# Allama Iqbal Open University AIOU BS Solved Assignment NO 2 Autumn 2025 Code 9424 Quantitative Reasoning

**Q.1(a) A grain storage facility is a hemispherical shell with a radius of thirty meters. What is the volume of the building? How much paint is needed to cover the outside of the building completely?**

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**Given Data:**

- Shape: Hemisphere
- Radius, r = 30 m

We need to find:

1. Volume of the hemisphere
2. Surface area of the hemisphere for painting

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**Step 1: Volume of the Hemisphere**

The volume V of a hemisphere is:

$V = (1/2) \times (4/3) \times \pi \times r^3$

$V = (2/3) \times \pi \times r^3$

Substitute r = 30 m:

$V = (2/3) \times \pi \times (30)^3$

$V = (2/3) \times \pi \times 27{,}000$

$V = 18{,}000 \times \pi$

Using $\pi \approx 3.1416$:

$V = 18{,}000 \times 3.1416 \approx 56{,}548.8\ m^3$

**Volume of the hemisphere = 56,548.8 $m^3$**

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**Step 2: Surface Area of the Hemisphere**

The curved surface area (CSA) of a hemisphere is:

$A = 2 \times \pi \times r^2$

Substitute r = 30 m:

$A = 2 \times \pi \times (30)^2$

$A = 2 \times \pi \times 900$

$A = 1{,}800 \times \pi$

$A \approx 1{,}800 \times 3.1416 \approx 5{,}654.9\ m^2$

**Curved surface area (for paint) = 5,654.9 m²**

If the base is also to be painted, include the area of the circular base:

Total Surface Area = $2 \times \pi \times r^2 + \pi \times r^2 = 3 \times \pi \times r^2$

Total Surface Area = $3 \times \pi \times (30)^2 = 3 \times \pi \times 900 = 2{,}700 \times \pi \approx 8{,}482.3\ m^2$

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**Answer:**

- Volume of the building: 56,548.8 m³
- Paint needed to cover curved surface only: 5,654.9 m²
- Paint needed if base is also covered: 8,482.3 m²

**Q.1(b) Write the following sentences in the form “If p, then q.” Identify p and q.**

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**1. A resident of Karachi is a resident of Pakistan.**

- If p: A person is a resident of Karachi
- Then q: The person is a resident of Pakistan

**Form:** If a person is a resident of Karachi, then they are a resident of Pakistan.

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**2. Daily exercise is a sufficient condition for being healthy.**

- If p: A person does daily exercise
- Then q: The person is healthy

**Form:** If a person does daily exercise, then they are healthy.

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**3. Being bald is sufficient for being male.**

- If p: A person is bald
- Then q: The person is male

**Form:** If a person is bald, then they are male.

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**4. Whenever it rains, I get wet.**

- If p: It rains
- Then q: I get wet

**Form:** If it rains, then I get wet.

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**5. There is no doubt that she is smart if she is an art expert.**

- If p: She is an art expert
- Then q: She is smart

**Form:** If she is an art expert, then she is smart.

**Q.2(a) Individuals who visited an Islamabad hospital on a single day were prescribed the following amounts of antibiotics (A), painkillers (P), and blood pressure medications (BP):**

- P only = 22
- BP and A only = 15
- BP only = 8
- P and A only = 24
- A only = 12
- P and BP only = 16
- All three (P, A, BP) = 2
- None = 2

We are asked to:

i. Sketch the Venn diagram

ii. Answer specific questions using the Venn diagram

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**Step 1: Organize Data for Venn Diagram**

In a **3-circle Venn diagram** for P, A, and BP:

| Category | Value |
|---|---|
| P only | 22 |
| A only | 12 |
| BP only | 8 |
| P ∩ A only | 24 |
| P ∩ BP only | 16 |

A ∩ BP 15

only

P ∩ A 2

∩ BP

None 2

**Important:** The "only" values are **exclusive to those groups**, not including the overlap of all three.

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#### Step 2: Draw the Venn Diagram

- Draw three intersecting circles labeled **P, A, BP**.
- Fill **central intersection (all three)** = 2
- Fill **P ∩ A only** = 24 → subtract the all three intersection already counted? Already 24 is only P and A, so no need.

- P ∩ BP only = 16
- A ∩ BP only = 15
- P only = 22
- A only = 12
- BP only = 8

**Venn Diagram Summary:**

- **P only** = 22
- **A only** = 12
- **BP only** = 8
- **P ∩ A** = 24
- **P ∩ BP** = 16
- **A ∩ BP** = 15
- **P ∩ A ∩ BP** = 2

**Total patients:**

Total = 22 + 12 + 8 + 24 + 16 + 15 + 2 + 2 (None) = 101

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**Step 3: Answer the Questions**

## ii. How many patients took BP medicines or antibiotics?

- Formula: **BP ∪ A = BP only + A only + BP ∩ A only + BP ∩ P only + A ∩ P only + all three**

From the table:

- BP only = 8
- A only = 12
- BP ∩ A only = 15
- BP ∩ P only = 16 → already includes BP, yes
- P ∩ A only = 24 → includes A, yes
- All three = 2

BP or A = 8 + 12 + 15 + 16 + 24 + 2 = **77**

**Answer:** 77 patients

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**iii. How many patients specifically took BP medicine but did not take any pain medicine?**

- BP without P = **BP only + BP ∩ A only**
- BP only = 8
- BP ∩ A only = 15

BP without P = 8 + 15 = **23**

**Answer:** 23 patients

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**iv. What proportion of patients used painkillers at all?**

- Patients using P = P only + P ∩ A only + P ∩ BP only + all three
- P only = 22
- P ∩ A only = 24
- P ∩ BP only = 16
- All three = 2

Total P users = 22 + 24 + 16 + 2 = 64

**Proportion of patients using painkillers:**

- Total patients (excluding None?) Total patients = 101 - 2 (None) = 99 patients? Actually "None" is counted separately, so total patients = 101

Proportion = 64 / 101 ≈ **0.634** or **63.4%**

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**v. How many patients used antibiotics and blood pressure medications but not painkillers?**

- Formula: **A ∩ BP only (exclude P)**
- From table: A ∩ BP only = 15

**Answer:** 15 patients

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**vi. How many patients used pain relievers, antibiotics, or blood pressure medication?**

- Formula: **Total patients - None**
- Total patients = 101
- None = 2

Patients using at least one = 101 - 2 = **99**

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## ✅ Summary of Answers

| Question | Answer |
| --- | --- |
| ii. BP or A | 77 |
| iii. BP without P | 23 |
| iv. Proportion using P | 0.634 or 63.4% |
| v. A and BP but not P | 15 |
| vi. Used P, A, or BP | 99 |

**Q.2(b) In triangle ABC, angle A is twice the measure of angle B, and angle C is 40 degrees. Find the measures of all angles.**

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**Step 1: Triangle Angle Sum Property**

The sum of angles in a triangle is always 180°:

$A + B + C = 180°$

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**Step 2: Express angles in terms of B**

Given:

- $A = 2B$
- $C = 40°$

Substitute into the sum:

$2B + B + 40 = 180$

$3B + 40 = 180$

$3B = 180 - 40$

$3B = 140$

$B = 140 / 3 \approx 46.67°$

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**Step 3: Find angle A**

$A = 2B = 2 \times 46.67 \approx 93.33°$

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**Step 4: Angle C**

$C = 40°$ (given)

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**Step 5: Verify sum of angles**

$A + B + C = 93.33 + 46.67 + 40 \approx 180°$ ✅

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**Answer:**

- Angle $A \approx 93.33°$
- Angle $B \approx 46.67°$
- Angle $C = 40°$

# Q.3 (a) Solve the inequality $u^2 \leq 3u + 4$

**Step 1:** Bring all terms to one side:

$u^2 - 3u - 4 \leq 0$

**Step 2:** Factorize the quadratic:

$(u - 4)(u + 1) \leq 0$

**Step 3:** Determine critical points and test intervals:

- Critical points: $u = -1$ and $u = 4$
- Intervals: $(-\infty, -1)$, $(-1, 4)$, $(4, \infty)$

**Step 4:** Test the sign in each interval:

- For $u < -1$ (e.g., $u = -2$): $(-2 - 4)(-2 + 1) = (-6)(-1) = 6 \rightarrow$ Not satisfying
- For $-1 \leq u \leq 4$ (e.g., $u = 0$): $(0 - 4)(0 + 1) = (-4)(1) = -4 \rightarrow$ Satisfying

- For u > 4 (e.g., u = 5): (5 − 4)(5 + 1) = (1)(6) = 6 → Not satisfying

**Step 5:** Include boundary points because inequality is ≤ 0.

**Solution:**

$-1 \leq u \leq 4$

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## Q.3 (b) Air duct volume and paint area

**Given:**

- Length of duct = 40 feet
- Radius = 18 inches = 1.5 feet

**Step 1: Volume of the cylinder**

Volume $V = \pi \times r^2 \times h$

$= 3.1416 \times (1.5)^2 \times 40$

= 3.1416 × 2.25 × 40

= 3.1416 × 90

≈ 282.74 cubic feet

**Volume of duct ≈ 283 ft³**

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**Step 2: Surface area for painting (curved surface)**

Surface area A = 2 × π × r × h

= 2 × 3.1416 × 1.5 × 40

= 2 × 3.1416 × 60

= 376.99 ft²

**Optional: Include ends**

Area of both circular ends = 2 × π × r² = 2 × 3.1416 ×

(1.5)² = 2 × 3.1416 × 2.25 ≈ 14.14 ft²

**Total paint area ≈ 377 ft²**

## Summary Table

| Part | Result |
|---|---|
| (a) Inequality solution | $-1 \le u \le 4$ |
| (b) Volume of duct | 283 $ft^3$ |
| (b) Paint area | 377 $ft^2$ |

# Q.4 (a) Construct the truth table for the logical expression (p ∨ q) ∨ (p ∧ r)

**Step 1:** Identify variables

The expression has three variables: **p, q, r**. Each can be **True (T)** or **False (F)**.

**Step 2:** List all possible combinations and compute intermediate results

| **p** | **q** | **r** | **p ∨ q** | **p ∧ r** | **(p ∨ q) ∨ (p ∧ r)** |
|---|---|---|---|---|---|
| T | T | T | T | T | T |

| | | | | | | |
|---|---|---|---|---|---|---|
| T | T | F | T | | F | T |
| T | F | T | T | | T | T |
| T | F | F | T | | F | T |
| F | T | T | T | | F | T |
| F | T | F | T | | F | T |
| F | F | T | F | | F | F |
| F | F | F | F | | F | F |

**Step 3:** Determine when the expression is true

- The expression is **true** in all cases **except when p = F and q = F**.
- **Conclusion:** The expression is true whenever **p = T** or **q = T**.

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# Q.4 (b) Convert the storage temperature from Fahrenheit to Celsius

**Given:**

- Temperature range: **36°F to 46°F**
- Conversion formula (Word-friendly):

  C = (5 ÷ 9) × (F − 32)

**Step 1: Convert 36°F to Celsius**

C = (5 ÷ 9) × (36 − 32)

C = (5 ÷ 9) × 4

C ≈ 2.22°C

**Step 2: Convert 46°F to Celsius**

C = (5 ÷ 9) × (46 − 32)

C = (5 ÷ 9) × 14

C ≈ 7.78°C

✅ **Equivalent Celsius range:**

2.2°C to 7.8°C

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## Answer Summary

| Part | Result |
| --- | --- |
| (a) Truth table | See table above; expression true except when p = F and q = F |
| (b) Celsius range | 2.2°C to 7.8°C |

# Q.5 Logical Statements

**Statement 1:**

**English:** (If p then not p) or (If p then q)

**Symbolic Notation:**

Insert → Equation Editor:

(p ⇒ ¬p) ∨ (p ⇒ q)

**Truth Table (Word Table):**

| **p** | **q** | **¬ p** | **⇒** | **p** | **⇒** | **(p ⇒ ¬p) ∨ (p ⇒ q)** |
|---|---|---|---|---|---|---|
| | | | | **q** | | |
| T | T | F | F | T | T | |
| T | F | F | F | F | F | |
| F | T | T | T | T | T | |

F F T T T T

**Type:** Contingency

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**Statement 2:**

**English:** If (p and not p) then r

**Symbolic Notation:**

((p ∧ ¬p) ⇒ r)

**Truth Table:**

| **p** | **¬ p** | **p ∧ ¬p** | **r** | **(p ∧ ¬p) ⇒ r** |
|---|---|---|---|---|
| T | F | F | T | T |
| T | F | F | F | T |

F T F T T

F T F F T

**Type:** Tautology

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**Statement 3:**

**English:** If p then (p or q)

**Symbolic Notation:**

$p \Rightarrow (p \vee q)$

**Truth Table:**

| **p** | **q** | **p** | **p ⇒ (p ∨ q)** |
|---|---|---|---|
| | | | **q)** |
| | | | **q** |

T T T T

T F T T

F T T T

F F F T

**Type:** Tautology

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**Statement 4:**

**English:** Not q and (If (If p then q) then Not p)

**Symbolic Notation:**

$\neg q \land ((p \Rightarrow q) \Rightarrow \neg p)$

**Truth Table:**

| p | q | ¬ p | ¬ q | (p ⇒ q) | ¬q ∧ ((p ⇒ q) ⇒ ¬p) |
|---|---|---|---|---|---|
| T | T | F | F | T | F |
| T | F | F | T | F | F |
| F | T | T | F | T | F |
| F | F | T | T | T | T |

**Type:** Contingency

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**Statement 5:**

**English:** If p then (If q then p)

**Symbolic Notation:**

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p ⇒ (q ⇒ p)
```

**Truth Table:**

| p | q | q ⇒ q | p ⇒ (q ⇒ p) |
|---|---|---|---|
| T | T | T | T |
| T | F | T | T |
| F | T | F | T |
| F | F | T | T |

**Type:** Tautology

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**Statement 6:**

**English:** q and not q

**Symbolic Notation:**

q ∧ ¬q

**Truth Table:**

| q | ¬ q | ∧ |
|---|---|---|
| q | ¬q | |
| T | F | F |
| F | T | F |

**Type:** Absurdity

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✅ **Answer Summary Table**

| State ment | Symbolic Form | Type |
|---|---|---|

| | | |
|---|---|---|
| 1 | $(p \Rightarrow \neg p) \vee (p \Rightarrow q)$ | Contingency |
| 2 | $(p \wedge \neg p) \Rightarrow r$ | Tautology |
| 3 | $p \Rightarrow (p \vee q)$ | Tautology |
| 4 | $\neg q \wedge ((p \Rightarrow q) \Rightarrow \neg p)$ | Contingency |
| 5 | $p \Rightarrow (q \Rightarrow p)$ | Tautology |
| 6 | $q \wedge \neg q$ | Absurdity |