

Physics Problem Set 1 Solutions

1. A carbon-carbon triple bond has a length of 120 picometers. What is its length in nanometers?

pico = 10^{-12}
 nano = 10^{-9}

method 1:

$$120 \text{ pm} \left(\frac{10^{-12} \text{ m}}{1 \text{ pm}} \right) \left(\frac{1 \text{ nm}}{10^{-9} \text{ m}} \right)$$

$$120 \cdot 10^{-12} \cdot 10^9 \text{ nm}$$

move 10^{-9} up by changing exponent sign

$$120 \cdot 10^{-3+2} \text{ nm}$$

Add exponents

$1.2 \times 10^{-1} \text{ nm}$
 OR
 $.12 \text{ nm}$

move decimal + change exponent to put in proper sci. not.

* there are only 2 sig fig because a zero before the decimal doesn't count

method 2

pico is 10^{-12} + nano is 10^{-9}

so the change is 10^3

pico is a smaller unit so the number would be larger. To move to a larger unit (nano) the number gets smaller (by 10^3)

$$\uparrow 120 \text{ pm} \Rightarrow \boxed{.12 \text{ nm}}$$

OR $\boxed{1.2 \times 10^{-1} \text{ nm}}$

2. A gremlin is a tiny mythical creature often blamed for mechanical failures. Suppose for a moment that a shrewd physicist catches one such gremlin and makes it work for her instead of against her. She determines that the gremlin can produce 24 milliwatts of power. How many gremlins are required to produce 24,000 megawatts of power?

1 gremlin = 24 mW

Mega = 10^6
 milli = 10^{-3}

I want to go from MW to mW to greml.

* we have 2 sig figs

$$24000 \text{ MW} \left(\frac{10^6 \text{ W}}{1 \text{ MW}} \right) \left(\frac{1 \text{ mW}}{10^{-3} \text{ W}} \right) \left(\frac{1 \text{ greml.}}{24 \text{ mW}} \right)$$

$$24000 \cdot 10^6 \cdot 10^3 \div 24$$

$$24 \times 10^3 \cdot 10^6 \cdot 10^3 \div 24$$

$$\frac{24}{24} \cdot 10^{12} = 1 \times 10^{12} \text{ gremlins}$$

but we need 2 sig fig

$1.0 \times 10^{12} \text{ gremlins}$

Physics Problem Set 1 Solutions

3. An electron can tunnel through an energy barrier with probability 0.000000000375. (This is a concept used in quantum mechanics.) Express this probability in scientific notation.

0.000000000375
moved 11 spaces

$$3.75 \times 10^{-11}$$

4. Light travels at 3.0×10^8 m/s in a vacuum. Find its speed in furlongs per fortnight. There are roughly 201 meters in a furlong, and a fortnight is equal to 14 days.

2 sig figs

$$3.0 \times 10^8 \frac{\text{m}}{\text{s}} \left(\frac{1 \text{ furlong}}{201 \text{ m}} \right) \left(\frac{60 \text{ s}}{1 \text{ min}} \right) \left(\frac{60 \text{ min}}{1 \text{ hr}} \right) \left(\frac{24 \text{ hr}}{1 \text{ day}} \right) \left(\frac{14 \text{ day}}{1 \text{ fortnight}} \right)$$

$$\frac{3.0 \times 10^8 \cdot 60 \cdot 60 \cdot 24 \cdot 14}{201} \frac{\text{furlong}}{\text{fortnight}}$$

$$\frac{3.6 \times 10^{14}}{201}$$

$$1.8 \times 10^{12} \text{ furlong/fortnight}$$

Physics Problem Set 1 Solutions

5. Multiply 3.65×10^{23} by 4.12×10^{154} by 1.11×10^{-11} and express the answer in scientific notation.

$$3.65 \times 10^{23} \cdot 4.12 \times 10^{154} \cdot 1.11 \times 10^{-11}$$

3 sig figs!

$$(3.65)(4.12)(1.11) \times 10^{23+154-11}$$

$$16.692 \times 10^{166+1}$$

1.67×10^{167}

6. Evaluate $(5.7 \times 10^6 \text{ kg}) \times (6.3 \times 10^{-2} \text{ m/s}^2)$ and express the answer in scientific notation.

$$(5.7)(6.3) \times 10^{6-2} \text{ kg} \cdot \frac{\text{m}}{\text{s}^2}$$

2 sig fig

$$35.91 \times 10^4 \frac{\text{kgm}}{\text{s}^2}$$

$3.6 \times 10^5 \frac{\text{kgm}}{\text{s}^2}$

7. Evaluate $(4.9 \times 10^{-8}) / (7.0 \times 10^{-3})$. Express the answer in scientific notation

$$\frac{4.9 \times 10^{-8}}{7.0 \times 10^{-3}} = \frac{4.9}{7} \times 10^{-8+3}$$

← sign of exponent changes when moved to numer.

$$7 \times 10^{-5-1}$$

but 2 sig fig

7.0×10^{-6}

Physics Problem Set 1 Solutions

8. A 3.70×10^6 kg piece splits off an iceberg of mass of 5.96×10^7 kg. Calculate the mass of the remaining iceberg and express the answer in scientific notation.

$$5.96 \times 10^7 \text{ kg} - 3.70 \times 10^6 \text{ kg}$$

we need same exponent!

$$5.96 \times 10^7 - 0.370 \times 10^7$$

$$(5.96 - 0.370) \times 10^7$$

$$5.59 \times 10^7$$

but our most precise figure is the thousandth place, so we need another sig fig.

$$\boxed{5.590 \times 10^7 \text{ kg}}$$

9. The silicon chip in a microelectronic component has a mass of 1.37×10^{-3} kg. To complete the wiring, 6.79×10^{-5} kg of solder is added to the chip. Compute the final mass of the circuit.

$$1.37 \times 10^{-3} + 6.79 \times 10^{-5}$$

$$137 \times 10^{-5} + 6.79 \times 10^{-5}$$

significant + hundredths place

$$143.79 \times 10^{-5}$$

$$\boxed{1.4379 \times 10^{-3} \text{ kg}}$$

10. An auto transport truck has a mass of 2.50×10^4 kg. A car has a mass of 1.31×10^3 kg. The car is loaded onto the truck. What is their total mass?

$$2.50 \times 10^4 + 1.31 \times 10^3$$

$$2.50 \times 10^4 + 0.131 \times 10^4$$

$$\boxed{2.631 \times 10^4 \text{ kg}}$$

significant + thousandths place