2.1 Algorithms – Past Exam Questions

2.1 – Algorithms

Sub topic	Guidance
2.1.1 Computational thinking	
☐ Principles of computational thinking: o Abstraction o Decomposition o Algorithmic thinking	**Required** ✓ Understanding of these principles and how they are used to define and refine problems
2.1.2 Designing, creating and refining algorithms	
☐ Identify the inputs, processes, and outputs for a problem ☐ Structure diagrams ☐ Create, interpret, correct, complete, and refine algorithms using: o Pseudocode o Flowcharts o Reference language/high-level programming language ☐ Identify common errors ☐ Trace tables	**Required** ✓ Produce simple diagrams to show: ▪ The structure of a problem ▪ Subsections and their links to other subsections ✓ Complete, write or refine an algorithm using the techniques listed ✓ Identify syntax/logic errors in code and suggest fixes ✓ Create and use trace tables to follow an algorithm **Flowchart symbols** Line; Input/ Output; Process; Decision; Sub program; Terminal
2.1.3 Searching and sorting algorithms	
☐ Standard searching algorithms: o Binary search o Linear search ☐ Standard sorting algorithms: o Bubble sort o Merge sort o Insertion sort	**Required** ✓ Understand the main steps of each algorithm ✓ Understand any pre-requisites of an algorithm ✓ Apply the algorithm to a data set ✓ Identify an algorithm if given the code or pseudocode for it **Not required** × To remember the code for these algorithms × To remember Exam Reference Language for Merge Sort

2022

(c) State the name of each of the following computational thinking techniques.

Breaking a complex problem down into smaller problems.

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Hiding or removing irrelevant details from a problem to reduce the complexity.

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[2]

2 A fast food restaurant offers half-price meals if the customer is a student or has a discount card. The offer is not valid on Saturdays.

A computer system is used to identify whether the customer can have a half-price meal.

(b) The restaurant needs an algorithm designing to help employees work out if a customer can have a half price meal or not. It should:

- input required data
- decide if the customer is entitled to a discount
- output the result of the calculation.

Design the algorithm using a flowchart.

[5]

(c) The restaurant adds a service charge to the cost of a meal depending on the number of people at a table. If there are more than five people 5% is added to the total cost of each meal.

Customers can also choose to leave a tip, this is optional and the customer can choose between a percentage of the cost, or a set amount.

Identify **all** the additional inputs that will be required for this change to the algorithm.

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..... **[2]**

(d) Each member of staff that works in the restaurant is given a Staff ID. This is calculated using the following algorithm.

```
01  surname = input("Enter surname")
02  year = input("Enter starting year")
03  staffID = surname + str(year)
04  while staffID.length < 10
05       staffID = staffID + "x"
06  endwhile
07  print("ID " + staffID)
```

(ii) Complete the following trace table for the given algorithm when the surname "Kofi" and the year 2021 are entered.

You may not need to use all rows in the table.

Line number	surname	year	staffID	Output
01	Kofi			
02		2021		

[4]

3 A program stores the following list of positive and negative numbers. The numbers need sorting into ascending order using a merge sort.

45	12	–99	100	–13	0	17	–27

(a) The first step is to divide the list into individual lists of one number each. This has been done for you.

Complete the merge sort of the data by showing each step of the process.

45	12	–99	100	–13	0	17	–27

[3]

(b) Once the numbers are in order, a binary search can be run on the data.

Describe the steps a binary search will follow to look for a number in a sorted list.

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(c) A linear search could be used instead of a binary search.

Describe the steps a linear search would follow when searching for a number that is **not** in the given list.

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..... **[2]**

4 Jack is writing a program to add up some numbers. His first attempt at the program is shown.

```
a = input("Enter a number")
b = input("Enter a number")
c = input("Enter a number")
d = input("Enter a number")
e = input("Enter a number")
f = (a + b + c + d + e)
print(f)
```

(c) Jack decides to improve his program. He wants to be able to input how many numbers to add together each time the algorithm runs, and also wants it to calculate and display the average of these numbers.

Write an algorithm to:

- ask the user to input the quantity of numbers they want to enter and read this value as input
- repeatedly take a number as input, until the quantity of numbers the user input has been entered
- calculate and output the total of these numbers
- calculate and output the average of these numbers.

6 marks

(e) The hotel car park charges £4 per hour. If the car is electric, this price is halved to £2 per hour.

Write an algorithm to:

- take as input the number of hours the user has parked and whether their car is electric or not
- calculate and output the total price
- repeat continually until the user enters 0 hours.

You must use **either**:

- OCR Exam Reference Language, **or**
- a high level programming language that you have studied.

6 marks

Sample Paper

2 A program needs to perform the following tasks:

- Input two numbers from the user
- Compare both numbers and output the largest number.

(a) Complete the pseudocode for this program.

```
num1 = .....

num2 = input("enter second number")

..... num1 > ..... then

    .....

else

    .....

endif
```

[5]

(b) A second program needs to perform the following tasks:

- Input a number from the user
- Double the number input and print the result
- Repeat bullets 1 and 2 until the user enters a number less than 0.

Write an algorithm for this program. 5 marks

4 A program creates usernames for a school. The first design of the program is shown in the flowchart in **Fig. 2**.

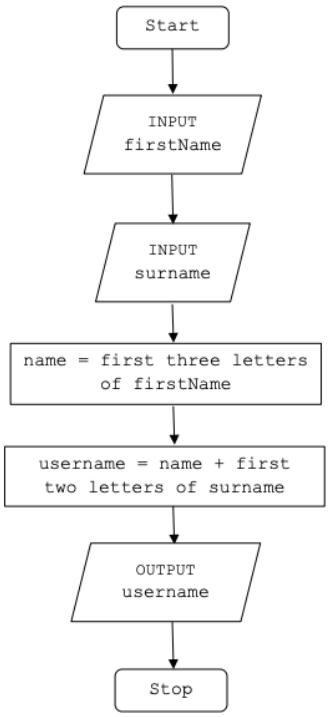

Fig. 2

For example, using the process in **Fig. 2**, Tom Ward's username would be TomWa.

(a) State, using the process in **Fig. 2**, the username for Rebecca Ellis.

..... **[1]**

(b) The program design is updated to create usernames as follows:

- If the person is a teacher, their username is the last 3 letters of their surname and then the first 2 letters of their first name.
- If the person is a student, their username is the first 3 letters of their first name and then the first 2 letters of their surname.

(i) What would be the username for a teacher called Fred Biscuit using the updated process?

..... **[1]**

(ii) Write an algorithm for the updated program design shown in question **4(b)(i)**.

6 marks

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6 A program uses a file to store a list of words that can be used in a game.

A sample of this data is shown in **Fig. 3**.

crime	bait	fright	victory	nibble	loose

Fig. 3

(a) Show the stages of a bubble sort when applied to data shown in **Fig. 3**.

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[4]

(b) A second sample of data is shown in **Fig. 4**.

amber	house	kick	moose	orange	range	tent	wind	zebra

Fig. 4

Show the stages of a binary search to find the word `zebra` using the data shown in **Fig. 4**.

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[4]

(e) The following program uses a condition-controlled loop.

```
x = 15
y = 0
while x > 0
    y = y + 1
    x = x - y
endwhile
print(y)
```

Complete the trace table to test this program.

x	y	output

[4]

(g) The teacher asks students how long they spend completing homework. Students answer in minutes and hours (for example 2 hours 15 minutes).

The teacher would like to create an algorithm that will display students' inputs in minutes only.

(i) Identify the input and output required from this algorithm.

Input .....

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Output .....

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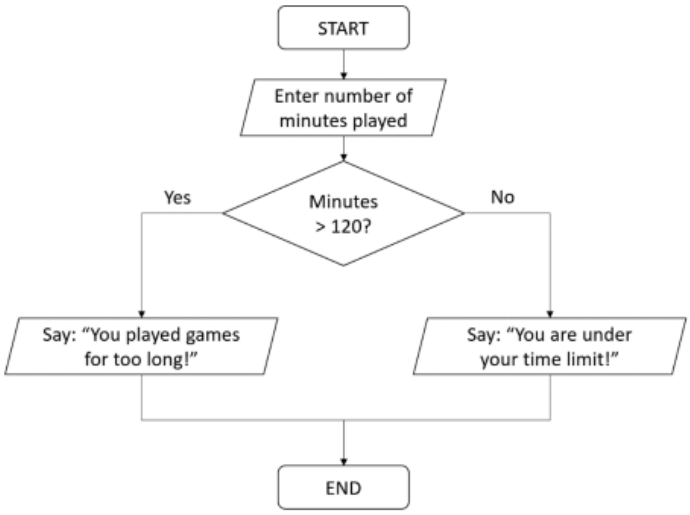
[2]

(iii) The following flowchart outputs a message depending on how long each person has spent playing computer games.



Rewrite the flowchart as a program.

You must use **either:**

- OCR Exam Reference Language, **or**
- a high-level programming language that you have studied.

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[4]

2021

2 An insertion sort is used to put the following words into ascending alphabetical order.

pumpkin	flour	wall	house	wall

(a) Tick (✓) **one** box in each row to identify whether each statement about the insertion sort is true or false.

Statement	True (✓)	False (✓)
The list of words is initially split into a sorted set and an unsorted set.		
The insertion sort uses a divide stage and then a conquer stage.		
The list of words must be in order before the insertion sort can start.		
Each word is inserted into the correct place in the array, one by one.		
The insertion sort will not work because the word "wall" appears twice.		

[5]

(b) The sorted list of words is shown below.

flour	house	pumpkin	wall	wall

Explain how a binary search would be used to try to find whether the word "house" appears in this list.

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..... **[4]**

3 Taylor is writing an algorithm to record the results of an experiment.

Taylor needs to be able to enter a numeric value which is added to a total which initially starts at 0.

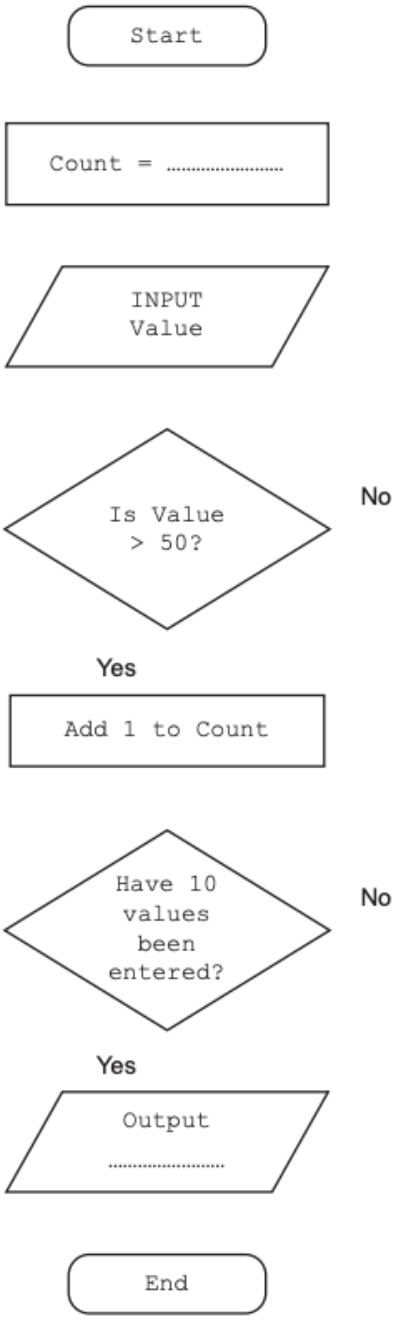
Every time she enters a value, the total is output.

The algorithm repeats until the total is over 100.

(a) Write an algorithm to implement Taylor's requirements. 6 marks

(c) For the next part of the experiment, Taylor needs to be able to enter 10 values and count how many of the values are over 50, outputting this value once all values have been entered.

(i) Complete the following flowchart to implement this algorithm.



[5]

(ii) Write a pseudocode algorithm that uses iteration to allow Taylor to:

- enter 10 values
- count how many values are over 50
- output the count of values over 50 after all 10 values are entered.

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(d) Taylor used computational thinking techniques to develop the algorithms.

Give **two** computational thinking techniques that Taylor has used, describing how they have been used.

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[4]

2020

2 Dru writes the following program using a high-level language.

```
01 function newscore(a,b)
02       temp = a*b
03       temp = temp + 1
04       return temp
05 endfunction
06 score = 18
07 name = "Dru"
08 print (score)
09 print ("name")
10 print (newscore(score,2))
11 print (score)
```

(a) The following table contains the program code for each line where this program outputs values.

State the values output by the program on each of the lines.

Line	Program code	Value output
08	`print (score)`	
09	`print ("name")`	
10	`print (newscore(score,2))`	
11	`print (score)`	

[4]

(b) The algorithm for one section of the vending machine program is shown in pseudocode.

```
if money >= price then
     venditem()
     giveChange(money - price)
else
     print("Error - not enough money inserted")
endif
```

(c) Draw the vending machine algorithm in **part (b)** as a flowchart.

5 marks

6 The following names of students are stored in an array with the identifier `studentnames`.

```
studentnames = ["Rob", "Anna", "Huw", "Emma", "Patrice", "Iqbal"]
```

(a) Describe the steps that a linear search would take to find `Anna` in `studentnames`

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..... **[4]**

(b) The names of students are sorted into ascending alphabetical order using an insertion sort.

Complete the following diagram to show the stages an insertion sort would take to complete this task.

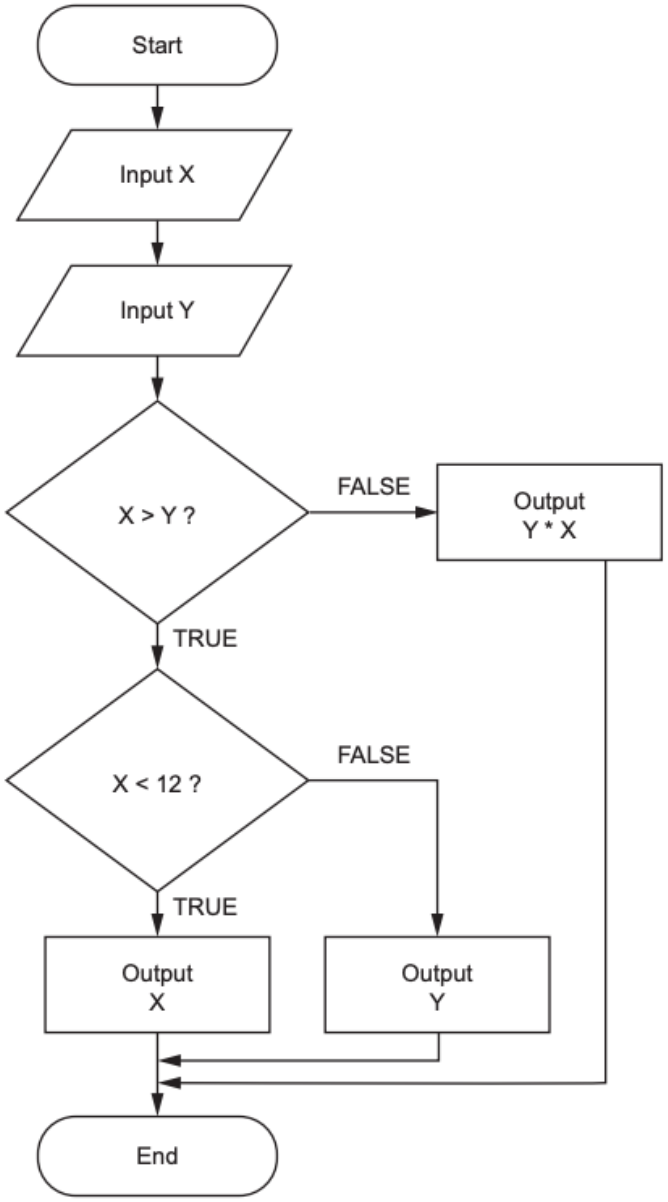
Each row represents one pass of the insertion sort algorithm. You may not need to use all empty rows.

Rob	Anna	Huw	Emma	Patrice	Iqbal

[5]

2019

2 A programmer creates an algorithm using a flow chart.



7

(a) Complete the table to give the output when each of the following set of values are input into the algorithm as X and Y.

Input value of X	Input value of Y	Output
15	10	
6	5	
2	3	
12	2	

[4]

(b) Write this algorithm using pseudocode.

6 marks

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3 Louise writes a program to work out if a number entered by the user is odd or even. Her first attempt at this program is shown.

```
01 num = input("enter a number")
02 if num MOD 2 >= 0 then
03       print("even")
04 else
05       pritn("odd")
06 endif
```

(a) The program contains a logic error on line **02**.

(i) State what is meant by a logic error.

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..... **[1]**

(ii) Give a corrected version of line **02** that fixes the logic error.

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..... **[1]**

(b) The program contains a syntax error on line **05**.

(i) State what is meant by a syntax error.

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..... **[1]**

(ii) Give a corrected version of line **05** that fixes the syntax error.

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..... **[1]**

4 Elliott plays football for OCR FC. He wants to create a program to store the results of each football match they play and the names of the goal scorers. Elliott wants individual players from the team to be able to submit this information.

(a) **(i)** Define what is meant by **abstraction**.

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..... **[2]**

(ii) Give **one** example of how abstraction could be used when developing this program.

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..... **[1]**

(c) A list of valid discount codes is shown below.

[NIC12B, LOR11S, STU12M, VIC08E, KEI99M, WES56O, DAN34S]

(i) State **one** reason why a binary search would not be able to be used with this data.

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..... **[1]**

(ii) Give the name of **one** searching algorithm that would be able to be used with this data.

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..... **[1]**

(d) OCR Land keeps track of the size of queues on its rides by storing them in an array with the identifier `queuesize`. It uses the following bubble sort algorithm to put these queue sizes into ascending numerical order.

```
01 swaps = True
02 while swaps
03       swaps = False
04       for p = 0 to queuesize.length-2
05            if queuesize[p] > queuesize[p+1] then
06                 temp = queuesize[p]
07                 queuesize[p] = queuesize[p+1]
08                 queuesize[p+1] = temp
09                 swaps = True
10            endif
11       next p
12 endwhile
```

(i) Explain the purpose of the Boolean variable `swaps` in this bubble sort algorithm.

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..... **[2]**

(ii) Explain the purpose of lines **06** to **08** in this bubble sort algorithm.

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(iv) Give the names of **two** other sorting algorithms that could be used instead of bubble sort.

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[2]

(e) One ride in OCR Land has a minimum height of 140 cm to ride alone or 120 cm to ride with an adult.

Create an algorithm that:

- asks the user to input the height of the rider, in centimetres
- if needed, asks if they are riding with an adult
- outputs whether or not they are allowed to ride
- repeats this process until 8 people have been allowed to ride.

8 marks

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2018

(c) The library sorts their books based on the book code.

(i) Show the steps that a merge sort would take to put the following list of book codes into ascending alphabetical order (from A to Z).

```
POE12 , BAC97 , FLY77 , JAV16 , TAL86 , AND18 , ZAR09 , HOP86
```

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4 marks

(ii) Explain **one** advantage of a merge sort compared to a bubble sort.

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..... **[2]**

8 OCR town are holding an election with three candidates (A, B and C). An electronic voting booth will be used to allow people to vote.

Write an algorithm that:

- Allows voters to enter either A, B or C.
- Keeps track of how many times each candidate has been voted for.
- As soon as one person has finished voting, allows the next person to vote.
- At any point allows the official to type in "END", which will print out the number of votes for each candidate and the total number of votes overall.

6 marks

2017

7 A computer game has a stored number. The game gives the user 10 attempts to guess what the number is. If the user has got it correct, the game congratulates them and it ends. If the user has guessed it incorrectly, the game tells the user if the number is higher or lower than their guess.

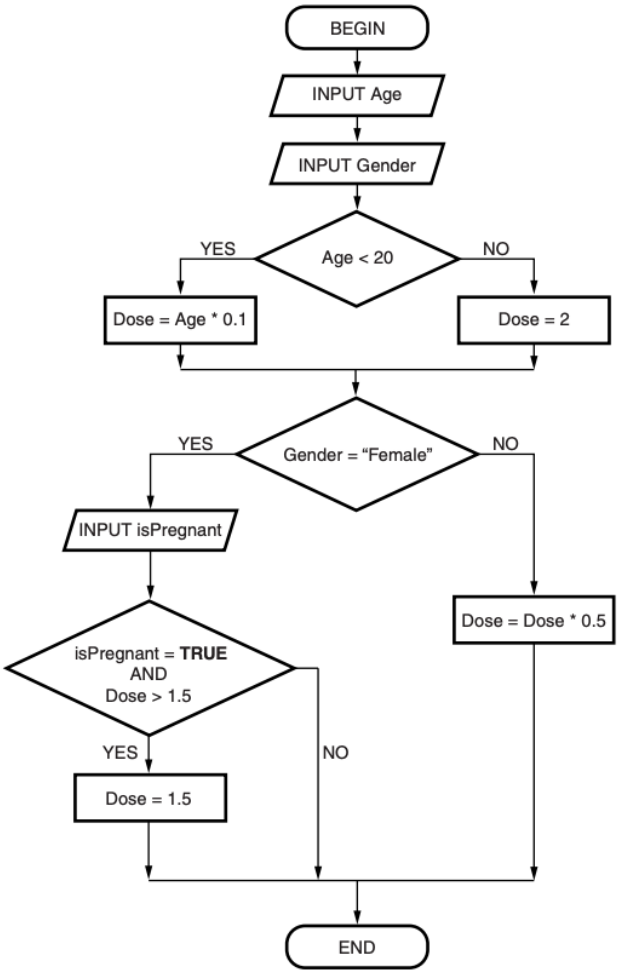
Write an algorithm, using iteration, which:

- stores a number for the user to guess
- asks the user to guess the number
- outputs "`congratulations`" if the guess is correct and ends the game
- outputs if the user needs to guess lower, or higher
- allows the user 10 attempts to guess the number **[6]**

2015

3 A computer program calculates the correct dose in grams of a type of medicine.

The algorithm used is shown by the flow diagram below.



(b) Use the flow diagram to calculate the correct dose of medicine for a male aged 30.

You must show your working.

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(c) Use the flow diagram to calculate the correct dose of medicine for a pregnant female aged 19.
You must show your working.

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..... **[4]**