Name: ______________________

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<th>Problem</th>
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1. (20 Points) Consider the data requirements for an “eTailer,” such as Amazon. Here are the kinds of information that the eTailer wishes to maintain:

- Their suppliers, including supplier names, addresses, and a logo to display.
- The items made by each supplier (e.g., HP), including the type of item (e.g., printer), the model number (e.g., 693C), and the retail price. Note that different suppliers may use the same model number for different items, even if those items are of the same type and price. However, one supplier will not use the same model number for two different items.
- Customers, including their name, address, and email.
- Credit cards, including the company (e.g., Visa), number, and expiration date. Each customer may have several credit cards on file, but each credit card belongs to only one customer.
- Orders. Each order has a unique ID, has a single customer who placed the order. One of the customer’s credit cards was used to pay for the order, and the order must tell which. A customer can place several orders and use different credit cards for each. An order is for some set of items, and there is an associated quantity for each. There are several ways to represent orders, but try to use a design that does not allow an order to be placed for a customer who does not own the credit card used to pay for the order.

Give an E/R design for this database. Briefly explain your reasoning, including the intuitive meaning of any relationships you use and any entity sets you use other than suppliers, items, customers, and orders. Do not forget to indicate keys, many-one relationships, and weak entity sets in the appropriate ways.
2. (20 Points) Generate a relational schema for the following E-R schema. The relational schema should be drawn using the graphical notation of ElMasri-Navathe text (rectangles for relation schema with partitions for each attribute; underlining for primary keys and pointers for foreign keys).
3. (20 Points) Reverse engineer an E-R schema from the following relational schema shown in SQL:

```sql
create table zipcodes (
    zip number(5),
    city varchar2(30),
    primary key (zip));

create table employees (
    eno number(4) not null primary key,
    ename varchar2(30),
    zip number(5) references zipcodes,
    hdate date);

create table parts (pno number(5) not null primary key,
    pname varchar2(30),
    qoh integer check(qoh &gt;= 0),
    price number(6,2) check(price &gt;= 0.0),
    olevel integer);

create table customers (cno number(5) not null primary key,
    cname varchar2(30),
    street varchar2(30),
    zip number(5) references zipcodes,
    phone char(12));

create table orders (ono number(5) not null primary key,
    cno number(5) references customers,
    eno number(4) references employees,
    received date,
    shipped date);

create table odetails (ono number(5) not null references orders,
    pno number(5) not null references parts,
    qty integer check(qty &gt; 0),
    primary key (ono,pno));
```
4. (25 Points) Consider the following schema:

```
 suppliers(SID,sname,address).
 parts(PID,pname,color).
 catalog(SID,PID,cost).
```

The primary keys are shown in uppercase. The SID column in catalog is a foreign key referring to SID in suppliers and the PID column in catalog is a foreign key referring to PID in parts. The catalog table lists the prices charged for parts by suppliers. Write the following queries in relational algebra.

(a) Get the names of suppliers who supply some red part or are at 221 Packer Ave.

(b) Get the names of suppliers who supply all red parts.

(c) Get the pnames of parts supplied by at least 3 different suppliers.

(d) Get the pnames of the most expensive parts supplied by suppliers named Yosemite Sham.
5. (15 Points) Consider two relations $r_1(R_1)$ and $r_2(R_2)$ where $r_1$ contains $N_1$ tuples and $r_2$ contains $N_2$ tuples with $N_2 > N_1 > 0$. For each of the following relational algebra expressions, give the MINIMUM and MAXIMUM possible sizes of the resulting relation produced by the expression. State any assumptions about the schemas that are necessary for the expressions to be meaningful.

(a) $r_1 \cup r_2$.

(b) $r_1 \cap r_2$.

(c) $r_1 - r_2$.

(d) $r_1 \times r_2$.

(e) $r_1 \div r_2$.

(f) $\Pi_A(r_1)$.

(g) $\sigma_{A=5}(r_1)$. 