Consider the following company dataset, where Emp.mgrno is a foreign key for Emp(eno) used to model the management chain in the company, Work.empno is a foreign key for Emp.eno, and Work.deptno is a foreign key for Dept.dno. Assume that salaries and budgets are given in dollars (per year) and ages are given in years. Write each of the queries that follow in the requested query language(s).

\[\text{Emp}(\text{eno, ename, salary, age, mgrno}) \quad \text{-- the usual info about employees}\]
\[\text{Work}(\text{empno, deptno, pcttime}) \quad \text{-- emps can split their time between depts}\]
\[\text{Dept}(\text{dno, dname, budget}) \quad \text{-- the usual info about departments}\]

1. (4 points) Print the employee numbers and names of all employees who earn more per year than their manager does:

   a) (2 pts) Relational algebra:
   \[
   \pi \text{eno, ename} (\sigma \text{salary} > \text{mgrsal} ((\pi \text{eno, ename, salary, mgrno (Emp)}) \bowtie (\rho (\text{mgrno} \leftarrow \text{eno}, \text{mgrsal} \leftarrow \text{salary} (\pi \text{eno, salary (Emp))))))]
   \]

   b) (2 pts) Relational calculus:
   \[
   \{t(\text{eno,ename}) \mid \exists e1 \in \text{Emp} (t.\text{eno} = e1.\text{eno}, t.\text{ename} = e1.\text{ename} \land
   \forall e2 \in \text{Emp}(e1.\text{mgrno} = e2.\text{eno}, e1.\text{salary} > e2.\text{salary})\}\}
   \]
2. (4 points) Print the names of employees who spend at least some part of their time working in every one of the departments with a budget over $1M.

a) (2 pts) Relational algebra:
\[ \pi \text{ename} (\text{Emp} \bowtie (\pi \text{eno}, \text{dno} (\rho \text{eno} \leftarrow \text{empno}, \text{dno} \leftarrow \text{deptno} (\text{Work}))) / (\pi \text{dno} (\sigma \text{budget} > 1000000 (\text{Dept})))) \]

b) (2 pts) Relational calculus:

Common mistake:
\{ t(\text{ename}) \mid \exists e \in \text{Emp} (t.\text{ename} = e.\text{ename} \land \\
\forall d \in \text{Dept} (d.\text{budget} > 1000000 \land \\
\exists w \in \text{Work} (w.\text{eno} = e.\text{eno} \land w.\text{dno} = d.\text{dno})) \} \}

Right answer:
\{ t(\text{ename}) \mid \exists e \in \text{Emp} (t.\text{ename} = e.\text{ename} \land \\
\forall d \in \text{Dept} (d.\text{budget} > 1000000 \rightarrow \\
\exists w \in \text{Work} (w.\text{eno} = e.\text{eno} \land w.\text{dno} = d.\text{dno})) \} \}
\{ t(\text{ename}) \mid \exists e \in \text{Emp} (t.\text{ename} = e.\text{ename} \land \\
\forall d \in \text{Dept} (\neg (d.\text{budget} > 1000000) \lor \\
\exists w \in \text{Work} (w.\text{eno} = e.\text{eno} \land w.\text{dno} = d.\text{dno})) \} \}

3. (2 points) Print the names, monthly salaries, and ages of employees whose annual salary is over 10000 times their age and whose name begins with the letter ‘T’.

a) (2 pts) SQL:
\begin{verbatim}
SELECT ename, salary/12, age FROM Emp
WHERE Emp.salary > Emp.age * 10000
AND Emp.ename LIKE 'T%';
\end{verbatim}