Relation Algebra Example Question

Relations:
Note: **Bold text** represents primary key, wavy line represents foreign key.

$Branch(\mathbf{bid}, address, city, manager\_name, opening\_hours, has\_atm)$
$Customer(\mathbf{cid}, first\_name, last\_name, address, date\_joined, \underset{\sim}{bid})$
$Loan(\mathbf{loan\_id}, amount, date, term, \underset{\sim}{cid}, \underset{\sim}{bid})$
$Account(balance, \underset{\sim}{cid}, \underset{\sim}{bid})$ 2 foreign keys as primary key

Questions:
1. The names of all branch managers in Vancouver:
$\pi_{manger\_name}(\sigma_{city=Vancouver}(Branch))$

2. The dates of all loans by customers with the name 'Anita Borg'
$R_{customerloans} = Loan \bowtie Customer$
$\pi_{date}(\sigma_{first\_name="Anita" \wedge\ last\_name="Borg"}(R_{customerloans}))$

3. The names of all people who have loans of more than $10,000
$\pi_{first\_name,\ last\_name}(\sigma_{amount\ >\ 10{,}000}(R_{customerloans}))$
Note: $R_{customerloans}$ is from above

4. The names of all people who have accounts in Toronto and loans of more than $5,000
$R_{toronto\_loans} = (Branch \bowtie_{city=Toronto} Loan) \bowtie Customer$
$\pi_{first\_name,\ last\_name}(\sigma_{amount\ >\ 5{,}000}(R_{toronto\_loans}))$

5. The names of all people who have accounts in Toronto but do not have any loans
$R_{tornto\_accounts} = (\sigma_{city=Toronto}(Branch)) \bowtie Customers$
$\pi_{first\_name,\ last\_name}(\sigma_{cid}(R_{toronto\_accounts}) - \sigma_{cid}(Loan))$

6. The names of all people who have a loan of more than $10,000 and a loan of less than $1,000
$R_{loan\_10{,}000} = Customer \bowtie_{Customer.cid\ =\ Loan.cid} (\sigma_{amount>10{,}000}\ Loan)$
$R_{loan\_1{,}000} = Customer \bowtie_{Customer.cid\ =\ Loan.cid} (\sigma_{amount<1{,}000}\ Loan)$
$\pi_{first\_name,last\_name}(R_{loan\_1{,}000} \wedge R_{loan\_10{,}000})$