Computers are used for problem solving. One of such problems is find solutions to logical conditions. In the following problem, the logical variables $x_1, x_2, x_3, x_4, x_5$ occur. Find a solution such that all five statements listed is true. For example, if $x_1, x_2$ are true and $x_3, x_4, x_5$ are false, then this would not be a solution since the second condition is false. Recall, $\land$ means “and”, $\lor$ means “or” and $\neg$ means “not”. Here the conditions.

- $x_1 \lor x_2 \lor x_3$;
- $\neg x_2 \land \neg x_3$;
- $x_3 \lor \neg x_3$;
- $x_3 \lor x_4$;
- $(x_1 \land \neg x_2 \land x_5) \lor (x_2 \land x_3 \land \neg x_5)$.

Give the solution here:
The following variables are true: $x_1, x_4, x_5$; 
the following variables are false: $x_2, x_3$.

**Question 2.** Which two of the following sorting algorithms are of the type “divide and conquer”?
- [ ] bubble sort;
- [x] merge sort;
- [x] pivot sort.
Question 3. Punch cards are cards with holes used to control machines or store data. Which of the following technologies apply punch cards? Check the appropriate three out of the five boxes.

- [ ] Abacus (for counting and computing) from the old Chinese and Romans;
- [x] Jaquards weaving loom from 1801;
- [ ] First railway near London in 1803;
- [x] Tabulating machines for American census in 1890;

Question 4. Answer the following questions:

OL: Which programming language is the oldest (among those still in use)?
EP: Which famous language was invented for education purposes only?
SP: Which is one of the pioneering languages for structured programming?
VO: Which language is specialized on vector- and tensor operations?

Please tick that line where all answers are correct.

- [ ] OL: APL, EP: PASCAL, SP: FORTRAN, VO: COBOL;
- [ ] OL: APL, EP: BASIC, SP: C, VO: PASCAL;
- [ ] OL: BASIC, EP: LISP, SP: PASCAL, VO: APL;
- [ ] OL: FORTRAN, EP: BASIC, SP: PASCAL, VO: APL;
- [x] OL: PASCAL, EP: FORTRAN, SP: BASIC, VO: LISP.

Question 5. What are (a) correctness, (b) specification and (c) verification? Write the words into the corresponding definitions:

1. Verification means the process to prove formally that a programme is correct.
2. Correctness means that a programme always terminates and always produces the output given in the specification.
3. Specification means the process to write down formally what a programme has to do and which inputs are legal.

Question 6. Check those two of the following statements which are correct:

- [x] $2n^3 \in O(n^3)$;
- [x] $2n^3 \in O(n^4)$;
- [x] $2n^3 \in O(n^4)$;
- [x] $2n^3 \in O(\log(n))$.
Question 7. The following function should evaluate the binary number stored in the input string x. For example, the binary value of “000” is 0, of “11” is 3 and of “1010” is 10. Complete the programme of the function.

```javascript
function binaryvalue(x) {
    var y = 0; var z = x.length; var u = 1; var k;
    while(z>0)
    {
        z = z-1; // << update the loop-variable
        if (x.charAt(z) == "1") { k=1; } else { k=0; }
        y = y+u*k; // << u carries the correct power of 2;
        u = u+u; } // << u = u*2; also possible
    return(y); }
```

Question 8. Complete the three underlined statements of the function binaryprint. This function should print out an integer number in binary format, so input ten should give the output “1010”.

```javascript
function binaryprint(x) {
    var y; var z;
    if (x==0) { document.write("0"); }
    else if (x==1) { document.write("1"); } // << print digit "1"
    else if (x>1) { y = x%2; z = Math.floor(x/2);
        binaryprint(z); binaryprint(y); } // << print digits in correct order
    else { document.write("-"); binaryprint(-x); }
    return; }
```

Question 9. Find the syntax errors in this function to compute $5^n$.

```javascript
function poweroffiwe(n) // Users can call functions as they want
    { int m = 1; int k; // Wrong: Java Script variables do not have types !!!
        for (k=1 to n;k=k+1) // Should be: for (k=1;k<=n;k=k+1) { m = m*5; }
            { m = m*5; } // update value of m
        return(m); }
```

Select the adequate error-report for this programme (check one line only):

- Function name misspelled and for-loop incorrect;
- Variable-declaration and for-loop incorrect;
- Variable-declaration incorrect and comment improperly marked;
- Only for-loop incorrect, should have two semicolons in third line;
- Programme syntactic correct, but result will be wrongly computed.
Question 10. Write a function which computes $1^3 + 2^3 + 3^3 + ... + n^3$ on input $n$.

```javascript
function sum(n)
    { var m=0; var k;
        for (k=n;k>0;k=k-1)
        { m = m+k*k*k; }
        return(m); }
```

Question 11. Complete the following programme to find the smallest factor of a number.

```javascript
function factorfind(x)
    { var y = 1;
        do
        { y = y+1;
            if ( (x%y) == 0 ) { return(y); } }
        // "%" computes the remainder, brackets optional
        while (y*y<x);
        return(x); }
```

Question 12. Determine what the following function does and check the appropriate formula. The input $n$ is always a natural number.

```javascript
function ff(n)
    { var m=n; var k;
        for (k=0;k<n;k=k+1)
        { m=k+m+k; }
        return(m); }
```

Which is the correct formula for $ff(n)$?

- $n$
- $\frac{n(n-1)}{2}$
- $n^2$
- $2n^2 + n$
- $\frac{n(n-1)(n-2)}{6}$
- $n^3$.