MANU2112 Engineering Science

Introductory Tutorial

Q1. Convert the following numbers to scientific notation:

a) 568017
b) 0.000309
c) 37004
d) 103.250

Q2. Re-write the following expression using scientific notation, calculate, and express the result in both, Scientific and standard arithmetic notations

$$\frac{213.4 * 0.003751}{3600.0 * 15.07}$$

Q3. Calculate the following without using a calculator:

$$\frac{10^{-3} * 10^{12}}{10^{-9} * \sqrt{10^{8}}}$$

Q4. A car completes a journey of 350 km in 4 hours 22 ½ minutes. What is its average speed in km/h expressed in scientific notation?

Q5. The radius of the Sun is 695 500 km. What is its approximate volume written in scientific notation? (Volume of a sphere is $(4/3)\ \pi R^3$)

Q6. The surface area of a door is 11 000 cm^2 . How many mm^2 is that?

Q7

(a) $V = \sqrt{u^2 + 2as}$, the final velocity of a body, where u = initial velocity, a = its acceleration, s = the distance travelled.
Evaluate v when $u = 20$ km/h, $a = 8$ m/s^2, $s = 685$ mm.

(b) $T = 2\pi\sqrt{\frac{l}{g}}$, the period (time of oscillation) of a simple pendulum.
Evaluate T when $l = 893$ mm, $g = 9.80$ m/s^2.

(c) On an unknown planet a period of oscillation of a simple pendulum with length of 1.0 m is 4.0 s. What is the acceleration due to gravity *g* on this planet?

Q8. Solve for a variable in parentheses:

1.

$$P = \frac{100(m_1 - m_m)}{m_m}$$

Percentage of excess air supplied to a combustion chamber, where m_1 = total mass of air supplied and m_m = minimum mass of air required for total combustion of the fuel.

a (m_1) b (m_m)

2.

a $\eta = \dfrac{W}{W + F}$ (F) Efficiency of a lifting machine, where W is the load and F is the friction load.

b $\eta = \dfrac{W}{E \times V}$ (V) Efficiency of a lifting machine where W is the load, V is the velocity ratio and E is the effort force.

Q9

1 The mass of one casting is 2.50 times the mass of another. If the total mass of the two castings is 16.7 kg, find the mass of the lighter casting.

2 It is known that resistor R_2 is 18.7 Ω greater than resistor R_1. The two resistors in series have a resistance of $R_1 + R_2 = 56.3$ Ω. Find the value of R_1 by setting up a single equation containing R_1.

3 A machine can produce article A in 12 minutes or article B in 16 minutes. If it is planned to produce twice as many of A as B in a working week of 40 hours, how many of each will be produced, assuming that the machine works non-stop?

Q10

In these exercises a formula is given.

a Evaluate the subject using the data provided.
b Change the subject to the pronumeral named.
c Evaluate the new subject using the data provided.

1 Work, $W = mgh$

a $g = 9.81$ m/s^2, $m = 5.50$ g, $h = 875$ mm
b h
c $g = 9.81$ m/s^2, $m = 2.65$ t, $W = 27.5$ MJ

emf, $e = iR + \dfrac{Q}{C}$

2. a $i = 3.50$ μA, $R = 6.80$ kΩ, $Q = 1.65$ μC, $C = 75.0$ μF
b C
c $Q = 1.50$ mC, $i = 645$ mA, $R = 4.70$ Ω, $e = 5.35$ V

Q11. Use the quadratic formula

$$if\ ax^2 + bx + c = 0, then\ x_{1,2} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

to solve following quadratic equations:

(a) $x^2 + 6x + 1 = 0$

(b) $x^2 - 8x + 16 = 0$

(c) $2x^2 - x - 3 = 0$

(d) $5x^2 - 7x - 2 = 0$

(e) $4x^2 - 9x + 4 = 0$

(f) $3x^2 - 11x - 4 = 0$

Q12. A cyclist travels in a straight line according to $x(t) = (-7 - 6t + t^2) m$, where t is in seconds.

(a) At what time does the cyclist reach the origin ($x = 0$)?

(b) What was her starting point (coordinate) at time = 0?

(c) How long does it take for her to move from the origin $x = 0$ to the coordinate $x = 10\ m$?

(d) If the velocity of the cyclist changes as $v(t) = (- 6 + 2t)m/s$, what is her velocity at $x = 10m$?

Answers.

1. (a) $5.68017*10^5$ (b) $3.09*10^{-4}$ (c) $3.7004*10^4$ (d) $1.0325*10^2$

2. $\frac{2.134*10^2*3.751*10^{-3}}{3.6000*10^3*1.507*10^1} = 1.475 * 10^{2-3-3-1} = 1.475 * 10^{-5}$

3. $\frac{10^{-3}* 10^{12}}{10^{-9}* \sqrt{10^8}} = 10^{-3+12+9-4} = 10^{14}$

4. $8.0 * 10^1\ km/h$

5. $1.409 * 10^{18}\ km^3$

6. $1.1 * 10^6\ mm^2 = 1\ 100\ 000\ mm^2$

7. (a) 6.47 m/s ≈ 7 m/s (b) 1.90 s (c) 2.5 m/s^2

8. 1. (a) $m_1 = \left(\frac{P}{100} + 1\right) m_m$ (b) $m_m = \frac{100}{P+100}\ m_1$

   2. (a) $F = \left(\frac{1}{\eta} - 1\right) W$ (b) $V = \frac{W}{\eta E}$

9. (1) 4.77 kg (2) 18.8 Ω (3) A = 120, B = 60

10. 1. (a) W = 0.0472J (b) h = 0.106×10^4 m = 1.06 km

    2 (a) e = 0.0458 V (b) C = 0.000647 F = 647 μF

11. (a) -0.17, -5.83 (b) 4.00, 4.00 (c) 1.50, -1.00 (d) 1.64, -0.24 (e) 1.64, 0.61 (f) 4.00, -0.33

12. (a) 7 s (b) -7 m (c) 1 s (d) 10 m/s

13. (1) Using uncertainties of direct measurements where

$t_{av} = \frac{\sum_i t_i}{N}$, N = 10, $\Delta t_i = |\ t_i - t_{av}\ |$, *and* $\Delta t_{av} = \frac{\sum_i \Delta t_i}{N}$

N	t(s)	Δt (s)
1	6.5	0.006
2	6.46	0.046
3	6.44	0.066
4	6.53	0.024
5	6.56	0.054
6	6.52	0.014
7	6.54	0.034
8	6.5	0.006
9	6.43	0.076
10	6.58	0.074
Average	**6.506**	**0.04**

NOTE: Average uncertainty of the measurements (0.04s) is larger than the accuracy of the instrument (0.02 s). The result for time *t* is

t = (6.51 ± 0.04)s

(2)

Using method to calculate uncertainties of indirect measurements we'll find the relative uncertainty of the speed first:

$$\frac{\Delta(A/B)}{A/B} = \frac{\Delta A}{A} + \frac{\Delta B}{B}$$

d = (1.50 ± 0.01) m , t = (6.51 ± 0.04) s

$$v = \frac{d}{t}, \quad v_{av} = \frac{1.50}{6.51} = 0.230\ \frac{m}{s},$$

$$\frac{\Delta v}{v_{av}} = \frac{\Delta \mathrm{d}}{d_{av}} + \frac{\Delta \mathrm{t}}{t_{av}} = \frac{0.01}{1.50} + \frac{0.04}{6.51} = 0.013$$

$$\Delta v = 0.013 * 0.230 = 0.003\frac{m}{s}$$

Finally,

$$v = (0.230 \pm 0.003)\ \frac{m}{s}$$