	Fruit Machines	*Lesson Plan*
Activity		*Notes* T: Teacher P: Pupil
1	**Introduction** T: Describe how fruit machines work T: Can you win? T: Here is a fruit machine with 3 DIALS and with 20 SYMBOLS on each dial. Each of the 20 symbols is equally likely to occur on each dial. T: What is the probability of obtaining a GRAPE on DIAL 1 ? $(\frac{7}{20})$ T: What is the probability of obtaining a GRAPE on DIAL 2 ? $(\frac{2}{20})$ T: What is the probability of obtaining a GRAPE on DIAL 3 ? $(\frac{3}{20})$ T: You only win with certain combinations of DIALS and SYMBOLS. T: What is the probability of getting 3 GRAPES (that is, a grape on each of the three symbol dials)? Who can show us on the board? $(\frac{7}{20}\times\frac{2}{20}\times\frac{3}{20}=\frac{42}{8000})$	Build on Ps descriptions and their ideas on winning. Show OS1a and also give copy to each P (or pair of Ps). Show OS1b. P at board gives calculations. Agree/disagree.
2	**Winning combinations** T: Now it's your turn. First work out the probability of obtaining 3 BARS. T: Who would like to show this on the board? $(\frac{2}{20}\times\frac{1}{20}\times\frac{1}{20}=\frac{2}{8000})$ T: How can we easily find all the relevant probabilities? *(Complete a frequency chart)* T: Now complete the frequency chart. T: Now find all the winning probabilities. T: Now let's complete the probability table. T: Let's check 3 STRAWBERRIES and 3 APPLES. What about 2 BARS? You need to consider 3 solutions. $(\frac{2}{20}\times\frac{1}{20}\times\frac{19}{20}+\frac{2}{20}\times\frac{19}{20}\times\frac{1}{20}+\frac{18}{20}\times\frac{1}{20}\times\frac{1}{20}=\frac{94}{8000})$ T: 2 CHERRIES $(\frac{2}{20}\times\frac{7}{20}\times\frac{20}{20}=\frac{280}{8000})$	Give the class a few minutes to work these out; checking and praising. Copy of OS2 to each P (or pair) and also put on board. Allow a few minutes before checking the chart; get Ps to put values on board. 3 STRAWBERRIES and 3 APPLES are straightforward $(\frac{56}{8000}$ and $\frac{64}{8000})$. Discuss with class if there are problems. Check, revise and ensure that Ps have understood.

3	**Expected gains** T: Each game on the fruit machine costs 10 p. Can we work out whether we are likely to win or lose our money? T: Our expected winnings (in 10 pences) will be $40 \times p(3\text{ BARS}) + 5 \times p(3\text{ STRAWBERRIES}) + \ldots\ 5 \times p(2\text{ CHERRIES}) - 1$ Using your probabilities, do this calculation. T: Answer *($0.48 \Rightarrow -4.8\text{ p}$ $0.48 \Rightarrow -4.8\text{ p}$)* T: What does this mean? *(On average, we will lose 4.8 p per game)*	Discuss with Ps to see what they think and if possible, get to the concept of 'expectation'. Give Ps the chance to obtain answer. Agree/disagree? Discussion on how generous this is. Compare to National Lottery.
4	**Extension** Design your own fruit machine, work out the probabilities of certain combination, assign payouts and check whether the player expects to gain or lose money.	Set as homework.

3	**Working with large and small numbers** T: Very large numbers often have many zeros; for example One million = 1 000 000 One billion = 1 000 000 000 In order to write these numbers in a more compact form we adopt the scientific notation or standard index form. This means writing the number as a power of 10. 100 10×10 10^2 1000 $10 \times 10 \times 10$ 10^3 1 000 000 $10 \times 10 \times 10 \times 10 \times 10 \times 10$ 10^6 Use the following tasks as a mental activity Write the following as powers of 10.	T can ask Ps to write these numbers on the board (quickly). Either: volunteer Ps can fill in the powers on tables prepared previously by T on the board or OS, describing aloud what they are writing; or: these can be mental activities.

Number	Powers of 10
10	
10 000	
100 000 000	
1 000 000 000	

Write these powers of 10 as ordinary numbers.

Number	Powers of 10
	10^5
	10^7
	10^{10}

What do you think we mean by 10^0?

This will probably need to be discussed and explained.

We've seen how to deal with large numbers – how do you think we deal with numbers that are very small?

Number	Powers of 10
0.01	
0.0001	
0.000001	
0.000000001	

4	**Definition of Logarithms** T: Logarithms are just an alternative method of writing down numbers, especially very large or very small numbers of the type you have just been working with. The simplest logarithms are those based on the powers of the number 10. The logarithm of 100 = 10^2 is 2; the logarithm of 100000 = 10^5 is 5 and so on. The logarithm is written as $\log_{10} 100 = 2$ etc. *Set Question 1 on the worksheet (without a calculator)* *Answers to Question 1* $\log_{10} 1000 = 3$; $\log_{10} 1000000 = 6$ $\log_{10} 0.001 = -3$ $\log_{10} 0.1 = -1$ $\log_{10} 1 = 0$ **Working with logarithms and the calculator** T introduces the log button (key) on the calculator. This may depend on the type of calculator that pupils have. T demonstrates how to use the log button by repeating the tasks on the Question 1 of the worksheet. T explains that whereas we do not need a calculator to find the logarithms of powers of 10, for other number we do. *Set Question 2 on the worksheet (with a calculator)* *Answers to Question 2* $\log_{10} 152 = 2.181844$ $\log_{10} 467 = 2.669317$ $\log_{10} 1\,132\,567 = 6.054064$ $\log_{10} 1\,995\,262 = 6.300000$ $\log_{10} 17 = 1.230449$ $\log_{10} 0.00145 = -2.838632$	Stress the importance of a universal notation for mathematics. Individual work, monitored. Class agrees/disagrees. Mistakes discussed and corrected. Individual work, monitored. Class agrees/disagrees. Correct answers praised. Mistakes discussed and corrected.
5	**Logarithms and the Richter Scale** T: We'll return to earthquakes. We know that an earthquake of magnitude 5 on the Richter Scale is 10 times stronger than an earthquake of magnitude 4 because 10^5 is 10 times larger than 10^4. What about an earthquake with magnitude 4.7 on the Richter Scale? How much stronger is it than an earthquake of magnitude 4? The challenge now is to find the number when the logarithm is not an integer. For example, using the log key on the calculator helped us to work out that $\log_{10} 467 = 2.669317$. But suppose we started with 2.669317, how do we find x so that $\log_{10} x = 2.669317$.	Discuss this in pairs for a short time. Feedback and praise any good insight.

6	T: The clue is that logarithms are related to powers of 10. So to recap: $\log_{10} 100 = \log_{10} 10^2 = 2$ $\log_{10} 10\,000 = \log_{10} 10^5 = 5$ $\log_{10} 100\,000\,000\,000 = \log_{10} 10^{11} = 11$ and going backwards $2 = \log_{10} 10^2$ $5 = \log_{10} 10^5$ $11 = \log_{10} 10^{11}$ so $2.669317 = \log_{10} 10^{2.669317}$ Using a calculator, $10^{2.669317} = 467.000128$ (not exactly 467 because of the rounding error) Now we can apply these ideas to earthquakes. An earthquake of magnitude 4.7 comes from $\log_{10} 10^{4.7}$ and $10^{4.7} = 50\,118$. and $10^4 = 10\,000$. The earthquake is 5 times stronger than an earthquake of magnitude 4 on the Richter Scale. *Set Question 3 on the worksheet (with a calculator)* *Answers* (a) The 1995 Kobe earthquake: 15.8 (b) The 1999 Turkish earthquake: 7.9 (c) The 2005 Pakistan earthquake : 39.8	Individual work, monitored. T asks individual Ps for answers; other Ps agree or give their own responses. Discussion and agreement.
Home work	Set Question 4 for homework.	