

THEME A: CONCEPTS · A3.2

Database design

Original practice questions · 35 marks · about 55 minutes · covers A3.2.1–A3.2.7

Instructions. Answer all questions. The maximum mark for this paper is [35 marks]. The marks available are shown in brackets. Parts badged **HL** assess higher level only content; standard level students may leave these out.

1**Total: 5 marks**

A city runs a public bike-hire scheme. Its database is being designed.

- (a)** Distinguish between a conceptual schema and a physical schema. **[3]**

- (b)** Outline **one** problem that could arise if the date and time of a hire were stored using the wrong data type. **[2]**

The designer identifies three entities: MEMBER, BIKE and HIRE. A member may make many hires, and a bike may be used for many hires.

- (a) State what is meant by the cardinality of a relationship. [1]

- (b)** Construct an entity relationship diagram (ERD) for the three entities, showing the relationships and their cardinality. **[4]**

- (c)** State the modality of the relationship between MEMBER and HIRE, given that a person may join the scheme without ever hiring a bike. **[1]**

Normalization is applied to a database design in stages.

- (a) State what is meant by atomicity in first normal form (1NF). [2]

- (b)** Explain the difference between second normal form (2NF) and third normal form (3NF). [4]

Table 1 shows an extract from the scheme's unnormalized HIRE view. A bike can begin only one hire at any given start time.

Table 1: extract from the HIRE view

MemberID	MemberName	MemberEmail	BikeID	BikeModel	StartTime	DurationMins
M12	Ada Bello	a.bello@example.net	B07	Cruiser 3	2026-04-02 08:15	22
M12	Ada Bello	a.bello@example.net	B19	Folder X	2026-04-02 17:40	35
M45	Tomas Ruiz	t.ruiz@example.org	B07	Cruiser 3	2026-04-03 09:05	14
M08	Wen Zhao	w.zhao@example.com	B07	Cruiser 3	2026-04-03 12:30	48
M08	Wen Zhao	w.zhao@example.com	B19	Folder X	2026-04-03 09:05	27
M45	Tomas Ruiz	t.ruiz@example.org	B19	Folder X	2026-04-04 07:50	19

HIRE (MemberID, MemberName, MemberEmail, BikeID, BikeModel, StartTime, DurationMins)

(a) Identify the composite key of the HIRE view. [1]

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(b) Identify **one** partial-key dependency in the HIRE view, and explain why it is partial. [2]

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(c) Construct the database in third normal form (3NF) for the three entities in the HIRE view. Underline each primary key. [5]

.....

5

Total: 5 marks

The finished design uses primary keys, foreign keys and a composite key.

- (a)** Explain how well-defined tables with primary and foreign keys help maintain data integrity. **[3]**

- (b)** Distinguish between a composite key and a foreign key. [2]

6

Total: 5 marks

A public dashboard shows how many bikes are available at each station. It refreshes every few seconds and currently joins three normalized tables each time. The scheme is considering storing some data more than once so that the dashboard reads from a single table.

- Evaluate** the decision to denormalize part of this database. [5]

END OF QUESTIONS