Chapter 1 Information Representation: Answers to coursebook questions and tasks

Syllabus sections covered: 1.1 (1.1.1–1.1.5)

Question 1.01

Internally never: hexadecimal numbers are only used for representation of binary codes for a person to read. A computer can, therefore, create hexadecimal representations for output or possibly accept them for input.

Task 1.01

For the conversion of denary 374 the slow but steady route is via an initial conversion to binary using successive division by two, noting the remainder each time and then reversing the remainders. The remainders are 0 1 1 0 1 1 1 0 1 which in reverse give the binary as: 101110110. For conversion to hexadecimal, groupings of four bits are converted starting at the least significant (RHS) end. The 0110 converts to 6, the 0111 to 7 so the hexadecimal representation is 176. The more able students will use a short cut. Noting that 374 is greater than 16^2 a three-digit hexadecimal representation is expected. Calculating 374 – 256 leaves 118. This can be seen to consist of 7 16s with 6 remaining, hence 176.

The conversion of 3A2C is best handled with a calculator via 3 x 16 = 48 then + 10 =58 then x 16 = 928 then + 2 = 930 then x 16 = 14 880 then + 12 = 14 892. Note that calculators are not allowed in the 9608 exam so a conversion with such a large value is unlikely to occur.

Task 1.02

The question assumes that a representation in a nibble will be used but the same result should be seen if more bits are used. The simplest conversion method from 1011 leaves the least significant 1 unchanged then flips the remainder to give 0101.

Task 1.03

The method is to take the two's complement of the binary value for 35 and to add this to the binary value for 67. The binary equivalent of denary 35 is 00100011, conversion to two's complement gives 11011101. Binary for 67 is 01000011. Addition gives (1)00100000. Students should note that there is a carry bit that cannot be stored in the byte but this does not matter because the result is the binary code for denary 32, the correct answer.

Exam-style Questions (with mark allocation in brackets):

1 a i 38 195 from $2^{15} + 2^{12}$ and so on (1 + 1)

ii 9533 from 4-bit groupings (1 + 1)

b Any example involving presentation of a hexadecimal representation of a binary code to make it easier for someone to read (1).

c i 10010101 because the most significant LHS bit is 1 (1).

ii -107 from $-2^7 + 2^4$ and so on and 51 from $2^5 + 2^4$ and so on (1 + 1).

d Only one representation of zero. Allows simple computation for addition and subtraction. (1 + 1)

e Many options here, some possibilities (1 each, max 3) are:

- BCD values either two per byte or just one per byte using just four bits.
- Two ASCII characters either using seven bits from each byte or using the full byte including a parity bit.
- One Unicode character using the two bytes.
- Bitmap code with any variation from 16 single-bit pixels for black and white through two pixels with each byte representing one of 256 colour codes to the two bytes representing a colour depth of 16.
- Values for sampled sound, sensibly using four bits, one byte or two bytes to represent one sampled value.
- A machine code instruction using the two bytes.
- A memory address using both bytes.
- Although not yet covered in the syllabus a floating-point representation.

2 a i There are many credit-worthy options such as mention of drawing list, individual objects, properties, attributes, geometric data or by example (1 each, max 2).

ii 'Uses a matrix of pixels' is a sufficient answer but also creditworthy would be to state that a pixel has a colour and a position (1 for pixel + 1 added comment).

iii Vector graphic. This should be justified by saying there is a re-calculation for the magnified image; might get credit for saying that a bitmap becomes pixelated on magnification or that a vector graphic does not. (1 for vector graphic + 1 for reason)

b i 640 x 480 = 307 200 pixels; each pixel has 16 bits which is two bytes. The best continuation is to divide 2 x 307 200 by 1024 to get 600 KiB. An alternative correct calculation is to divide by 1000 to get 614.4 kB. (1 for value + 1 for units)

ii A bitmap file has a header metadata that defines the colour depth and the dimensions of the image matrix (1).

c i Run-length encoding, which replaces a consecutive series of identical codes by one code value plus a value for the number of repetitions (1 for approach + 1 for explanation).

ii One possibility is to reduce the colour depth by changing each pixel code to an approximation stored with fewer bits. An alternative is to identify regions of the image where colour changes are small and to use just one code for all pixels in that region so that run-time encoding can then be applied. (1 for approach + 1 for explanation)

3 a i Sound is transmitted as a continuous waveform and is, therefore, an analogue phenomenon.Normal practice nowadays is to store a representation of the sound in digital form. The ADC is used to convert the analogue signal to a digital representation. (1 for analogue sound + 1 for digital storage)

- ii The sampling rate is simply the number of samples of the sound intensity taken per unit time (1). The rate chosen should be in accordance with Nyquist's theorem (1). The sound intensity is measured when a sample is taken. The value obtained has to be stored as a digital value (1). The number of bits used for this defines the sampling resolution (1). If more bits are used the values that can be stored are more closely spaced so that the approximation to the actual intensity value is more accurate (1).

b
- i A band-limiting filter (1)
- ii To remove higher frequency components that the human ear would not be able to hear (1)and that would have such a high frequency that Nyquist's theorem would not be satisfied with any sensible sampling rate used (1)

c There are many options. The editing could involve simple processes like producing a shorter sound clip or creating a fade-in or fade-out. Two or more recordings could be combined. Alternatively, the editing software might be able to convert from one file format to another or apply a filter to the sound. To get full marks the techniques must be described, not just identified so some experience of using such software would be needed. (1 for each technique name + 1 for each description, max 3)