VIU VANCOUVER ISLAND UNIVERSITY
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CHEMISTRY 047

STUDY PACKAGE

This material is intended as a review of skills you once learned.

PREPARING TO WRITE

THE

ASSESSMENT

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SOLVING FORMULAE (PART A)

INTRODUCTION

- **A formula** is an equation with letters. Solving a formula involves manipulating it, so that a particular letter is "isolated" in the formula. The techniques used in manipulating formulae are similar to those previously discussed in solving equations.

FORMULAE WITH ONE TERM ON EACH SIDE

- When solving a formula, first locate the letter that you are asked to solve for. Then, "isolate" the letter in the same way as solving equations.

e.g.

$$\frac{2x}{3} = \frac{1}{5}$$

$$x = \frac{1(3)}{5(2)}$$

$$x = \frac{3}{10}$$

e.g. $\frac{ax}{b} = \frac{2}{c}$, solve for x

$$x = \frac{2b}{ac}$$

e.g. Solve $F = \frac{mv^2}{r}$, for m

$$\frac{Fr}{v^2} = m$$

e.g. Solve $\frac{a}{b} = \frac{c}{d}$, for d

$$\frac{b}{a} = \frac{d}{c}$$

$$\frac{bc}{a} = d$$

e.g. If Force (F) equals mass (m) times acceleration (a) , what is the mass?

$$F = ma$$

$$\frac{F}{a} = m$$

The mass equals the force divided by the acceleration.

e.g. The volume (v) of a cylinder equals pi (π) times the radius squared times the height. What is the height?

$$v = \pi r^2 h$$

$$\frac{v}{\pi r^2} = h$$

The height equals the volume divided by the product of π and the radius squared.

FORMULAE WITH BRACKETS

- When solving a formula, a bracket can be thought of as one unit. Note that the bracket (a + b) behaves in an identical manner to the letter x in the examples below.

e.g. $A = \frac{1}{2}hx$, for h

$\frac{2A}{x} = h$

e.g. $A = \frac{1}{2}h\,(a + b)$, for h

$\frac{2A}{(a+b)} = h$ or $\frac{2A}{a+b} = h$

- When solving for a letter which is inside a bracket, solve for (or isolate) the bracket first. Then a term which is added will be subtracted on the other side of the equation.

e.g. $A = \frac{1}{2}h(a+b)$, for a

$\frac{2A}{h} = a + b$

$\frac{2A}{h} - b = a$ or $\frac{2A - bh}{h} = a$

e.g. $\frac{t(V_1 + V_2)}{2} = S$, for V_1

$V_1 + V_2 = \frac{2S}{t}$

$V_1 = \frac{2S}{t} - V_2$ or $V_1 = \frac{2S - V_2t}{t}$

EXERCISE I

Solve:

1. a) $A = lw$, for w
   b) $\frac{V}{R} = I$, for V
   c) $\frac{W}{I} = E$, for I
   d) $I = prt$, for t
   e) $E = mc^2$, for m
   f) $\frac{A}{\pi} = r^2$, for A
   g) $V = \frac{4}{3}\pi r^3$, for π
   h) $F = \frac{mv^2}{r}$, for r
   i) $V = \frac{1}{3}\pi r^2 h$, for h
   j) $\frac{a}{x} = \frac{c}{2}$, for x
   k) $A = \frac{1}{2}bh$, for b
   l) $\frac{w_1}{w_2} = \frac{d_1}{d_2}$, for d_2
   m) $F = \frac{km_1m_2}{r^2}$, for k
   n) $\frac{E}{e} = \frac{R + r}{r}$, for e

2. a) $A = \frac{1}{2}h(a+b)$, for h
   b) $A = \frac{1}{2}h(c+d)$, for d
   c) $C = \frac{5}{9}(F - 32)$, for F
   d) $s = \frac{t(V_1 + V_2)}{2}$, for t
   e) $s = \frac{t(V_1 + V_2)}{2}$, for V_2
   f) $s = \frac{H}{m(t_1 - t_2)}$, for H

RULES FOR WORKING WITH POSITIVE AND NEGATIVE NUMBERS

★★★ Think of “combining” numbers rather than **adding or subtracting** them.

<u>RULE I</u>: If the signs are the same, add the numbers, and use the same sign.

<u>RULE II</u>: If the signs are different, ignore the signs, subtract the smaller number from the larger and use the larger number’s sign.

<u>Examples</u>

a) –5 + 2 The signs are different, so subtract the numbers (5 – 2 = 3) and use the sign of the larger (–5)
–5 + 2 = –3

b) 2 – 9 Again, the signs are different, so subtract the numbers (9 – 2 = 7) and use the sign of the larger (the 9 which is negative)
2 – 9 = –7

c) –2 – 3 The signs are the same (both negative), so add the numbers (2 + 3 = 5) and use the same sign (–)
–2 – 3 = –5

d) 3 – (–5) Use the rules for multiplication:
negative times negative is a positive, so
3 – (–5) = 3 + 5 = 8

e) –5 – (–6) = – 5 + 6 = 1

<u>RULE III</u>: When **multiplying or dividing**, if the signs are the same, the answer is positive.

<u>RULE IV</u>: When **multiplying or dividing**, if the signs are different, the answer is negative.

Examples

a) (–5) (–5) = 25 The signs are **the same**, so the answer is **positive**.

b) (– 3) (4) = –12 The signs are **different**, so the answer is **negative**.

c) (–2) (1) (–6) (3)

= (–2) (–6) (3)

= (12) (3)

= 36

d) $\frac{-50}{10}$ **or** (–50) ÷ (10) = –5 The signs are **different**, so the answer is **negative**.

e) $\frac{-81}{-9}$ **or** (–81) ÷ (–9) = 9 The signs are the **same**, so the answer is **positive**.

EXERCISE II

1.	– 3 + 4	**2.**	8 – 12	**3.**	– 6 + 7
4.	– 4 – 8	**5.**	5 + 8	**6.**	10 – 6
7.	– 12 + 28	**8.**	14 – 38	**9.**	– 101 + 33
10.	(14) (– 6) or (14) x (–6)	**11.**	(5) (–8) or (5) x (–8)		
12.	(–20) (–3) or (–20) x (–3)	**13.**	(14) ÷ (–2)		
14.	$\frac{-36}{-6}$	**15.**	$\frac{-42}{6}$	**16.**	–7 – (–10)
17.	–12 + 108	**18.**	15 ÷ (–3)	**19.**	–123 – (–10)
20.	(27) ÷ (–3)	**21.**	(13) (8)	**22.**	(–4) (–6)
23.	–13 + 62	**24.**	–94 – (–37)	**25.**	(–48) ÷ (8)
26.	(–16) ÷ (–4)	**27.**	$-\frac{1}{2}+\frac{3}{4}$	**28.**	$-\frac{3}{5} - \frac{7}{8}$
29.	–1.25 + 8.31	**30.**	$\left(-\frac{2}{3}\right)\left(\frac{1}{4}\right)$ **or** $\left(-\frac{2}{3}\right) \text{x} \left(\frac{1}{4}\right)$		

31. $\left(-5\frac{1}{2}\right)\left(-2\frac{3}{7}\right)$ **or** $\left(-5\frac{1}{2}\right) \text{x} \left(-2\frac{3}{7}\right)$

32. (3.14) (–2.17) **or** (3.14) x (–2.17)

33. –7.81 – (–3.16)

34. –2.5 – 4.8

35. (–4.8) ÷ (–2.2)

36. $\frac{1}{8} - \frac{3}{4}$

37. (13.2) (–14.3)

38. (–2.6) (–1.8)

39. $\left(-4\frac{1}{2}\right)\left(2\frac{1}{2}\right)$

40. (– 3.2) (– 4.1)

41. $3\frac{1}{5} - 7\frac{2}{3}$

42. $-2\frac{2}{3} - \left(-3\frac{1}{3}\right)$

43. (4.68) (–2.13)

44. $-3\frac{7}{8} - 2\frac{1}{3}$

45. $\left(5\frac{2}{5}\right) \div \left(-2\frac{2}{3}\right)$

46. $\left(1\frac{1}{2}\right) - \left(-2\frac{1}{4}\right)$

47. (4.3) (–2.4)

48. (–1.23) (–2.34)

49. $4\frac{1}{8} - \left(-2\frac{2}{7}\right)$

50. $-3\frac{8}{13} - 2\frac{4}{5}$

51. $\left(-3\frac{1}{2}\right) \div \left(-8\frac{1}{4}\right)$

52. –4 + 8

53. $\frac{1}{4} - \frac{9}{10}$

54. (–3.25) ÷ (–0.25)

SUBSTITUTION

- Letters are often used to represent numbers for general calculations. For example, if you borrow \$1000 (Principal = P) at 12% interest (rate = r) for 2 years (time = t), you could calculate the amount owed at the end of two years by using the general formula below.

Amount owed = Principal + Principal x rate x time
= P + Prt
= (1000) + (1000) (0.12) (2)
= 1000 + 240
= 1240

Amount owed is \$1240

Note: 1. When substituting, always store the number in a bracket.
2. Change % to a decimal

EXAMPLES USING SUBSTITUTION

- In the following examples, numbers are substituted (with brackets). Then the order of operation (B.E.M.A.) is completed.

e.g. Evaluate $2xy - 3x^2y$, if x = –1 and y = 4

$2xy - 3x^2y$
$= 2(-1)(4) - 3(-1)^2(4)$
$= 2(-1)(4) - 3(+1)(4)$
$= -8 - 12$
$= -20$

e.g. Evaluate the surface area (A) of a ball, if $A = 4\pi r^2$ when r = 5 and $\pi \approx 3.14$

$A = 4\pi r^2$
$= 4(3.14)(5)^2$
$= 4(3.14)(25)$
$= 314$

EXERCISE III

1. Evaluate the following:

a) $(-2)(-1) + (3)(-2)$

b) $\frac{(-1)(-2)(3)}{-1} - (-2)(-3)$

c) $\frac{(-5)(+6)}{+2} - \frac{3}{4}(-8)$

d) $(5 + 4 - 2)(3) - 2(2+5)$

e) $\frac{(2-5)(-1)}{3} - \frac{(4+6)}{5}$

f) $(-1)^2(2)^3 + (-1)^3(3)^2$

g) $\frac{(-2)^3(-3)^2}{8} + \frac{3+2^2}{2^2}$

h) $3(-1)^2 - 5(5 + 2 - 9)^2 - (-2)^3$

2. Substitute and evaluate the following:

a) Amount owed = P + Prt, if P = \$2500, r = 9%, and t = 3 years

b) Amount owed if P = \$5000, r = 11%, and t = $\frac{1}{2}$ year

c) xy – xz, if x = 2, y = –1, and z = –3

ANSWERS

I Answers (Formula Solving)

1. **a)** $\frac{A}{l} = w$ **b)** $V = IR$ **c)** $\frac{W}{E} = I$ **d)** $\frac{I}{pr} = t$ **e)** $\frac{E}{c^2} = m$

f) $A = \pi r^2$ **g)** $\frac{3V}{4r^3} = \pi$ **h)** $r = \frac{mv^2}{F}$ **i)** $\frac{3V}{\pi r^2} = h$ **j)** $x = \frac{2a}{c}$

k) $\frac{2A}{h} = b$ **l)** $d_2 = \frac{d_1 w_2}{w_1}$ **m)** $\frac{Fr^2}{m_1 m_2} = k$ **n)** $e = \frac{rE}{R + r}$

2. **a)** $\frac{2A}{a+b} = h$ **b)** $\frac{2A}{h} - c = d$ **c)** $\frac{9}{5}C + 32 = F$ **d)** $\frac{2s}{V_1 + V_2} = t$ **e)** $\frac{2s}{t} - V_1 = V_2$

f) $sm(t_1 - t_2) = H$

II Answers (Working with Positive and Negative Numbers)

1. 1	**2.** – 4	**3.** 1	**4.** – 12	**5.** 13	**6.** 4	**7.** 16
8. – 24	**9.** – 68	**10.** – 84	**11.** – 40	**12.** 60	**13.** – 7	**14.** 6
15. – 7	**16.** 3	**17.** 96	**18.** – 5	**19.** – 113	**20.** – 9	**21.** 104
22. 24	**23.** 49	**24.** – 57	**25.** – 6	**26.** 4	**27.** $\frac{1}{4}$	**28.** $-1\frac{19}{40}$
29. 7.06	**30.** $-\frac{1}{6}$	**31.** $13\frac{5}{14}$	**32.** – 6.8138	**33.** – 4.65	**34.** – 7.3	**35.** $2.\overline{18}$
36. $-\frac{5}{8}$	**37.** – 188.76	**38.** 4.68	**39.** $-11\frac{1}{4}$	**40.** 13.12	**41.** $-4\frac{7}{15}$	**42.** $\frac{2}{3}$
43. – 9.9684	**44.** $-6\frac{5}{24}$	**45.** $-2\frac{1}{40}$	**46.** $3\frac{3}{4}$	**47.** – 10.32	**48.** 2.8782	**49.** $6\frac{23}{56}$
50. $-6\frac{27}{65}$	**51.** $\frac{14}{33}$	**52.** 4	**53.** $-\frac{13}{20}$	**54.** 13		

III Answers (Substitution)

1. **a)** – 4 **b)** –12 **c)** – 9 **d)** 7 **e)** – 1 **f)** – 1 **g)** $-7\frac{1}{4}$ **h)** – 9

2. **a)** \$ 3175.00 **b)** \$ 5275.00 **c)** + 4

SCIENTIFIC NOTATION

SCIENTIFIC NOTATION WITH 'LARGE' NUMBERS

- A large number can be converted into a one-digit number times the number '10' to a power. This process converts the number into Scientific Notation. Note the list of exponents for the base 10 to the right.

$10^1 = 10$
$10^2 = 100$
$10^3 = 1{,}000$
$10^4 = 10{,}000$
$10^5 = 100{,}000$
$10^6 = 1{,}000{,}000$

e.g. $2{,}000{,}000 = 2 \times 1{,}000{,}000 = 2 \times 10^6$

e.g. $3{,}500 = 3.5 \times 1{,}000 = 3.5 \times 10^3$

SCIENTIFIC NOTATION WITH 'SMALL' NUMBERS

- A 'small' number (i.e. a decimal less than '1') can also be converted to a one-digit number times the number '10' to a negative power. Note the list of negative exponents for the base 10 to the right.

e.g. $.0003 = 3 \times .0001 = 3 \times 10^{-4}$

e.g. $.045 = 4.5 \times .01 = 4.5 \times 10^{-2}$

$10^{-1} = \frac{1}{10^1} = .1$

$10^{-2} = \frac{1}{10^2} = .01$

$10^{-3} = \frac{1}{10^3} = .001$

CONVERTING TO AND FROM SCIENTIFIC NOTATION

- When converting a number into scientific notation, move the decimal place to create a one-digit number. Multiply this one-digit number by the appropriate power of 10.

e.g. $5200 = 5.2 \times 10^3$

e.g. $.0049 = 4.9 \times 10^{-3}$

e.g. $30{,}000{,}000 = 3.0 \times 10^7$

e.g. $.000671 = 6.71 \times 10^{-4}$

- When converting from scientific notation into a number, move the decimal point the appropriate number of places to the right (for large numbers) or to the left (for small numbers).

e.g. $3.11 \times 10^3 = 3110$

e.g. $2.3 \times 10^{-4} = .00023$

e.g. $2.5 \times 10^8 = 250{,}000{,}000$

e.g. $5.0 \times 10^{-1} = .5$

USING SCIENTIFIC NOTATION

- When using scientific notation, your answer must have a one-digit number. In the following examples, numbers are converted into 'proper' scientific notation (i.e. with a one-digit number).

e.g. $52 \times 10^3 = \underline{5.2 \times 10^1} \times 10^3 = 5.2 \times 10^4$

e.g. $.15 \times 10^{-4} = \underline{1.5 \times 10^{-1}} \times 10^{-4} = 1.5 \times 10^{-5}$

SCIENTIFIC NOTATION AND THE THREE RULES OF EXPONENTS

When using scientific notation, note the following:

- Answers must be in ‘proper’ scientific notation (i.e. a one-digit number).
- Negative powers of 10 are not converted into positive powers.
- Fractions must be converted to decimals.

RULE I : When multiplying with the same base, add powers.

e.g. $(3.0 \times 10^{4})(2.0 \times 10^{-7}) = 6.0 \times 10^{-3}$

e.g. $5.1 \times 10^{4} \times 3.0 \times 10^{7} = 15.3 \times 10^{11}$

$= 1.53 \times 10^{12}$

RULE II : When dividing with the same base, subtract powers.

e.g. $\dfrac{9 \times 10^{-5}}{2 \times 10^{-1}} = 4.5 \times 10^{-4}$

e.g. $\dfrac{5.0 \times 10^{-4}}{8.0 \times 10^{-7}} = .625 \times 10^{3}$

$= 6.25 \times 10^{2}$

RULE III : When a bracket is taken to a power, multiply powers.

e.g. $(2.0 \times 10^{3})^{2} = 2.0^{2} \times 10^{6}$

$= 4.0 \times 10^{6}$

e.g. $(5 \times 10^{-4})^{3} = 5^{3} \times 10^{-12}$

$= 125 \times 10^{-12}$

$= 1.25 \times 10^{-10}$

EXERCISE

1. Convert to Scientific Notation:

   a) 6000 b) 250,000 c) 36,700,000 d) .002 e) .00061 f) .000005

2. Convert to numbers:

   a) 3.6×10^{4} b) 5×10^{6} c) 1.23×10^{3}

   d) 3×10^{-3} e) 2.68×10^{-4} f) 1.0×10^{-1}

3. Convert to ‘proper’ scientific notation (i.e. a one-digit number):

   a) 55×10^{4} b) 23×10^{-3} c) $.5 \times 10^{6}$ d) $.23 \times 10^{-5}$

4. Simplify the following and write your answer in ‘proper’ scientific notation:

   a) $(1.5 \times 10^{4})(3.0 \times 10^{-11})$ b) $(5.0 \times 10^{4})(3.0 \times 10^{5})$

   c) $(6.2 \times 10^{-3})(2.0 \times 10^{-2})$ d) $\dfrac{8.0 \times 10^{6}}{4.0 \times 10^{-2}}$ e) $\dfrac{1.0 \times 10^{-3}}{2.0 \times 10^{-6}}$

   f) $\dfrac{3.0 \times 10^{-1}}{9.0 \times 10^{5}}$ g) $(2 \times 10^{4})^{3}$ h) $(5.0 \times 10^{-3})^{2}$

   i) $(5.0 \times 10^{-3})^{-2}$

ANSWERS

1. **a)** 6×10^{3} **b)** 2.5×10^{5} **c)** 3.67×10^{7}
   d) 2×10^{-3} **e)** 6.1×10^{-4} **f)** 5×10^{-6}

2. **a)** 36,000 **b)** 5 000 000 **c)** 1 230
   d) .003 **e)** .000268 **f)** 0.1

3. **a)** 5.5×10^{5} **b)** 2.3×10^{-2} **c)** 5×10^{5} **d)** 2.3×10^{-6}

4. **a)** 4.5×10^{-7} **b)** 1.5×10^{10} **c)** 1.24×10^{-4} **d)** 2×10^{8} **e)** 5×10^{2}
   f) $3.\overline{33} \times 10^{-7}$ **g)** 8×10^{12} **h)** 2.5×10^{-5} **i)** 4.0×10^{4}