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Tarea 03

Problema 3.4

As a sample of radioactive atoms decays, the number of atoms steadily diminishes and the sample's radioactivity decreases in proportion. To study this effect, a nuclear physicist monitors the particles ejected by a radioactive sample for 2 hours. She counts the number of particles emitted in a 1-minute period and repeats the measurement at half-hour intervals, with the following results:

Time elapsed, t (hours):	0.0	0.5	1.0	1.5	2.0
Number counted, ν, in 1 min:	214	134	101	61	54

(a) Plot the number counted against elapsed time, including error bars to show the uncertainty in the numbers. (Neglect any uncertainty in the elapsed time.)

(b) Theory predicts that the number of emitted particles should diminish exponentially as $\nu = \nu_0\, exp(-rt)$, where (in this case) $\nu_0 = 200$ and $r = 0.693\ h$. On the same graph, plot this expected curve and comment on how well the data seem to fit the theoretical prediction.

(a)

se procede a sacar el promedio de ν

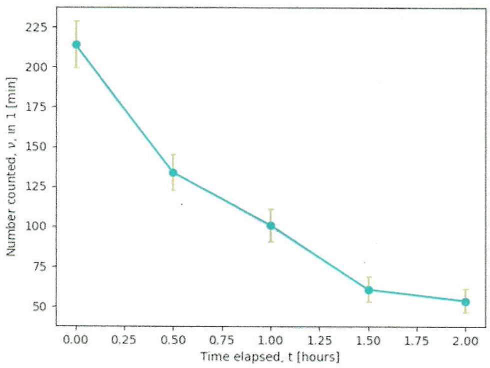
$$\bar{\nu} = \frac{1}{N}\sum_{i=1}^{N} \nu_i \quad , \quad N=5$$

$$\therefore \bar{\nu} = \frac{1}{5}(214+134+101+61+54) \doteq 112{,}8$$

se sabe que $\delta\nu = \sqrt{\bar{\nu}}$, entonces se tiene que

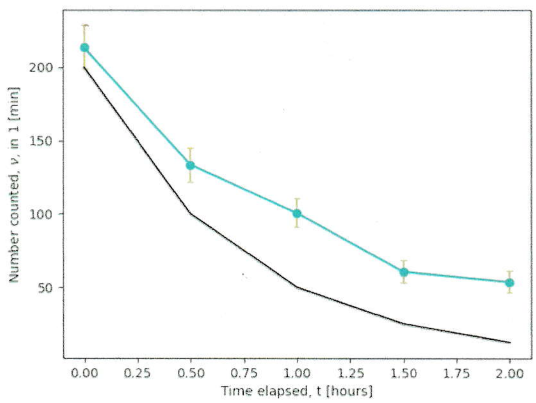
ν	214	134	101	61	54
$\delta\nu$	14,62	11,57	10,05	7,81	7,34

con ello se tiene la siguiente gráfica, generada en python con el empleo de la librería Pyplot.



b)

Disminuye : $\nu = \nu_0 \cdot e^{-rt}$; $\nu_0 = 200$, $r = 0{,}693\ [h^{-1}]$



Se puede observar que los datos obtenidos experimentalmente están dentro del rango tolerable con respecto a los valores teóricos, justamente cuando $t = 0{,}0$.
Sin embargo, conforme avanza t los valores experimentales no se llegan a ajustar con los valores teóricos.

Problema 3.46**

If you measure two independent variables as

$$x = 6.0 \pm 0.1 \qquad \text{and} \qquad y = 3.0 \pm 0.1\ ,$$

and use these values to calculate $q = xy + x^2/y$, what will be your answer and its uncertainty? [You must use the general rule (3.47) to find δq. To simplify your calculation, do it by first finding the two separate contributions δq_X and δq_y as defined in (3.50) and (3.51) and then combining them in quadrature.]

- Determinando δq_x a partir de la ecuación (3,50)

$$\delta q_x = \left|\frac{\partial q}{\partial x}\right| \delta x \rightarrow \delta q_x = \left|\frac{\partial}{\partial x}\left[xy + \frac{1}{y}x^2\right]\right| \delta x$$

$$\delta q_x = \left| y + \frac{2}{y}x \right| \delta x \rightarrow \delta q_x = \left| (3{,}0) + \frac{2}{(3{,}0)}(6{,}0) \right| (0{,}1)$$

$$\therefore \delta q_x = 0{,}7$$

- Determinando δq_y a partir de la ecuación (3,51)

$$\delta q_y = \left|\frac{\partial q}{\partial y}\right| \delta y \rightarrow \delta q_y = \left| x - \left(\frac{x}{y}\right)^2 \right| \delta y \rightarrow \delta q_y = \left| (6{,}0) - \left(\frac{6{,}0}{3{,}0}\right)^2 \right| (0{,}1)$$

$$\therefore \delta q_y = 0{,}2$$

- Determinando el valor de q

$$q = xy + \frac{x^2}{y} \rightarrow q = (6{,}0)(3{,}0) + \frac{(6{,}0)^2}{(3{,}0)} \longrightarrow q = 30{,}0$$

- Determinando δq usando la ecuación

$$\delta q = \sqrt{(\delta q_x)^2 + (\delta q_y)^2} \longrightarrow \delta q = \sqrt{(0{,}7)^2 + (0{,}2)^2}$$

$$\delta q = \frac{1}{10}\sqrt{53} \longrightarrow \delta q \simeq 0{,}72801 \longrightarrow \delta q \approx 0{,}7$$

$$\boxed{q = 30{,}0 \pm 0{,}7}$$

Problema 3.47**

The Atwood machine consists of two masses M and m (with $M > m$) attached to the ends of a light string that passes over a light, frictionless pulley. When the masses are released, the mass M is easily shown to accelerate down with an acceleration

$$a = g\frac{M-m}{M+m}$$

Suppose that M and m are measured as $M = 100 \pm 1$ and $m = 50 \pm 1$, both in grams. Use the general rule (3.47) to derive a formula for the uncertainty in the expected acceleration oa in terms of the masses and their uncertainties and then find δa for the given numbers.

- se tiene que

$$M = (100 \pm 1)\,[g] \qquad m = (50 \pm 1)\,[g]$$

- calculando la aceleración a

$$a = g\frac{(100)-(50)}{(100)+(50)}, \quad \text{si } g = 9{,}8\left[\frac{m}{s^2}\right] = 9.800\left[\frac{mm}{s^2}\right]$$

$$\therefore a \simeq \frac{1}{3}(9800)\left[\frac{mm}{s^2}\right] \rightarrow a \approx 3.266{,}67\left[\frac{mm}{s^2}\right]$$

- Determinando δa_M

$$\delta a_M = \left|\frac{\partial}{\partial M}\left[\frac{M-m}{M+m}g\right]\right|\delta M \rightarrow \delta a_M = \left|\frac{[(M+m)-(M-m)]g}{(M+m)^2}\right|\delta M$$

$$\delta a_M = \left|\frac{2mg}{(M+m)^2}\right|\delta M \rightarrow \delta a_M = \left|\frac{2(50{,}0)(9.800)}{[100+50]^2}\right|(1)$$

$$\therefore \delta a_M = \frac{392}{9} \rightarrow \delta a_M \approx 43{,}56$$

- Determinando δa_m

$$\delta a_m = \left|\frac{\partial}{\partial m}\left[\frac{M-m}{M+m}g\right]\right|\delta m \rightarrow \delta a_m = \left|\frac{[-(M+m)-(M-m)]g}{(M+m)^2}\right|\delta m$$

$$\delta a_m = \left|\frac{-2Mg}{(M+m)^2}\right|\delta m \rightarrow \delta a_m = \left|\frac{2(100{,}0)(9.800)}{(150)^2}\right|(1)$$

$$\therefore \delta a_m = \frac{784}{9} \rightarrow \delta a_m \approx 87{,}11$$

- Determinando δa

$$\delta a = \sqrt{(\delta a_M)^2 + (\delta a_m)^2} \rightarrow \delta a = \sqrt{(43{,}56)^2 + (87{,}11)^2}$$

$$\delta a \approx 97{,}3931 \rightarrow \delta a \sim 100$$

$$\therefore \boxed{a \approx (3.000 \pm 100)\left[\frac{mm}{s^2}\right]}$$

Problema 1.1**

How many significant features are there in the following numbers?

(a) 976.45 <u>5</u> (b) 84,000 <u>2</u> (c) 0.0094 <u>2</u> (d) 301.07 <u>5</u>
(e) 4.000 <u>1</u> (f) 10 <u>1</u> (g) 5280 <u>3</u> (h) 400. <u>3</u>
(i) 4.00×10^2 <u>3</u> (j) 3.010×10^4 <u>5</u>

Problema 1.2**

What is the most significant figure in each of the numbers in Exercise 1.1? What is the least significant?

a) 9 | 5 b) 8 | 4 c) 9 | 4 d) 3 | 7 e) 4 | 0 most | leas
f) 1 | 0 g) 5 | 8 h) 4 | 0 i) 4 | 0 j) 3 | 0

Problema 1.3**

Round off each of the numbers in Exercise 1.1 to two significant digits.

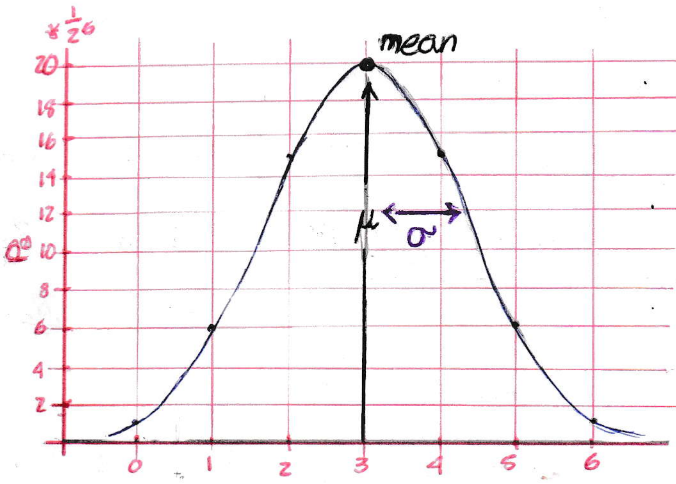
(a) 980 (b) 84,000 (c) 0,0094 (d) 30.0×10^1
(e) 40×10^{-1} (f) 10. (g) 5300 (h) 400
(i) 40.0×10^1 (j) 30×10^3

Problema 2.3**

Evaluate the binomial distribution $P_B(x; n, p)$ for $n = 6, p = 1/2$, and $x = 0$ to 6. Sketch the distribution and identify the mean and standard deviation. Repeat for $p = 1/6$.

∘ $n = 6$; $p = 1/2$; $x = 0 \rightarrow x = 6$

x	p^x	q^{n-x}	$p^x \cdot q^{n-x}$	$C(x,n)$	P_B
0	$(\frac{1}{2})^0$	$(\frac{1}{2})^6$	$1/2^6$	$\frac{6!}{0!(6-0)!} = 1$	$1/2^6$
1	$(\frac{1}{2})^1$	$(\frac{1}{2})^5$	$1/2^6$	$\frac{6!}{1!(6-1)!} = 6$	$6/2^6$
2	$(\frac{1}{2})^2$	$(\frac{1}{2})^4$	$1/2^6$	$\frac{6!}{2!(6-2)!} = 15$	$15/2^6$
3	$(\frac{1}{2})^3$	$(\frac{1}{2})^3$	$1/2^6$	$\frac{6!}{3!(6-3)!} = 20$	$20/2^6$
4	$(\frac{1}{2})^4$	$(\frac{1}{2})^2$	$1/2^6$	$\frac{6!}{4!(6-4)!} = 15$	$15/2^6$
5	$(\frac{1}{2})^5$	$(\frac{1}{2})^1$	$1/2^6$	$\frac{6!}{5!(6-5)!} = 6$	$6/2^6$
6	$(\frac{1}{2})^6$	$(\frac{1}{2})^0$	$1/2^6$	$\frac{6!}{6!(6-6)!} = 1$	$1/2^6$



$\mu = np \longrightarrow \mu = (6)(\frac{1}{2}) \longrightarrow \mu = 3$

$\sigma^2 = np(1-p) \rightarrow \sigma^2 = 6(\frac{1}{2})[1 - \frac{1}{2}] \longrightarrow \sigma^2 = \frac{1}{2} \rightarrow \sigma \approx 1{,}2247$

∘ $n = 6$; $p = 1/6$; $q = 5/6$.

x	p^x	q^{n-x}	$p^x q^{n-x}$	$C(x,n)$	$P_B\ (1/6^6)$
0	$(1/6)^0$	$(5/6)^6$	$5^6/6^6$	1	$5^6 = 15625$
1	$(1/6)^1$	$(5/6)^5$	$5^5/6^6$	6	$6 \cdot 5^5 = 18.750$
2	$(1/6)^2$	$(5/6)^4$	$5^4/6^6$	15	$15 \cdot 5^4 = 9.375$
3	$(1/6)^3$	$(5/6)^3$	$5^3/6^6$	20	$20 \cdot 5^3 = 2.500$
4	$(1/6)^4$	$(5/6)^2$	$5^2/6^6$	15	$15 \cdot 5^2 = 375$
5	$(1/6)^5$	$(5/6)^1$	$5^1/6^6$	6	$6 \cdot 5^1 = 30$
6	$(1/6)^6$	$(5/6)^0$	$1/6^6$	1	$1 \cdot 1 = 1$

$\mu = (6)(\frac{1}{6}) = 1$

$\sigma \approx \sqrt{\mu(1-p)}$

$\sigma \approx 0{,}9128$