Problem I

Write a procedure \texttt{islist} which succeeds if its argument is a list, and fails otherwise.
Problem II

Write a procedure `alter` which changes English sentences according to rules given in the database. Example:

```prolog
change(you, i).
change(are, [am, not]).
change(french, german).
change(do, no).
?- alter([do,you,know,french],X).
   X = [no,i,know,german]
?- alter([you,are,a,computer],X).
   X = [i,[am,not],a,computer]
```
Problem III

Write a list subtraction procedure.
Example:

?- sub([1,2,4,6,8], [2,6], L).
L=[1,4,8].
Answer III
Write a procedure `pick` which returns the first $N$ elements of a given list.

Example:

?- pick([1,2,4,6,8], 3, L).
L=[1,2,4].
Answer IV
Problem V

Write a procedure `alt` which produces every other element in a list.
Example:

```prolog
?- alt([1,2,3,4,5,6], A).
A = [1,3,5]
```
Answer V
Problem VI

Write a procedure `del` which removes duplicate elements from a list.
Example:

```
?- del([a,c,x,a,g,c,d,a], A).
A = [a,c,x,g,d]
```
Answer VI
Problem VII

Write a procedure tolower which converts an atom containing upper case characters to the corresponding atom with only lower case characters.

Example:

?- tolower('hEj_HoPp3', A).
A = hej_hopp3
Answer VII
Problem VIII

Write a procedure \texttt{max3} which produces the largest of three integers.
Example:

\begin{verbatim}
?- max3(3,5,1,X).
X = 5
\end{verbatim}
Answer VIII
Write a procedure `double` which multiplies each element in a list of numbers by 2.
Example:

```
?- double([1,5,3,9,2], A).
A = [2,10,6,18,4]
```
Answer IX
Write a procedure `ave` which computes the average of a list of numbers.
Example:

?- ave([1, 5, 3, 9, 2], A).
   A = 4
Answer X
Problem XI

Write a procedure \texttt{sum} which produces the sum of the integers up to and including its first argument. Example:

\begin{verbatim}
?- sum(5, S).
S = 15
\end{verbatim}
Answer XI
Problem XII

Suppose our database contains facts of the form

\[
\text{person\_age}(\text{Name, Age}).
\]
\[
\text{person\_sex}(\text{Name, Sex}).
\]

where \text{Sex} is either \text{male} or \text{female}. Write a procedure \text{combine} which extends the database with additional facts of the form

\[
\text{person\_full}(\text{Name, Age, Sex}).
\]

The procedure should produce one such fact for each person who has both an age record and a sex record.
Problem XII...

Example: Given the following database

```
person_age(chris, 25). % Yeah, right...
person_sex(chris, male).
person_age(louise, 8).
person_sex(louise, female).
```

`combine` should produce these additional facts:

```
person_full(chris, 25, male).
person_full(louise, 8, female).
```
Answer XII
Problem XIII

Write a Prolog procedure which reverses the order of Johns children in the database. For example, given the following database

```
child(mary, john).
child(jane, john).
child(bill, john).
```

the goal `?- reversefacts.` should change it to

```
child(bill, john).
child(jane, john).
child(mary, john).
```
Answer XIII
Problem XIV

Write a Prolog procedure to assemble a list of someone’s children from the facts in the database. The database should remain unchanged.

Example:

```
child(mary, john).
child(jane, john).
child(bill, john).

?- assemble(john, L).
   L = [mary, jane, bill]
```
Problem XV

Write down the *all* results (including variable bindings) of the following query:

?– append([], [1, 2|B], C),
append([3, 4], [5], B).
Answer XV
Problem XVI

Write down the *all* results (including variable bindings) of the following query:

```prolog
?- bagof(X, Y^append(X, Y, [1,2,3,4]), Xs).
```
Answer XVI
Write down the *all* results (including variable bindings) of the following query:

?- L=[1,2], member(X, L), delete(X, Y, L).
Problem XVIII

Write down the *all* results (including variable bindings) of the following query:

?– member(X, [a,b,c]), member(Y, [a,b,c]), !, X ≠ Y.
Answer XVIII
Problem XIX

Given the following Prolog database

\[
\begin{align*}
\text{balance}(\text{john}, 100). \\
\text{balance}(\text{sue}, 200). \\
\text{balance}(\text{mary}, 100). \\
\text{balance}(\text{paul}, 500). \\
\end{align*}
\]

list all the results of these Prolog queries:

1. \(\text{?- bagof(}\text{Name}, \text{balance(}\text{Name}, \text{Amount}), \text{Name})\).

2. \(\text{?- bagof(}\text{Name}, \text{Amount}\neg\text{balance(}\text{Name}, \text{Amount}), \text{Name})\).

3. \(\text{?- bagof(}\text{Name}, \text{Name}\neg\text{balance(}\text{Name}, \text{Amount}), \text{Name})\).\)
Answer XIX...
Answer XIX...
Describe (in English) what the following predicate does:

% Both arguments to bbb are lists.
bbb([], []).  
bbb(A, [X|F]) :- append(F, [X], A).
Answer XX
Problem XXI

Given the following program

\[
\begin{align*}
  a(1,2). \\
  a(3,5). \\
  a(R, S) & : = b(R, S), b(S, R). \\
  b(1,3). \\
  b(2,3). \\
  b(3, T) & : = b(2, T), b(1, T). 
\end{align*}
\]

list the first answer to this query:

\[
?- a(X, Y), b(X, Y)
\]

Will there be more than one answer?
Problem XXII

Given the following definitions:

\[
\begin{align*}
&f(1, \text{one}). \\
&f(s(1), \text{two}). \\
&f(s(s(1)), \text{three}). \\
&f(s(s(s(X))), N) :- f(X, N).
\end{align*}
\]

what are the results of these queries? If there is more than one possible answer, give at least two.

1. \(?- f(s(1), A).\)
2. \(?- f(s(s(1), \text{two}).\)
3. \(?- f(s(s(s(s(s(s(1))))))), C).\)
4. \(?- f(D, \text{three}).\)
Answer XXII
Problem XXIII

Write a Prolog predicate `sum_diffs(List1, List2, Diffs)` which sums the absolute differences between two integer lists of the same length.
Example:

```
?- sum_abs_diffs([1,2,3], [5,4,2], X).
   X = 7 % abs(1-5) + abs(2-4) + abs(3-2)
```
Answer XXIII
Write a Prolog predicate `transpose(A, AT)` which transposes a rectangular matrix given in row-major order. Example:

```
?- transpose([[1, 2], [3, 4]], AT).
AT = [[1, 3], [2, 4]]
```
Answer XXIV
Answer XXIV...
Answer XXIV...
Problem XXV

Write Prolog predicates that given a database of countries and cities

% country(name, population (in thousands),
% capital).
country(sweden, 8823, stockholm).
country(usa, 221000, washington).
country(france, 56000, paris).
% city(name, in_country, population).
city(lund, sweden, 88).
city(paris, usa, 1). % Paris, Texas.
Problem XXV...

Answer the following queries:

1. Which countries have cities with the same name as capitals of other countries?

2. In how many countries do more than $\frac{1}{3}$ of the population live in the capital?

3. Which capitals have a population more than 3 times larger than that of the secondmost populous city?
Problem XXV...
Answer XXV
Answer XXV...
Answer XXV...
Problem XXVI

Write a Prolog predicate that extracts all words immediately following “the” in a given list of words.

Example:

?- find([the, man, closed, the, door, of, the, house], X).
   X = [man, door, house]
Answer XXVI
Answer XXVI...