Answer 1

Problem 1

- creator
    - `RatNum(int n)`
    - `RatNum(int n, int d)`
    - `valueOf(String ratStr)`
- observer
    - `isNaN()`
    - `isNegative()`
    - `isPositive()`
    - `compareTo(RatNum rn)`
    - `doubleValue()`
    - `intValue()`
    - `floatValue()`
    - `long longValue()`
    - `hashCode()`
    - `equals(/*@Nullable*/ Object obj)`
    - `toString()`
- producer
    - `negate()`
    - `add(RatNum arg)`
    - `sub(RatNum arg)`
    - `mul(RatNum arg)`
    - `div(RatNum arg)`
- mutator None

Problem 2

`checkrep()`[check rap invariant] is called in every constructor, which means that `this` object will only be created when it is vaild, so `this` won't be null at any time.

Problem 3

- Because it is a factory method that creates the object itself.
- We can have a constructor that accepts a string and we can also create object as the same.

Problem 4

The @modified is none in all these methods, so the method should not change the object fields.

Problem 5

Since there is no mutator in the class, the only way rep invariant can be violated is when the object is created, which is done by the constructors.