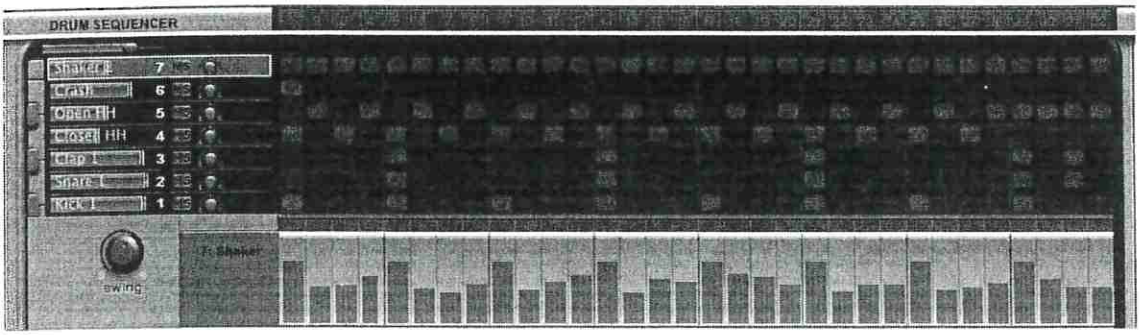
SAMPLERS AND DRUM MACHINES REVISION PACK

The digital sampler has transformed the sonic palette available to musicians and producers by allowing any sound to be incorporated into a recording with accurate control. **Describe what a sampler is** and **how sampling technology has developed** from the 1980s to the present day. You should refer to **technical specifications of sampling** equipment in your answer.

Question 11

Drum machines and matrix editors

The matrix editor on the sequencer below shows a programmed drum beat. The tempo is 120 bpm and the pattern lasts for two bars of $\frac{4}{4}$.



***a.** In the pattern shown above, describe what is being played by each part of the drum kit by filling in the table below. (5)

Part of Kit	Description
Kick	(1)
Snare/clap	(1)
Hi-hat	(1)
Shaker	(1)
Crash	(1)

***b.** Identify two things that have been done to the drum beat to make it sound more realistic (2)

1. .....

2. .....

***c.** If the drum kit had been inputted live as MIDI data, explain how the rhythms of the part could be tightened up while maintaining some sense of freedom. (3)

.....

.....

.....

Total for AS Level: 10 marks/Total for A Level: 10 marks

Software synthesisers

- As computers became more powerful, plug-in instruments became popular because of their ability to produce the sounds of their hardware equivalent without having to purchase more than one synth!
- This is especially true of the popular vintage synths that may be hard to get hold of in playable condition, and are often very expensive due to the popularity of vintage gear amongst enthusiasts
- There remains a demand for 'vintage' **analogue** synthesisers; equipment worth very little in the late 1980s and early 1990s now sometimes sells for thousands of pounds
- In recent years, the cost of manufacturing analogue synthesisers has decreased, and manufacturers have developed and released equipment that combines analogue technology and sounds with computer control.

Benefits of software synthesisers	Benefits of analogue synthesisers
■ Can be automated, **MIDI** controlled and easily sequenced ■ **DAWs** with a global tempo allow you to easily sync **LFOs/ arpeggiators** to a note value (this is much harder to do aurally on a hardware synth) ■ Better **signal-to-noise ratio** ■ Wide variety of presets available at the touch of a button ■ Can create your own presets, and share on the internet ■ Can use multiple instances of the plug-in ■ Stay in tune reliably; it is common for **analogue** synthesisers to go out of tune when they heat up ■ Can have more envelope stages, types of **waveform**, **oscillators** and filter types.	■ Enthusiasts refer to the analogue sound as 'warm' when compared to 'harsher' or 'sterile' digital sounds; this is because of the 'flaws' associated with analogue technology – things like the tuning drifting, **noise**, aurally-pleasing **distortion** and subtle and random variations in wave shape, **amplitude** and **frequency** ■ Possible to use **CV/gate** systems to sync analogue equipment together; converters exist to connect analogue synthesisers to **MIDI** equipment ■ Your music can 'stand out from the crowd' – less reliant on presets and sounds others are using – sounds more individual ■ Analogue synthesisers by definition have a 'hands-on' interface – with permanently routed controls, it is easy to change settings 'on-the-fly'.

Samplers

Sampling is when you take a part of a song, single note or sound and reuse it in another context. It is common to use a sampler to either record, manipulate or playback one of these pieces of audio material (or any combination of the three). The technique of using everyday noises in music began in earnest with the Musique Concrète movement of 20th century experimental music.

The tape recorder and early sampling

- The tape recorder was the main 'instrument' for early Musique Concrète composers
- They would use it to **capture** sounds and then manipulate them by cutting and splicing the tape, making loops (by splicing the ends of a length of tape together, forming a literal loop), **reversing** the playback direction, altering the speed of playback and combining/layering sounds
- There were limitations to what could be achieved with tape, for example, it is impossible to change the speed of playback without altering the pitch
- This process formed the basis for modern-day **sampling**, and the 1960s saw the first instruments used in pop music that could play back samples.

Listening
The Beatles – 'Tomorrow Never Knows'
This song showcases a variety of tape-based manipulations, from tape loops and changing the playback speed to reversing and using **tape saturation** as a creative tool.

Mellotron (1962)

It was the Mellotron that first achieved widespread acceptance as an early sampler. It used different banks of pre-recorded tapes (one tape strip for each key) giving several choices of sound (including strings, brass, flute and choir). It was expensive, and notoriously fragile.

Listening
The Beatles – 'Strawberry Fields Forever' (opening flute)
Led Zeppelin – 'The Rain Song' (strings from 1:36)

Digital samplers as instruments

- Samplers can record audio either as one-shot, single note samples or as short loops/musical excerpts

- They can then store this audio ready for playback or apply processing and sample manipulations
- Early digital samplers had limited memory in which to store samples and thus the **bit depth** and **sample rate** were lowered, making the samples sound lo-fi
- Bitcrusher plug-ins in a DAW create a lo-fi effect in the same way by lowering the bit depth and the sample rate for a track.

For more information on digital sampling, bit depth and sample rate, turn to pages 87-88.

- Drum machines embraced early **sampling** technology; the samples required were short, at a single pitch, and thus did not take up much memory
- The Roland TR-909 used sampled cymbal sounds; this greatly improved the realism of the sounds compared to those synthesised on the TR-808
- Modern samplers often feature controls that are similar to a synthesiser, such as **LFOs** and envelopes.

Historically important samplers:

- **Fairlight CMI** (1979) Kate Bush – 'Cloudbusting' (vocal sample in bridge, steam engine sounds at end), Jean-Michel Jarre – *Zoolook* (made completely on a Fairlight CMI)
- **E-MU Emulator** (1981) Depeche Mode – 'Construction Time Again' (uses the Emulator throughout), Cutting Crew – '(I Just) Died In Your Arms Tonight' (used an Emulator stock patch for the Shakuhachi opening phrase, although was played on an Emulator II)
- **AKAI S900** (1986) Prodigy – 'Out Of Space' (drum samples) , Fatboy Slim used the S950 in 'Right Here, Right Now' and throughout *You've Come A Long Way Baby*
- **E-MU ESI Series** (1994) Famously used by Daft Punk, particularly on *Homework*
- **Nemesys Gigasampler** (1997) This was a software sampler that held only the attack of the sample in memory and streamed the rest from a hard disk. This was revolutionary and meant that limited RAM was less of an issue, improving the quality of stored and replayed samples.

Making samples realistic

- Just like the synthesiser, it is now common to see samplers as software instruments on **DAW** software

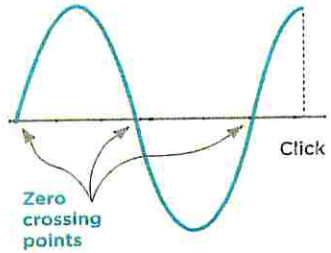
- If sampling a real instrument, in order for it to be played on the keyboard at various pitches, three key techniques are used to make samples sounds realistic:

Keyboard tracking	Spreading a single sample out across the keyboard. The sample is pitch-shifted in response to the key played; however, it is noticeable when a sound is pitch-shifted beyond a few tones
Multisampling	Taking a sample every few notes and mapping across the keyboard so that samples are pitch-shifted across a smaller range of notes.
Velocity layering	Switching between a number of different samples depending on the **MIDI** velocity of the note.

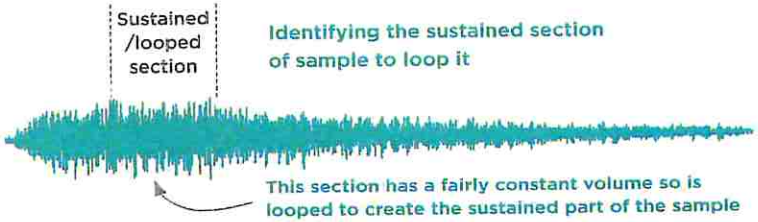
- When done well, it can be impossible to tell that a sound source has been sampled, just as it might be impossible to spot a well-executed edit in a multitrack recording
- When done badly, **sampling** can introduce **artefacts** such as clicks when a loop point is badly chosen.

Zero crossing editing

- It is important to cut samples at a **zero crossing** point to avoid creating a click; you could also fade the sample out (if the edit is at the end), or use **crossfade looping**.



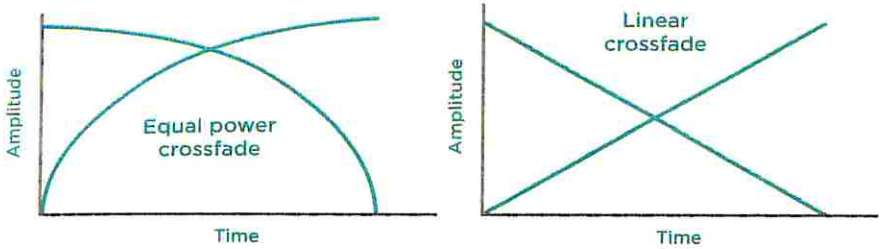
Loop points



Types of crossfade

A fade can be used to avoid a click when it is not practical to find a **zero crossing** point for a sample audio edit.

A **crossfade** can be used to fade between two different samples, audio regions or loops. There are a number of different types of crossfade, two are illustrated below:



Using synthesis parameters on samples

- The key difference between a sampler and a synthesiser is that a sampler uses an audio source as its starting point rather than a tone produced by an **oscillator** on a synthesiser
- Samplers often incorporate similar controls to those you might see on a synthesiser
- Such controls might include filters, **LFOs** and envelopes, along with the ability to change the octave and route parameters in different ways.

Manipulating & altering samples

Loop	Repeats the sample.
Transpose	Changes the starting pitch/key of a sample.
Normalise	Increases the volume to the maximum without distorting.
Stuttering	Repeating small parts of the sample to create a 'stutter' effect.
Gapping	Adding spaces between small parts of the sample.
Reverse	Playing the sample backwards.
Time stretch	Slowing down or speeding up the sample. On tape and on many digital samplers, slowing the sample down will also decrease the pitch and vice versa.
Pitch shift	Moving the entire sample up or down in pitch. On tape and on many digital samplers, a higher pitch will result in a faster sample playback and vice versa.

When working with tape, time and pitch are linked. On most samplers, when pitch-shifting a sample (such as when mapping to a keyboard), the length of the sample also changes as a side-effect. However, time stretch and pitch shift can be independently achieved with digital technology.

Destructive and non-destructive editing

- **Destructive editing** changes the audio file associated with the sample; processing is not normally reversible. Normally, editing in a **DAW** sample editor is destructive. Physically making changes to a tape is another example of destructive editing
- Non-destructive editing does not change the audio file, and effects or processing are normally easily removed. Channel strip plug-ins used as inserts and send effects are non-destructive.

Software samplers

- Musicians still struggle with the reliability of software-based equipment when touring, so despite the capabilities of software, hardware still has its place in the working musician's gig bag
- The line between synths and samplers has become gradually more blurred, as many synths provide sample playback or integrate fully-fledged samplers and can use sampled **waveforms** as the basis of their **synthesis** engines
- You can use synthesis functions such as filters, envelopes and **LFOs** to manipulate samples, in effect replacing the **oscillator** with a sample as a sound source
- It is also possible to apply **sampling** techniques in the arrange window in a **DAW**, and this can sometimes provide more flexibility in editing and manipulating a short extract of audio.

Listening

Fatboy Slim – 'Praise You' (1999)

This track is famous for the obvious **looping** of the vowel 'oo' in the word 'should', where the loop points have been poorly chosen to create an audible step instead of a smooth, sustained note. What is less well-known is that the opening backing is a series of looped samples as well, demonstrating Fatboy Slim's true abilities in sample manipulation. Fatboy Slim deliberately introduced the **sampling** artefact to make an interesting, ear-catching musical feature, and to deliberately add rhythmic interest.

Question 11

Drum machines and matrix editors

***a.** Acceptable answers:

Part of Kit	Role
Kick	Four-to-the-floor pattern/every crotchet beat (1)
Snare/clap	Crotchet beats 2 and 4/backbeat and a fill at the end (1)
Hi-hat	Alternating closed/open hi-hats except last beat, which has four semiquaver open hi-hats (1)
Shaker	Playing on semiquaver beats throughout (1)
Crash	Single hit at the start of the cycle/first semiquaver of beat 1 (1)

[max. 5 marks]

***b.** Acceptable answers:

- 'Swing' turned up to 60% to give swung rhythms
- Velocities of the shaker part have been edited to emphasise the first semiquaver beat

[max. 2 marks]

***c.** Acceptable answers:

- Quantise (1) with 1/16 resolution (1)
- Percentage/iterative quantise (1)
- Groove templates (1)

[max. 3 marks]

SECTION B

*Question 12

Recording vocals

Total for AS Level: 16 marks – AO3 4 marks, AO4 12 marks
Total for A Level: 20 marks – AO3 5 marks, AO4 15 marks

Marking instructions
Markers must apply the descriptors in line with the general marking guidance and the qualities outlined in the levels-based mark scheme below.

Responses that demonstrate only AO3 without any AO4 should be awarded marks as follows:

AS Level:

- Level 1 AO3 performance: 1 mark
- Level 2 AO3 performance: 2 marks
- Level 3 AO3 performance: 3 marks
- Level 4 AO3 performance: 4 marks.

In the case that a student has answered both questions, mark both and take the highest mark, unless one response is crossed out.

Question Number	Question	Mark
4(a)	The digital sampler has transformed the sonic palette available to musicians and producers by allowing any sound to be incorporated into a recording with accurate control. Describe what a sampler is and how sampling technology has developed from the 1980s to the present day. You should refer to technical specifications of sampling equipment in your answer.	**16**
	Acceptable Answers	
	A sampler is a musical instrument that stores recordings of sounds (1) digitally in RAM (or ROM) (1). These are usually played back on a keyboard (1) using MIDI (1). Sounds are played at different pitches (1) by speeding up or slowing down (1) the digital recordings. Unfortunately this changes their length (1) and timbre (1) and is more noticeable when transposed more than a couple of tones (1). Multisampling (1) is used to overcome this. This ensures that each sample is transposed over a limited range (1). Each key may be assigned an individual sample (1). Velocity layering (1) is where different samples are assigned to different velocity ranges (1) e.g. brighter timbre for high velocities (1). Accept any other appropriate example of velocity layering. Samples are often looped (1) to create a longer / more sustained sound (1) or to create a groove (1). Care must be taken at the loop point so as not to get a glitch / click (1). Crossfade looping (1) or choosing a zero-crossing (1) loop point overcomes this. Samples can be reversed (1). Nyquist's criteria (1) states that sample rate (1) is double (1) the frequency response (1). Low sample rates give lower quality of sound because high frequencies (1) are not captured. A typical sample rate that captures the human hearing range (1) is 44100Hz (1). Bit depth/resolution (1). Lower bit depths reduce the signal to noise ratio (1) and also give a brittle/crunchy (accept any other appropriate descriptor) quality to the sound (1). This is often sought after in lo-fi recordings (1). A common bit depth for samplers is 16-bit (1). Red book standard (1). Pioneering early samplers include the Synclavier (1) and the Fairlight CMI (1). In the 1980's computer systems didn't have much RAM (1). This limited sample time (1). To compensate bit depths and sample rates were lowered (1). **Award any suitable examples of bit depths (1) and sample rates (1).** Drum machines embraced early sampling technology (1) because only short samples are required for drum hits (1). **Award an**	

What is a drum machine?

An electronic device that allows the user to playback and sequence drum sounds

DEVELOPMENT OF DRUM MACHINES

1931 -RHYTHMICON

Invented by Leo Theremin was the first machine that could be called a drum machine but was limited in its capacity and preset patterns.

Name another Leo invention.

1979 – LINN LM-1.

The first digital drum machine which used drum samples from live drums. The samples were short in length which meant that they didn't take up much memory which helped keep the cost down of producing these units, as memory at the time was very expensive. The Linn LM-1 produced realistic drum sounds (featured on Prince's 'When Doves Cry' and many other 80s pop songs)

https://www.youtube.com/watch?v=10sWBa8wKKk

1980 – ROLAND TR-808

Popular in the hip-hop scene and is still in huge demand today. Uses analogue synthesis so lacked the realism of competing digital units of the time (featured on Marvin Gaye's 'Sexual Healing', The Beastie Boys 'Licensed to ill' , ABC's "The Look of Love')

https://www.youtube.com/watch?v=yJfSGxJH4U

1984 – ROLAND TR-909.

Successor to the TR-808, uses analogue synthesis combines with digital cymbals to produce its drum sounds

https://www.youtube.com/watch?v=ydCDro4YerY

1988 – AKAI MPC60

A collaboration with Roger Linn which saw in a successful era of the ever popular series of drum machines (MPC series). The MPC60 was a fully programmable digital drum machine that included pads to help with programming. This series is popular with electronic artists and hip hop producers

https://www.youtube.com/watch?v=ICIBQNz0Ai8

Akai today…
https://www.youtube.com/watch?v=AHdouFZ6FCs

EARLY 1990S – ROLAND V-DRUMS.

Pioneered the electric drum kits using midi to triggers drum and percussion samples.

https://www.youtube.com/watch?v=eCbt2WVnGtM

STARTER

- ❑ Get out your C2 composition PLANNING DOCUMENT AND LISTENING
- ❑ Collect your written work on my desk
- ❑ The picture is a device that has been used on many Pop music records of 80s. Explain the functionality of this device.

Today's lesson

Aims and objectives

- Review the sampling requirements for C2
- Understand the assessment grid
- Explore sampling techniques
- Build a sample instrument using the EXS24
- Assign pitch mapping and tuning zones

What is a sampler?

Hardware

- A sampler plays back AUDIO files, called *SAMPLES*
- The samples are combined into tuned, organised collections called *SAMPLE INSTRUMENTS*
- *Samplers* have similar parameters to synthesizers, however, the sound generator plays back audio files(not an oscillator), which makes it suitable for emulating REAL INSTRUMENTS such as strings(violins, cellos etc), piano, drums etc.
- There are hardware and software versions of samplers e g AKAI MPC range are popular hardware samplers and NI Kontakt is a third party software sampler used in DAW
- A sampler is limited by the amount of STORAGE(hard drive space)a device has. Early models of hardware(and software) samplers relied on RAM. However, new tech can access content directly from the HD
- There are companies that just manufacture sample libraries to load in a dedicated sampler e.g EastWest Hollywood Orchestra 680GB of samples

Software

Component 2

Identify 3 ways to manipulate audio in Logic Pro X without using a sampler

Non-destructive editing
Using audio editing tools
-Cut
-Delete
-Move
-Fade in/out(Speed up/Slow down
Destructive editing
-Reverse
-Normalise
-Gain
-Time Stretch/Pitch Shift
Flex
-Flex Pitch
-Flex Time

Assessment grid 2

Sampling – using short audio files to develop new sonic elements, including manipulation of stimulus samples; pitch-mapping, cutting/trimming, looping.

Level	Mark	Create and edit sounds-sampling
	0	No rewardable material
Level 1	1–2	• Limited use of sampling techniques • Sample use is ineffective and does not make a significant contribution to the piece overall
Level 2	3–4	• Inconsistent use of sampling techniques • Sample use is evident but with some misjudgements
Level 3	5–6	• Competent use of a range of sampling techniques • Sample use is evident and makes a positive contribution to the piece overall
Level 4	7–8	• Excellent use of a range of sampling techniques throughout • Samples have been used creatively with a high level of skill and control to develop an original sonic palette

Introducing logic's sampler
EXS24 MKII

Creating a sample instrument

- Control Click(or right click) on the audio region/s you want to add to your sampler
- Select Convert Regions to New Sampler Track
- 2 choices- Regions or Transient Markers(Region will assign the entire region to 1 note trigger. Transient will split the region across several notes by detecting the transients of the audio(good for drum sampling)
- Select the trigger note(C-2 is low change to C3 or C4)
- A new track is created with a midi region and the trigger note

Your instrument is created but there's nothing amazing yet and no sampling marks will be awarded. Time to set zones and pitch map

Exploring your newly created instrument

- Double click on the EXS24 on your channel strip
- On the Parameter window click the Edit button-The EXS24 instrument editor opens.
- Set the zone range by click and dragging the sample across an octave of the keyboard. This maps the sample across multiple pitches(i.e. pitch mapping)
- Trigger your sample and hear the difference. The sample changes in pitch and speed.
- You can tune your sample with the Coarse(semitones) and Fine(cents) tuning parameters

Creating a sample instrument using audio regions

COMPONENT 2 SAMPLE NUMBER 1-VOCAL SAMPLE

Task 1-Single Zone

- Import 8M10 01 sample into by dragging the file into Logic-this is your first sample for Component 2
- Add a new software instrument and open a EXS24 sampler
- On the EXS24 front panel click the EDIT button
- A EDIT window pops up, drag the audio region from your arrange window into the EXS24 EDIT window. This creates a single zone sample instrument mapped across the keyboard
- Play your new sampler instrument and listen to the results.

Task 2-Multiple Zone

- Press T(for tools) and select the Scissor tool
- Alt-click on the region, this should cut the region up in ¼ note(crotchet) lengths
- Select all the new regions and right click(control-click) and choose Convert>Convert to New Sampler Track in the pop up menu
- Change the trigger note range to C3 and OK
- Each region is now assigned to a specific note starting at C3

Creating Loop Points

THE SAMPLER CHALLENGE

- Looping in samplers is a technique used to create a sustaining sound when you hold down a trigger
- Click on the View Menu and select View All
- Select the Loop on function
- You can select the start and end time, however, it is easier and more precise using your sample editor using your
- Click on your audio file in the sampler and choose open Sample Editor
- Select the portion you want to loop and ensure Snap Edits to Zero Crossing is selected to avoid audio clicks
- For a smoother edit make sure Xfades in ticked.

Creating a sample instrument using audio regions

COMPONENT 2 SAMPLE NUMBER 1-VOCAL SAMPLE

Task 1-Single Zone

- Import 8MT0 01 sample into by dragging the file into Logic-this is your first sample for Component 2
- Add a new software instrument and open a EXS24 sampler
- On the EXS24 front panel click the EDIT button
- A EDIT window pops up, drag the audio region from your arrange window into the EXS24 EDIT window. This creates a single zone sample instrument mapped across the keyboard
- Play your new sampler instrument and listen to the results.

Task 2-Multiple Zone

- Press T(for tools) and select the Scissor tool
- Alt-click on the region, this should cut the region up in ¼ note(crotchet) lengths
- Select all the new regions and right click(control-click) and choose Convert>Convert to New Sampler Track in the pop up menu
- Change the trigger note range to C3 and OK
- Each region is now assigned to a specific note starting at C3

	example of a sampling drum machine (Max 1) As RAM increased (1) in the late 1980's sampling synthesisers (1) appeared. These synthesisers gave more realistic sounds than previous synthesisers (1). **Award an example of a sampling synthesiser (max 1).** In the 1980's and 1990's samplers were hardware (1) units. **Award any example of hardware (max 1).** Storage was initially on floppy discs (1), and later on external hard-drives (1) and CD ROM (1). These were normally SCSI devices (1). Editing waveforms was difficult (1) because of the small displays (1). Polyphony was often limited (1). In the latter half of the 1990's sampling moved onto the PC/computer (1) as plug-ins etc (1) **(award any example (max 1))** because computers had enough processing power (1) and enough RAM (1). Digital audio is now stored on hard drives (1) so sample time is virtually limitless (1). The advantages are: better sound quality because more layered (1) and velocity sensitive samples (1); large screen/GUI (1) makes it easier to edit samples (1). Sample edit window (1). Sampling plug-ins are normally supplied with sequencing software (1). Samples are often found on CD ROM sample libraries (1) and increasingly on the internet (1). Samplers usually have the same controls as a synthesiser (1), for example, filters (DCF) (1), envelope/ADSR (1), LFO/modulation (1). **Max 3 for discussion of synthesis.** In late 1990's/2000's, because processing power had improved (1), timestretching (1) became a common feature. This is when the length of the sample can be changed without changing the pitch (or vice versa)(1). In 2000's, phrase samplers (1) sampled entire phrases of a performance (1) allowing performers to build up looped textures of themselves playing multiple parts (1). **Award an example of a phrase sampler.**	