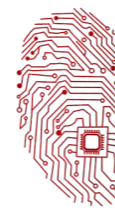


Topic: 1.1.1 Binary systems

1. Express the denary value 109 as
 - (i) a binary number using an 8-bit byte;
2. Express the denary number 78 as
 - (i) a binary number stored in an 8 bit byte,
3. 01011101 and 11010010 are two numbers stored in the computer.
 - (i) Write down the decimal equivalent of 11010010.
4. Convert the following binary numbers into decimal number & hexadecimal number:
 - (i) $(00001100)_2$
 - (ii) $(01011001)_2$
 - (iii) $(00000111)_2$
5. Is there a short cut to working out a binary number that is made of solid ones, such as: $(01111111)_2$?

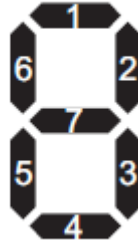




Topic: 1.1.1 Binary systems

May/June 2007

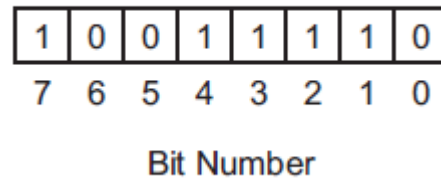
9 .A 7-segment display is used to indicate which floor a lift is on. Each segment is numbered as shown:



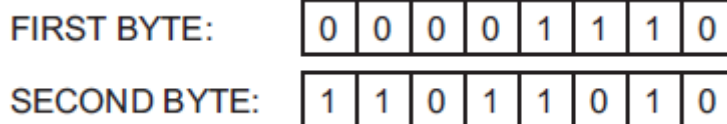
A byte is used to hold the data needed to light the correct segments. Bit 0 is always zero. For example, 3 is represented by



and by



(a) If the lift is to stop at more than one floor, the data is held in successive bytes. For example:

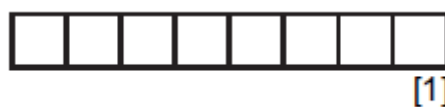


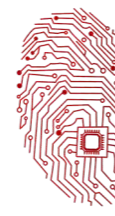
Which floor numbers are stored in each byte?

First byte floor number.....

Second byte floor number.....

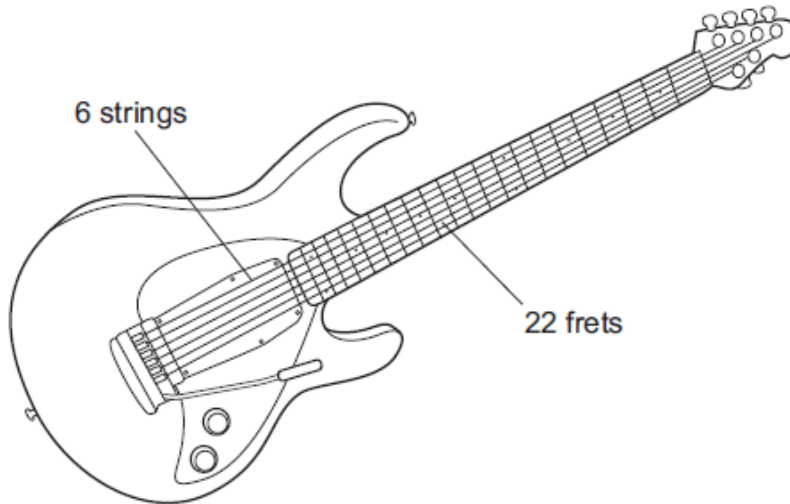
(b) What bit pattern is used to indicate Floor 2?



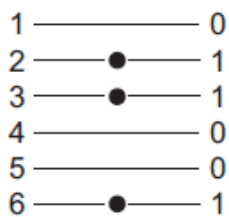


Topic: 1.1.1 Binary systems

Oct/Nov 2009: 15 Electric guitars consist of strings and frets.



Musical notes on the guitar can be represented using the TAB notation:



Each line represents a string; the dots indicate which strings must be held down with the fingers. These are shown with a binary value of 1; otherwise the binary value is 0.

Thus, the above note would be shown as:

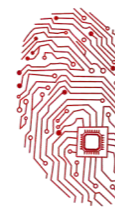
6	5	4	3	2	1	
1	0	0	1	1	0	TAB notation

It is also important to indicate **where** the strings should be held down. This is shown on the FRET. If the fingers are to be held down at the 20th FRET, this is shown in binary as:

32	16	8	4	2	1	
0	1	0	1	0	0	FRET position

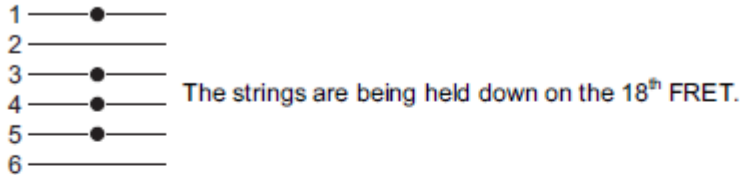
(NOTE: add up the numbers in the headings where binary 1s appear, i.e. $16 + 4 = 20$)





Topic: 1.1.1 Binary systems

(a) A note is being played according to the TAB notation:



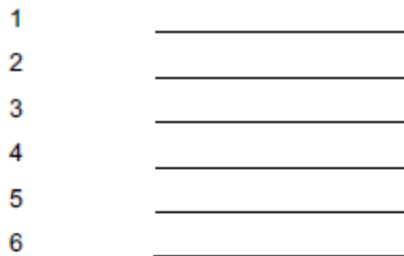
Write down the binary notation for the TAB and for the FRET position:

TAB notation:	6	5	4	3	2	1

FRET position:	32	16	8	4	2	1



(b) (i) Show on the diagram below which note corresponds to TAB notation: 000010. [2]



(ii) What FRET position corresponds to 010011?

.....
 [2]

(c) Describe **two** advantages of storing musical notes in this format.

1

.....

.....

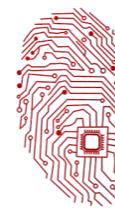
.....

2

.....

.....

..... [2]

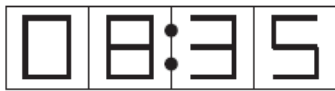


Topic: 1.1.1 Binary systems

Oct/Nov 2011. P13

11 A digital alarm clock is controlled by a microprocessor. It uses the 24-hour clock system (i.e. 6 pm is 18:00). Each digit in a typical display is represented by a 4-digit binary code:

For example:



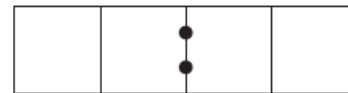
(clock display)

is represented by:

8	4	2	1	
0	0	0	0	1st digit (0)
1	0	0	0	2nd digit (8)
0	0	1	1	3rd digit (3)
0	1	0	1	4th digit (5)

What time is shown on the clock display if the 4-digit binary codes are:

8	4	2	1
0	0	0	1
0	1	1	0
0	1	0	0
1	0	0	1



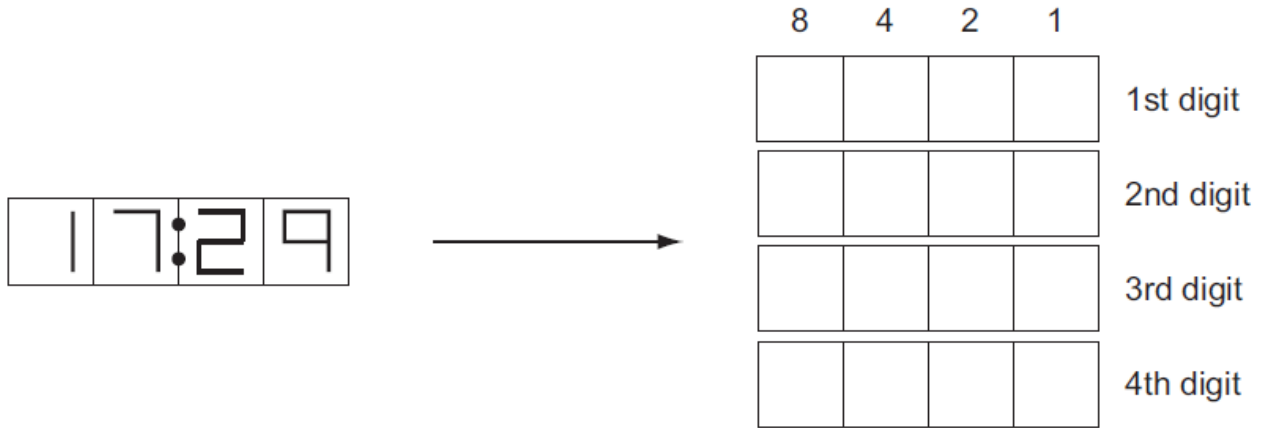
(clock display)

[2] (b)

What would be stored in the 4-digit binary codes if the clock display time was:



Topic: 1.1.1 Binary systems



The clock alarm has been set at 08:00.

Describe the actions of the microprocessor which enable the alarm to sound at 08:00 [2]

[4](c)

Topic: 1.1.1 Binary systems

May/June 2012. P11

2. A vending machine has the choices shown below.

10	tea	11	with milk	12	with sugar	13	with milk and sugar
20	coffee	21	with milk	22	with sugar	23	with milk and sugar
30	hot chocolate	31	extra milk	32	extra sugar	33	with extra milk and extra sugar
40	cold water	41	hot water	42	fizzy water		
50	coke	51	orange	52	lemon		
60	chicken soup	61	tomato soup				

A customer uses a keypad to make their choice. Each number entered is represented in a 6-bit binary register.

For example, key press 33 (hot chocolate with extra milk and extra sugar) is represented by:

1	0	0	0	0	1
32	16	8	4	2	1

(a) (i) If a customer chooses coffee with milk and sugar what is the key press?

--	--

(ii) How is it represented in the 6-bit register?

32	16	8	4	2	1

(b) If the 6-bit register shows

1	0	1	0	0	1
---	---	---	---	---	---

what drink has the customer chosen?

.....

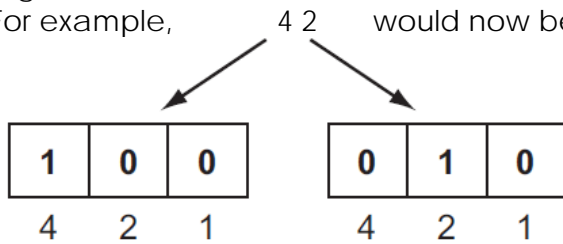
Topic: 1.1.1 Binary systems

- (c) A customer using the vending machine gets an error message after keying in their selection.
What could have caused this error message?

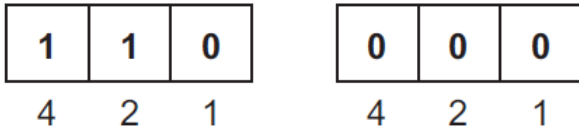
.....
.....

- (d) It was decided to split the register so that each digit was represented by its own 3-bit register:

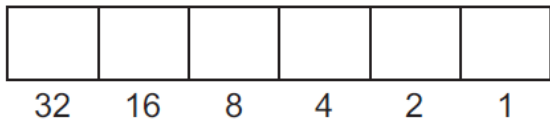
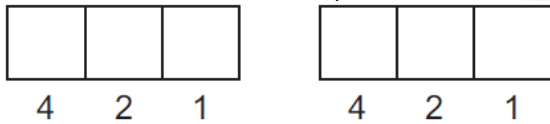
For example, 4 2 would now be represented as:



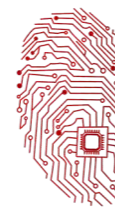
- (i) What drink has been chosen if the 3-bit registers contain:



- (ii) How would the lemon option be shown on both types of register?



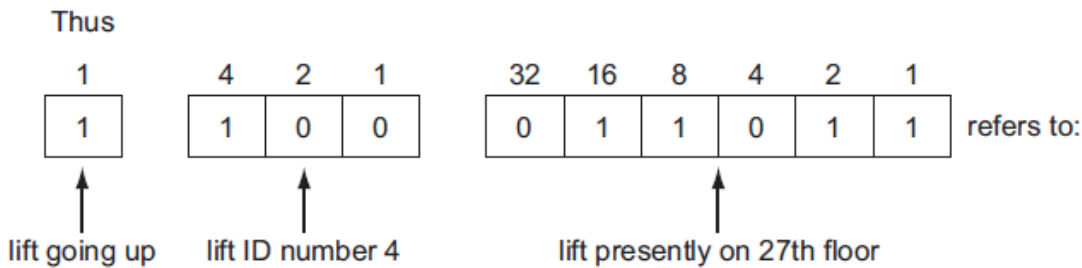
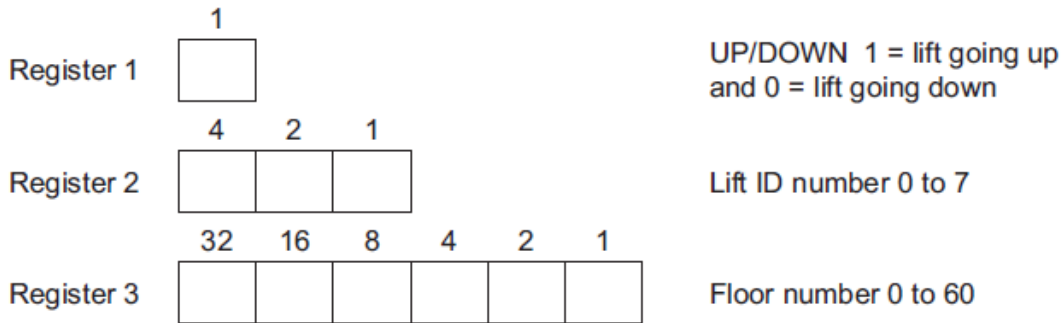
- (iii) What is the advantage of using two 3-bit registers rather than one 6-bit register?



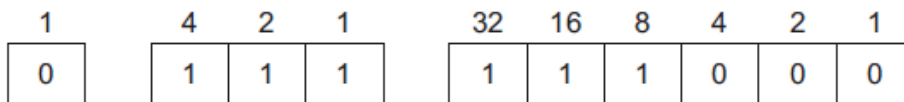
Topic: 1.1.1 Binary systems

Oct/Nov 201. P13

13 A large hotel uses eight lifts (elevators) to carry passengers between its sixty floors. A computer is used to control and monitor the lifts. Each lift has three registers to represent its state.



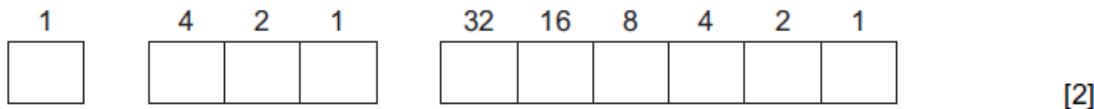
(a) If the three registers contain the following data:



what information about the lift is shown? [2]

(b) How would the following information be shown in the three registers:

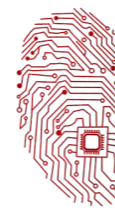
lift 6 presently on the 45th floor and going down



(c) (i) A customer is on the 14th floor and wants to go to the 50th floor. She presses the button to call the lift.

What two pieces of information would the computer check to identify which of the eight lifts should be made available? [2]

(ii) Using your answers to part (i), which of the following lifts would be made available to the customer?



Topic: 1.1.1 Binary systems

1	0 0 0	1 0 0 1 0 0	A
0	0 0 1	0 0 1 1 1 1	B
1	0 1 0	1 1 0 0 1 0	C
1	0 1 1	0 0 1 0 1 0	D

[1]

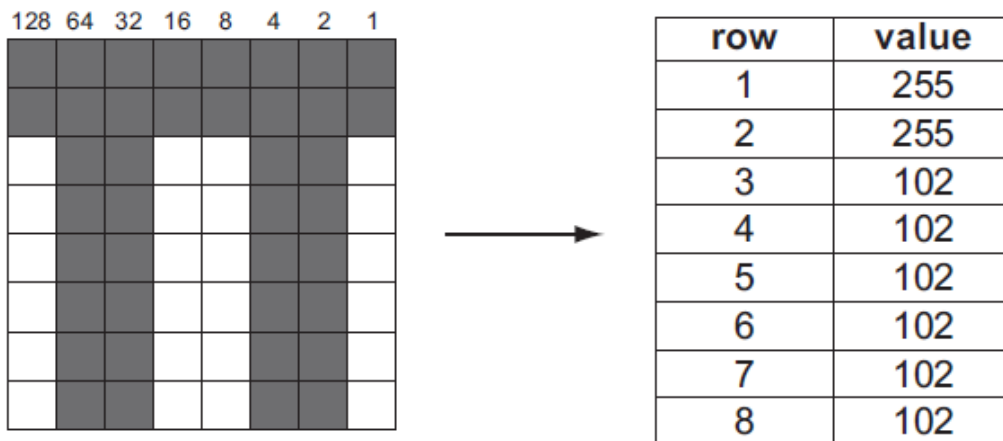
(d) An engineer wishes to test that this computer system detects incorrect data. Describe what input the engineer might use to check that the computer can correctly identify a fault condition.

[2]

May/June 2013. P11

11 Letters from the Greek alphabet are to be transferred to a computer system. Each letter can be represented on an 8 by 8 grid. Each column has a value from 1 to 128. The value of each row is stored in a table. The values in the column headings are used to work out the value for each row (e.g. in our example, row 8 has the value $64 + 32 + 4 + 2 = 102$).

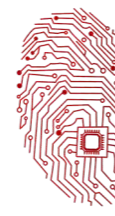
Thus, in the example below, the letter (π) is stored as:



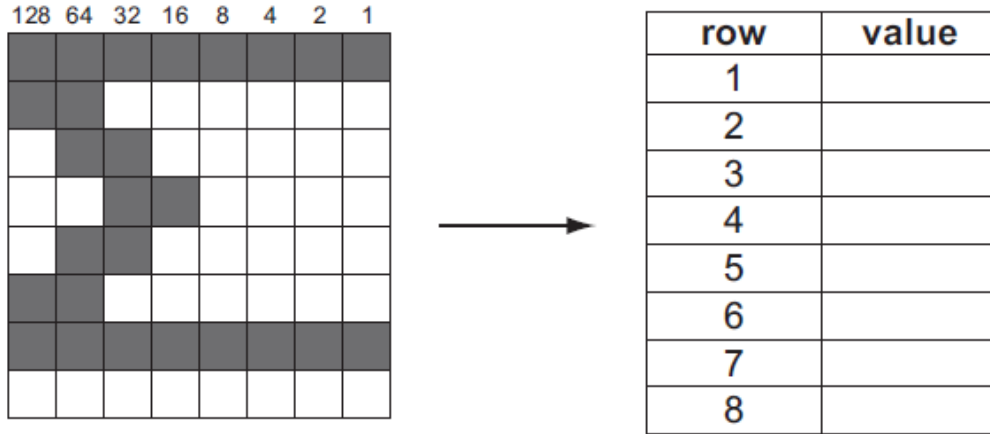
(a) What values would be stored in the table for the Greek character (Σ)?

[4]

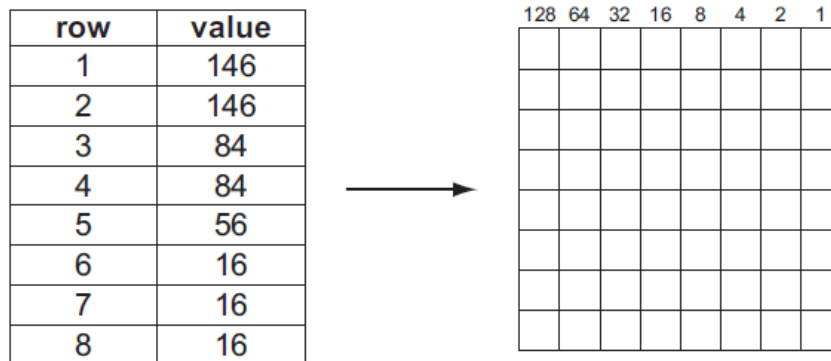




Topic: 1.1.1 Binary systems



(b) Draw the character formed from the following value table: [4]



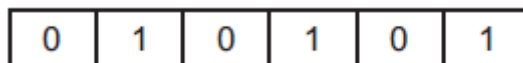
May/June 2013. P12

14 Some decorative lights are made up from a cluster of red, blue, green, yellow and white LEDs.

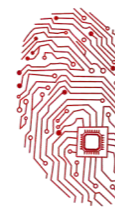
Each colour is represented by a binary code:

	32	16	8	4	2	1	
1	0	0	0	0	0	0	red
0	1	0	0	0	0	0	blue
0	0	1	0	0	0	0	green
0	0	0	1	0	0	0	yellow
0	0	0	0	1	0	0	white
0	0	0	0	0	0	1	black (all lights off)

A 6-bit register, R1, stores the 1-values to represent a sequence of colours. Thus, if R1 contains:



this means the blue, yellow and black colour sequence is stored and displayed in that order. The length of time each light is on is set by a binary value in another register, R2:



Topic: 1.1.1 Binary systems

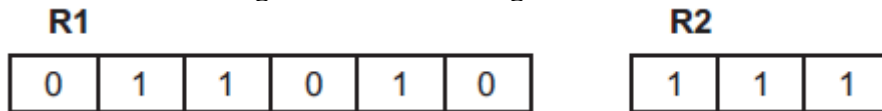
Thus



means each colour is on for 2 seconds.

(a) The two registers contain the following values.

What is the sequence of coloured lights and the timing for each colour?

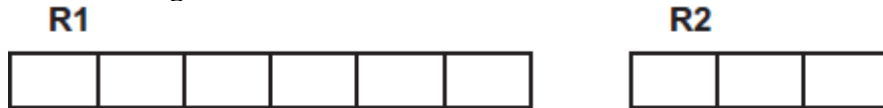


sequence of colours

timing

[2]

(b) What will the two registers contain if the coloured light sequence is red, green and black and the timing is 5 seconds?



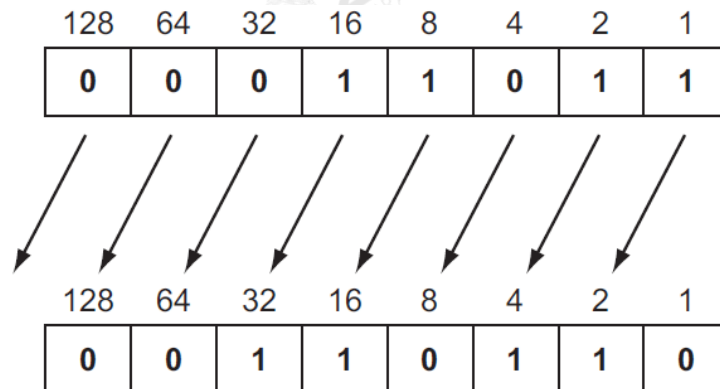
[2]

(c) What is the problem with trying to display green, blue, red in that order?

[2]

Oct/Nov 2013. P12

11 A denary number can be represented as an 8-bit binary number. For example:
27 would be represented as:



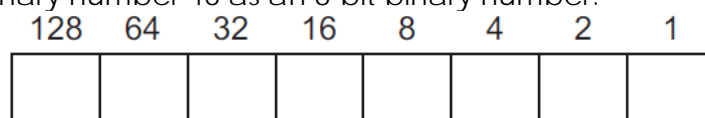
All the bits in the binary number have now been shifted (moved) one place to the left.

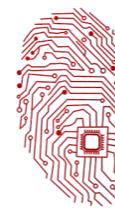
(a) What denary number does this now represent? [1]

(b) What effect did the shift have on the original denary number? [1]

(c) If the above binary number was shifted another one place to the left, what denary number would it be equivalent to? [1]

(d) (i) Represent the denary number 46 as an 8-bit binary number. [1]



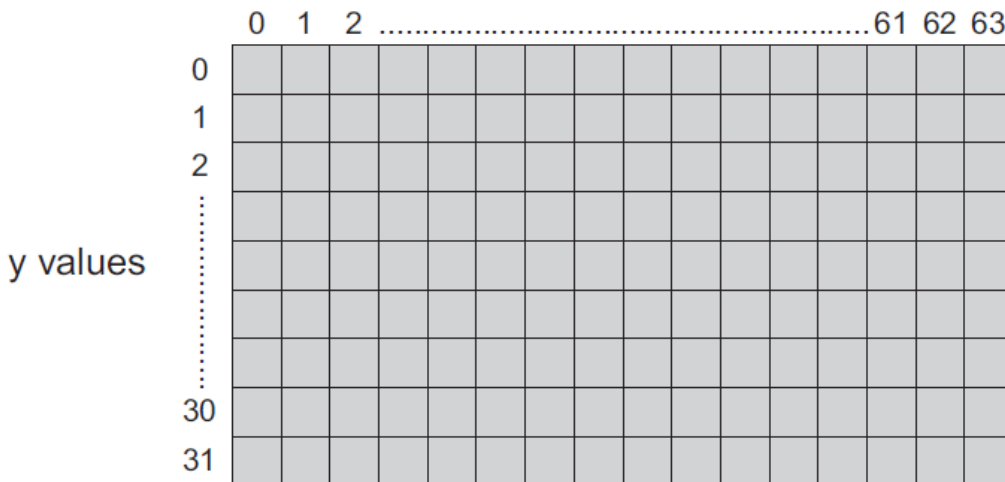


Topic: 1.1.1 Binary systems

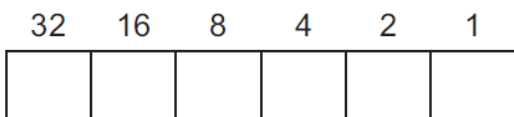
- (ii) Shift this 8-bit binary number 2 places to the left.
What is the denary equivalent? [1]
- (iii) What problem would arise if you tried to shift this 8-bit binary number 3 places to the left? [1]
- (e) If any 8-bit binary number was shifted one place to the right, what would this be equivalent to? [1]

Oct/Nov 2013. P13

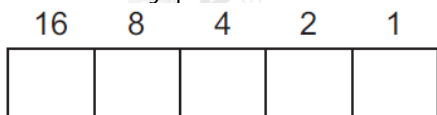
13. A touch screen is divided up into a number of locations:
x values



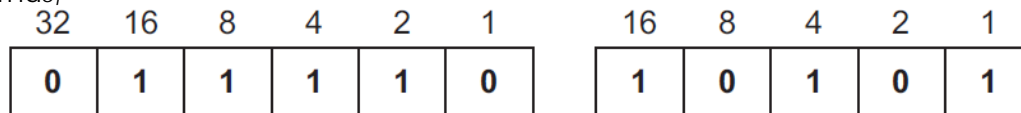
Each x-position is shown in a 6-bit register:



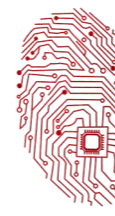
and each y-position is shown in a 5-bit register:



Thus,



refers to screen position: (30, 21)



Topic: 1.1.1 Binary systems

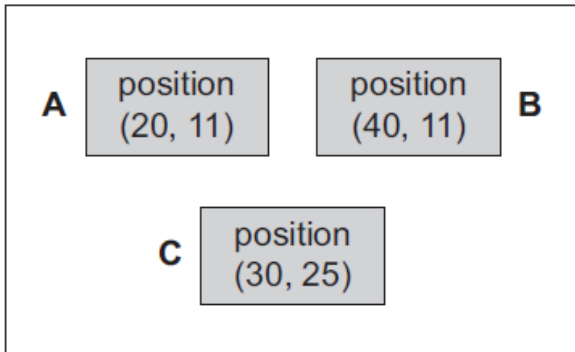
(a) Give the screen position referred to if the two registers contain:

32	16	8	4	2	1
1	1	0	1	0	0

16	8	4	2	1
0	1	1	1	0

(..... ,)

(b) Three options (A, B, C) are shown on the touch screen below:



If the two registers contain:

32	16	8	4	2	1
1	0	1	0	0	0

16	8	4	2	1
0	1	0	1	1

what option (A, B or C) has been chosen?

.....

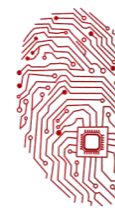
(c) Each box A, B, C is made up of 128 x 64 pixels.

(i) What is meant by the term pixel?

.....

(ii) The value of each pixel is stored in 1 byte of memory.
How much memory is needed to store one of these boxes?
Give your answer in kilobytes.

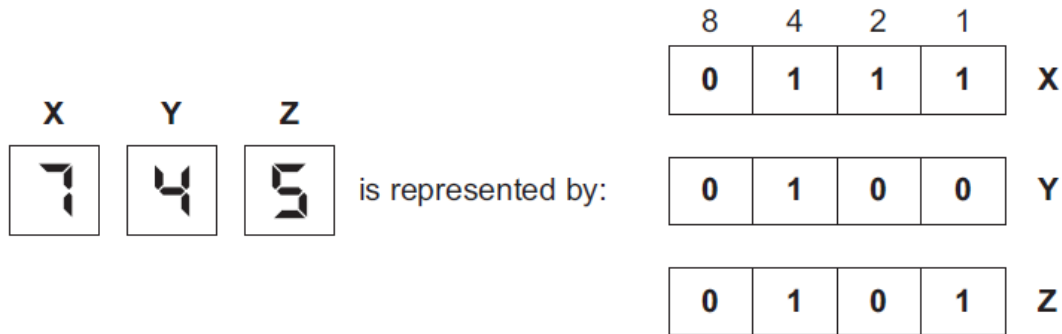
.....



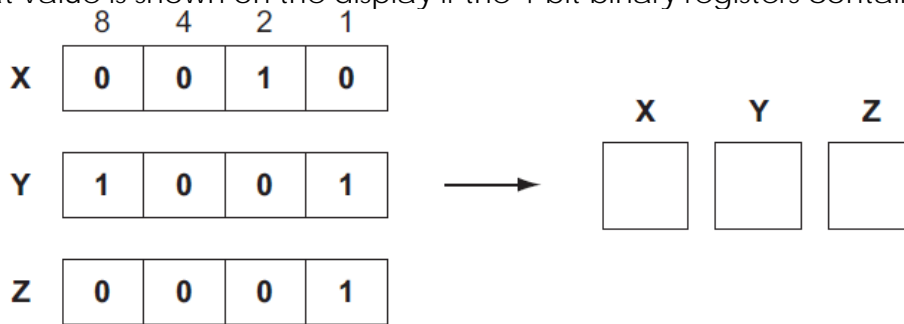
Topic: 1.1.1 Binary systems

May/June 2014. P11

12 A digital light meter has a 3-digit LCD. The value of each digit on the instrument display is stored as a 4-bit binary number in a register.
For example:

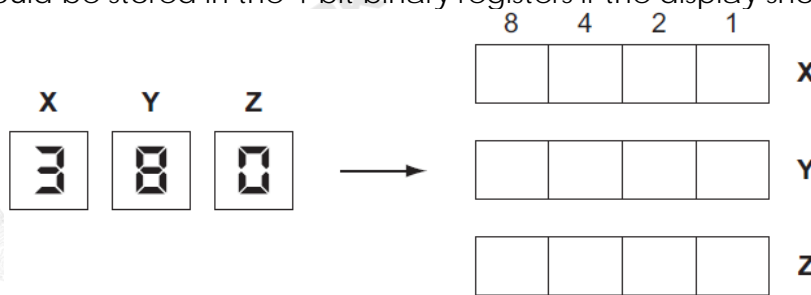


(a) What value is shown on the display if the 4-bit binary registers contain:



[3]

(b) What would be stored in the 4-bit binary registers if the display shows:

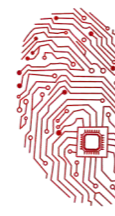


[3]

(c) If any of the 4-bit binary registers X, Y or Z contain the value 1 1 1 1 this indicates an error.

- (i) How could this error be shown on the instrument display? [1]
- (ii) What could cause an error to occur? [1]





Topic: 1.1.1 Binary systems

May/June 2014. P12

16 An encryption system gives each letter of the alphabet a value:
A = 1, B = 2, C = 3, , Y = 25, Z = 26.

Each letter is stored in a 12-bit binary register. The letter "S" (19th letter) is stored as:

2048	1024	512	256	128	64	32	16	8	4	2	1
0	0	0	0	0	0	0	1	0	0	1	1

A 4-bit register is used to store the encryption key. This register shows how many places the bits are shifted to the left in the 12-bit register when it is encrypted. So,

8	4	2	1
0	1	0	1

means each bit in the 12-bit register is shifted 5 places to the left and the register now becomes:

2048	1024	512	256	128	64	32	16	8	4	2	1
0	0	1	0	0	1	1	0	0	0	0	0

Therefore, the letter "S" would be transmitted with the 4-bit register and the 12-bit register as follows:

0	1	0	1	0	0	1	0	0	1	1	0	0	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

(a) "W" is the 23rd letter of the alphabet.

(i) Show how this letter would be stored in the 12-bit register before encryption:

--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

(ii) The 4-bit register contains the following value:

8	4	2	1
0	1	1	0

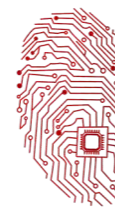
Show how the letter "W" is now stored in the 12-bit register in encrypted form:

--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

(b) Find which letter of the alphabet has been encrypted here. (Show all your working.)

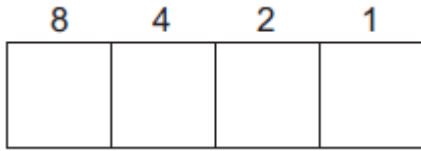
0	0	1	1	0	0	0	0	1	1	0	0	1	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---





Topic: 1.1.1 Binary systems

(c) (i) What is the largest encryption key that can be stored in the 4-bit register?



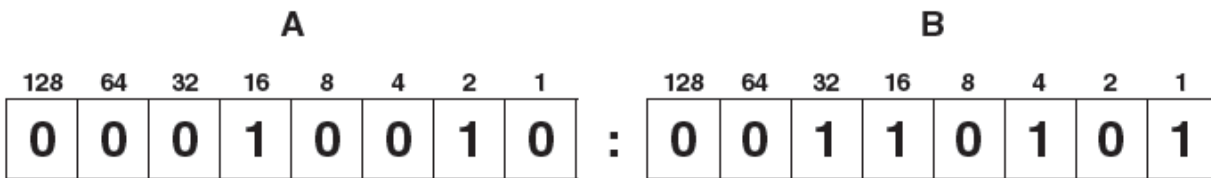
(ii) Convert this into denary (base 10).

(iii) If this encryption key were used, what problem would it cause? [3]

May/June 2015 P11 (2210)

8 An alarm clock is controlled by a microprocessor. It uses the 24 hour clock. The hour is represented by an 8-bit register, **A**, and the number of minutes is represented by another 8-bit register, **B**.

(a) Identify what time is represented by the following two 8-bit registers.



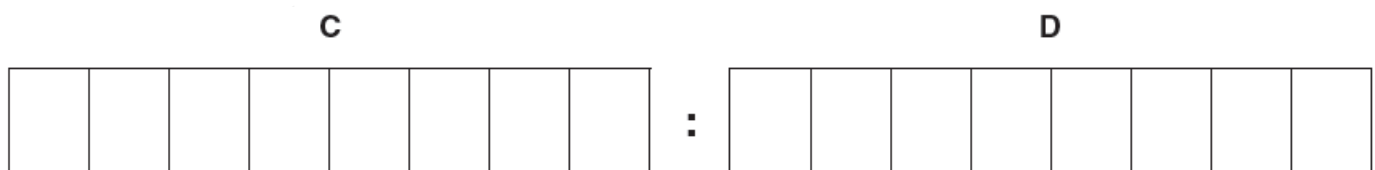
Hours

Minutes

[2]

(b) An alarm has been set for 07:30. Two 8-bit registers, **C** and **D**, are used to represent the hours and minutes of the alarm time.

Show how 07:30 would be represented by these two registers:



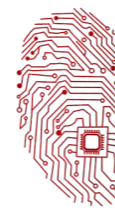
Hours

Minutes

[2]

(c) Describe how the microprocessor can determine when to sound the clock alarm. [3]





Topic: 1.1.1 Binary systems

May/June 2015 P11 (2210)

10 Letters from the alphabet are represented in a computer by the following denary (base 10) values:

- A = 97
- G = 103
- I = 105
- L = 108
- N = 110

The word "ALIGN" is stored as: 97 108 105 103 110

(a) Convert each of the five values to binary. The first one has been done for you.

Letter	Denary value							
A (97):	0	1	1	0	0	0	0	1
L (108):								
I (105):								
G (103):								
N (110):								

[2]

