(iv) Method of least squares.

Yr	Sales in (1000s)
2001	10
2002	12
2003	15
2004	16
2005	18.

(a.) Calculate Trend line Eq.

(b.) Cal. expected sales of 2009.

(c.) Cal avg. change in sales.

(d.) sum of diff in trend values and actual values.

← → For a linear fit, eq of line is

$$Y_t = a + bt.$$

value of a and b can be calculated using following equations.

$$\Sigma Y = na + b\Sigma X$$
$$\Sigma XY = a\Sigma X + b\Sigma X^2$$

since $\Sigma X = 0$ always i.e. summation from actual mean is zero

$$\Rightarrow a = \Sigma Y/n$$
$$\Rightarrow b = \Sigma XY/\Sigma X^2$$

→ For a parabolic fit, eq of parabola is

$$Y_t = a + bt + ct^2$$

to calculate $a, b,$ and c we use following equations.

$$\Sigma Y = na + b\Sigma X + c\Sigma X^2$$
$$\Sigma XY = a\Sigma X + b\Sigma X^2 + c\Sigma X^3$$
$$\Sigma X^2 Y = a\Sigma X^2 + b\Sigma X^3 + c\Sigma X^4$$

Now since $\Sigma X = 0$ and $\Sigma X^3 = 0$ always.

=)
$$\Sigma Y = na + c\Sigma X^2$$
$$\Sigma XY = b\Sigma X^2$$
$$\Sigma X^2 Y = a\Sigma X^2 + c\Sigma X^4$$

→ For a exponential fit, eq is

$$Y_t = a \cdot b^t$$
$$\therefore \log Y_t = \log a + t \log b$$

to calculate a and b use following eq.

$$\Sigma \log Y_t = (\log a)(n) + \log b \Sigma X$$
$$\Sigma X \log Y_t = n\Sigma X + (\Sigma X^2)(\log b)$$

$$\hookrightarrow \Sigma X = 0 \text{ always.}$$

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↗ you can choose any value as reference.

Now let's solve that question.

(a)

Yr	Sales(y)	deviation(x)	xy	x²
2001	10	2001-2003 = -2	= -20	4
2002	12	2002-2003 = -1	= -12	1
2003	15	2003-2003 = 0	= 0	0
2004	16	2004-2003 = 1	= 16	1
2005	18	2005-2003 = 2	= 36	4
	$\Sigma y = 71$	$\Sigma x = 0$	$\Sigma xy = 20$	$\Sigma x^2 = 10$

$$\therefore \Sigma y = na + b\Sigma x \Rightarrow \boxed{a = \frac{71}{5} = 14.2}$$
$$\qquad\qquad\qquad 0$$

$$\therefore \Sigma xy = a\Sigma x + b\Sigma x^2$$
$$\therefore 20 = \frac{71}{5} \times 0 + b(10) \Rightarrow \boxed{b = 2}$$

$$\therefore \text{eq is } \boxed{Y_t = 14.2 + 2t}$$

(b) expected ~~sales~~ sales $= 14.2 + 2(\cancel{2009})(2009 - 2003)$
for 2009 $= 14.2 + 2 \times 6$
$= \boxed{26.2}$ —ans.

(c) avg change in $= bx$ (unit of sales)
sales $= 2 \times 1000$
(cause, given that sales
~~is~~ in 1000)
$= \boxed{2000}$ —ans.

(d.) sum of diff in
trend values and $= 0$ (always)
actual values

$= (14.2 + 2(-2) - 10) + (14.2 + 2(-1) - 12)$
$+ (14.2 + 2(0) - 15) + (14.2 + 2(1) - 16)$
$+ (14.2 + 2(2) - 18)$

$= 0.$