Question 1
Employees of JB and Sons Consultants Ltd are paid on an hourly basis at the end of every week. If an employee works for not more than 40 hours a week, it is considered regular and Overtime for hours worked in excess of 40. Regular hours are paid at 500 cedis and 550 cedis per hour for males and females respectively while the overtime rate is one and half times the regular rate per hour for the different sexes. All employees are to pay 15% of their gross pay as Income Tax, 2.5% as National Health Contribution Levy, 1% as District Tax. Employees who have more than three children are to pay 10 and 20 cedis per child in excess of three towards Educational Fund For All for males and females respectively. Devise a computer solution that can be used to calculate the Net Pay of employees.

Question 2
Devise a computer solution that interchanges the values of two variables, X and Y. The original values of X and Y will be entered via the keyboard. Test your solution with initial values of X and Y being 10 and 20 respectively. At the end of the test, do you have X and Y to be 20 and 10 respectively? If yes then your computer solution may be correct.

Question 3
Devise a computer solution that can be used to find the position of the last occurrence of a given number from a given set of input. You may 'dry run' your solution with the following test data.

0 2 4 2 5 6 8 2 6 3 4 5 6 3 2 2 7 8 9 1 2 2 1

Let 2 be the number that we want to find the position of its last occurrence (this should be 22)

Question 4
Device a computer solution that can be used to compute the median and the mean of a set of numbers given that the numbers have already been arranged in decreasing order of magnitude.

Question 5
Devise a computer solution that reads in a positive integer *n* and then prints the sum of the first *n* even integers and the sum of the first *n* odd numbers.

Question 6
Write down a computer solution that can be used to count the number of times a particular digit appears in an (integer) input. Hint you may assume that there is an operator % that returns the remainder when one integer is divided by another and has the syntax *a %b* where *a* and *b* are integer constants.

Question 7
Assume that there is a function *MID* with the syntax, *MID(s1,m,n)* where *s1* a string, and *m* and *n* are integers. Given that *MID(s1,m,n)* is to return *n* middle characters of *s1* starting from the

character at position *m*, write a computer solution that accepts as input a string of characters and output the number of times a particular character appears in the input.

Question 8
Write a computer solution that accepts as input an integer value and then output the sum of the digits in the number as well as the number of digits it has with appropriate captions.

Question 9
(a) A prime number may be defined as any number that has only two factors, the digit 1 and the number itself. Using this definition, write down a computer solution that can allow a number to entered as input and output a message indicating whether or not the given number is a prime. Do not assume any pre-defined function.

(b) Given a positive integer, N, devise a computer solution that can be used to find another integer M whose factorial is N. For example if N is given as 720 then M should be 6.

Question 10
If p and q are both primes and $q=p+2$, then the pair p,q are called **twin primes**. For example, 5,7 are twin primes. Devise a computer solution to list all twin primes that are less than a positive integer n.

Question 11
Without using the division (/) devise a computer solution that can be used to *m* goes into *n* as well as the remainder. The values for *m* and *n* will be read as inputs.

Question 12
Brofoyedur is a small town in the Central Region of Ghana. It has been estimated that the population of this town is about 2000 people and that the population is increasing at a rate of 15% every six months. You are required to write a computer solution to determine the number of years that it would take for the population size to exceed two million for the village to become a city.

Question 13
The square root of a number N can be approximated by a repeated calculation using the following formula.

NewGuess = 0.5(LastGuess + N /LastGuess)

where *NewGuess* is the next guess and *LastGuess* the last guess. The calculation of a *NewGuess* should be terminated when the absolute value of the difference between the *NewGuess* and the *LastGuess* is about 0.0000001. Write down a computer solution for the above formula. You may use the function ABS(x) or '|x|' to obtain the absolute value of x.

Question 14

A number N may be said to be either a perfect, deficient or abundant number. If the sum of divisors (excluding the number itself) equals the original number, the number is said to be perfect. If the sum of the divisors is less than the number itself then the number is said to be deficient otherwise the number is said to be abundant. For example, the number 12 has the divisors 1, 2, 3, 4 and 6. The sum of these divisors is 16. Since the sum of the divisors of 6 is greater than 6, we will say 6 is an abundant number. Write down a computer solution that can classify a given number as a perfect, abundant or a deficient number with an appropriate caption.

Question 15

The RUSSIAN PEASANT method is one way of finding the product of any two given numbers. Given that A and B are two positive numbers, A is divided by 2 and its decimal part truncated, while B is also multiplied by 2. This process of dividing and multiplying is repeated until A attains a value of 1. The product of the two numbers is then the sum of all B values whose corresponding A values (including the initial value of A) are odd. As a typical example, let A and B be 21 and 10 respectively then the division and the multiplication can be written down as follows:

Current value of A	Current value of B
21	**10**
10	20
5	**40**
2	80
1	**160**

In the above, the bolded lines show when the value of A is odd. The product of the two numbers will therefore be the sum of the bolded B values, which is 210 (10+40+160). Write a computer solution that accepts as input two positive integers and then return the product of the two numbers using the above method with an appropriate caption. Hint use the modulus operator (%) where necessary.

Question 16

Assume you are the captain of JB and SONS Airline Ltd (JBSL) and you are approaching Britain, a country that still measures distances in miles, yards and feet. Your range finder unfortunately can read only distances in feet to the nearest whole number. Fortunately enough, your plane has a small personal computer on which the C++ compiler has been installed. It has become very necessary for you to write a simple computer solution that will later be coded in C++ language to convert a number of distances in feet to miles, yards and feet. You should accept as input a distance in feet and display the equivalent in miles, yards and feet. If a term is zero, it should not be printed.

For example

5287 should be displayed as 1 mile 2 yards 1 foot
5279 should be displayed as 1759 yards 2 feet

Note: 1 mile = 1760 yards and 3 feet = 1 yard.

Question 17

Pay As You Study University of Ghana charges 1000 cedis for each semester hour of credit, 500000 cedis for regular room (R) and 1000000 cedis for an air-conditioned room (A) and 500000 cedis for use of academic facilities. All students pay 200000 for matriculation and graduating students pay 300000 cedis for degree certificate. Devise a computer solution that computes fees that must be paid by each student. A warning message should be displayed if a student is taking more than 21 credit hours and less than 15 credit hours per semester. The input per student should be students' id number (4 digits), room type (A or R), credit hours and graduating status (Y or N).

Question 18

The transportation fare along a certain road in Ghana is calculated using the following sliding scale:

- A fixed amount of ¢2000.00 is paid by all passengers
- The first 10 kilometers is free
  The next 30 kilometers attract ¢100.00 each
  The next 110 kilometers attract ¢175.00 each
  Any excess kilometer over 150 kilometers attract ¢50.00.

Your problem is to write a computer solution that would allow a distance to be entered, compute the required fare and then return as output the expected fare and the distance traveled.

Question 19

Write a computer solution for evaluating the value of $\sin^2 x$ according to the formula

$$\sin^2 x = x^2 - \frac{2^3 x^4}{4!} + \frac{2^5 x^6}{6!} - \frac{2^7 x^8}{8!} + \ldots$$

Your computer solution should also return the number of terms needed to evaluate $\sin^2 x$ to 1 in 1,000,000 together with the value of $\sin^2 x$ for a given x with appropriate captions. You must put in a check so that your computer solution accepts *x* as input if only the absolute value of x is less than $\frac{\pi}{2}$.

Question 20

You are required to write a computer solution that can be used to display the numbers 0 to 99 inclusive in the following format, that is as a 10 by 10 array: Use writeln where necessary to mean write on the next line.

0	10	20	30	40	50	60	70	80	90
1	11	21	31	41	51	61	71	81	91
2	12	22	32	42	52	62	72	82	92
3	13	23	33	43	53	63	73	83	93
4	14	24	34	44	54	64	74	84	94
5	15	25	35	45	55	65	75	85	95
6	16	26	36	46	56	66	76	86	96

7 17 27 37 47 57 67 77 87 97
8 18 28 38 48 58 68 78 88 98
9 19 29 39 49 59 69 79 89 99

Question 21

A numeric palindrome is any number that can be read in both directions, that is from left to right and from right to left to give the same value. For example, 13533531 is a numeric palindrome. Write down a computer solution that can accept an n-digit integer number (not necessarily a numeric palindrome) and find an n-digit number, M when appended to the original number would make it a numeric palindrome.

Question 22

Write a computer solution to generate the Fibonacci series given the first two terms. For example, if the first two terms of a series are 0 and 1, the next (3rd) term is obtained by adding the two preceding terms (1st and 2nd), etc. Thus the third term of the series will be 1 and the fourth will be 2, etc. Generally, the Fibonacci series is defined as follows:

$$f_i = f_{i-2} - f_{i-1} \text{ for i=3, 4, ..., } n$$

Question 23

Employees of JB and SONS Consultants Limited are paid at an hourly rate of 25,000.00 cedis per hour for regular hours and one and one-half times per hour for overtime hours in a week. Any hour worked over forty hours per week is overtime. The following national tax sliding scale is then applied to determine the amount of tax to be paid by an employee.

GROSS PAY	TAX RATE (%)
Below 125,001	0
125,001 – 250,000	5
250,001 – 1,750,000	10
1,750,001 – 2,750,000	15
2,750,001 – 5,000,000	20
Over 5,000,000	30

In addition, 6% of an employee's gross pay is withheld for Social Security or GUSSS contribution, 3% is withheld as constituency tax and 2% is withheld by the employer as welfare contribution. If an employee has more than three dependents then an amount of 5,000.00 cedis is paid for each dependent in excess of 3 towards National Health Insurance Scheme. The company has no more than 100 employees. You are required to write a computer solution for computing a worker's gross pay, the deductions and his/her net pay. Your computer solution should allow for a number of staff details to be entered for the necessary computations.

Question 24

Write down a computer solution for finding the standard deviation for a given set of X values. The standard deviation, σ is given by the following relation

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - xbar)^2}{n}}$$

where x_i is a data point and *xbar* is the mean of the x_is

Question 25

Some three-digit numbers (in the range 100 to 999 inclusive) have the characteristic that the sum of the cubes of the individual digits in a number equals to the number itself. A typical example of such a number is 153 ($1^3 + 5^3 + 3^3 = 1 + 125 + 27 = 153$). You are required to write down a computer solution for displaying all three digits numbers that have the above characteristics. Your computer solution should be written such that no inputs are to be entered from the keyboard.

Question 26

A prime number is any positive integer that is divisible by itself and the number 1. Write down a computer solution that can display as output all prime numbers less than or equal to 1000.

Question 27

Given that **a % b** will give the remainder when **a** is divided by **b**, write a detailed computer solution that can be used to convert a number in base 10 to a different base. The inputs to your computer solution should be a number in base 10 and a base the number is to be converted to.

Question 28

Write a computer solution that can be used to convert a number in a given base to base 10. The input to your program should be the number to convert and the base of the number.

Question 29

Write a computer solution that can be used to reverse the digits in a given integer and display the new number. Hint, you are NOT to use a write statement within a loop structure.

Question 30

Assume that no programming language has a function for returning the result of one integer raised to the power of another integer. It has become very necessary for you to write a computer solution that can be used to calculate a^b where *a* and *b* are integers. Note that *a* may also be a real number but *b* should always be an integer.

Question 31

When one takes a loan, there are a number of repayment methods that one can adopt to pay the loan within a reasonable time. One of such methods is to use the formula $RP = \frac{Ar\left(1+\frac{r}{100}\right)^n}{\left(1+\frac{r}{100}\right)^n - 1}$ where *PR* is the monthly repayment amount, *A* is the amount borrowed, *r* is

the monthly interest rate and *n* is the number of months the loan is to be paid back. Write a computer solution that can be used to calculate and display the monthly repayments until the loan is fully paid back. Your input should be the amount borrowed, the annual interest rate and the number of years the loan is to be paid back. The output should have the following layout

Month	Repayment	Balance Outstanding
1	xxxxxxx.xx	xxxxxxxxxx.xx
2	:	:
:	:	:
m	xxxxx.xx	0

Question 32

Newton's method is one way of finding the location of the zero or the root of a mathematical function, *f(x)* say. The method works by initially guessing the *x* location of the zero. The functional value at the current x is computed to get a better estimate of the zero. This process is repeated until the difference between two successive estimates is at most 0.0000001. Each estimate of *xnew* is computed from *xold* as follows:

$$x_{new} = x_{old} - \frac{f(x_{old})}{f'(x_{old})}$$

Where $f'(x_{old})$ is the derivative of the function $f(x_{old})$. Given that $f(x) = 5x^2 + 4x - 72$ write a computer solution that will accept as input an initial guess value, x_{old} and then find the zero of the above function. Your output should be the root of the function and the number of iteration performed to obtain the root.

Question 33

Talk and Talk More (TTM) mobile phone service provider requires a program to compute the cost of national and international calls. National calls are of two types namely same network and other network. The cost of the calls is determined as follows:

(i) Any call started between 7am and 7pm, Monday through Friday, is charged as follows:
- 1200 and 2400 cedis per minute for same and other network respectively
- 8,200 cedis for international calls.

(ii) Any call started before 7am or after 7pm, Monday through Friday, is charged as follows:
- 800 and 1400 cedis per minute for same and other network respectively
- 5,200 cedis for international calls.

(iii) Any call started on Saturday or Sunday is free, 600 and 4000 cedis respectively for same network, different network and international calls.

The days of the week are coded 1 through 7 for Monday through Sunday respectively. Also the same network, different network and international calls have codes 1, 2 and 3 respectively.

You are required to write a computer solution that will accept as input the code for the day and the code for the type of the call, which is the same network, other network or international. In

addition, your computer solution should accept for each call the length of the call in minutes and the time a call started. The time will be inputted in 24-hour notation so that time 1.48 is input as 1348.

Question 34

Assume that there is a function called **tab** which is used with an output statement such as the print to specify the number of print positions to be left blank from the current cursor position. Let the syntax of *tab* be *tab(x)* where *x* is the number of spaces required. You are required to write a detailed computer solution for printing the calendar of a given input data. The input should be the number of days in the month and the day (Monday, Tuesday, etc) on which the first of the month falls. For example, if the number of days is 31 and the first of the month falls on a Wednesday then your output should be as follows:

MON	TUE	WED	THU	FRI	SAT	SUN
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Question 35

There are a number of methods that are used for calculating the depreciation of an asset. One commonly used method is the **sum-of-the-years-digits**. For example, consider equipment of value 15 million cedis required to be depreciated over 5 years. We first calculate the sum of the years' digits by adding 1, 2, 3, 4 and 5. Thus the sum-of-the-years-digits is 15. For the first year the amount of depreciation is $\frac{5}{15} x15million$ (i.e. 5million), the second year will be $\frac{4}{15} x15million$ (i.e. 4million), the third will be $\frac{3}{15} x15million$ (i.e. 3million) and so forth. You are required to devise a computer solution to accept the value of an asset and the number of years of depreciation as inputs and output the year, the amount of depreciation starting with year 1 up to the year required and the balance outstanding at the end of each year under appropriate headings.

Question 36

Another method of calculating depreciation is the **straight-line** method. If *value* is the value of the asset and it is to be depreciated over *years* years, then *value/years* is depreciated every year. Write a detailed computer solution that accepts as input values for *value* and *years* and then display the depreciation and the outstanding amount for the different years.

Question 37

In addition to the methods described in questions 36 and 37 for calculating depreciation, one can also use the **double-declining balance** method. If the *amount* is the value of the asset and *years*

years is the number of years the asset is to be depreciated, then $\frac{2}{years}$ times the undepreciated amount is depreciated every year. Since only a fraction of the undepreciated amount is depreciated, the entire amount will never be depreciated fully. One way of solving this problem is therefore to switch over to the **straight-line** method. You are required to devise a computer solution that accepts as input *amount*, *years* and *switch* (the year in which to switch to the straight-line method) and then display the depreciation and the outstanding amount for the different years.

Question 38 (a)

Devise a detailed computer solution to accept pairs of data points (x, y) as input and calculate the equation of the line. Your output should be of the form $y = ax + b$, that is the line of best fit where *a* and *b* are constants. The values for *a* and *b* can be obtained using the following relations:

$$a = \frac{\sum_{i=1}^{n} y_i - b\sum_{i=1}^{n} x_i}{n}$$

$$b = \frac{\sum_{i=1}^{n} x_i y_i - \frac{\sum_{i=1}^{n} x_i \sum_{i=1}^{n} y_i}{n}}{\frac{\sum_{i=1}^{n} x_i^2 - \left(\sum_{i=1}^{n} x_i\right)^2}{n}}$$

where

$\sum_{i=1}^{n} x_i y_i$ = sum of the product $x_1y_1 + x_2y_2 + \ldots + x_ny_n$

$\sum_{i=1}^{n} x_i$ = sum of x-values=$x_1 + x_2 + \ldots x_n$

$\sum_{i=1}^{n} y_i$ = sum of y-values = $y_1 + y_2 + \ldots + y_n$

$\sum_{i=1}^{n} x_i^2$ = sum of squares of x-values = $x_1^2 + x_2^2 + \ldots + x_n^2$

Question 38(b)

The values for a and b in question 38(a) can also be calculated as follows:

$$b = \frac{n(\sum xy) - (\sum x)(y)}{n(\sum x^2) - (\sum x)^2}$$

and $a =$

Question 39
Write a detailed computer solution that can be used to accept as input any amount in cedis and display the number such that thousands are separated by commas. For example, an input of 1234567.78 should be displayed as 1,234,567.78.

Question 40
Some banks in the country use a very complicated way of granting loans. For example, if a customer applies for a loan of 1000 cedis at an interest rate of 15% over a period of 18 months for repayment, the interest is calculated as 1000 * 0.15 * 1.5 to give 225 cedis. The interest is immediately deducted from the face value of 1000, leaving the customer with only 775 cedis. Repayment is made in equal installments based on the face value. So, the monthly loan payment will be 1000 divided by 18 months, which is 55.56 cedis. The method of calculation would have been fair if the customer was actually looking for a loan of 775 but the customer receives 775 instead of 1000. Devise a computer solution based on the above method that will ensure that if a customer wants a loan of 1000 cedis in his/her pocket he applies for an amount that will give him exactly that. Thus, your computer solution should read as input the amount a user wants in his/her pocket, the repayment period and the interest rate. The output should be the total loan and the monthly installments.

Question 41
A newly established company, KKF Ltd sells electronic equipment to customers on a negotiable credit plan. For example, if a piece of equipment sells at 1000 cedis at an interest rate of 18% (i.e 1.5% per month) and a monthly payment of 50 cedis, no down payment is required, however, the monthly payment is used to pay the interest and whatever is left is used to pay part of the remaining debt. Thus, for the first month, an amount of 1.5% of 1000 in interest (that is 15 cedis). The remaining 35 (that is 50-15) cedis is used to pay part of the 1000 cedis which leaves the customer with a debt of 965 cedis. For the next month, the interest will be 1.5% of 965, which is 14.48. Thus, 35.52 (50-14.48) cedis is deducted from the debt of 965 leaving the debt as 929.48. The process is repeated until the full amount is paid. Please note that for the last month the balance plus the interest may be less than 50 cedis yet the company will demand the full 50 cedis. Devise a computer solution to read as input the value of the equipment, the interest rate, the period of repayment and the monthly payment amount, and output the outstanding balances from the 1st month to the last month.

Question 42
A young boy was sent by his mother to get some eggs from a nearby supermarket for his birthday party. On his way home, he was knocked down by a motorist and had all the eggs broken. The boy was unhurt and the motorist agreed to pay for the eggs. The boy could not remember the exact number of eggs, only that when he took them out in pairs there was one left; similarly there was one left when he took them out threes, fours, fives, or sixes at a time. When he took them out in sevens at a time they came out even, that is there was nothing left. You are required to write a computer solution to determine the smallest number of eggs the boy could have had and the total cost if the boy claims that he paid 4 pesewas per egg.

Question 43

Modify your solution to question 42 such that all possible numbers of eggs that less than 500000 and their corresponding cost are displayed under appropriate headers.

Question 44

One way of approximating the cube root of x given an initial approximation is to use Newton's Method for computing the cube root,

$$BetterAppoximation = OldAppproximation + \frac{1}{3}\left(\frac{x}{OldApproximation^2} - OldAppproximation\right)$$

A continued *BetterApproximation* is calculated until the difference between successive *BetterApproximation*s is less than 0.000001. Devise a computer solution for finding the cube root of a number using the above approximation.

Question 45

Without using any additional variable(s) to X and Y, device an algorithm that can be used to interchange the content of two variables X and Y. Use inital values of X and Y to be 10 and 20 respectively to go through your solution and see if the new values of X and Y are now 20 and 10 respectively.