Date_____ Time_____ Location_____ Casino_____

Name of machine_____ Program Number_____ Line (1 3 5 8), TM or NTM, Buy-a-Pay

1) Beginning Credits_____ Ending Credits_____ Credits Won or Lost_____ Denomination_____

Maximum Coins Played_____ Maximum Payout_____coins

(Each box contains the **hit amount / coins played**. A "✓" means nothing was won for that spin.)
Fill in the chart for each play. When a hit occurs, write the **hit amount / coins played** in each box.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	total

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	total

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	total

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	total

2) Total spins (From above chart - must be 100).

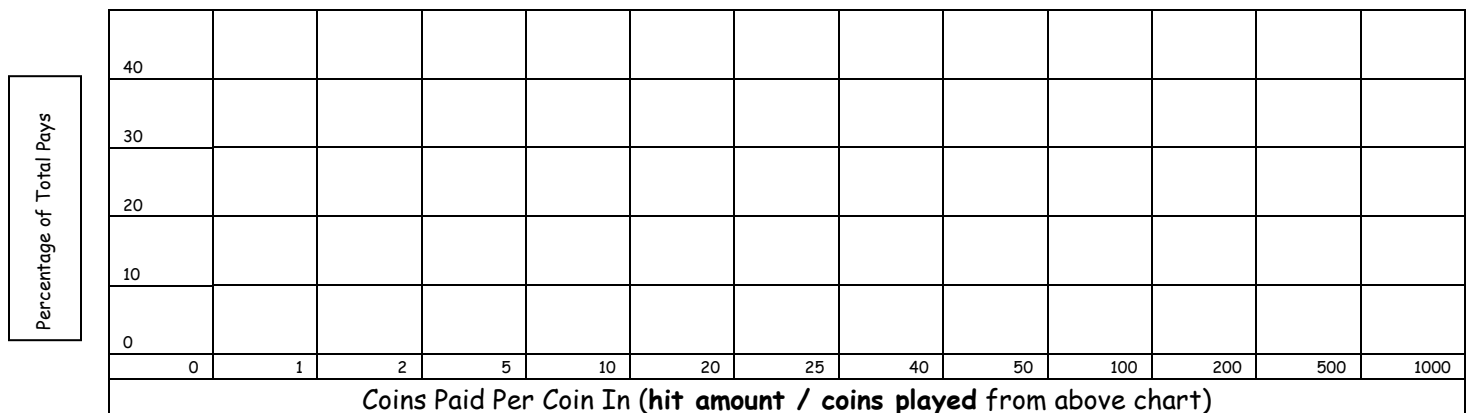3) Total number of "hits" where a payout occurred_____(**number of filled boxes** from above chart).

4) Hit frequency_____% (Value from **3**). *This is a term used to describe the average frequency at which winning game outcomes will occur on a gaming machine. It is calculated by dividing the number of individual hits, or winning games, by the number of possible game outcome combinations. A hit frequency of 21% means 21 hits out of 100 spins (1 hit sometime during approximately 5 spins.) Only after many thousands of spins will the actual hit frequency begin to approximate the (theoretical) hit frequency of the game.*

5) Win frequency (reciprocal of **4**), this is spins with a hit occurring _____. *Theoretical number of plays between pays. Cycle ÷ number of combinations involving a pay = win frequency. A hit frequency of 21 out of 100 (see above) means that the win frequency is (100/21) or possibly 4.762 spins that will occur with at least one win during those spins. Results DO NOT OCCUR WITH REGULARITY! Like the explanation above, there could be many spins before any hit occurs. After many thousands of spins, this number approaches the theoretical amount.*

6) List the number of each **hit amount / coins played** for x-axis values: 1s, 2s, 5s, 10s, 20s, 25s, 40s, 50s, 100s, 200s, 500s, 1000s; then calculate the percentage by dividing this value by the number of "hits". Multiply by 100.

1s=	2s=	5s=	10s=	20s	25s	40s=	50s=	100s=	200s=	500s=	1000s=
%	%	%	%	%	%	%	%	%	%	%	%

Total the **percentages of total pays** for the x-axis values. It will most likely be less than 100%._____(This is your percent payback, crudely calculated.)

Percentage of Total Pays (y-axis: 0, 10, 20, 30, 40) vs. Coins Paid Per Coin In (**hit amount / coins played** from above chart) (x-axis: 0, 1, 2, 5, 10, 20, 25, 40, 50, 100, 200, 500, 1000)

7) Variance (see the next page for definitions and the calculations)_____.

Machine_____ Date_____ Time_____

Hit amount / coins played (coins paid per coin in), smallest to largest, from above chart. This is the "**x**" value for the next calculation.

_____, _____, _____, _____, _____, _____, _____, _____, _____,

_____, _____, _____, _____, _____, _____, _____, _____, _____,

_____, _____, _____, _____, _____, _____, _____, _____, _____,

_____, _____, _____, _____, _____, _____, _____, _____, _____,

_____, _____, _____, _____, _____, _____, _____, _____, _____,

_____, _____, _____, _____, _____, _____, _____, _____, _____,

_____, _____, _____, _____, _____, _____, _____, _____, _____,

lower extreme:_____ lower quartile:_____ median:_____ upper quartile:_____ upper extreme:_____

N (total number of "hits", line 3): _____

Range (largest **x** minus smallest **x** plus 1): _____

Mean (total of all "hit amounts", **x** divided by N): _____

Median (middle of numbers): _____

Mode (frequency of occurrence of a certain **x**): _____

Find the mean (average) of the data set, A. Find the *deviation from the mean (x – A)*. *Square* these numbers, these are called the *squared deviations*. Find the average of the squared deviations, this is *variance V*. Calculate the **standard deviation** (lower case sigma) by taking the square root of the variance ($\sigma = \sqrt{V}$). Calculations are performed on the next page.

total number of hits (N)	Average (A)	x – A	$(x – A)^2$

V = total / N, this is the variance for the slot machine in question, a low variance (less than or equal to 10) is generally a high hit frequency machine. A high variance (greater than 10, less than 20) is a low hit frequency machine. A very high variance (greater than 20) is a very low hit frequency machine.   The variance is a figure that represents how far the data in your sample is clustered around the mean. Variance is in squared units. This figure will give you an idea of how far your data is spread out. Samples with low variance have data that is clustered closely about the mean. Samples with high variance have data that is clustered far from the mean. Variance is normally too large to deal with in statistics, but it is perfect here when discussing slot machine operations.

$\sqrt{V} = \sigma$, this is the standard deviation. The positive square root of variance is the standard deviation. Standard deviation is in linear units. **SD** is a measure that is used to quantify the amount of variation or dispersion of a set of data values. A low standard deviation indicates that the data points tend to be close to the mean (also called the expected value) of the set, while a high standard deviation indicates that the data points are spread out over a wider range of values. (When mean, mode and median are close to one another, it is said there is a "strong measure of central tendency.") The closer the SD is to zero, the less volatile the game is.

34.1% of all values will fall above and below the mean (68.2% total) **one standard deviation away** in a large sample. (13.6% fall above and below the mean **two standard deviations** away, 27.3% total. 2.1% fall above and below **three standard deviations** away, 4.2% total. Finally, 0.1% fall above and below **four standard deviations** away, 0.2% total. This forms nearly 100% of all numbers under a curve and is a typical Bell Curve.) **SD** describes how close the population is to the mean. It is a conveniently small enough number to discuss this variation. To calculate the volatility index (VI), multiply the SD by 1.65.

Hit amount / coins played (x)	Average (A)	(x – A)	$(x - A)^2$
			Total =
			Total / N = (V) =
			√V = σ =

largest hit amount ------------------------------ smallest hit amount

Date_____ Time_____ Location_____ Casino_____

Name of machine_____ Program Number_____ Line (1   3   5   8), TM or NTM, Buy-a-Pay

1) Beginning Credits__80___ Ending Credits_279_ Credits Won or Lost__+199_ Denomination_25 cent_

Maximum Coins Played__3___ Maximum Payout__7500___coins

(Each box contains the **hit amount / coins played**. A "✓" means nothing was won for that spin.)
Fill in the chart for each play. When a hit occurs, write the **hit amount / coins played** in each box.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	total
15/3 5	15/3 5	✓	90/3 30	✓	✓	30/3 10	✓	✓	✓	✓	✓	✓	✓	15/3 5	✓	✓	15/3 5	✓	6/3 2	✓	15/3 5	60/3 20	✓	✓	

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	total
30/3 10	✓	15/3 5	✓	15/3 5	✓	✓	✓	✓	15/3 5	✓	✓	15/3 5	15/3 5	✓	15/3 5	15/3 5	✓	6/3 2	6/3 2	✓	✓	15/3 5	✓	✓	

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	total
✓	✓	✓	90/3 30	✓	✓	✓	✓	✓	✓	✓	15/3 5	✓	15/3 5	6/3 2	6/3 2	✓	✓	✓	30/3 10	60/3 20	6/3 2	✓	✓	15/3 5	

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	total
✓	✓	✓	✓	✓	✓	✓	✓	✓	15/3 5	15/3 5	✓	✓	✓	90/3 30	✓	6/3 2	15/3 5	✓	✓	30/3 10	✓	✓	✓	✓	

2) Total spins (From above chart - must be **100**).

3) Total number of "hits" (**N**) where a payout occurred____35_____(**number of filled boxes** from above chart).
4) Hit frequency____35_____% (Value from **3**).

5) Win frequency (reciprocal of **4**), this is spins per hit__2.86___.

6) List the number of each **hit amount / coins played** for x-axis values: 1s, 2s, 5s, 10s, 20s, 25s, 40s, 50s, 100s, 200s, 500s, 1000s; then calculate the percentage by dividing this value by the number of "hits". Multiply by 100.

1s=	2s= 7	5s= 19	10s= 4	20s= 2	30s= 3	40s=	50s=	100s=	200s=	500s=	1000s=
	20%	54%	11%	5%	8%	%	%	<<1%	%	%	<<1%

Total the **percentages of total pays** for the x-axis values. It will most likely be less than 100%.___98___(This is your percent payback, crudely calculated.) The 100s and 1000s are from the Paytable and Reel Strips estimates.

7) Variance____48.39_____. Some games can present long dry spells with occasional big wins (**lower hit frequency**). Likewise, these games can often feature a large number of big wins in a short period of time. These are known as high volatility or high variance slots. The opposite is true of low volatility slots. In those games, you'll score winning paylines frequently (**higher hit frequency**), but more often than not, the payouts will be on the smaller side. Because volatility can be crudely determined through play, it's recommended to play and record your wins with the above charts. Another way to have at least some idea of volatility is to look at the game's paytable. If really high prizes are offered, that's a sign that the game is medium-to-high volatility. This is because it's certainly not going to award these huge prizes frequently. A high-volatility machine will have a low hit frequency. Volatility is a measurement of the spread between numbers in a data set. The variance measures how far each number in the set is from the mean. The volatility index (VI) is calculated by taking the standard deviation and multiplying it by 1.65. 1.65 standard deviations (+/-), (from a Bell Curve) is used to reach 90% of all data game payouts. Remember, 68% are within 1 SD, 95% are within 2 SD, and 99% are within 3 SD. So, 90% are 1.65 SD above and below. The 90% tells us that 90% of all the data (paying combinations) will occur within the above 1.65 SD from the mean.

Machine_____ Date_____ Time_____

Hit amount / coins played (coins paid per coin in), smallest to largest, from above chart. This is the "**x**" value for the next calculation.

2, 2, 2, 2, 2, 2, 2, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 10, 10, 10, 10, 20, 20, 30, 30, 30

lower extreme: 2, lower quartile: 5, median: 5, upper quartile: 5, upper extreme: 30

N (total number of "hits", line 3): 35

Range (largest **x** minus smallest **x** plus 1): 29

Mean (total of all "hit amounts", **x** divided by N): 279 / 35 = 7.97

Median (middle of numbers): 5

Mode (frequency of occurrence of a certain **x**): 5

Find the mean (average) of the data set, A. Find the *deviation from the mean (x – A)*. *Square* these numbers, these are called the *squared deviations*. Find the average of the squared deviations, this is *variance V*. Calculate the **standard deviation** (lower case sigma) by taking the square root of the variance ($\sigma = \sqrt{V}$). Calculations are performed on the next page.

total number of hits (N)	*Average (A)*	*x – A*	*(x – A)^2*
35	7.97	(see next **Sample Calculations** page)	

Sample Calculations

	Hit amount / coins played (x)	Average (A)	(x – A)	(x – A)²
-----smallest hit amount --------------------------------------	2	7.97	-5.97	35.64
	2	7.97	-5.97	35.64
	2	7.97	-5.97	35.64
	2	7.97	-5.97	35.64
	2	7.97	-5.97	35.64
	2	7.97	-5.97	35.64
	2	7.97	-5.97	35.64
	5	7.97	-2.97	8.82
	5	7.97	-2.97	8.82
	5	7.97	-2.97	8.82
	5	7.97	-2.97	8.82
	5	7.97	-2.97	8.82
	5	7.97	-2.97	8.82
	5	7.97	-2.97	8.82
	5	7.97	-2.97	8.82
	5	7.97	-2.97	8.82
	5	7.97	-2.97	8.82
	5	7.97	-2.97	8.82
	5	7.97	-2.97	8.82
	5	7.97	-2.97	8.82
	5	7.97	-2.97	8.82
	5	7.97	-2.97	8.82
	5	7.97	-2.97	8.82
	5	7.97	-2.97	8.82
largest hit amount -----------------------	5	7.97	-2.97	8.82
	10	7.97	2.03	4.12
	10	7.97	2.03	4.12
	10	7.97	2.03	4.12
	10	7.97	2.03	4.12
	20	7.97	12.03	144.72
	20	7.97	12.03	144.72
	30	7.97	22.03	485.32
	30	7.97	22.03	485.32
				Total = 1693.62
				Total / N = (V) = 48.39
				√V = σ = 6.96

The variance for the slot machine in question is 48.39. A low variance (10 or below) means a machine generally is a high hit frequency machine. A high variance (above 10) means a machine generally is a low hit frequency machine. This would not be a good machine to play. The largest payoff for this one is 7500 credits. One might win smaller amounts occasionally and then maybe a larger win. This is a stubborn machine to play at. Keep in mind that this is a sample space of only 100.

The standard deviation for this same slot machine is 6.96. This number is the square root of the above number. It is a bit smaller, since it is the positive root. (On a graph, the typical Bell Curve would be represented by all of the hit amounts clustered above and below the mean at 1 σ * ∓ 6.96, 34.1%; 2 σ * ∓ 6.96, 13.6%; 3 σ * ∓ 6.96, 2.1%; and 4 σ * ∓ 6.96, 0.1%.)

The volatility index is 6.96 * 1.65 = 11.484. VI is calculated on a basis of 10,000 games (industry standard). If the payout percentage is 98.00% (from our example above), then add and subtract the VI to get a range (98.00 - 11.484 = 86.516; 98.00 + 11.484 = 109.484). This number can vary from machine to machine. Here, 98.00% for the above example, is accurate for the player only after many thousands of spins, not the 100 we crudely calculated. We can expect reasonably, that the machine will pay out somewhere between 86.516% to 109.484% after 10,000 games. Examine the PAR sheets for the percent payback for the machine in question. It will range from 75% to 97% depending on the program number on the chip located on the mother board inside a particular slot machine. Look the program number up on the PAR sheets from the manufacturer to obtain the payback percentage. Then, add or subtract from this percentage to get the payout range for the 10,000 game sample space.

-4   -2   0   2   4
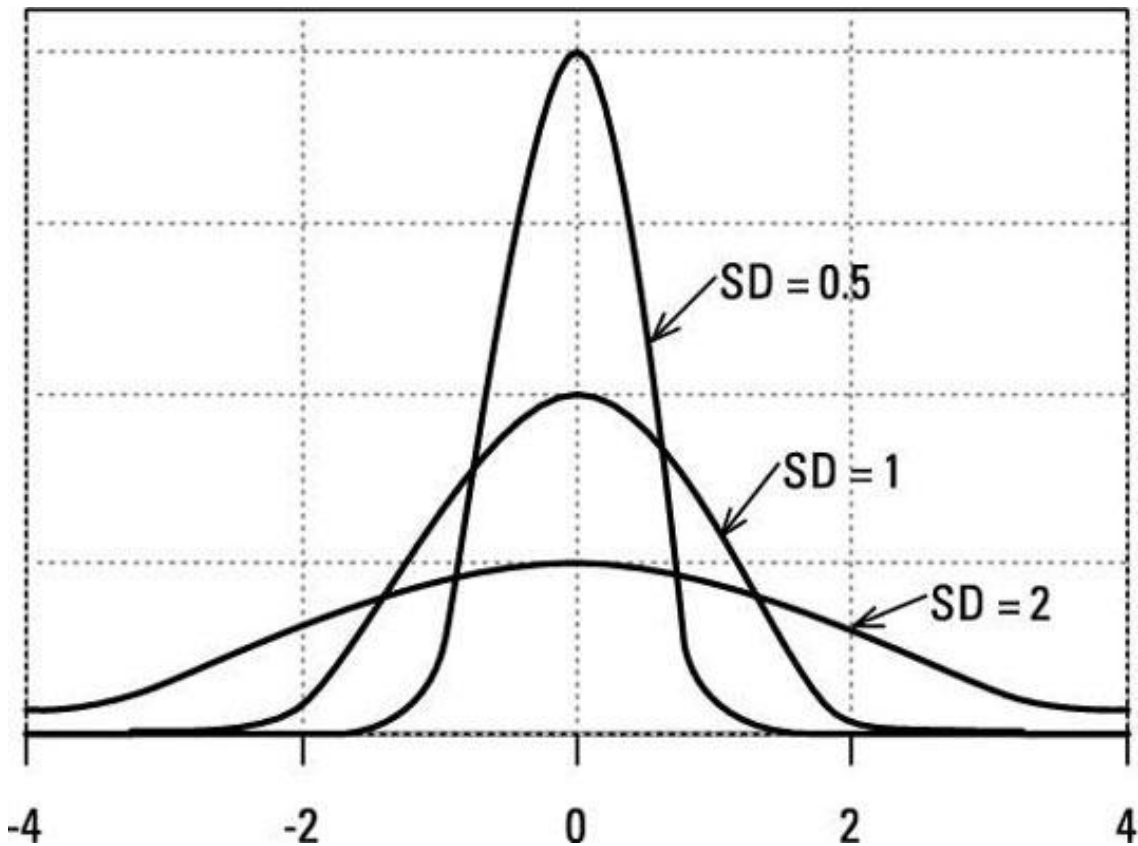
The graph shows low standard deviation (SD=0.5), normal standard deviation (SD=1), and high standard deviation (SD=2). Notice how "spread out" the curve becomes as standard deviation gets larger. Now remember, variance is the square of standard deviation. The graph shape for variance would differ very little from what is shown here.
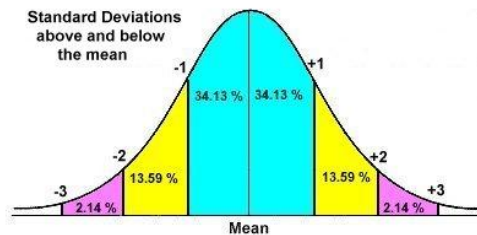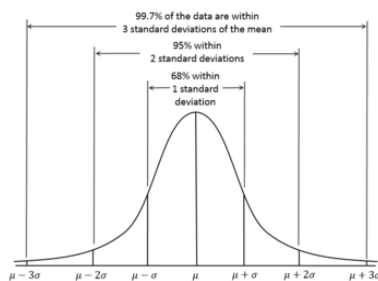
Slot machine results would fall within the curves shown above. This would happen quite reliably after many millions of spins.

Brown - penny
Red – nickel
Green – dime
Yellow – quarter
Orange/Gold – half dollar
Blue – one dollar
Purple – five dollar

Three types of machines to look for:
1. Line (1, 3, 5 and 8)
2. Multiplier (true multiplier or near-true multiplier)
3. Buy-a-Pay

Play at a true or near true multiplier (TM or NTM). (Look carefully for these machines. You do NOT need to play MAX COIN when using them. Your ratio of losses to wins will always be the same. Hence, you can play longer.) Play at a flat top machine (there will be no meter at the top). Play at an upright console. Play at a machine with a maximum payoff of 3000 coins or less.

Play at a quarter, half dollar or one dollar machine. Play at a machine that is first, second, or third from either end of a row of machines. Play the maximum coins possible, unless it is a TM or NTM machine. Play at machines that only use 2 or 3 coin maximums. Play the stand-alone machine if it is a local area progressive (LAP).

Stop playing at a machine if no wins in 5 spins. Stop playing when the machine you have been playing for awhile is in a quiet period (no pays have occurred for at least 10 spins.)

Avoid the penny, nickel and dime machines. Avoid the machines in a middle of a row. Avoid the "life altering jackpot" machines (the wide area progressives – WAPs). Someone will win the jackpot. Most likely, it will NOT be you. If you do play one of these machines, ALWAYS play the maximum number of coins.

Pay attention to the performance of this game. Watch for quiet periods. This will indicate the machine is in its sinusoidal downturn mode. It will take many spins (200 to 300 or so, or at least 30 minutes) to come back up to an active period. Remember, the machine is not truly random, but pseudo-random. It is somewhat predictable, but only after many, many spins.

Four machine types to look for:
1. Low hit frequency and low payback - does not hit often, does not pay back well, (1 cent, 5 cent, dime machines, possibly at the airport or near table areas)
2. High hit frequency and low payback - hits often with many small wins, (1 cent, 5 cent, dime machines, possibly with many other slots of these types near buffet lines and show queues)
3. Low hit frequency and high payback - does not hit often, but when it does, the payouts are substantial, (25 cent, 50 cent and dollar machines, large coin payouts, with more than 3000 credits, and possible wide area progressives near entrances and hotel check-ins)
4. High hit frequency and high payback - hits often and with large wins, (25 cent, 50 cent, dollar and video poker machines, flat tops with 3000 credits or less as top payout scattered about the casino near restaurants, elevators, escalators and entrances/exits)

Vocabulary:
low hit frequency (high volatility index or high variance) - hitting very seldom (1 out of 10 spins and above)
high hit frequency (low volatility index or low volatility) - hitting often (1 out of 5, 1 out of 4, 1 out of 3, 1 out of 2 or hitting every spin), this game would have a high win frequency (a few spins and then a win somewhere during those spins)
low payback (less than 90 percent returned to player)
high payback (90 percent or more returned to player)