| Question | Answer | Marks |
|---|---|---|
| **1** | D | 1 |
| **2** | If the sampling rate is lower than twice the maximum frequency of the sample spurious low-frequency signals can be generated (this effect is known as aliasing).<br>The recording filters out frequencies above 20 000 Hz because such frequencies can produce audible aliasing.<br>44.1 kHz is more than twice the highest frequency of the recorded signal, preventing aliasing. | 1<br>1<br>1 |
| **3 a** | Signal to noise ratio = $\frac{609}{9}$ = 67.66<br>Number of bits = $\log_2 67.66$ = 6.1 bits, number of bit used = 6 | 1<br>1 |
| **3 b** | More than 6 bits will code noise variation<br>which adds no useful noise detail. | 1<br>1 |
| **4** | Resolution = $\frac{380\,\text{mV}}{2^8}$<br>= 1.5 mV (2 s.f.) | 1<br>1 |
| **5** | Time = file size in bits / bit rate = $\frac{28\times10^6\times8\text{ bits}}{1\times10^6\text{ bits s}^{-1}}$<br>= 224 s = 220 s (2 s.f.) | 1<br>1 |
| **6** | 12 kbytes per second | 1 |
| **7 a** | Each level is represented by three binary digits. | 1 |
| **7 b** | The digital values do not all lie on the line of the original waveform. | 1 |
| **7 c** | More bits per sample.<br>Greater sampling rate. | 1<br>1 |
| **8 a** | 100 μs = 1 x $10^{-4}$ s. Samples in one second = $\frac{4}{1\times10^{-4}\text{s}}$ = 40 000 $\text{s}^{-1}$ | 1 |
| **8 b** | 20 000 Hz<br>Higher frequencies than this can produce spurious low frequency signals (aliases) | 1<br>1 |
| **8 c** | $\frac{10\,\text{mV}}{2^{16}}$<br>= 0.15 μV | 1<br>1 |
| **8 d** | Number of bits required in 3.5 minutes = 16 x 40 000 $\text{s}^{-1}$ × 3.5 × 60 s<br>=1.344 × $10^8$<br>= 16.8 Mbyte | 1<br>1<br>1 |
| **8 e** | If the sampling rate is above 40 000 Hz and the recording filters remove frequencies above 20 000 Ha the sound quality of the recordings will match that of analogue.<br>Digital recordings are stored and transmitted as streams of (binary) digits.<br>This allows easy manipulation, editing, and storing. | 1<br>1<br>1 |