1. Consider the following family tree of the famous wizard Harry Potter:

```
Mary (with John)
   /     /
Petunia (with Vernon) Lily (with James)
      /   /        /   /
    Dudley    Harry (with Ginny)
          /     /          /    /
         Sirius Albus Luna
```

(a) Encode the family tree as a Prolog knowledge base, making use of a binary predicate `parent` and two unary predicates `male` and `female`.

(b) Write a predicate `sister(X,Y)` that is true if `X` is a sister of `Y`. Hint: what is the definition of (half-)sister?

(c) How can I query the knowledge base to:

   i. Test whether Lily is sister of Petunia?
   ii. Obtain the sisters of Lily?
   iii. Obtain the persons having Lily as a sister?

(d) Run the query `sister(A,B)`. What does this query return? Then fetch more answers. Can you explain why the pairs of persons appearing in the answer are returned in this particular order?

(e) Write a predicate `grandfather(X,Y)` that is true if `X` is a grandfather of `Y`.

(f) Write a predicate `aunt(X,Y)` that is true if `X` is an aunt of `Y`.

2. Extend the knowledge base in 1.

(a) Encode the magical power of the family members, making use of three unary predicates `magician`, `wizard`, and `witch`.

   i. Mary, John, Petunia, Vernon, and Dudley, are all the family members that do not have magical powers.
(b) Encode the magical-blood purity of the family members, making use of four unary predicates \texttt{muggle}, \texttt{muggle\_born}, \texttt{pure\_blood}, and \texttt{half\_blood}.

i. Muggles are people without magical powers whose parents are both muggles. Mary, John, and Vernon are muggles.

ii. Muggle-borns are people with magical powers whose parents are muggles or muggle-borns.

iii. Pure-blood individuals are born from parents who are both pure-bloods. James and Ginny are pure-bloods.

iv. Half-blood individuals are born from one pure-blood or half-blood parent, with the other parent being a muggle, a muggle-born, or a half-blood.

(c) Petunia hates anyone who has magical powers, while Draco hates anyone who is not a pure-blood. How can I query to obtain the people who are hated by both Petunia and Draco?

3. (a) Write a knowledge base representing the following directory tree:

```
documents
  private
  images videos
  work
    research teaching
```

(b) Add a clause that can be used to retrieve all descendant nodes of a node.

4. Write a Prolog program to compute the Fibonacci series (1, 1, 2, 3, 5, 8 . . .).

For example, to compute the 10th Fibonacci number the query must be as follows:

```
?- fibonacci(10,X).
```

5. Write a Prolog program to compute powers. For example, to compute $3^4$ the query must be as follows:

```
?- pow(3,4,X).
```

6. (a) Create a basic Prolog knowledge base (consisting of facts) describing relationships on Twitter:

- Anne follows Fred
- Fred follows Anne, Julie and Susan
- John follows Fred
- Julie follows Fred
- Susan follows John and Julie
Add some for facts describing that the persons above tweeted the following messages:

- Anne tweeted tweet1 and tweet5
- Fred tweeted tweet2, tweet7, and tweet8
- John tweeted tweet3, and tweet4
- Julie tweeted tweet6
- Susan tweeted tweet9 and tweet10

(b) Write the rules required in order to answer the following questions:

i. Assuming that only direct followers will see a tweet, which tweets can Fred see?

ii. Find all the persons who are friends, i.e., they follow each other.

iii. Output for each person which tweets they can see.

iv. Assuming that Julie can see all the tweets of her friends and all the tweets of her friends’ friends, which tweets can Julie see (exclude her own tweets)?