**1**	Interval (10.2, 13.4) excludes 10 → claim not supported (A)
4	**5**	1 state · 1 plan+conditions · 1 SE 0.5313 and df ≈ 73 · 1 interval (0.43, 2.57) · 1 conclusion in context
5	**1**	Random assignment → two-sample t for a difference between POPULATION means (D)
6	**1**	"Changes" → two-sided: H_0: $\mu_d = 0$, H_a: $\mu_d \neq 0$ (C)
7	**1**	Hypotheses in μ, one-sided less, centred on 1200 (B)
8	**5**	1 state · 1 plan · 1 t = −3.48, df ≈ 88 · 1 p ≈ 0.0008 · 1 conclusion in context
9	**5**	1 variable · 1 study type · 1 procedure · 1 interval (−5210, 25010) · 1 interpretation with 0 inside
Y1	**3**	1 matched pairs · 1 hypotheses $\mu_d < 0$ · 1 conditions

Main lesson total: 30 marks. Starter: 2 practice marks (not assessed).

Answer key

One line per question

ANSWERS

- S1 $\mu(x_1 - x_2) = 3.5 - 3.5 = 0$ (B)
- S2 not appropriate for n = 10, skewed (B)
- 1 (C) — confident the population mean is inside
- 2 (D) $430 \pm 1.943(26.9/\sqrt{7})$
- 3 (A) claim not supported; 10 outside (10.2, 13.4)
- 4 (0.43, 2.57) days; tourists take longer
- 5 (D) two-sample t, population means

FREE RESPONSE

- 6 (C) H_0: $\mu_d = 0$, H_a: $\mu_d \neq 0$
- 7 (B) H_0: $\mu = 1200$, H_a: $\mu < 1200$
- 8 $t = -3.48$, $df \approx 88$, $p \approx 0.0008$ → reject H_0
- 9 observational; two-sample t-interval; (−5210, 25010)
- Y1 matched pairs t-test; H_a: $\mu_d < 0$
- Cycle check: state · plan · do · conclude — every time.

True or false · 1

T / F

Decide, then justify your decision — answer on the next slide

A confidence interval for a mean tells us the probability that μ lies inside this particular interval.

True or false · 1 — answer

FALSE

FALSE

μ is a fixed number, not random. The correct reading: repeated intervals built this way capture μ about C% of the time — so “we are C% confident that μ is between … and …”.

True or false · 2

T / F

Decide, then justify your decision — answer on the next slide

The mean of the sampling distribution of $\bar{x}$ is larger than μ when n is large.

True or false · 2 — answer

FALSE

FALSE

The sampling distribution of $\bar{x}$ is always centred at μ, whatever n is. Larger n reduces the SPREAD ($\sigma/\sqrt{n}$), not the centre.

True or false · 3

T / F

Decide, then justify your decision — answer on the next slide

If a claimed value of μ lies inside a 95% confidence interval, the data are consistent with that claim.

True or false · 3 — answer

TRUE

TRUE

Values inside the interval are plausible at that confidence level. The claim is supported in the sense that the data do not contradict it.

True or false · 4

T / F

Decide, then justify your decision — answer on the next slide

Random assignment of subjects to two groups means the samples are matched pairs.

True or false · 4 — answer

FALSE

FALSE

Random assignment creates two INDEPENDENT groups → a two-sample procedure. Matched pairs means the SAME unit is measured twice, and you analyse the differences.

True or false · 5

T / F

Decide, then justify your decision — answer on the next slide

Hypotheses are always written about population parameters, never about sample statistics.

True or false · 5 — answer

TRUE

TRUE

H_0 and H_a use μ, μ_d or $\mu_1 - \mu_2$. Writing H_0: $\bar{x} = 1200$ is always wrong — $\bar{x}$ is known once the sample is taken.

True or false · 6

T / F

Decide, then justify your decision — answer on the next slide

For a two-sample t-procedure, the degrees of freedom are $n_1 + n_2 - 2$.

True or false · 6 — answer

FALSE

FALSE

AP Statistics uses the Welch–Satterthwaite df, computed by technology (e.g. 72.9 for the passport data, 60.6 for the cars). The n_1+n_2-2 shortcut belongs to pooled procedures, which are not used.

True or false · 7

T / F

Decide, then justify your decision — answer on the next slide

If 0 lies outside a confidence interval for $\mu_1 - \mu_2$, the data support a difference between the means.

True or false · 7 — answer

TRUE

TRUE

0 represents “no difference”. Excluding it means the interval contains only nonzero differences — evidence of a real difference, in the direction of the interval.

True or false · 8

T / F

Decide, then justify your decision — answer on the next slide

Using z* instead of t* is acceptable when σ is unknown but the sample is large.

True or false · 8 — answer

FALSE

FALSE

When σ is estimated by s, the procedure is a t-procedure — for any n. Large n makes t^* close to z^*, but the exam expects t with df = n − 1 (or Welch df).

FIVE THINGS TO DO IN THE EXAM

Do these and inference for means will not cost you marks

- Write state · plan · do · conclude for every procedure, conditions included.
- Matched pairs = same unit twice → one-sample t on the differences.
- Hypotheses use μ, never $\bar{x}$ — and “difference/changes” is two-sided.
- Interpret intervals as “confident the true mean is between … and …”.
- t^*, not z^*, whenever s estimates σ — with df = n − 1 or Welch df.

Built from the Inference for Means past-paper booklet.