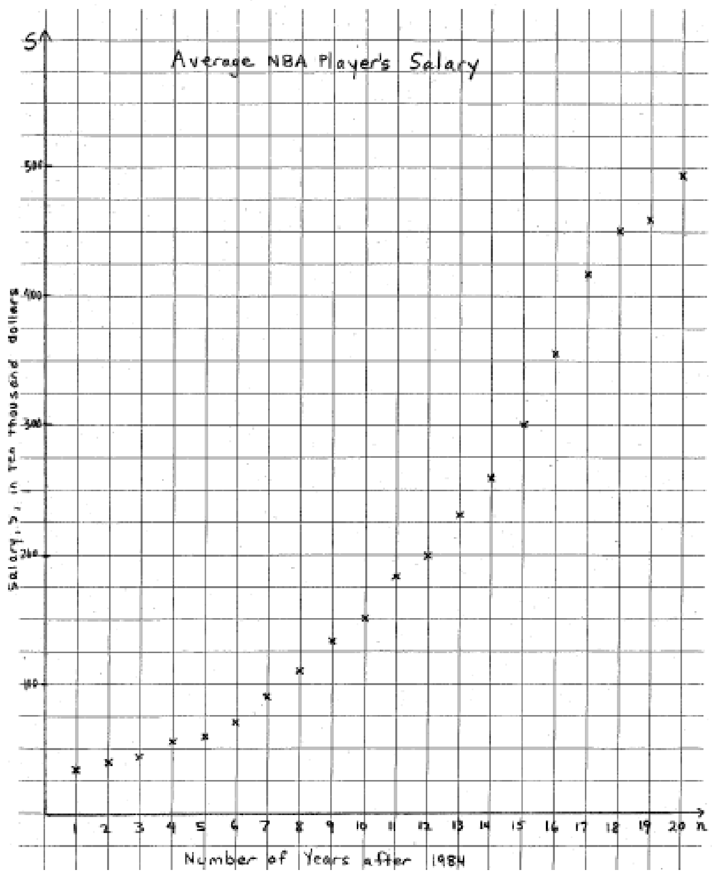
# Chapter 7 TASK: Escalating NBA Salaries

## Level 4 Sample Response

**1.** Approximate Average NBA Player's Salary for each season for the twenty-year period from 1984 to 2004

| **Season, *n*** | **Average Salary, *S*, ($)** |
|---|---|
| 1 | 330 000 |
| 2 | 382 000 |
| 3 | 431 000 |
| 4 | 502 000 |
| 5 | 575 000 |
| 6 | 717 000 |
| 7 | 927 000 |
| 8 | 1 100 000 |
| 9 | 1 300 000 |
| 10 | 1 500 000 |
| 11 | 1 800 000 |
| 12 | 2 000 000 |
| 13 | 2 300 000 |
| 14 | 2 600 000 |
| 15 | 3 000 000 |
| 16 | 3 600 000 |
| 17 | 4 200 000 |
| 18 | 4 500 000 |
| 19 | 4 546 000 |
| 20 | 4 917 000 |

**2.** Scatter plot of the data, created using paper and pencil.




**3.** To determine if the graph of the relation would be a linear relation and have a line of best fit, a quadratic relation and have a curve of best fit, or an exponential relation and have a curve of best fit, I calculated the first differences, the second differences, and the ratio of successive *y*-values for the table of values.

| **Season** | **Average Salary ($)** | **First Differences** | **Second Differences** | **Ratio of Successive *y*-values** |
|---|---|---|---|---|
| 1984-1985 | 330 000 | | | |
| 1985-1986 | 382 000 | 52 000 | | 1.158 |
| 1986-1987 | 431 000 | 49 000 | −3000 | 1.128 |
| 1987-1988 | 502 000 | 71 000 | 22 000 | 1.165 |
| 1988-1989 | 575 000 | 73 000 | 2000 | 1.145 |
| 1989-1990 | 717 000 | 142 000 | 69 000 | 1.246 |
| 1990-1991 | 927 000 | 210 000 | 68 000 | 1.293 |
| 1991-1992 | 1 100 000 | 173 000 | −37 000 | 1.187 |
| 1992-1993 | 1 300 000 | 200 000 | 27 000 | 1.182 |
| 1993-1994 | 1 500 000 | 200 000 | 0 | 1.154 |

| | | | | |
|---|---|---|---|---|
| 1994-1995 | 1 800 000 | 300 000 | 100 000 | 1.2 |
| 1995-1996 | 2 000 000 | 200 000 | −100 000 | 1.111 |
| 1996-1997 | 2 300 000 | 300 000 | 100 000 | 1.15 |
| 1997-1998 | 2 600 000 | 300 000 | 0 | 1.130 |
| 1998-1999 | 3 000 000 | 400 000 | 100 000 | 1.154 |
| 1999-2000 | 3 600 000 | 600 000 | 200 000 | 1.2 |
| 2000-2001 | 4 200 000 | 600 000 | 0 | 1.167 |
| 2001-2002 | 4 500 000 | 300 000 | −300 000 | 1.071 |
| 2002-2003 | 4 546 000 | 46 000 | −254 000 | 1.01 |
| 2003-2004 | 4 917 000 | 371 000 | 325 000 | 1.082 |

Since the first differences and the second differences are not constant, but the ratios of successive $y$-values are equal to one (to the nearest unit), therefore this is an exponential relation and will have a curve of best fit.

**3.** I used the following trial-and-error method to determine the equation of the exponential curve of best fit for data in question 2.

I first researched players' salaries for the year 1983 on the Internet using the website, http://www.nbpa.com/history.php. In this year the players and owners reached an unprecedented agreement to share League revenues and the average player salary for the National Basketball Association (NBA) for the year 1983 was about $275 000.

I then divided the salary from the table for the year 1984-1985 which was $330 000 by $275 000 and the result was 1.2. I used this value to predict that the possible equation of the exponential curve of best fit might be $y = 275\ 000(1.2)^x$. I then checked the curve for accuracy as follows in Trial 1.

**Trial 1** **Exponential Curve $y = 275\ 000(1.2)^x$**

| **Season** | ***x* (Year)** | **Average Salary, (*y*)** | ***y*** |
|---|---|---|---|
| 1984-1985 | 1 | 275 000 × 1.2 | 330 000.00 |
| 1985-1986 | 2 | 275 000 × 1.2^2 | 396 000.00 |
| 1986-1987 | 3 | 275 000 × 1.2^3 | 475 200.00 |
| 1987-1988 | 4 | 275 000 × 1.2^4 | 570 240.00 |
| 1988-1989 | 5 | 275 000 × 1.2^5 | 684 288.00 |
| 1989-1990 | 6 | 275 000 × 1.2^6 | 821 145.60 |
| 1990-1991 | 7 | 275 000 × 1.2^7 | 985 374.72 |
| 1991-1992 | 8 | 275 000 × 1.2^8 | 1 182 449.66 |
| 1992-1993 | 9 | 275 000 × 1.2^9 | 1 418 939.60 |
| 1993-1994 | 10 | 275 000 × 1.2^10 | 1 702 727.52 |
| 1994-1995 | 11 | 275 000 × 1.2^11 | 2 043 273.02 |
| 1995-1996 | 12 | 275 000 × 1.2^12 | 2 451 927.62 |
| 1996-1997 | 13 | 275 000 × 1.2^13 | 2 942 313.15 |
| 1997-1998 | 14 | 275 000 × 1.2^14 | 3 530 775.78 |
| 1998-1999 | 15 | 275 000 × 1.2^15 | 4 236 930.93 |
| 1999-2000 | 16 | 275 000 × 1.2^16 | 5 084 317.12 |
| 2000-2001 | 17 | 275 000 × 1.2^17 | 6 101 180.54 |
| 2001-2002 | 18 | 275 000 × 1.2^18 | 7 321 416.65 |
| 2002-2003 | 19 | 275 000 × 1.2^19 | 8 785 699.98 |
| 2003-2004 | 20 | 275 000 × 1.2^20 | 10 542 839.98 |

The salary for year 2003-2004 was more than double the salary for the year 2003-2004 in the table in question 1. I then decided to lower the value of the base in the exponential equation as follows, with the new equation $y = 275\ 000(1.19)^x$.

| **Trial 2** | | **Exponential Curve $y = 275\ 000(1.19)^x$** | |
|---|---|---|---|
| **Season** | **$x$ (Year)** | **Average Salary, ($y$)** | **$y$** |
| 1984-1985 | 1 | 275 000 × 1.19 | 327 250.00 |
| 1985-1986 | 2 | 275 000 × 1.19^2 | 389 427.50 |
| 1986-1987 | 3 | 275 000 × 1.19^3 | 463 418.73 |
| 1987-1988 | 4 | 275 000 × 1.19^4 | 551 468.28 |
| 1988-1989 | 5 | 275 000 × 1.19^5 | 656 247.26 |
| 1989-1990 | 6 | 275 000 × 1.19^6 | 780 934.24 |
| 1990-1991 | 7 | 275 000 × 1.19^7 | 929 311.74 |
| 1991-1992 | 8 | 275 000 × 1.19^8 | 1 105 880.97 |
| 1992-1993 | 9 | 275 000 × 1.19^9 | 1 315 998.35 |
| 1993-1994 | 10 | 275 000 × 1.19^10 | 1 566 038.04 |
| 1994-1995 | 11 | 275 000 × 1.19^11 | 1 863 585.27 |
| 1995-1996 | 12 | 275 000 × 1.19^12 | 2 217 666.47 |
| 1996-1997 | 13 | 275 000 × 1.19^13 | 2 639 023.10 |
| 1997-1998 | 14 | 275 000 × 1.19^14 | 3 140 437.49 |
| 1998-1999 | 15 | 275 000 × 1.19^15 | 3 737 120.61 |
| 1999-2000 | 16 | 275 000 × 1.19^16 | 4 447 173.53 |
| 2000-2001 | 17 | 275 000 × 1.19^17 | 5 292 136.50 |
| 2001-2002 | 18 | 275 000 × 1.19^18 | 6 297 642.44 |
| 2002-2003 | 19 | 275 000 × 1.19^19 | 7 494 194.50 |
| 2003-2004 | 20 | 275 000 × 1.19^20 | 8 918 091.45 |

The salary for the year 2003-2004 was still too high, so I did another trial, Trial 3, with a new equation, $y = 275\ 000(1.18)^x$.

| **Trial 3** | | **Exponential Curve $y = 275\ 000(1.18)^x$** | |
|---|---|---|---|
| **Season** | **$x$ (Year)** | **Average Salary, ($y$)** | **$y$** |
| 1983-1984 | | 275 000 | |
| 1984-1985 | 1 | 275 000 × 1.18 | 324 500.00 |
| 1985-1986 | 2 | 275 000 × 1.18^2 | 382 910.00 |
| 1986-1987 | 3 | 275 000 × 1.18^3 | 451 833.80 |
| 1987-1988 | 4 | 275 000 × 1.18^4 | 533 163.88 |
| 1988-1989 | 5 | 275 000 × 1.18^5 | 629 133.38 |
| 1989-1990 | 6 | 275 000 × 1.18^6 | 742 377.39 |
| 1990-1991 | 7 | 275 000 × 1.18^7 | 876 005.32 |
| 1991-1992 | 8 | 275 000 × 1.18^8 | 1 033 686.28 |
| 1992-1993 | 9 | 275 000 × 1.18^9 | 1 219 749.81 |
| 1993-1994 | 10 | 275 000 × 1.18^10 | 1 439 304.78 |
| 1994-1995 | 11 | 275 000 × 1.18^11 | 1 698 379.64 |
| 1995-1996 | 12 | 275 000 × 1.18^12 | 2 004 087.97 |

| | | | |
|---|---|---|---|
| 1996-1997 | 13 | 275 000 × 1.18^13 | 2 364 823.81 |
| 1997-1998 | 14 | 275 000 × 1.18^14 | 2 790 492.09 |
| 1998-1999 | 15 | 275 000 × 1.18^15 | 3 292 780.67 |
| 1999-2000 | 16 | 275 000 × 1.18^16 | 3 885 481.19 |
| 2000-2001 | 17 | 275 000 × 1.18^17 | 4 584 867.80 |
| 2001-2002 | 18 | 275 000 × 1.18^18 | 5 410 144.01 |
| 2002-2003 | 19 | 275 000 × 1.18^19 | 6 383 969.93 |
| 2003-2004 | 20 | 275 000 × 1.18^20 | 7 533 084.52 |

The value for the year 2003-2004 was still too large, so I did another trial, Trial 4, as follows, using the exponential curve $y = 275\ 000(1.17)^x$.

| **Trial 4** | | **Exponential Curve $y$ = 275 000(1.17)$^x$** | |
|---|---|---|---|
| **Season** | ***x* (Year)** | **Average Salary, (*y*)** | ***y*** |
| 1984-1985 | 1 | 275 000 × 1.17 | 321 750.00 |
| 1985-1986 | 2 | 275 000 × 1.17^2 | 376 447.50 |
| 1986-1987 | 3 | 275 000 × 1.17^3 | 440 443.58 |
| 1987-1988 | 4 | 275 000 × 1.17^4 | 515 318.98 |
| 1988-1989 | 5 | 275 000 × 1.17^5 | 602 923.21 |
| 1989-1990 | 6 | 275 000 × 1.17^6 | 705 420.16 |
| 1990-1991 | 7 | 275 000 × 1.17^7 | 825 341.58 |
| 1991-1992 | 8 | 275 000 × 1.17^8 | 965 649.65 |
| 1992-1993 | 9 | 275 000 × 1.17^9 | 1 129 810.09 |
| 1993-1994 | 10 | 275 000 × 1.17^10 | 1 321 877.81 |
| 1994-1995 | 11 | 275 000 × 1.17^11 | 1 546 597.03 |
| 1995-1996 | 12 | 275 000 × 1.17^12 | 1 809 518.53 |
| 1996-1997 | 13 | 275 000 × 1.17^13 | 2 117 136.68 |
| 1997-1998 | 14 | 275 000 × 1.17^14 | 2 477 049.92 |
| 1998-1999 | 15 | 275 000 × 1.17^15 | 2 898 148.40 |
| 1999-2000 | 16 | 275 000 × 1.17^16 | 3 390 833.63 |
| 2000-2001 | 17 | 275 000 × 1.17^17 | 3 967 275.35 |
| 2001-2002 | 18 | 275 000 × 1.17^18 | 4 641 712.16 |
| 2002-2003 | 19 | 275 000 × 1.17^19 | 5 430 803.22 |
| 2003-2004 | 20 | 275 000 × 1.17^20 | 6 354 039.77 |

I then did Trial 5 using the equation, $y = 275\ 000(1.16)^x$.

| **Trial 5** | | **Exponential Curve $y$ = 275 000(1.16)$^x$** | |
|---|---|---|---|
| **Season** | ***x* (Year)** | **Average Salary, (*y*)** | ***y*** |
| 1983-1984 | | 275 000 | |
| 1984-1985 | 1 | 275 000 × 1.16 | 319000.00 |
| 1985-1986 | 2 | 275 000 × 1.16^2 | 370040.00 |
| 1986-1987 | 3 | 275 000 × 1.16^3 | 429246.40 |
| 1987-1988 | 4 | 275 000 × 1.16^4 | 497925.82 |
| 1988-1989 | 5 | 275 000 × 1.16^5 | 577593.96 |

| | | | |
|---|---|---|---|
| 1989-1990 | 6 | 275 000 × 1.16^6 | 670008.99 |
| 1990-1991 | 7 | 275 000 × 1.16^7 | 777210.43 |
| 1991-1992 | 8 | 275 000 × 1.16^8 | 901564.10 |
| 1992-1993 | 9 | 275 000 × 1.16^9 | 1045814.35 |
| 1993-1994 | 10 | 275 000 × 1.16^10 | 1213144.65 |
| 1994-1995 | 11 | 275 000 × 1.16^11 | 1407247.79 |
| 1995-1996 | 12 | 275 000 × 1.16^12 | 1632407.44 |
| 1996-1997 | 13 | 275 000 × 1.16^13 | 1893592.63 |
| 1997-1998 | 14 | 275 000 × 1.16^14 | 2196567.45 |
| 1998-1999 | 15 | 275 000 × 1.16^15 | 2548018.24 |
| 1999-2000 | 16 | 275 000 × 1.16^16 | 2955701.16 |
| 2000-2001 | 17 | 275 000 × 1.16^17 | 3428613.34 |
| 2001-2002 | 18 | 275 000 × 1.16^18 | 3977191.48 |
| 2002-2003 | 19 | 275 000 × 1.16^19 | 4613542.11 |
| 2003-2004 | 20 | 275 000 × 1.16^20 | 5351708.85 |

If the base is further reduced to 1.15, the average player salary for the year 2003-2004 would be 275 000 × 1.16^20 = 4500797.8, which is lower that the value in the table in question 1.

Therefore, by trial-and-error, a possible equation for the exponential curve of best fit is $y = 275\ 000(1.16)^x$.

**4.** Using the equation from question 3, the average NBA player's salary for the 2006-2007 season, which would be the 23rd season would be calculated as follows:

$$y = 275000(1.16)^x = 275000(1.16)^{23} = 8\ 353.460.94$$

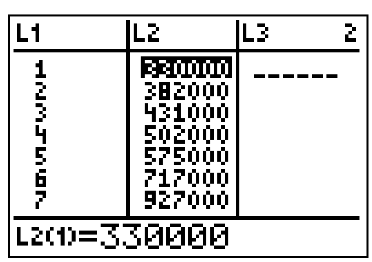
Therefore, my prediction for the average NBA player's salary for the 2006-2007 season is \$8 353 460, to the nearest ten dollars.

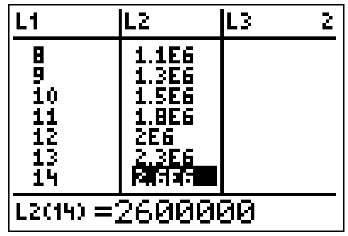
**5.** The average NBA player's salary for the Season 2006-2007 season was listed as \$5 215 000.

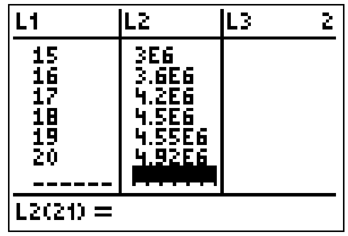
Reference: http://members.cox.net/lmcoon/salarycap.htm#24. This amount is less than the amount predicted in question 4. The website explains the method that is used to calculate "average salary" for the NBA. Normally the league computes the average salary by taking the total salaries paid during the previous season, dividing by 13.2 times the number of teams (other than expansion teams in their first two seasons) and then adding eight percent. For the Season 2005-2006 a defined figure of \$5 000 000 was used for the average salary, rather than applying a formula. This would account for the difference in the average NBA player's salary for the 2006-2007 season calculated in question 4.

**6.** I used the following method to graph the data in question 1 using a graphing calculator.

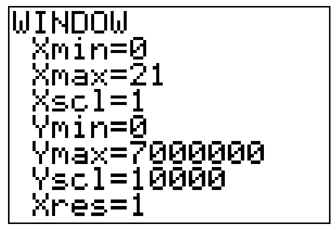
- Press 2nd **[MEM]** to clear all lists. Then press **ENTER.**
- Press **STAT** then select **1:Edit**. Enter the number representing the season into list **L1**, and the Average Salary into list **L2**.



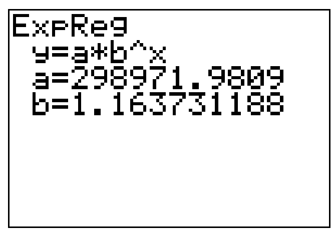


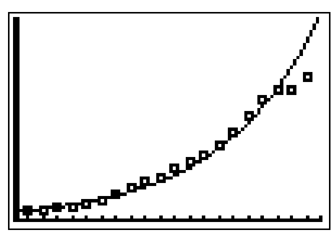

- Press **2nd** [STATPLOT]. Select **Plot1**. Ensure that it is turned **On**. Set the graph to scatter plot, the **XList** to **L1**, and the **YList** to **L2**. Check that **Plot2** and **Plot3** are turned **Off**.
- Press **WINDOW** and adjust the variables as shown.



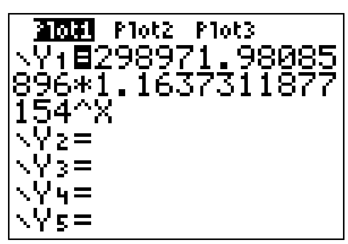

- Press **STAT**, then from the **CALC** menu, select **0:ExpReg.**
- Press **VARS**. Cursor over to the **Y-VARS** menu, then select **1:Function.**
- Press **ENTER** twice.




- Press **GRAPH.**



- Press **Y=** to determine the equation of the exponential curve of best fit.




The exponential curve of best fit determined using a graphing calculator is
$y = 298971.98085896(1.1637311877154)^x$.

**7.** The 2013-2014 season would be season number 30. Using the equation from question 6, the average NBA player's salary would be $28 300 000 for the 2013-2014 season, assuming the trend continues.

The average NBA player's salary could also be found by pressing **2nd** [GRAPH] and determine the value of *y* when the value of $x = 30$.

| X | Y1 | |
|---|---|---|
| 24 | 1.14E7 | |
| 25 | 1.32E7 | |
| 26 | 1.54E7 | |
| 27 | 1.79E7 | |
| 28 | 2.09E7 | |
| 29 | 2.43E7 | |
| 30 | 2.83E7 | |

X=30

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**Level 4 Notes**

Look for the following:

- a highly organized detailed solution showing accurate calculations and justifications for the responses in the solution
- very few or no errors in the solutions
- a thorough understanding of the problem and how it relates to exponential relations
- the graph of the scatter plot of the data is drawn using a ruler and the axes are scatter plot are labelled completely
- use of technology, such as a graphing calculator, with instructions is incorporated in the solution to create a scatter plot of the data.
- evidence of use of the Internet to research the average NBA player's salary for the 2006-2007 season

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**Level 3 Notes**

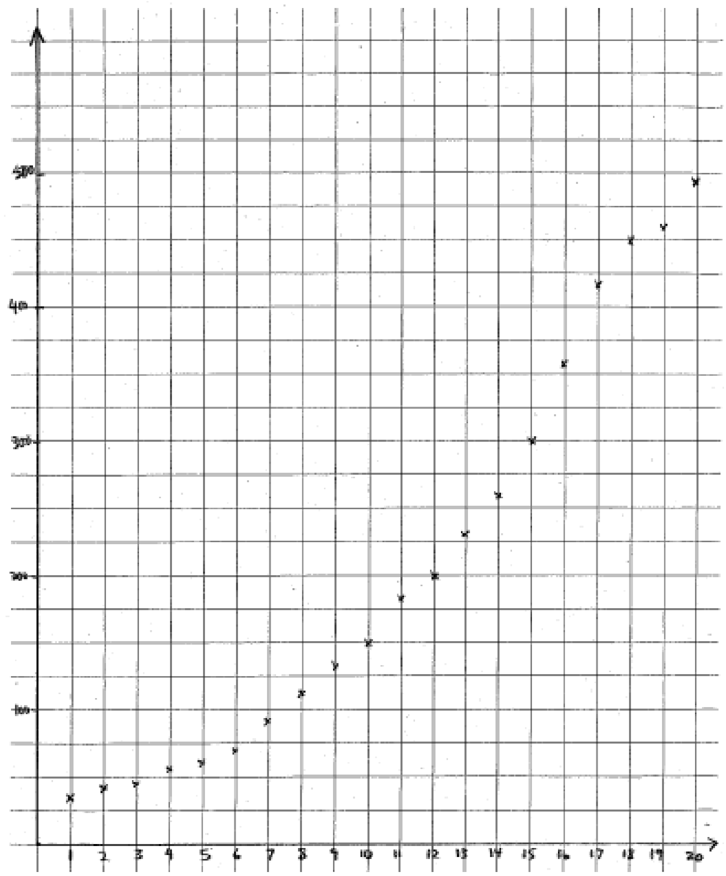
A level 3 response to the questions will be very similar to the level 4 responses shown above, with the following omissions:
For **question 1**, the table will be copied exactly as in the question without taking into consideration the changes suggested in the question.
For **question 2**, the scatter plot may not be completely labelled.
For **question 3**, the student may recognize that the curve is an exponential relation, but have difficulty finding a possible exponential equation that can be used in question **4** through a trial-and-error method.
For **question 5**, the solution may not show evidence of research using the Internet.
For **question 6**, the solution will show evidence that the student can use a graphing calculator to graph the scatter plot of the data and determine the equation exponential curve of best fit, but the solution will not contain an explanation of the exponential equation of best fit was determined.

## Level 2 Sample Response

**1.** Approximate NBA Player's Salary for each season for the twenty-year period from 1984 to 2004

| Season | Average Salary ($) |
|---|---|
| 1984-1985 | 330 000 |
| 1985-1986 | 382 000 |
| 1986-1987 | 431 000 |
| 1987-1988 | 502 000 |
| 1988-1989 | 575 000 |
| 1989-1990 | 717 000 |
| 1990-1991 | 927 000 |
| 1991-1992 | 1 100 000 |
| 1992-1993 | 1 300 000 |
| 1993-1994 | 1 500 000 |
| 1994-1995 | 1 800 000 |
| 1995-1996 | 2 000 000 |
| 1996-1997 | 2 300 000 |
| 1997-1998 | 2 600 000 |
| 1998-1999 | 3 000 000 |
| 1999-2000 | 3 600 000 |
| 2000-2001 | 4 200 000 |
| 2001-2002 | 4 500 000 |
| 2002-2003 | 4 546 000 |
| 2003-2004 | 4 917 000 |

**2.**



The data is best modelled with an exponential relation. The points on the scatter plot appear to lie on a curve.

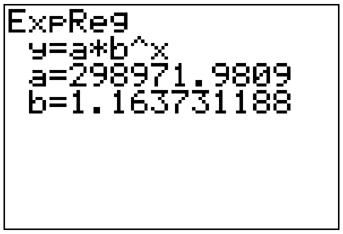
**3.** The salary for the 1984-1985 season is $330 000. The salary for the 1985-1986 season is $382 000. The ratio of the successive $y$-terms is 1.158.
The curve of best fit is $y = 330\ 000(1.158)^x$.

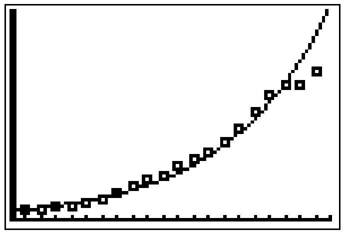
**4.** The 2006-2007 season is the 23rd season. The average NBA player's salary for the 2006-2007 season is

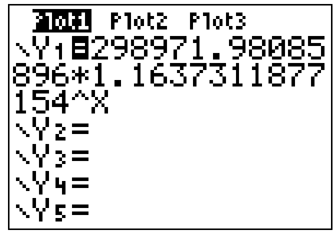
$$y = 330\ 000(1.158)^{23}$$
$$= \$9\ 634\ 092, \text{ to the nearest dollar}$$

**5.** The average NBA player's salary for the Season 2006-2007 season was listed as $8 568 000.

**6.**






The exponential curve of best fit determined using technology on a graphing calculator is $y = 298971.98085896(1.1637311877154)^x$.

**7.** The 2013-2014 season would be season number 30. Using the equation from question 6, the average NBA player’s salary would be $28 300 000 for the 2013-2014 season, assuming the trend continues.

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**Level 2 Notes**

Look for the following

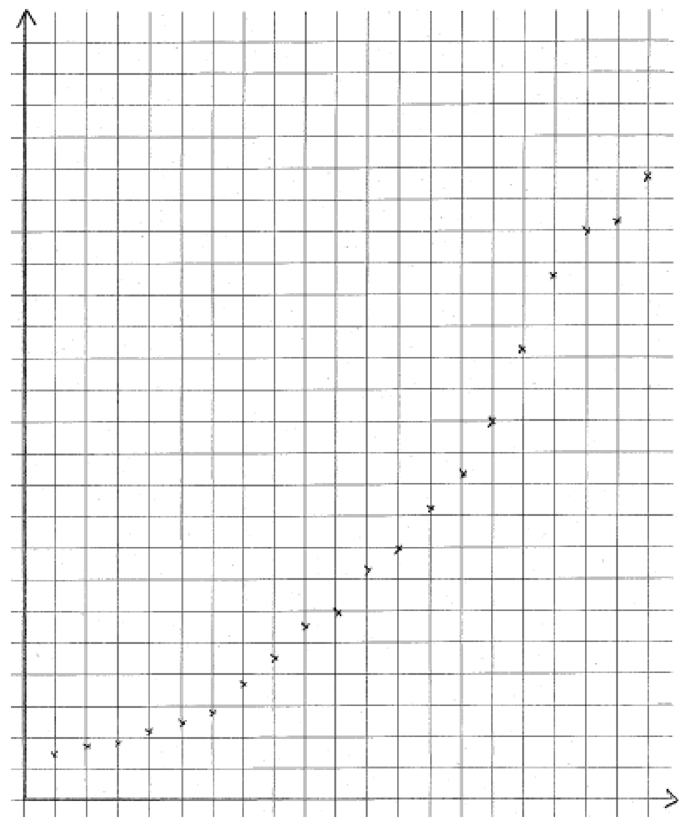
- The structure that is apparent in the level 3 and level 4 solutions is missing.
- Some evidence of correct answers and justification of answers.
- For **question 2**, the labels on the scatter plot may be missing.
- For **question 5**, there is no evidence of research using the Internet to find the answer.
- For **question 6** and **question 7**, the student can graph the exponential curve of best fit and find the equation of the exponential curve of best fit, but there is no explanation of how they completed the solution.

## Level 1 Sample Response

**1.**

| Season | Average Salary ($) |
|---|---|
| 1984-1985 | 330 000 |
| 1985-1986 | 382 000 |
| 1986-1987 | 431 000 |
| 1987-1988 | 502 000 |
| 1988-1989 | 575 000 |
| 1989-1990 | 717 000 |
| 1990-1991 | 927 000 |
| 1991-1992 | 1 100 000 |
| 1992-1993 | 1 300 000 |
| 1993-1994 | 1 500 000 |
| 1994-1995 | 1 800 000 |
| 1995-1996 | 2 000 000 |
| 1996-1997 | 2 300 000 |
| 1997-1998 | 2 600 000 |
| 1998-1999 | 3 000 000 |
| 1999-2000 | 3 600 000 |
| 2000-2001 | 4 200 000 |
| 2001-2002 | 4 500 000 |
| 2002-2003 | 4 546 000 |
| 2003-2004 | 4 917 000 |

**2.**



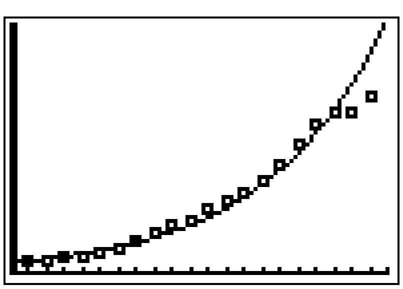
The data is best modelled with an exponential relation.

**3.** The equation of the curve of best fit is $y = (330\ 000)1.2^x$.

**4.** The average NBA player's salary for the 2006-2007 season is $6 850 000.

**5.** The average NBA player's salary for the Season 2006-2007 season is $8 500 000.

**6.**



**7.** The average NBA player's salary for the 2013-2014 season will be $10 000 000.

**Level 1 Notes**

Look for the following

- little or no effort to explain the answers using mathematical terms
- For **question 2**, the curve is correctly identified as an exponential relation without any justification
- Some evidence of correct answers and some evidence of guessing answers
- For **question 5**, there is no evidence of research using the Internet to find the answer.
- For **question 6** and **question 7**, the student can graph the exponential curve of best fit but there is no evidence that exponential regression has been used to find the equation of the curve.