1 a) $T = 2s$

$f_s = 20KHz$

$T \cdot f_s = 40K$ samples

40×10^3 samples

b) $0.2 \times 20\ KHz = 4000$ samples

$T = [0, 4000, 8000, 12000, \ldots, 40000]$

c)

```
clear;
close;
home;

nbits = 8;
fs = 20e3;
dt = 1/fs;
t = dt:dt:2;
d = zeros(size(t));
for i = 1:0.2*fs:2*fs
	d(i) = 1/pow2(i/(0.2*fs));
Endfor

ts = dt:dt:0.1;
s = sin(2*pi*440*ts);

player1 = audioplayer(conv(d,s),fs,nbits);
play(player1);
```

2

a) $y[i] = h[n] * x[n] = \sum_{j=0}^{M-1} h[j]x[i-j]$

$$s[n] * l[n] + s[n] * h[n]$$

$$= \sum_{j=0}^{M-1} l[j]s[i-j] + \sum_{j=0}^{M-1} h[j]s[i-j]$$

$$= \sum_{j=0}^{M-1} l[j]s[i-j] + h[j]s[i-j]$$

$$= \sum_{j=0}^{M-1} (l[j]+h[j])s[i-j] \qquad l[j] + h[j] = \delta[j]$$

$$= \sum_{j=0}^{M-1} \delta[j]s[i-j] = s[n]$$

b) $l[j] + h[j] = \delta[j]$

$l[n] + h[n] = \delta[n]$

$h[n] = \delta[n] - l[n]$

c) A

only one that results in a band width

3:1

a)

$$X_K = \sum_{n=0}^{N-1} x_n e^{-2\pi j\left(\frac{K}{N}\right)n}$$

$$X_{1K} = \sum_{n=0}^{N-1} x_{1n} e^{-2\pi j\left(\frac{K}{N}\right)n}$$

$$X_{2K} = \sum_{n=0}^{N-1} x_{2n} e^{-2\pi j\left(\frac{K}{N}\right)n}$$

$$x_1 + x_2 = X_{1K} + X_{2K}$$

$$\text{dft}(x_1 + x_2) = \sum_{n=0}^{N-1} (x_{1n} + x_{2n}) e^{-2\pi j\left(\frac{K}{N}\right)n}$$

$$= \sum_{n=0}^{N-1} x_{1n} e^{-2\pi j\left(\frac{K}{N}\right)n} + x_{2n} e^{-2\pi j\left(\frac{K}{N}\right)n}$$

$$= \sum_{n=0}^{N-1} x_{1n} e^{-2\pi j\left(\frac{K}{N}\right)n} + \sum_{n=0}^{N-1} x_{2n} e^{-2\pi j\left(\frac{K}{N}\right)n}$$

$$= X_{1K} + X_{2K}$$ additive

a) $\sum_{n=0}^{N-1} (kx_n) e^{-2\pi j \left(\frac{k}{N}\right) n}$

$= \sum_{n=0}^{N-1} k\left(x_n e^{-2\pi j \left(\frac{k}{N}\right) n}\right)$

$= k \sum_{n=0}^{N-1} x_n e^{-2\pi j \left(\frac{k}{N}\right) n}$

$= k X_k$ homogenous

b) $x_n = \frac{1}{N} \sum_{k=0}^{N-1} X_k e^{2\pi j \left(\frac{k}{N}\right) n}$

$X_k = \delta[k]$

$\delta[k_0] = X[k_0]$

$\frac{1}{N} \sum_{k=0}^{N-1} \delta[k] e^{2\pi j \left(\frac{k}{N}\right) n} = \frac{1}{N} \quad e^{2\pi j \left(\frac{k_0}{N}\right) n}$

$= \frac{1}{N} \quad \left(\cos\left(2\pi\left(\frac{k_0}{N}\right)n\right) + i\sin\left(2\pi\left(\frac{k_0}{N}\right)n\right)\right)$

$f = k_0$

3:2

a) as somethins happens at a faster rate the frequencies that comprise it must be higher in value. more cycles per second is faster change. same happens when slowed down except it must be comprised of lower frequencies. in the graph this results in the frequency graph getting wider stretching to higher frequencies as the pulse is shortened.

b) $0.01 \times 100 = 1$

$0.02 \times 50 = 1$

$0.04 \times 25 = 1$

$0.08 \times 12 = 1$