

Name: \_\_\_\_\_

1. (1 pt.)

- **Read all material carefully.**
- You may refer to your books, papers, and notes during this test.
- No computer or network access of any kind is allowed (or needed).
- Write, and draw, carefully. Ambiguous or cryptic answers receive zero credit.
- Use the conventions used in class and the textbook for all material.
- Some questions refer to the database suggested by Figure 1 on the last page. You may detach that page for easy reference. There is no need to reattach it.
- Reminder: In all query-writing questions, your answers should work on *all* database instances, not only the instance of Figure 1.

Write your name in the space provided above.

2. (4 pts.) Indicate the result of evaluating the following query on the database instance of Figure 1.

```
select B1.tag, sum(B2.price) as S
from Batteries B1, Batteries B2
where B1.price < 2.50 and B2.price >= 2.25
group by B1.tag
order by B2.price desc, B1.tag
```

3. (10 pts.) Write a SQL query to find the names of manufacturers whose batteries, in our database, have the highest average capacity, where the average is taken over all the mAh values as recorded in the Charges table, for batteries from that manufacturer.

4. (10 pts.) Write a SQL query to find the tags of batteries in our database that have a rated capacity at least 20% higher than their average charged-capacity in 2012 (averaging over all charge records in the year 2012). The result should be a list of tuples of the form  $(t, r, c, d)$  where  $t$  is the battery tag,  $r$  is its rated capacity,  $c$  is its average charged-capacity in 2012, and  $d$  is the difference  $r - c$ . The list should be sorted in descending order of  $d$  and, secondarily, in ascending order of  $t$ .

5. (5 pts.) Refer to Codd's paper from the readings. Can the join operator as defined there be expressed in PSC algebra as described in class? If so, provide an PSC expression equivalent to that operator. If not, explain why not. Illustrate your answer with a suitable example. There is no credit for answers without explanations.

# Scratch page

Material here will not be graded. You may detach and discard this page.

Batteries

tag varchar(50)	model varchar(50)	buy_date date	price float	manuf_date date	color varchar(50)	notes varchar(50)
x1	Tenergy AB	2009-01-23	2.20	2008-06-01	blue	heavy
x2	Tenergy AB	2009-01-23	2.20	2008-06-01	blue	light
pq	Tenergy AB	2010-10-03	2.25	2009-06-01	blue	check
pq2	Tenergy AB	2010-10-30	2.50	2009-06-01	blue	

Charges

tag varchar(50)	model varchar(50)	charger varchar(50)	date date	mAh float	method varchar(50)
x1	Tenergy AB	maha-101	2012-01-22	1883	charge
x1	Tenergy AB	maha-101	2012-02-12	1983	refresh

Models

model varchar(50)	manuf varchar(50)	model varchar(50)	rated_mAh float	notes varchar(50)
Tenergy AB	Tenergy	Essential	2500	
Amazon B	Amazon	Basics	2200	OEM unknown

For notational convenience in relational algebra, we may abbreviate as follows:

Batteries(tag, model, buy\_date, price, manuf\_date, color, notes)  $B(T, M, B, P, F, C, N)$

Charges(tag, model, charger, date, mAh, method)  $C(T, M, C, D, A, E)$

Models(model, manuf, model, rated\_mAh, notes)  $M(M, F, P, A, N)$

Figure 1: A battery database.