Grade 13 A/L ICT

Lesson 8: Database

- 8.1 Data, Information and Database Models
- 8.2 Relational Database Model and Constraints
- 8.3 DBMS and SQL: DDL and DML
- 8.4 ER Diagrams: Conceptual Database Design
- 8.5 Logical Schema, Relation Instances and Keys
- 8.6 Transforming ER Diagrams to a Logical Schema
- 8.7 Normalisation: 0NF to 3NF

© 2026 schoolict.net (Ruwan Mangala Suraweera)
All rights reserved.

Grade 13 A/L ICT · Lesson 8

8.1 Data, Information and Database Models

Syllabus 8.1. A database lets an organisation store data **once** and use it **many times**. In this part you separate **data** from **information**, **structured** from **unstructured** data, define a **database**, and compare the five **database models**: flat file, hierarchical, network, relational and object relational.

1. Data and information

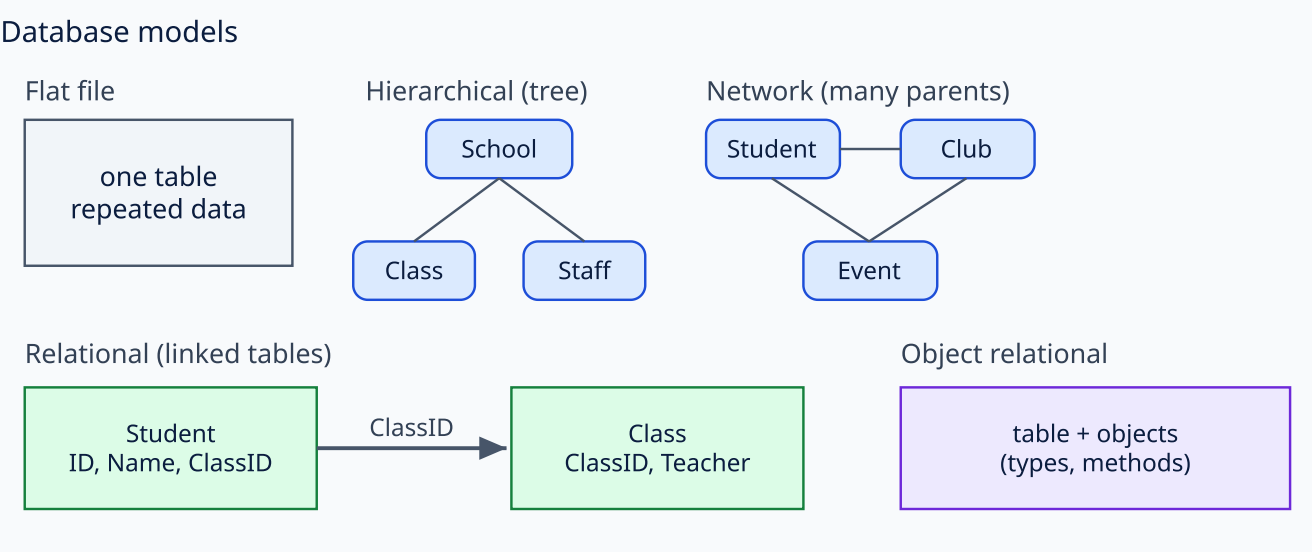
Data are raw facts such as 78, “Nimal” or 2026-03-01. **Information** is data that has been processed so it has meaning, for example “Nimal scored 78 in ICT, above the class average of 62.4”.

Structured data	Unstructured data
Fixed fields and types (rows and columns)	No fixed format
Marks table, bank transactions	Emails, photos, videos, voice notes
Easy to search with SQL	Needs special tools to search

2. What is a database?

A **database** is an organised collection of **logically related data**, stored so that many users and programs can share it. It reduces **redundancy** (repeated data), avoids **inconsistency**, and supports security, backup and fast searching.

3. Database models



The five database models

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

Flat file
One table or text file; simple but data is repeated.

Hierarchical
Tree: each child has one parent (one-to-many).

Network
Graph: a record can have many parents (many-to-many).

Relational
Tables linked by keys; queried with SQL.

Object relational
Relational tables plus objects, user types and methods.

Feature	Hierarchical	Network	Relational
Structure	Tree	Graph	Tables
Relationships	1:N only	M:N	Any, through keys
Flexibility	Low	Medium	High
Query	Follow the path	Follow pointers	SQL

🧱 **Worked example: A school keeps marks in three spreadsheets. Nimal's class is stored in each one. What problems appear and which model fixes them?**
The class is stored **3 times** (redundancy). If Nimal changes class and only one file is updated, the files disagree (**inconsistency**). A **relational database** stores the class **once** in a Student table and links Marks by StudentID.

💡 Hierarchical = one parent; network = many parents; relational = tables and keys.

🚀 **Beyond the syllabus (2026 update)** *Not required for the exam – read for interest.* In 2026 many apps also use NoSQL document and vector databases for AI search, but school exams test the relational model.

Key Words

Data – Raw facts without context.

Information – Processed data with meaning.

Structured data – Data in fixed fields such as rows and columns.

Unstructured data – Data with no fixed format such as video or email.

Database – Organised collection of logically related shared data.

Redundancy – The same data stored more than once.

Inconsistency – Copies of the same data that disagree.

Flat file – Single table or file holding all data.

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

Hierarchical model – Tree model where each child has one parent.

Network model – Model where a record may have many parents.

Relational model – Model of tables linked by key values.

Object relational model – Relational model extended with objects and user types.

Sample Q&A

1. Distinguish data and information.

> **Answer:** Data are raw facts; information is processed data with meaning, e.g. 78 vs “78 is above average”.

2. Give two examples of unstructured data.

> **Answer:** Photos and emails (also videos, voice notes).

3. Define a database.

> **Answer:** An organised collection of logically related data shared by many users.

4. Why is a database better than separate files?

> **Answer:** Less redundancy, consistent data, sharing, security and easy searching.

5. How does the network model differ from the hierarchical model?

> **Answer:** Hierarchical allows one parent per record; network allows many parents (M:N).

6. What does the object relational model add?

> **Answer:** Objects, user-defined types and methods on top of relational tables.

MCQ

1. Raw facts without meaning are

A. knowledge
B. a report
C. data
D. a query
E. information

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

2. “Average ICT mark is 62.4” is an example of

A. raw data
B. a field name
C. a primary key
D. unstructured data
E. information

3. Which is unstructured data?

A. a recorded video lesson
B. a marks table
C. a bank transaction table
D. a timetable grid
E. an invoice row

4. Storing the same class name in three files causes

A. compression
B. encryption
C. normalisation
D. redundancy
E. indexing

5. A model where each child record has exactly one parent is

A. network
B. flat file
C. hierarchical
D. relational
E. object relational

6. A model where a record can have many parents is

A. flat file
B. network
C. tree
D. sequential
E. hierarchical

7. Tables linked by key values form the

A. relational model
B. flat file
C. network model
D. hierarchical model
E. spreadsheet model

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

8. Adding user-defined types and methods to tables gives the

A. flat file model
B. hierarchical model
C. object relational model
D. network model
E. file system

9. Which term means: “Raw facts without context”?

A. Structured data
B. Redundancy
C. Relational model
D. Flat file
E. Data

10. Which term means: “Processed data with meaning”?

A. Inconsistency
B. Information
C. Unstructured data
D. Object relational model
E. Hierarchical model

11. Which term means: “Data in fixed fields such as rows and columns”?

A. Flat file
B. Database
C. Network model
D. Data
E. Structured data

12. Which term means: “Data with no fixed format such as video or email”?

A. Relational model
B. Hierarchical model
C. Information
D. Unstructured data
E. Redundancy

13. Which term means: “Organised collection of logically related shared data”?

A. Object relational model
B. Structured data
C. Inconsistency
D. Database
E. Network model

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

14. Which term means: “The same data stored more than once”?

A. Redundancy
B. Unstructured data
C. Relational model
D. Data
E. Flat file

15. Which term means: “Copies of the same data that disagree”?

A. Inconsistency
B. Database
C. Information
D. Object relational model
E. Hierarchical model

16. Which term means: “Single table or file holding all data”?

A. Data
B. Structured data
C. Redundancy
D. Network model
E. Flat file

17. Which term means: “Tree model where each child has one parent”?

A. Relational model
B. Hierarchical model
C. Unstructured data
D. Information
E. Inconsistency

18. Which term means: “Model where a record may have many parents”?

A. Database
B. Structured data
C. Network model
D. Flat file
E. Object relational model

19. Which term means: “Model of tables linked by key values”?

A. Hierarchical model
B. Relational model
C. Redundancy
D. Data
E. Unstructured data

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

20. Which term means: “Relational model extended with objects and user types”?

A. Inconsistency
B. Network model
C. Information
D. Object relational model
E. Database

Structured Questions

1. Distinguish data and information with a school example. *(3 marks)*

> Data raw marks; information processed; example average or rank.

2. Compare structured and unstructured data (two points each). *(3 marks)*

> Fixed fields vs no format; table vs video; easy SQL search vs special tools.

3. List three advantages of a database over separate files. *(3 marks)*

> Less redundancy; consistency; sharing and security.

4. Describe the hierarchical and network models with a diagram. *(3 marks)*

> Tree one parent; graph many parents; diagram.

5. Why is the relational model the most widely used? *(3 marks)*

> Simple tables; flexible relationships through keys; SQL standard.

Summary

- Data are raw facts; information has meaning.
- Structured data fits rows and columns.
- A database stores related data once and shares it.
- Hierarchical: one parent; network: many parents.
- Relational tables are linked by keys and queried with SQL.

MCQ answer key – 8.1

1. **C** – Data.
2. **E** – Processed data.
3. **A** – No fixed fields.
4. **D** – Repeated data.
5. **C** – Tree.
6. **B** – Graph.
7. **A** – Relational.

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

8. **C** – Object relational.
9. **E** – Data – Raw facts without context.
10. **B** – Information – Processed data with meaning.
11. **E** – Structured data – Data in fixed fields such as rows and columns.
12. **D** – Unstructured data – Data with no fixed format such as video or email.
13. **D** – Database – Organised collection of logically related shared data.
14. **A** – Redundancy – The same data stored more than once.
15. **A** – Inconsistency – Copies of the same data that disagree.
16. **E** – Flat file – Single table or file holding all data.
17. **B** – Hierarchical model – Tree model where each child has one parent.
18. **C** – Network model – Model where a record may have many parents.
19. **B** – Relational model – Model of tables linked by key values.
20. **D** – Object relational model – Relational model extended with objects and user types.

© 2026 schoolict.net (Ruwan Mangala Suraweera). All rights reserved.

Grade 13 A/L ICT · Lesson 8

8.2 Relational Database Model and Constraints

Syllabus 8.2. The relational model stores data in **relations** (tables). A relation has **attributes** (columns) and **tuples** (rows), and tables are joined by **relationships**. **Constraints** – NOT NULL, UNIQUE, PRIMARY KEY, FOREIGN KEY and CHECK – stop bad data from entering.

1. Relations, attributes and tuples

Parts of a relation (table)

StudentID	Name	ClassID
S001	Nimal	C12A
S002	Kamala	C12A
S003	Sunil	C12B

↑ attribute / column (field) highlighted row = tuple / record

Primary key: StudentID · Foreign key: ClassID → Class

degree = 3 columns · cardinality = 3 rows

Parts of the Student relation

- **Relation / table** – a named set of rows with the same columns.
- **Attribute / column** – one property, e.g. Name; it has a **domain** (allowed values).
- **Tuple / row** – one record, e.g. (S001, Nimal, C12A).
- **Degree** = number of columns; **cardinality** = number of rows.
- **Relationship** – a link between tables through matching key values.

2. Types of constraints

Table definitions with constraints (SQL)

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

```
CREATE TABLE Class (
  ClassID   CHAR(4)     PRIMARY KEY,
  ClassName VARCHAR(10) NOT NULL UNIQUE,
  Teacher   VARCHAR(30) NOT NULL
);
CREATE TABLE Student (
  StudentID CHAR(4)     PRIMARY KEY,
  Name      VARCHAR(30) NOT NULL,
  ClassID   CHAR(4)     REFERENCES Class(ClassID)
);
CREATE TABLE Marks (
  StudentID   CHAR(4) REFERENCES Student(StudentID),
  SubjectCode CHAR(4),
  Mark        INTEGER CHECK (Mark BETWEEN 0 AND 100),
  PRIMARY KEY (StudentID, SubjectCode)
);
```

Constraint	Rule	Rejected example
NOT NULL	A value must be given	Class with no Teacher
UNIQUE	No two rows share the value	a second class named 12A
PRIMARY KEY	Unique and not null; identifies a row	a second S001
FOREIGN KEY	Value must exist in the parent table	ClassID C13Z (no such class)
CHECK	Value must pass a condition	Mark 105

🧱 **Worked example: Which of these inserts does the database reject, and why?**
We ran all five in sqlite3 with foreign keys on. **All 5 were rejected**: S001 again (primary key), class C13Z (foreign key), mark 105 (CHECK 0–100), a NULL teacher (NOT NULL) and a second 12A (UNIQUE).

💡 A primary key is UNIQUE + NOT NULL together; a table has only one primary key.

🚀 **Beyond the syllabus (2026 update)** *Not required for the exam – read for interest.* Modern cloud databases in 2026 still enforce these same constraints, and AI coding assistants often suggest them when generating tables.

Key Words

Relation – A table of rows with the same columns.

Attribute – A column that holds one property.

Tuple – A single row or record of a relation.

Domain – The set of allowed values for an attribute.

Degree – The number of attributes in a relation.

Cardinality – The number of tuples in a relation.

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

Relationship – A link between tables using key values.

NOT NULL constraint – Rule that a column must always have a value.

UNIQUE constraint – Rule that no two rows share a column value.

Primary key constraint – Unique, not null column that identifies each row.

Foreign key constraint – Rule that a value must exist in the referenced table.

Check constraint – Rule that a value must satisfy a condition.

Sample Q&A

1. What is a tuple?

> **Answer:** One row (record) of a relation.

2. Degree and cardinality of the Student table shown?

> **Answer:** Degree 3, cardinality 3.

3. What does a foreign key constraint prevent?

> **Answer:** Rows that refer to a parent record that does not exist.

4. How is PRIMARY KEY different from UNIQUE?

> **Answer:** Primary key is also NOT NULL and only one per table.

5. Write a CHECK for marks.

> **Answer:** CHECK (Mark BETWEEN 0 AND 100).

6. What is a domain?

> **Answer:** The set of allowed values of an attribute, e.g. 0–100 for Mark.

MCQ

1. A row of a relation is called a

A. tuple
B. attribute
C. domain
D. degree
E. schema

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

2. A column of a relation is called an

A. instance
B. attribute
C. index
D. tuple
E. cardinality

3. The number of columns in a relation is its

A. degree
B. size
C. domain
D. cardinality
E. key

4. A rule that a value must exist in the parent table is a

A. not null constraint
B. unique constraint
C. foreign key constraint
D. default value
E. check constraint

5. Inserting mark 105 is rejected by

A. NOT NULL
B. CHECK (Mark BETWEEN 0 AND 100)
C. PRIMARY KEY (Name)
D. FOREIGN KEY (ClassID)
E. UNIQUE (Name)

6. Inserting a second S001 breaks the

A. not null on Teacher
B. foreign key constraint
C. domain of Mark
D. primary key constraint
E. check constraint

7. A constraint that is UNIQUE and NOT NULL together is

A. PRIMARY KEY
B. INDEX
C. DEFAULT
D. FOREIGN KEY
E. CHECK

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

8. Of the five bad inserts tested in sqlite3, how many were rejected?

A. 1
B. 4
C. 3
D. 0
E. 5

9. Which term means: “A table of rows with the same columns”?

A. Relation
B. NOT NULL constraint
C. Foreign key constraint
D. Cardinality
E. Tuple

10. Which term means: “A column that holds one property”?

A. Check constraint
B. Attribute
C. Domain
D. Relationship
E. UNIQUE constraint

11. Which term means: “A single row or record of a relation”?

A. Degree
B. Primary key constraint
C. NOT NULL constraint
D. Tuple
E. Relation

12. Which term means: “The set of allowed values for an attribute”?

A. Cardinality
B. UNIQUE constraint
C. Foreign key constraint
D. Attribute
E. Domain

13. Which term means: “The number of attributes in a relation”?

A. Tuple
B. Check constraint
C. Primary key constraint
D. Relationship
E. Degree

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

14. Which term means: “The number of tuples in a relation”?

A. Domain
B. Cardinality
C. Foreign key constraint
D. Relation
E. NOT NULL constraint

15. Which term means: “A link between tables using key values”?

A. Degree
B. Check constraint
C. UNIQUE constraint
D. Relationship
E. Attribute

16. Which term means: “Rule that a column must always have a value”?

A. Cardinality
B. Relation
C. NOT NULL constraint
D. Primary key constraint
E. Tuple

17. Which term means: “Rule that no two rows share a column value”?

A. Attribute
B. Domain
C. Relationship
D. UNIQUE constraint
E. Foreign key constraint

18. Which term means: “Unique, not null column that identifies each row”?

A. Degree
B. Tuple
C. Primary key constraint
D. NOT NULL constraint
E. Check constraint

19. Which term means: “Rule that a value must exist in the referenced table”?

A. Relation
B. UNIQUE constraint
C. Foreign key constraint
D. Domain
E. Cardinality

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

20. Which term means: “Rule that a value must satisfy a condition”?

A. Degree
B. Primary key constraint
C. Relationship
D. Attribute
E. Check constraint

Structured Questions

1. Define relation, attribute and tuple using the Student table. *(3 marks)*

> Relation table; attribute column; tuple row.

2. State the degree and cardinality of a table with 3 columns and 5 rows. *(2 marks)*

> Degree 3; cardinality 5.

3. Explain five types of constraints with an example each. *(5 marks)*

> NOT NULL; UNIQUE; PRIMARY KEY; FOREIGN KEY; CHECK.

4. Write SQL to create Marks with a composite primary key and a CHECK. *(4 marks)*

> CREATE TABLE Marks; StudentID REFERENCES Student; CHECK Mark 0–100; PRIMARY KEY (StudentID, SubjectCode).

5. Explain how a foreign key keeps referential integrity. *(3 marks)*

> FK value must match parent PK; rejects orphans; e.g. C13Z rejected.

Summary

- A relation is a table of tuples and attributes.
- Degree = columns; cardinality = rows.
- Primary key = unique + not null.
- Foreign keys keep links between tables valid.
- CHECK and NOT NULL stop invalid values.

MCQ answer key – 8.2

1. **A** – Tuple.
2. **B** – Attribute.
3. **A** – Degree.
4. **C** – FK.
5. **B** – CHECK.
6. **D** – Duplicate key.

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

7. **A** – Primary key.
8. **E** – All rejected.
9. **A** – Relation – A table of rows with the same columns.
10. **B** – Attribute – A column that holds one property.
11. **D** – Tuple – A single row or record of a relation.
12. **E** – Domain – The set of allowed values for an attribute.
13. **E** – Degree – The number of attributes in a relation.
14. **B** – Cardinality – The number of tuples in a relation.
15. **D** – Relationship – A link between tables using key values.
16. **C** – NOT NULL constraint – Rule that a column must always have a value.
17. **D** – UNIQUE constraint – Rule that no two rows share a column value.
18. **C** – Primary key constraint – Unique, not null column that identifies each row.
19. **C** – Foreign key constraint – Rule that a value must exist in the referenced table.
20. **E** – Check constraint – Rule that a value must satisfy a condition.

© 2026 schoolict.net (Ruwan Mangala Suraweera). All rights reserved.

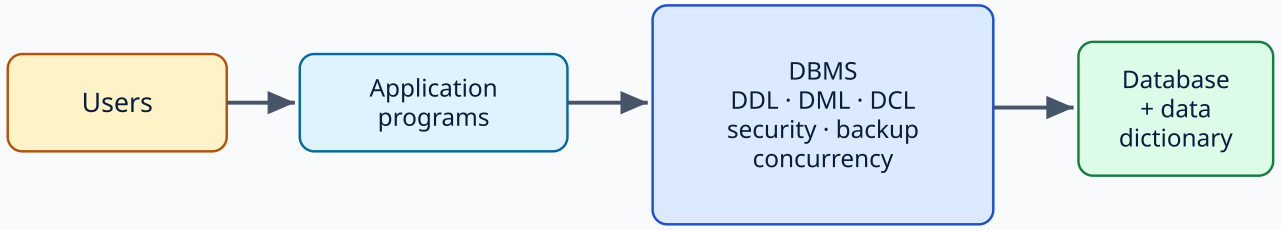
Grade 13 A/L ICT · Lesson 8

8.3 DBMS and SQL: DDL and DML

Syllabus 8.3. A **Database Management System (DBMS)** is the software between users and the stored data. We talk to it with **SQL**. **DDL** (CREATE, ALTER, DROP) defines the structure; **DML** (INSERT, SELECT, UPDATE, DELETE) works with the data, including queries on one table and **inner joins** on several tables.

1. Components of a database system

Database system: users → applications → DBMS → database



DDL: CREATE, ALTER, DROP – define structure

DML: INSERT, SELECT, UPDATE, DELETE – work with data

DBA controls the DBMS; SQL is the language for both

Users, applications, DBMS and database

- **Hardware** and **software** (the DBMS, e.g. MySQL).
- **Data** and the **data dictionary** (metadata).
- **Users**: end users, programmers and the **database administrator (DBA)**.
- **Procedures**: rules for backup, security and access.

2. SQL and its classification

Group	Purpose	Commands
DDL	Define structure	CREATE, ALTER, DROP
DML	Work with data	INSERT, SELECT, UPDATE, DELETE
DCL	Control access	GRANT, REVOKE

3. DDL: creating and changing structure

DDL commands (SQL)

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

```
CREATE DATABASE SchoolDB;
USE SchoolDB;
-- add and remove a column
ALTER TABLE Student ADD Phone VARCHAR(10);
ALTER TABLE Student DROP COLUMN Phone;
-- add and remove keys (MySQL style)
ALTER TABLE Student ADD PRIMARY KEY (StudentID);
ALTER TABLE Student ADD CONSTRAINT fk_class
  FOREIGN KEY (ClassID) REFERENCES Class(ClassID);
ALTER TABLE Student DROP FOREIGN KEY fk_class;
ALTER TABLE Student DROP PRIMARY KEY;
-- remove objects
DROP TABLE Marks;
DROP DATABASE SchoolDB;
```

When we added Phone in sqlite3 the Student columns became **StudentID, Name, ClassID, Phone**; after DROP COLUMN they were **StudentID, Name, ClassID**; after DROP TABLE Marks the tables left were **Class, Student**.

4. DML: inserting, updating and deleting

DML commands (SQL)

```
INSERT INTO Student (StudentID, Name, ClassID) VALUES ('S006', 'Dilini', 'C12B');
UPDATE Marks SET Mark = Mark + 5 WHERE SubjectCode = 'ICT' AND Mark < 50;
DELETE FROM Marks WHERE SubjectCode = 'MATH' AND Mark < 60;
```

🧱 **Worked example: How many rows does each statement change on the sample data?**
INSERT adds **1** row (students now 6). UPDATE changes **2** rows (S002 45→50, S005 39→44). DELETE removes **1** row (S003 MATH 55), leaving **7** mark rows.

5. SELECT queries

Single-table queries

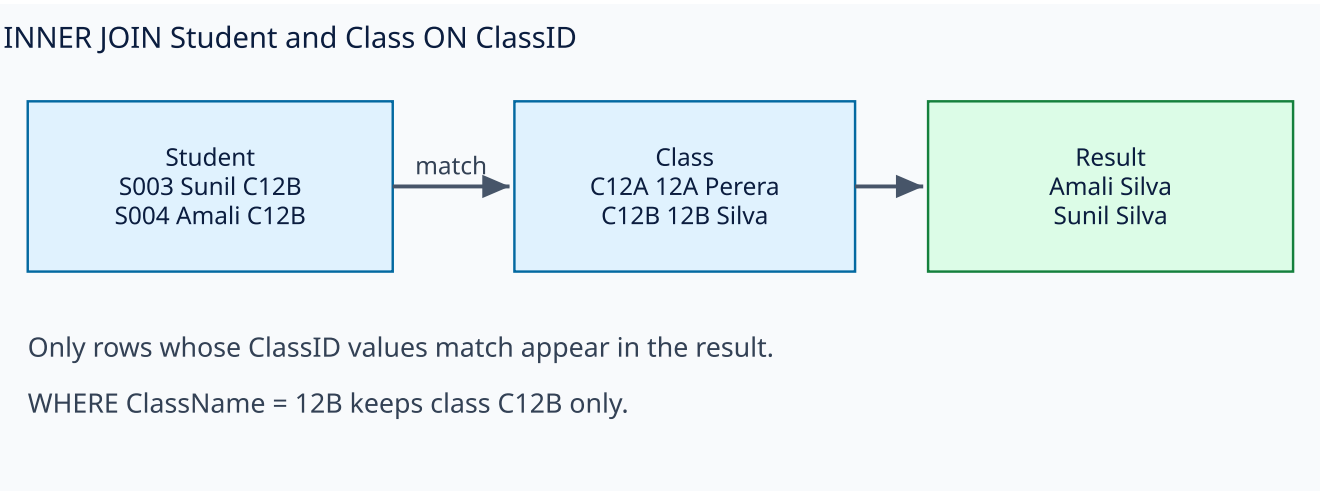
```
SELECT Name FROM Student WHERE ClassID = 'C12A' ORDER BY Name;

SELECT AVG(Mark) FROM Marks WHERE SubjectCode = 'ICT';

SELECT ClassID, COUNT(*) FROM Student GROUP BY ClassID ORDER BY ClassID;
```

Query	Result
Students in C12A (by name)	Kamala; Nimal; Ruwan
Average ICT mark	62.4
Students per class	C12A, 3; C12B, 2

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved



Inner join of Student and Class

Inner join queries

```
SELECT Student.Name, Class.Teacher
FROM Student INNER JOIN Class
  ON Student.ClassID = Class.ClassID
WHERE Class.ClassName = '12B'
ORDER BY Student.Name;

SELECT Student.Name, Marks.Mark
FROM Student INNER JOIN Marks
  ON Student.StudentID = Marks.StudentID
WHERE Marks.SubjectCode = 'ICT' AND Marks.Mark >= 60
ORDER BY Marks.Mark DESC;
```

Query 1: Name	Teacher
Amali	Silva
Sunil	Silva

Query 2: Name	ICT mark
Sunil	88
Nimal	78
Amali	62

💡 Always write the join condition (ON …); without it every row joins every row.

🚀 **Beyond the syllabus (2026 update)** *Not required for the exam – read for interest.* In 2026 many DBMSs accept natural-language questions and turn them into SQL, but you must still check the generated query.

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

Key Words

DBMS – Software that creates, manages and controls access to a database.

SQL – Standard language for defining and querying relational databases.

DDL – SQL commands that define database structure.

DML – SQL commands that insert, read, change and delete data.

DCL – SQL commands that grant or revoke access.

CREATE TABLE – Command that makes a new table with columns and types.

ALTER TABLE – Command that changes the structure of an existing table.

DROP TABLE – Command that deletes a whole table and its data.

SELECT – Command that retrieves rows and columns.

INNER JOIN – Combines rows of two tables where key values match.

UPDATE – Command that changes values in existing rows.

Database administrator – Person who manages security, backup and performance of a database.

Sample Q&A

1. List four components of a database system.

> **Answer:** Hardware, software (DBMS), data, users (and procedures).

2. Distinguish DDL and DML.

> **Answer:** DDL defines structure (CREATE/ALTER/DROP); DML handles data (INSERT/SELECT/UPDATE/DELETE).

3. Write SQL to add a Phone column to Student.

> **Answer:** ALTER TABLE Student ADD Phone VARCHAR(10);

4. What does the C12A query return?

> **Answer:** Kamala; Nimal; Ruwan.

5. What is the average ICT mark?

> **Answer:** 62.4.

6. Who are the 12B students and their teacher?

> **Answer:** Amali and Sunil; teacher Silva.

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

MCQ

1. CREATE, ALTER and DROP belong to

A. DCL
B. DDL
C. HTML
D. TCL
E. DML

2. INSERT, UPDATE and DELETE belong to

A. CSS
B. XML
C. DML
D. DDL
E. DCL

3. The command that removes a whole table is

A. DELETE FROM
B. ALTER TABLE
C. REMOVE ROW
D. DROP TABLE
E. TRUNCATE COLUMN

4. Rows changed by the UPDATE (+5 to ICT marks under 50) are

A. 8
B. 2
C. 0
D. 3
E. 5

5. The average ICT mark of the sample data is

A. 78.0
B. 62.0
C. 60.0
D. 64.5
E. 62.4

6. The 12B join query returns

A. Amali Perera; Ruwan Silva
B. Nimal Perera; Kamala Perera
C. no rows
D. Sunil Perera
E. Amali Silva; Sunil Silva

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

7. ICT marks of 60 or more, highest first, are

A. Sunil 88, Nimal 78, Amali 62
B. Kamala 45, Ruwan 39
C. Nimal 78, Sunil 88
D. Sunil 88 only
E. Amali 62, Sunil 88, Nimal 78

8. Who controls security and backup of a database?

A. web designer
B. end user
C. database administrator
D. compiler
E. network cable

9. Which term means: “Software that creates, manages and controls access to a database”?

A. DBMS
B. CREATE TABLE
C. UPDATE
D. DDL
E. DROP TABLE

10. Which term means: “Standard language for defining and querying relational databases”?

A. Database administrator
B. SQL
C. DML
D. ALTER TABLE
E. SELECT

11. Which term means: “SQL commands that define database structure”?

A. DDL
B. DBMS
C. DROP TABLE
D. DCL
E. INNER JOIN

12. Which term means: “SQL commands that insert, read, change and delete data”?

A. SQL
B. UPDATE
C. SELECT
D. CREATE TABLE
E. DML

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

13. Which term means: “SQL commands that grant or revoke access”?

A. DDL
B. ALTER TABLE
C. INNER JOIN
D. DCL
E. Database administrator

14. Which term means: “Command that makes a new table with columns and types”?

A. DML
B. DBMS
C. DROP TABLE
D. CREATE TABLE
E. UPDATE

15. Which term means: “Command that changes the structure of an existing table”?

A. SELECT
B. SQL
C. ALTER TABLE
D. DCL
E. Database administrator

16. Which term means: “Command that deletes a whole table and its data”?

A. DROP TABLE
B. INNER JOIN
C. CREATE TABLE
D. DDL
E. DBMS

17. Which term means: “Command that retrieves rows and columns”?

A. SQL
B. UPDATE
C. SELECT
D. ALTER TABLE
E. DML

18. Which term means: “Combines rows of two tables where key values match”?

A. Database administrator
B. DCL
C. DDL
D. INNER JOIN
E. DROP TABLE

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

19. Which term means: “Command that changes values in existing rows”?

A. DBMS
B. UPDATE
C. SELECT
D. DML
E. CREATE TABLE

20. Which term means: “Person who manages security, backup and performance of a database”?

A. INNER JOIN
B. ALTER TABLE
C. SQL
D. DCL
E. Database administrator

Structured Questions

1. Describe the components of a database system. *(5 marks)*

> Hardware; DBMS; data and dictionary; users and DBA; procedures.

2. Write SQL to create database SchoolDB and table Class with a primary key. *(2 marks)*

> CREATE DATABASE SchoolDB; CREATE TABLE Class (ClassID CHAR(4) PRIMARY KEY, ClassName VARCHAR(10) NOT NULL, Teacher VARCHAR(30)).

3. Write SQL to add then remove a foreign key on Student.ClassID. *(2 marks)*

> ALTER TABLE ADD CONSTRAINT fk_class FOREIGN KEY REFERENCES Class; ALTER TABLE DROP FOREIGN KEY fk_class.

4. Write SQL to add 5 marks to ICT marks below 50 and state rows changed. *(2 marks)*

> UPDATE Marks SET Mark = Mark + 5 WHERE SubjectCode = ICT AND Mark < 50; 2 rows.

5. Write an inner join listing each 12B student with the teacher, and give the output. *(4 marks)*

> SELECT Name, Teacher; FROM Student INNER JOIN Class ON ClassID; WHERE ClassName = 12B; Amali Silva, Sunil Silva.

Summary

- A DBMS sits between users and stored data.
- DDL = CREATE, ALTER, DROP.
- DML = INSERT, SELECT, UPDATE, DELETE.

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

- WHERE filters rows; ORDER BY sorts; GROUP BY groups.
- INNER JOIN combines tables on matching keys.

MCQ answer key – 8.3

1. **B** – DDL.
2. **C** – DML.
3. **D** – DROP.
4. **B** – S002, S005.
5. **E** – 312 ÷ 5.
6. **E** – Matching ClassID.
7. **A** – ORDER BY DESC.
8. **C** – DBA.
9. **A** – DBMS – Software that creates, manages and controls access to a database.
10. **B** – SQL – Standard language for defining and querying relational databases.
11. **A** – DDL – SQL commands that define database structure.
12. **E** – DML – SQL commands that insert, read, change and delete data.
13. **D** – DCL – SQL commands that grant or revoke access.
14. **D** – CREATE TABLE – Command that makes a new table with columns and types.
15. **C** – ALTER TABLE – Command that changes the structure of an existing table.
16. **A** – DROP TABLE – Command that deletes a whole table and its data.
17. **C** – SELECT – Command that retrieves rows and columns.
18. **D** – INNER JOIN – Combines rows of two tables where key values match.
19. **B** – UPDATE – Command that changes values in existing rows.
20. **E** – Database administrator – Person who manages security, backup and performance of a database.

© 2026 schoolict.net (Ruwan Mangala Suraweera). All rights reserved.

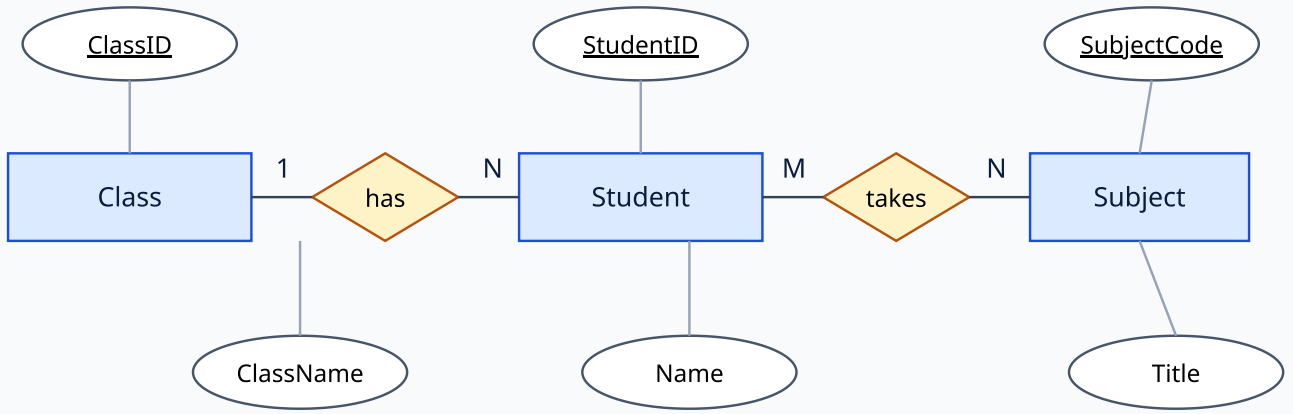
Grade 13 A/L ICT · Lesson 8

8.4 ER Diagrams: Conceptual Database Design

Syllabus 8.4. The **conceptual schema** shows what data an organisation needs, without tables or code. We draw it as an **Entity Relationship (ER) diagram** with **entities**, **attributes**, **entity identifiers**, **relationships** and **cardinality**, and meet **Extended ER (EER)** ideas such as subtypes.

1. Building blocks

ER diagram (Chen notation)



Rectangle = entity · ellipse = attribute (underlined = identifier) · diamond = relationship

ER diagram for a school

Entity (rectangle)
A thing we store data about: Student, Class, Subject.

Attribute (ellipse)
A property of an entity: Name, Title.

Identifier (underlined)
Attribute that is unique for each entity: StudentID.

Relationship (diamond)
An association between entities: has, takes.

2. Attribute types

- **Simple** (Age) vs **composite** (Address = Street + City).
- **Single-valued** vs **multi-valued** (Phone numbers) – double ellipse.
- **Derived** (Age from DateOfBirth) – dashed ellipse.

3. Cardinality

Type	Meaning	School example
1:1	one to one	Principal manages School

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

1:N	one to many	Class has Students
M:N	many to many	Students take Subjects

🧱 **Worked example: Library scenario: "A member can borrow many books; a book can be borrowed by many members over time. Each book has one publisher." Find the entities and cardinalities.**
Entities: **Member, Book, Publisher**. Member–Book is **M:N** (borrows, with attribute DateBorrowed). Publisher–Book is **1:N** (publishes). Identifiers: MemberNo, ISBN, PublisherID.

4. Extended ER (EER)

EER adds **specialisation/generalisation**: a supertype Person can have subtypes Student and Teacher that inherit its attributes. Subtypes can be **disjoint** (only one) or **overlapping** (both).

💡 Read a relationship both ways: one Class has many Students; one Student is in one Class → 1:N.

🚀 **Beyond the syllabus (2026 update)** *Not required for the exam – read for interest.* Design tools in 2026 can sketch an ER diagram from a written scenario, but you must still check cardinality and identifiers yourself.

Key Words

Conceptual schema – High-level description of data needs without implementation detail.

ER diagram – Diagram of entities, attributes and relationships.

Entity – A real-world thing about which data is stored.

Attribute – A property that describes an entity.

Entity identifier – Attribute whose value is unique for each entity.

Relationship – An association between two or more entities.

Cardinality – How many instances of one entity relate to another.

Composite attribute – Attribute made of smaller parts such as an address.

Multi-valued attribute – Attribute that can hold several values such as phone numbers.

Derived attribute – Attribute calculated from others such as age.

EER diagram – ER diagram extended with supertypes and subtypes.

Specialisation – Dividing a supertype into more specific subtypes.

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

Sample Q&A

1. What does a diamond show in an ER diagram?

> **Answer:** A relationship.

2. How is an identifier shown?

> **Answer:** Underlined attribute name.

3. Cardinality of Students and Subjects?

> **Answer:** M:N – a student takes many subjects and a subject has many students.

4. Give a derived attribute.

> **Answer:** Age, calculated from DateOfBirth.

5. What is a multi-valued attribute?

> **Answer:** An attribute with several values for one entity, e.g. phone numbers (double ellipse).

6. What does EER add?

> **Answer:** Supertypes/subtypes with inheritance (specialisation and generalisation).

MCQ

1. In an ER diagram an entity is drawn as a

A. cylinder
B. arrow
C. rectangle
D. ellipse
E. diamond

2. A relationship is drawn as a

A. diamond
B. double line only
C. ellipse
D. circle with number
E. rectangle

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

3. An underlined attribute is the

A. derived attribute
B. relationship name
C. foreign key only
D. multi-valued attribute
E. entity identifier

4. One class has many students is

A. 1:1
B. 1:N
C. N:1:M
D. 0:0
E. M:N

5. Students and subjects have cardinality

A. none
B. 1:N
C. M:N
D. N:1
E. 1:1

6. Age calculated from date of birth is a

A. multi-valued attribute
B. entity
C. composite attribute
D. derived attribute
E. identifier

7. Address made of Street and City is a

A. subtype
B. relationship
C. derived attribute
D. composite attribute
E. identifier

8. Person with subtypes Student and Teacher is shown in an

A. DFD level 1
B. EER diagram
C. context diagram
D. flat file
E. Gantt chart

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

9. Which term means: “High-level description of data needs without implementation detail”?

A. Composite attribute
B. EER diagram
C. Entity
D. Relationship
E. Conceptual schema

10. Which term means: “Diagram of entities, attributes and relationships”?

A. ER diagram
B. Cardinality
C. Attribute
D. Specialisation
E. Multi-valued attribute

11. Which term means: “A real-world thing about which data is stored”?

A. Conceptual schema
B. Entity
C. Composite attribute
D. Entity identifier
E. Derived attribute

12. Which term means: “A property that describes an entity”?

A. Relationship
B. Multi-valued attribute
C. Attribute
D. EER diagram
E. ER diagram

13. Which term means: “Attribute whose value is unique for each entity”?

A. Cardinality
B. Specialisation
C. Entity
D. Derived attribute
E. Entity identifier

14. Which term means: “An association between two or more entities”?

A. Relationship
B. Composite attribute
C. EER diagram
D. Conceptual schema
E. Attribute

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

15. Which term means: “How many instances of one entity relate to another”?

A. ER diagram
B. Entity identifier
C. Specialisation
D. Cardinality
E. Multi-valued attribute

16. Which term means: “Attribute made of smaller parts such as an address”?

A. Conceptual schema
B. Relationship
C. Derived attribute
D. Composite attribute
E. Entity

17. Which term means: “Attribute that can hold several values such as phone numbers”?

A. ER diagram
B. Attribute
C. Cardinality
D. EER diagram
E. Multi-valued attribute

18. Which term means: “Attribute calculated from others such as age”?

A. Entity
B. Derived attribute
C. Specialisation
D. Entity identifier
E. Composite attribute

19. Which term means: “ER diagram extended with supertypes and subtypes”?

A. Conceptual schema
B. Attribute
C. EER diagram
D. Multi-valued attribute
E. Relationship

20. Which term means: “Dividing a supertype into more specific subtypes”?

A. Specialisation
B. Cardinality
C. Derived attribute
D. ER diagram
E. Entity identifier

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

Structured Questions

1. Name and draw the symbols of an ER diagram. *(4 marks)*

> Rectangle entity; ellipse attribute; underline identifier; diamond relationship.

2. Explain 1:1, 1:N and M:N with school examples. *(3 marks)*

> 1:1 principal–school; 1:N class–students; M:N students–subjects.

3. Draw an ER diagram for the library scenario. *(4 marks)*

> Member, Book, Publisher; borrows M:N with DateBorrowed; publishes 1:N; identifiers.

4. Describe composite, multi-valued and derived attributes. *(3 marks)*

> Composite parts; multi-valued many values; derived calculated.

5. Explain specialisation in an EER diagram. *(4 marks)*

> Supertype Person; subtypes Student/Teacher; inherit attributes; disjoint or overlapping.

Summary

- ER diagrams model the conceptual schema.
- Rectangle = entity, ellipse = attribute, diamond = relationship.
- Identifiers are underlined.
- Cardinality is 1:1, 1:N or M:N.
- EER adds supertypes and subtypes.

MCQ answer key – 8.4

1. **C** – Rectangle.
2. **A** – Diamond.
3. **E** – Identifier.
4. **B** – One to many.
5. **C** – Many to many.
6. **D** – Derived.
7. **D** – Composite.
8. **B** – EER.
9. **E** – Conceptual schema – High-level description of data needs without implementation detail.
10. **A** – ER diagram – Diagram of entities, attributes and relationships.
11. **B** – Entity – A real-world thing about which data is stored.
12. **C** – Attribute – A property that describes an entity.
13. **E** – Entity identifier – Attribute whose value is unique for each entity.
14. **A** – Relationship – An association between two or more entities.
15. **D** – Cardinality – How many instances of one entity relate to another.

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

16. **D** – Composite attribute – Attribute made of smaller parts such as an address.
17. **E** – Multi-valued attribute – Attribute that can hold several values such as phone numbers.
18. **B** – Derived attribute – Attribute calculated from others such as age.
19. **C** – EER diagram – ER diagram extended with supertypes and subtypes.
20. **A** – Specialisation – Dividing a supertype into more specific subtypes.

© 2026 schoolict.net (Ruwan Mangala Suraweera). All rights reserved.

Grade 13 A/L ICT · Lesson 8

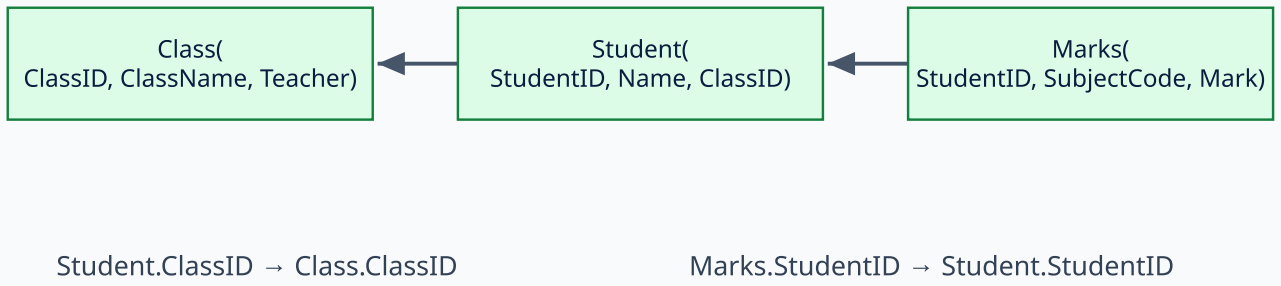
8.5 Logical Schema, Relation Instances and Keys

Syllabus 8.5. The **logical schema** describes the database as relations: each table name with its attributes, keys and **domains**. A **relation instance** is the data in a table at one moment. You learn **candidate**, **primary**, **alternate** and **foreign** keys.

1. Relational schema and instance

A **relational schema** is written as Name(attributes) with the primary key underlined, e.g. Student(StudentID, Name, ClassID). The schema rarely changes; the **instance** (rows) changes every time data is inserted, updated or deleted.

Logical schema: PK underlined, FK arrows



Logical schema of the school database

2. Keys

Candidate key
Minimal set of attributes that uniquely identifies each row.

Primary key
The candidate key chosen to identify rows.

Alternate key
A candidate key that was not chosen as primary.

Foreign key
Attribute that refers to the primary key of another table.

Composite key
Key made of two or more attributes, e.g. (StudentID, SubjectCode).

EmpID	NIC	Email	Name	Dept
E1	901234567V	nimal@co.lk	Nimal	IT

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

E2	912345678V	kamala@co.lk	Kamala	HR
E3	923456789V	sunil@co.lk	Nimal	IT
E4	934567890V	amali@co.lk	Amali	IT

🧱 **Worked example: Find the candidate, primary and alternate keys of Employee from this instance.**
A program tested every set of columns for uniqueness. Single-column candidate keys: **EmpID, NIC, Email**. Name is not unique (two Nimal) and (Name, Dept) is not unique (Nimal, IT twice). Choose **EmpID** as primary key; **NIC, Email** are alternate keys.

3. Domains

A **domain** is the set of allowed values for an attribute: Mark is an integer 0–100, ClassID is 4 characters starting with C, Date is a valid calendar date. Domains are enforced with data types and CHECK constraints.

💡 A sample instance can prove a set is NOT a key (a duplicate appears), but the real rule comes from the business meaning.

🚀 **Beyond the syllabus (2026 update)** *Not required for the exam – read for interest.* In 2026 many systems use random UUIDs as surrogate primary keys so records from phones and the cloud never clash.

Key Words

Logical schema – Description of a database as relations, attributes and keys.

Relational schema – The name and attribute list of one relation.

Relation instance – The set of rows in a table at a given time.

Candidate key – Minimal attribute set that uniquely identifies rows.

Primary key – Candidate key chosen as the main identifier.

Alternate key – Candidate key not chosen as primary key.

Foreign key – Attribute referencing the primary key of another relation.

Composite key – Key consisting of more than one attribute.

Super key – Any attribute set that uniquely identifies rows, minimal or not.

Domain – Allowed values of an attribute.

Surrogate key – Artificial key such as an auto number with no business meaning.

Referential integrity – Every foreign key value matches an existing primary key.

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

Sample Q&A

1. Schema vs instance?

> **Answer:** Schema is the structure; instance is the current rows.

2. Candidate keys of Employee?

> **Answer:** EmpID, NIC, Email.

3. Why is Name not a key?

> **Answer:** Two employees are named Nimal.

4. What is an alternate key?

> **Answer:** A candidate key not chosen as primary, e.g. NIC.

5. Give a composite key in the school database.

> **Answer:** (StudentID, SubjectCode) in Marks.

6. What is the domain of Mark?

> **Answer:** Integers from 0 to 100.

MCQ

1. The rows of a table at one moment form a

A. relation instance
B. domain
C. relational schema
D. candidate key
E. data model

2. A minimal set of attributes that identifies rows is a

A. candidate key
B. tuple
C. domain
D. degree
E. foreign key

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

3. A candidate key not chosen as primary is a

A. surrogate key
B. alternate key
C. foreign key
D. super key only
E. composite key

4. Number of single-column candidate keys in the Employee instance

A. 1
B. 2
C. 4
D. 5
E. 3

5. Why is (Name, Dept) not a key of Employee?

A. Name is a foreign key
B. (Nimal, IT) appears twice
C. keys cannot use text
D. it has two columns
E. Dept is numeric

6. (StudentID, SubjectCode) in Marks is a

A. composite primary key
B. alternate key
C. domain
D. derived attribute
E. foreign key only

7. The allowed values 0–100 for Mark are its

A. degree
B. domain
C. instance
D. schema
E. cardinality

8. Every FK value matching an existing PK is

A. redundancy
B. a domain
C. referential integrity
D. a super key
E. normalisation

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

9. Which term means: “Description of a database as relations, attributes and keys”?

A. Composite key
B. Relation instance
C. Surrogate key
D. Logical schema
E. Alternate key

10. Which term means: “The name and attribute list of one relation”?

A. Foreign key
B. Super key
C. Relational schema
D. Referential integrity
E. Candidate key

11. Which term means: “The set of rows in a table at a given time”?

A. Domain
B. Composite key
C. Logical schema
D. Relation instance
E. Primary key

12. Which term means: “Minimal attribute set that uniquely identifies rows”?

A. Super key
B. Candidate key
C. Relational schema
D. Alternate key
E. Surrogate key

13. Which term means: “Candidate key chosen as the main identifier”?

A. Domain
B. Relation instance
C. Foreign key
D. Primary key
E. Referential integrity

14. Which term means: “Candidate key not chosen as primary key”?

A. Logical schema
B. Composite key
C. Candidate key
D. Surrogate key
E. Alternate key

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

15. Which term means: “Attribute referencing the primary key of another relation”?

A. Super key
B. Referential integrity
C. Foreign key
D. Relational schema
E. Primary key

16. Which term means: “Key consisting of more than one attribute”?

A. Domain
B. Relation instance
C. Composite key
D. Logical schema
E. Alternate key

17. Which term means: “Any attribute set that uniquely identifies rows, minimal or not”?

A. Surrogate key
B. Relational schema
C. Foreign key
D. Candidate key
E. Super key

18. Which term means: “Allowed values of an attribute”?

A. Domain
B. Relation instance
C. Composite key
D. Primary key
E. Referential integrity

19. Which term means: “Artificial key such as an auto number with no business meaning”?

A. Super key
B. Alternate key
C. Candidate key
D. Logical schema
E. Surrogate key

20. Which term means: “Every foreign key value matches an existing primary key”?

A. Relational schema
B. Primary key
C. Domain
D. Referential integrity
E. Foreign key

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

Structured Questions

1. Define logical schema and relation instance. *(2 marks)*

> Logical schema relations and keys; instance current rows.

2. Write the relational schema of the school database with keys. *(3 marks)*

> Class(ClassID…); Student(StudentID…, ClassID FK); Marks(StudentID, SubjectCode, Mark).

3. Identify candidate, primary and alternate keys of Employee. *(3 marks)*

> Candidate EmpID, NIC, Email; primary EmpID; alternate NIC, Email.

4. Distinguish foreign key and composite key. *(2 marks)*

> FK references another PK; composite key has several attributes.

5. Explain domain with two examples. *(3 marks)*

> Allowed values; Mark 0–100; ClassID 4 characters.

Summary

- Logical schema = relations, attributes and keys.
- Instance = rows at one moment.
- Candidate keys are minimal unique sets.
- One candidate becomes primary; others are alternate.
- Foreign keys reference primary keys.

MCQ answer key – 8.5

1. **A** – Instance.
2. **A** – Candidate.
3. **B** – Alternate.
4. **E** – EmpID, NIC, Email.
5. **B** – Duplicate.
6. **A** – Composite.
7. **B** – Domain.
8. **C** – Referential integrity.
9. **D** – Logical schema – Description of a database as relations, attributes and keys.
10. **C** – Relational schema – The name and attribute list of one relation.
11. **D** – Relation instance – The set of rows in a table at a given time.
12. **B** – Candidate key – Minimal attribute set that uniquely identifies rows.
13. **D** – Primary key – Candidate key chosen as the main identifier.
14. **E** – Alternate key – Candidate key not chosen as primary key.
15. **C** – Foreign key – Attribute referencing the primary key of another relation.

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

16. **C** – Composite key – Key consisting of more than one attribute.
17. **E** – Super key – Any attribute set that uniquely identifies rows, minimal or not.
18. **A** – Domain – Allowed values of an attribute.
19. **E** – Surrogate key – Artificial key such as an auto number with no business meaning.
20. **D** – Referential integrity – Every foreign key value matches an existing primary key.

© 2026 schoolict.net (Ruwan Mangala Suraweera). All rights reserved.

Grade 13 A/L ICT · Lesson 8

8.6 Transforming ER Diagrams to a Logical Schema

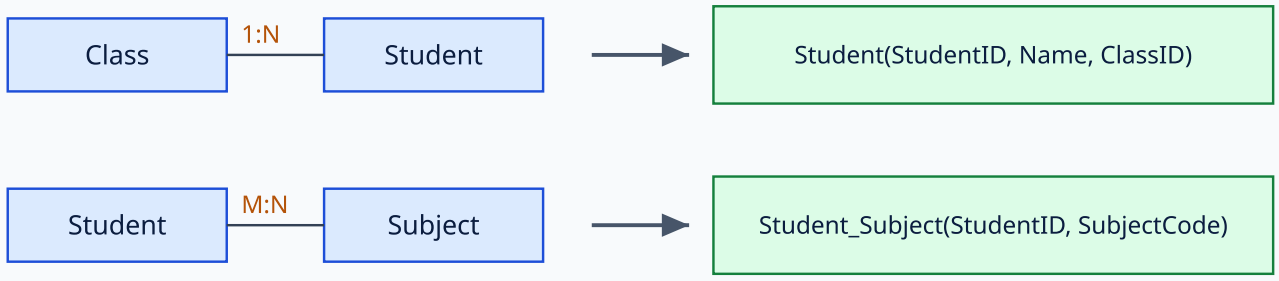
Syllabus 8.6. After drawing an ER diagram we **transform** it into tables. **Entities** become relations, **attributes** become columns, identifiers become **primary keys**, and **relationships** become **foreign keys** or new **linking tables** depending on cardinality.

1. Entity and attribute transformation

- Each strong **entity** → one table; the **identifier** → primary key.
- **Simple** attributes → columns; **composite** → one column per part (Street, City).
- **Multi-valued** → a new table with the owner key, e.g. StudentPhone(StudentID, Phone).
- **Derived** attributes are usually not stored (calculate Age when needed).

2. Relationship transformation

ER → tables: 1:N adds a foreign key, M:N adds a new table



Entity → table · attribute → column · identifier → primary key

1:N and M:N transformation

Cardinality	Rule	Example
1:1	Put the PK of one side as a FK (often UNIQUE) in the other	School(..., PrincipalID)
1:N	Put the PK of the “1” side as a FK in the “N” side	Student(..., ClassID)
M:N	Create a new table with both PKs as a composite PK	Student_Subject(StudentID, SubjectCode)

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

🧱 **Worked example: Transform the school ER diagram (Class 1:N Student, Student M:N Subject).**
A program applied the rules: **4 tables** – Student(StudentID, Name, ClassID); Subject(SubjectCode, Title); Class(ClassID, ClassName); Student_Subject(StudentID, SubjectCode). Student gets the foreign key ClassID; the M:N becomes Student_Subject with a composite key.

Resulting logical schema

```
Student(StudentID, Name, ClassID)
Subject(SubjectCode, Title)
Class(ClassID, ClassName)
Student_Subject(StudentID, SubjectCode)
```

Attributes of an M:N relationship (e.g. DateBorrowed in the library) go into the linking table: Borrow(MemberNo, ISBN, DateBorrowed).

💡 Count tables: one per entity + one per M:N relationship + one per multi-valued attribute.

🚀 **Beyond the syllabus (2026 update)** *Not required for the exam – read for interest.* ORM tools in 2026 (used with web frameworks) generate these tables automatically from class diagrams, using the same rules.

Key Words

Entity transformation – Turning each entity into a table.	**Attribute transformation** – Turning attributes into columns of a table.
Relationship transformation – Turning relationships into foreign keys or linking tables.	**Linking table** – Table created for an M:N relationship holding both keys.
One-to-many rule – The key of the one side goes into the many side.	**Many-to-many rule** – A new table with both primary keys is created.
One-to-one rule – The key of one side is placed as a unique foreign key in the other.	**Composite primary key** – Primary key made from two or more columns.
Strong entity – Entity with its own identifier.	**Weak entity** – Entity that depends on another for its identity.
Multi-valued table – Separate table that stores each value of a multi-valued attribute.	**Mapping** – The process of converting a conceptual model into a logical model.

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

Sample Q&A

1. How is an entity transformed?

> **Answer:** Into a table; its identifier becomes the primary key.

2. How is a 1:N relationship transformed?

> **Answer:** The PK of the one side is added as FK to the many side.

3. How is an M:N relationship transformed?

> **Answer:** A linking table with both PKs as a composite key.

4. How many tables for the school ER?

> **Answer:** 4.

5. Where does DateBorrowed go?

> **Answer:** Into the linking table Borrow.

6. How is a multi-valued attribute stored?

> **Answer:** In a separate table with the owner key.

MCQ

1. Each entity in an ER diagram becomes a

A. column
B. table
C. index
D. view
E. foreign key only

2. An entity identifier becomes the

A. foreign key
B. check rule
C. domain
D. index only
E. primary key

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

3. For Class 1:N Student, the foreign key goes in

A. neither table
B. both tables
C. Class
D. Student
E. a new table

4. An M:N relationship becomes

A. one extra column
B. nothing
C. a new linking table
D. a derived attribute
E. a CHECK rule

5. The school ER (3 entities, one 1:N, one M:N) gives

A. 4 tables
B. 3 tables
C. 6 tables
D. 2 tables
E. 5 tables

6. The key of Student_Subject is

A. StudentID only
B. SubjectCode only
C. (StudentID, SubjectCode)
D. ClassID
E. Title

7. A multi-valued attribute such as Phone becomes

A. a separate table
B. a diamond
C. a derived column
D. a primary key
E. a CHECK

8. A composite attribute Address becomes

A. a new entity always
B. one diamond
C. a foreign key
D. a linking table
E. separate columns for each part

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

9. Which term means: “Turning each entity into a table”?

A. Many-to-many rule
B. Composite primary key
C. Relationship transformation
D. Entity transformation
E. Multi-valued table

10. Which term means: “Turning attributes into columns of a table”?

A. Linking table
B. Mapping
C. One-to-one rule
D. Strong entity
E. Attribute transformation

11. Which term means: “Turning relationships into foreign keys or linking tables”?

A. Weak entity
B. Relationship transformation
C. One-to-many rule
D. Composite primary key
E. Entity transformation

12. Which term means: “Table created for an M:N relationship holding both keys”?

A. Linking table
B. Attribute transformation
C. Many-to-many rule
D. Strong entity
E. Multi-valued table

13. Which term means: “The key of the one side goes into the many side”?

A. Mapping
B. One-to-many rule
C. Weak entity
D. Relationship transformation
E. One-to-one rule

14. Which term means: “A new table with both primary keys is created”?

A. Multi-valued table
B. Entity transformation
C. Many-to-many rule
D. Composite primary key
E. Linking table

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

15. Which term means: “The key of one side is placed as a unique foreign key in the other”?

A. Strong entity
B. One-to-many rule
C. Mapping
D. One-to-one rule
E. Attribute transformation

16. Which term means: “Primary key made from two or more columns”?

A. Composite primary key
B. Relationship transformation
C. Weak entity
D. Entity transformation
E. Many-to-many rule

17. Which term means: “Entity with its own identifier”?

A. Attribute transformation
B. Multi-valued table
C. Strong entity
D. One-to-one rule
E. Linking table

18. Which term means: “Entity that depends on another for its identity”?

A. Mapping
B. Weak entity
C. One-to-many rule
D. Relationship transformation
E. Composite primary key

19. Which term means: “Separate table that stores each value of a multi-valued attribute”?

A. Strong entity
B. Many-to-many rule
C. Entity transformation
D. Multi-valued table
E. Linking table

20. Which term means: “The process of converting a conceptual model into a logical model”?

A. One-to-many rule
B. Weak entity
C. One-to-one rule
D. Attribute transformation
E. Mapping

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

Structured Questions

1. State the rules to transform entities and attributes. *(5 marks)*

> Entity table; identifier PK; simple column; composite parts; multi-valued table.

2. Explain the transformation of 1:1, 1:N and M:N relationships. *(3 marks)*

> 1:1 unique FK; 1:N FK in many side; M:N linking table.

3. Transform the school ER diagram into a logical schema. *(4 marks)*

> Class; Student with ClassID FK; Subject; Student_Subject composite key.

4. Transform the library ER (Member M:N Book, Publisher 1:N Book). *(4 marks)*

> Member; Publisher; Book with PublisherID FK; Borrow(MemberNo, ISBN, DateBorrowed).

5. Why is a derived attribute normally not stored? *(3 marks)*

> Can be calculated; avoids redundancy; avoids out-of-date values.

Summary

- Entity → table; identifier → primary key.
- Attribute → column; composite → parts.
- 1:N → foreign key in the many side.
- M:N → linking table with a composite key.
- Multi-valued → separate table.

MCQ answer key – 8.6

1. **B** – Table.
2. **E** – PK.
3. **D** – Many side.
4. **C** – Linking table.
5. **A** – 3 + 1.
6. **C** – Composite.
7. **A** – Separate table.
8. **E** – Parts.
9. **D** – Entity transformation – Turning each entity into a table.
10. **E** – Attribute transformation – Turning attributes into columns of a table.
11. **B** – Relationship transformation – Turning relationships into foreign keys or linking tables.
12. **A** – Linking table – Table created for an M:N relationship holding both keys.
13. **B** – One-to-many rule – The key of the one side goes into the many side.
14. **C** – Many-to-many rule – A new table with both primary keys is created.
15. **D** – One-to-one rule – The key of one side is placed as a unique foreign key in the other.

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

16. **A** – Composite primary key – Primary key made from two or more columns.
17. **C** – Strong entity – Entity with its own identifier.
18. **B** – Weak entity – Entity that depends on another for its identity.
19. **D** – Multi-valued table – Separate table that stores each value of a multi-valued attribute.
20. **E** – Mapping – The process of converting a conceptual model into a logical model.

© 2026 schoolict.net (Ruwan Mangala Suraweera). All rights reserved.

Grade 13 A/L ICT · Lesson 8

8.7 Normalisation: 0NF to 3NF

Syllabus 8.7. A badly designed table repeats data and suffers **insert, update and delete anomalies**. **Normalisation** splits it using **functional dependencies** (full, partial and transitive) through **zero, first, second and third normal form**.

1. Redundancy and anomalies

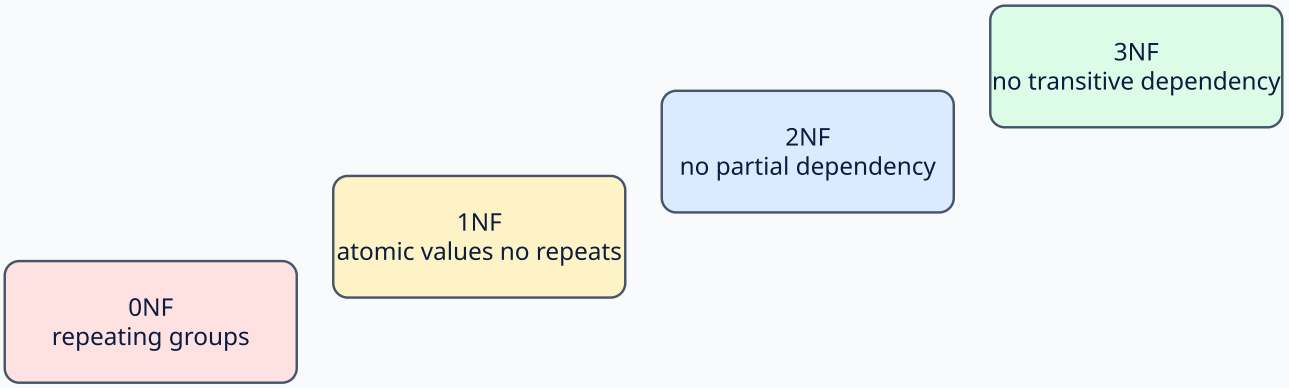
OrderNo	Date	CustID	CustName	ItemCode	ItemName	Qty	Price
1001	2026-03-01	C01	Perera	P1	Pen	3	50
1001	2026-03-01	C01	Perera	P2	Book	2	200
1002	2026-03-02	C02	Silva	P1	Pen	5	50
1003	2026-03-02	C01	Perera	P2	Book	1	200
1003	2026-03-02	C01	Perera	P3	Ruler	4	80

- **Insert anomaly** – a new item cannot be stored until someone orders it.
- **Update anomaly** – Perera appears in 4 rows; changing the name in one row only makes data inconsistent.
- **Delete anomaly** – deleting order 1002 also loses customer Silva.

2. Functional dependencies

A → B means each value of A fixes one value of B. With key (OrderNo, ItemCode): **full** – (OrderNo, ItemCode) → Qty; **partial** – OrderNo → Date, CustID and ItemCode → ItemName, Price; **transitive** – OrderNo → CustID → CustName.

Normalisation steps



Each step removes a cause of insert, update and delete anomalies.

Steps of normalisation

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

3. Normal forms

0NF
Unnormalised: repeating groups (several items in one order row).

1NF
Atomic values, no repeating groups; a key is chosen.

2NF
1NF and no partial dependency on part of a composite key.

3NF
2NF and no transitive dependency between non-key attributes.

🧱 **Worked example: Normalise the order data to 3NF and check that nothing is lost.** 0NF has 3 orders with repeating items → **1NF: 5 rows** (key OrderNo + ItemCode). Remove partial dependencies → **2NF**: Order(OrderNo, Date, CustID, CustName), Item(ItemCode, ItemName, Price), OrderLine(OrderNo, ItemCode, Qty). Remove the transitive CustID → CustName → **3NF: 4 tables** (Customer split off). Joining them in sqlite3 gives back exactly the 1NF rows (lossless). Cells: 40 → 37. Order totals: 1001 = Rs. 550, 1002 = Rs. 250, 1003 = Rs. 520.

3NF schema

```
Customer(CustID, CustName)
Order(OrderNo, Date, CustID)        -- FK CustID
Item(ItemCode, ItemName, Price)
OrderLine(OrderNo, ItemCode, Qty)   -- PK (OrderNo, ItemCode)
```

💡 2NF only matters when the key is composite; a single-column key in 1NF is already in 2NF.

🚀 **Beyond the syllabus (2026 update)** *Not required for the exam – read for interest.* Big data warehouses in 2026 sometimes denormalise on purpose for faster reports, but day-to-day systems stay in 3NF.

Key Words

Normalisation – Process of organising tables to reduce redundancy and anomalies.

Insert anomaly – Cannot add data without unrelated other data.

Update anomaly – Changing repeated data in some rows only leaves inconsistency.

Delete anomaly – Deleting a row also loses other needed facts.

Functional dependency – A value of one attribute set determines another attribute.

Full dependency – Attribute depends on the whole composite key.

Partial dependency – Attribute depends on only part of a composite key.

Transitive dependency – Non-key attribute depends on another non-key attribute.

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

Zero normal form – Unnormalised data with repeating groups.

First normal form – Atomic values and no repeating groups.

Second normal form – 1NF with no partial dependencies.

Third normal form – 2NF with no transitive dependencies.

Sample Q&A

1. What is an update anomaly?

> **Answer:** Repeated data changed in only some rows becomes inconsistent.

2. Give a partial dependency in the order table.

> **Answer:** ItemCode → ItemName, Price (part of the key).

3. Give the transitive dependency.

> **Answer:** OrderNo → CustID → CustName.

4. How many rows in 1NF?

> **Answer:** 5.

5. How many tables in 3NF?

> **Answer:** 4: Customer, Order, Item, OrderLine.

6. Condition for 3NF?

> **Answer:** In 2NF and no transitive dependency.

MCQ

1. Data with repeating groups is in

A. 2NF
B. BCNF only
C. 3NF
D. 0NF
E. 1NF

2. Removing repeating groups gives

A. 1NF
B. 3NF
C. 2NF
D. 0NF
E. no form

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

3. ItemCode → ItemName with key (OrderNo, ItemCode) is a

A. transitive dependency
B. partial dependency
C. multi-valued key
D. foreign key
E. full dependency

4. OrderNo → CustID → CustName is a

A. candidate key
B. full dependency
C. transitive dependency
D. partial dependency
E. domain

5. (OrderNo, ItemCode) → Qty is a

A. full dependency
B. partial dependency
C. insert anomaly
D. redundancy
E. transitive dependency

6. The order data in 1NF has

A. 10 rows
B. 6 rows
C. 8 rows
D. 5 rows
E. 3 rows

7. Losing customer Silva when order 1002 is deleted is a

A. insert anomaly
B. join
C. partial dependency
D. update anomaly
E. delete anomaly

8. The 3NF design of the order data has

A. 1 table
B. 6 tables
C. 4 tables
D. 3 tables
E. 5 tables

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

9. Which term means: “Process of organising tables to reduce redundancy and anomalies”?

A. Second normal form
B. Normalisation
C. Update anomaly
D. Full dependency
E. Transitive dependency

10. Which term means: “Cannot add data without unrelated other data”?

A. Third normal form
B. Zero normal form
C. Insert anomaly
D. Partial dependency
E. Delete anomaly

11. Which term means: “Changing repeated data in some rows only leaves inconsistency”?

A. Normalisation
B. Transitive dependency
C. Functional dependency
D. Update anomaly
E. First normal form

12. Which term means: “Deleting a row also loses other needed facts”?

A. Zero normal form
B. Second normal form
C. Insert anomaly
D. Full dependency
E. Delete anomaly

13. Which term means: “A value of one attribute set determines another attribute”?

A. Partial dependency
B. Functional dependency
C. Update anomaly
D. Third normal form
E. First normal form

14. Which term means: “Attribute depends on the whole composite key”?

A. Transitive dependency
B. Second normal form
C. Normalisation
D. Delete anomaly
E. Full dependency

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

15. Which term means: “Attribute depends on only part of a composite key”?

A. Insert anomaly
B. Partial dependency
C. Zero normal form
D. Functional dependency
E. Third normal form

16. Which term means: “Non-key attribute depends on another non-key attribute”?

A. Transitive dependency
B. Full dependency
C. Normalisation
D. First normal form
E. Update anomaly

17. Which term means: “Unnormalised data with repeating groups”?

A. Partial dependency
B. Second normal form
C. Insert anomaly
D. Zero normal form
E. Delete anomaly

18. Which term means: “Atomic values and no repeating groups”?

A. First normal form
B. Transitive dependency
C. Third normal form
D. Update anomaly
E. Functional dependency

19. Which term means: “1NF with no partial dependencies”?

A. Full dependency
B. Delete anomaly
C. Second normal form
D. Zero normal form
E. Normalisation

20. Which term means: “2NF with no transitive dependencies”?

A. Functional dependency
B. Insert anomaly
C. First normal form
D. Partial dependency
E. Third normal form

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

Structured Questions

1. Explain insert, update and delete anomalies with the order table. *(3 marks)*

> Insert new item; update Perera rows; delete order 1002 loses Silva.

2. Define full, partial and transitive dependency with examples. *(3 marks)*

> Full (OrderNo, ItemCode) → Qty; partial ItemCode → Price; transitive CustID → CustName.

3. Convert the 0NF order data to 1NF and state the key. *(3 marks)*

> Repeat order data per item; 5 rows; key (OrderNo, ItemCode).

4. Normalise the 1NF table to 2NF. *(3 marks)*

> Order(OrderNo, Date, CustID, CustName); Item(ItemCode, ItemName, Price); OrderLine(OrderNo, ItemCode, Qty).

5. Normalise to 3NF and explain which anomaly is removed. *(3 marks)*

> Customer(CustID, CustName) split; Order keeps CustID FK; removes update anomaly on CustName.

Summary

- Redundancy causes insert, update and delete anomalies.
- 1NF: atomic values, no repeating groups.
- 2NF: remove partial dependencies.
- 3NF: remove transitive dependencies.
- A good decomposition is lossless – joins rebuild the data.

MCQ answer key – 8.7

1. **D** – Unnormalised.
2. **A** – 1NF.
3. **B** – Part of key.
4. **C** – Via non-key.
5. **A** – Whole key.
6. **D** – Each item line.
7. **E** – Delete.
8. **C** – Customer, Order, Item, OrderLine.
9. **B** – Normalisation – Process of organising tables to reduce redundancy and anomalies.
10. **C** – Insert anomaly – Cannot add data without unrelated other data.
11. **D** – Update anomaly – Changing repeated data in some rows only leaves inconsistency.
12. **E** – Delete anomaly – Deleting a row also loses other needed facts.

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

13. **B** – Functional dependency – A value of one attribute set determines another attribute.
14. **E** – Full dependency – Attribute depends on the whole composite key.
15. **B** – Partial dependency – Attribute depends on only part of a composite key.
16. **A** – Transitive dependency – Non-key attribute depends on another non-key attribute.
17. **D** – Zero normal form – Unnormalised data with repeating groups.
18. **A** – First normal form – Atomic values and no repeating groups.
19. **C** – Second normal form – 1NF with no partial dependencies.
20. **E** – Third normal form – 2NF with no transitive dependencies.

© 2026 schoolict.net (Ruwan Mangala Suraweera). All rights reserved.