Grade 12 Computing

Unit 4 · Systems at Scale

WORKSHEET

Full marks 32

Name _____ Class _____ Roll no. ____ Date _____ Marks _____ / 32

1 Key words [4]

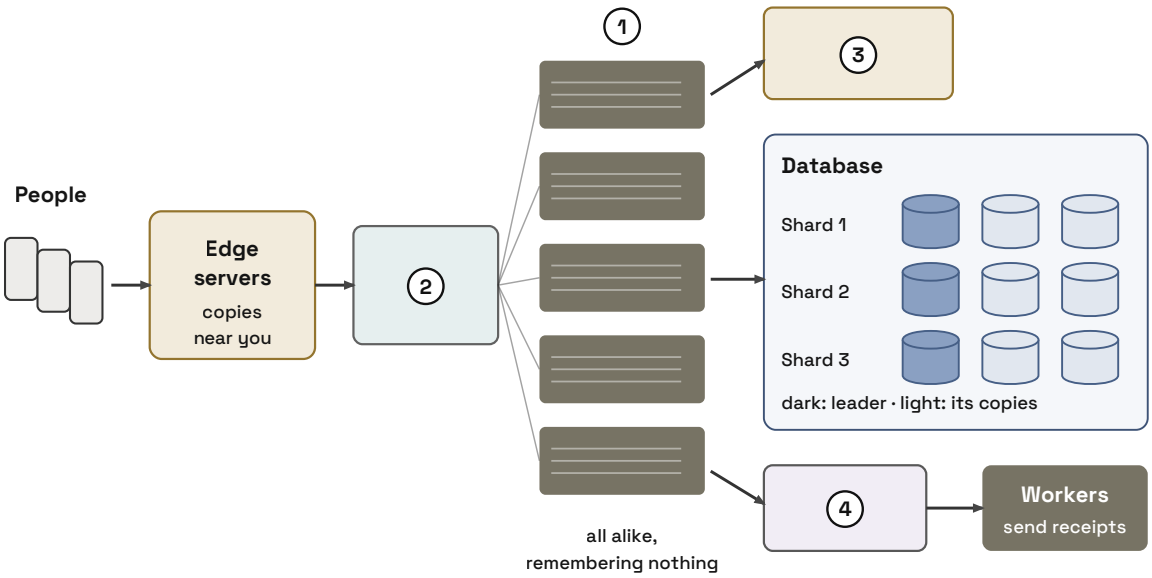
Fill in the blanks with words from the box. Two words in the box are not needed. Each blank carries 0.5 mark.

bottleneck	compiler	exponential backoff	firewall	hit	load balancer	network partition	shard	stateless	transaction

A server that keeps nothing about a user between requests is _____. The part that passes each request to one of the app servers is the _____. The one part that limits the whole system, so that adding to any other part does nothing, is the _____. One part of a database split by a rule worked out from each key is a _____. A group of changes that either all happen or none do is a _____. A network split into parts that can't reach each other is a _____. A request answered from a cache is a _____. Waiting longer before each try again, doubling the wait each time, is called _____.

2 The parts of a big service [2]

The diagram shows the parts of a service with millions of users. Write the words that belong in place of 1 to 4. Each carries 0.5 mark.



1. _____ 2. _____

3. _____ 4. _____

3 Multiple choice [5]

Choose the correct option for each of the following questions.

i. A shopping site keeps each signed-in customer's cart in the memory of the app server that first served them. What goes wrong at scale? [1]

a. Nothing: memory is the fastest place to keep it.

b. Every later request from that customer must reach the same server, and if it breaks or is removed, the cart is lost.

c. Carts in memory can't hold more than ten items.

d. The load balancer can't read the cart.

ii. Some requests to a bank's app take 20 times longer than others (a year's statement beside a balance check). Which way of sharing them out suits it best? [1]

a. round robin

b. send each request to the server with the fewest requests in progress

c. send every request to the first server until it is full

d. send each request to a random server

iii. During a network partition, a ticket booking system lets both sides keep selling seats. What can go wrong? [1]

a. Nothing: each side has its own copy.

b. The same seat can be sold on both sides, and the two sales only clash when the link is back.

c. Both sides stop selling.

d. The seats are sold more slowly.

iv. A wallet app shows "Sent", and a second later the server loses power. When it restarts, the payment is still there. Which ACID property is that? [1]

a. atomicity **b.** consistency

c. isolation **d.** durability

v. You post a comment, refresh, and it has disappeared; a minute later it is back. What is the most likely cause? [1]

a. The comment was deleted and then restored by a moderator.

b. The refresh read from a follower copy that hadn't yet received your change.

c. Your phone ran out of memory.

d. The load balancer lost your comment.

4 Think [2]

Think, then answer.

A wallet company keeps three copies of every balance, in Kathmandu, Pokhara and Biratnagar. Its advert says: "Even when the network between our cities is cut, you can pay from anywhere, and your balance will always be exactly right." Can it keep both promises? Explain.

5 Waiting, and waiting for the slowest [4]

Answer on the lines. Show your working.

A server needs 0.04 s for a request. Use the rule time per request = time to serve one ÷ (1 − how busy the server is).

i. How long does a request take, waiting included, when the server is 75% busy? When it is 96% busy?

ii. A page needs answers from 20 servers, and each is slow on 2% of requests. On what share of page loads is at least one of them slow?

6 A lost update [3]

Read the table, then answer.

Sita's wallet holds Rs. 1,000. At the same moment, her salary of Rs. 500 is paid in and her phone bill of Rs. 200 is paid out. Each program reads the balance, then writes a new one worked out from what it read:

Step	Program 1 (adds 500)	Program 2 (takes 200)
1	reads the balance: 1,000	
2		reads the balance: 1,000
3	writes 1,000 + 500 = 1,500	
4		writes 1,000 − 200 = 800

i. What balance is left, and what should it be?

ii. What is this problem called, and which ACID promise has been broken?

iii. How does record locking prevent it?

7 A data center's electricity and water [3]

Answer on the lines. Show your working.

A data center's computers use 8 MW all year. Its PUE is 1.4 and its WUE is 2.0 L/kWh. Estimate:

i. the electricity the whole data center uses in a year, in GWh;

ii. the water it uses on site in a year, in million liters;

iii. how many people's basic water that is, at 100 liters a day each.

8 What does it print? [4]

Write exactly what the program prints, in the box under it. Then answer.

A bank splits its accounts into shards by account number mod 4, and is about to add a fifth shard.

```
for account in [1007, 2026, 3333]:
    print(account, account % 4, account % 5)

moved = 0
for account in range(1, 21):
    if account % 4 != account % 5:
        moved += 1
print(moved)
```

OUTPUT

i. Why do big services share keys out by consistent hashing instead?

9 The four promises [2]

Match each ACID promise, in Column A, with what it means, in Column B. Two items in Column B are not needed. Each carries 0.5 mark.

Column A		Column B
1. atomicity	☐	a. every rule of the database still holds after a transaction
2. consistency	☐	b. once committed, a change survives a crash or a power cut
3. isolation	☐	c. a transaction happens completely or not at all
4. durability	☐	d. transactions running at the same time don't see each other's half-done changes
		e. a copy is kept close to the user
		f. every copy answers, even when the network is split

10 Find and fix the bug [3]

Read the program, then answer.

A wallet may hold at most Rs. 50,000, so sending Rs. 500 to Hari is refused. The program prints `Refused`, then `[('Sita', 1500), ('Hari', 49800)]`.

```
import sqlite3

db = sqlite3.connect(":memory:", isolation_level=None)
db.execute("CREATE TABLE wallets (name TEXT, "
           "balance INTEGER CHECK (balance <= 50000))")
db.execute("INSERT INTO wallets VALUES ('Sita', 2000), ('Hari', 49800)")
TAKE = "UPDATE wallets SET balance = balance - ? WHERE name = ?"
ADD = "UPDATE wallets SET balance = balance + ? WHERE name = ?"

def send(sender, receiver, amount):
    try:
        db.execute("BEGIN")
        db.execute(TAKE, (amount, sender))
        db.execute(ADD, (amount, receiver))
        db.execute("COMMIT")
        print("Sent", amount)
    except sqlite3.IntegrityError:
        print("Refused")

send("Sita", "Hari", 500)
print(db.execute("SELECT * FROM wallets").fetchall())
```

i. Where has Sita's Rs. 500 gone, and why?

ii. Write the line that fixes it, and say where it goes.

11 Activity: Results day (not marked)

At a computer or on a phone, open the unit's page (the QR code) and find **Results day.** Try each number of web servers, first with the cache off, then with it on, and fill in the table.

Web servers	Cache off: do visitors give up? How many?	Cache on: do visitors give up? How long do they wait?
2		
3		
5		
6		
Which part is full?		