DAWSON COLLEGE

DEPARTMENT OF CHEMISTRY
and LABORATORY TECHNOLOGY
General Chemistry : 202-SN1-RE

Name: _____ _____
first (print) family (print)

Test no 2
Thursday, March 26, 2026
Room: 4D.2, 10:00 h

PLEASE turn off your cell phone

Instructions:

1. The duration of the exam is 75 minutes.
2. No extra books or paper may be used.
3. Make sure that there are no pages missing: total of 6 pages.
4. A Periodic Table of the Elements with constants has been provided.
5. Answers must be submitted in ink in order to preserve the right to grieve.
6. In order to receive full credit for your answer, your work must be shown.
7. Calculators may not be shared. Programmable calculators are not allowed.
8. Your attention is drawn to the college policy on cheating. This policy will be enforced.
9. Check you numbers twice. A calculator never does mistake, it just calculate the numbers input by the operator. If the number of digits is insufficient throughout the calculation, which gives a result different from the expected one, it will be considered as a calculation error.

For each math error or bad number transcript: −1 mark.

for questions involving calculations, write your final answer in ink in the appropriate space

Question 1 :	/ 4	Question 4 :	/ 3	Question 7 :	/ 6
Question 2 :	/ 3	Question 5 :	/ 8	Question 8 :	/ 3
Question 3 :	/ 4	Question 6 :	/ 10	Question 9 :	/ 4

Total : / 45

Question 1

Illustrate how each of the following strong electrolytes dissociates into its constituent ions when dissolved in water. (Example: $NaBr \rightarrow Na^+ + Br^-$, no need to write the state of matter) (3 marks)

a. $MgCl_2 \rightarrow$ **Mg^{2+} + $2Cl^-$**

b. $(NH_4)_2SO_4 \rightarrow$ **$2NH_4^+$ + SO_4^{2-}**

c. $AgCH_3CO_2 \rightarrow$ **Ag^+ + $CH_3CO_2^-$**

. . . . . .

d. Which of the following solutions of strong electrolytes contains the largest number of moles of chloride ions (circle one): (1 mark)

i) 40.0 mL of 0.15 M $AlCl_3$ **$18x10^{-3}$ mol Cl^-**

ii) 25.0 mL of 0.30 M $CaCl_2$ **$15x10^{-3}$ mol Cl^-**

iii) 100.0 mL of 0.20 M KCl **$20x10^{-3}$ mol Cl^-**

Question 2

What mass of $Ba(OH)_2$ is required to make 250.0 mL of a 0.400 M of OH^-(aq) solution? (3 marks)

$$\uparrow 171.3\ g/mol$$

$$\frac{(250.0\ mL)}{1000\ mL/L}\left(0.400\ \frac{mol}{L}\right)\frac{Ba(OH)_2}{2\ OH^-}\left(171.3\ g/mol\right) = 8.57\ g$$

answer: _____ **8.57 g** _____

Question 3

Complete and balance the formula equation AND write the corresponding balanced net ionic equations (without spectator ions) for each of the following reactions. (4 marks)

a. formula equation: $HCN(aq) + NaOH(aq) \rightarrow$ **$NaCN(aq) + H_2O(l)$**

b. net ionic equation of(a): **$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$**

(since HCN is a weak acid then $HCN(aq) + OH^-(aq) \rightarrow H_2O(l) + CN^-(aq)$ must also be accepted)

c. formula equation: $Fe(OH)_3(s) + H_3PO_4(aq) \rightarrow$ **$FePO_4(s) + 3H_2O(l)$**

d. net ionic equation of (c): **$Fe(OH)_3(s) + 3H^+(aq) + PO_4^{3-}(aq) \rightarrow FePO_4(s) + 3H_2O(l)$**

Question 4

A 25.00 mL sample of HCl(aq) solution requires 24.16 mL of 0.106 M NaOH(aq) for complete neutralization. What is the concentration of the original hydrochloric acid solution? (3 marks)

$$\frac{(24.16\ \text{mL})\times(0.106\ \text{mol/L}\ OH^-)\times(1H^+/1OH^-)}{25.00\ \text{mL}} = 0.102\ \text{mol/L}$$

answer: _____ **0.102 mol/L** _____

Question 5

On the basis of the general solubility rules, predict which of the following compounds are likely to be soluble in water. (4 marks)

	compound	water soluble		
		yes	no	
a.	H_3PO_4	■	☐	Acid
b.	$Ba(CH_3COO)_2$	■	☐	Acetate
c.	LiCN	■	☐	Alkali metal
d.	$(NH_4)_2S$	■	☐	Ammonium

e. Circle the chemical that will form a precipitate if added to an NaOH(aq) solution: (1 mark)

$Zn(OH)_2(s)$ ZnI_2 K_2SO_4 CsBr

f. Circle the chemical that will NOT form a precipitate if added to an NaCl(aq) solution: (1 mark)

AgCl(s) **$PbCl_2(s)$**

$AgNO_3$ $Pb(ClO_3)_2$ $Sn(NO_3)_2$

g. What mass of Na_2CrO_4 is required to precipitate all of the silver ions from 75.0 mL of a 0.100 M solution of $AgNO_3$? (2 marks)

$$2Ag^+(aq) + CrO_4^{2-}(aq) \rightarrow Ag_2CrO_4(s)$$

$$(75\times10^{-3}\ \text{L})\times(0.100\ \frac{\text{mol}}{\text{L}}\ Ag^+)\times(\frac{1\,Na_2CrO_4}{2\,Ag^+})\times(161.98)\frac{\text{g}}{\text{mol}} = 0.607\ \text{g}$$

answer: _____**0.607 g**_____

Question 6

Assign oxidation number (or oxidation state) for the **underlined** atoms in each of the following:

(4 marks)

a. $\underline{\mathbf{Mn}}O_4^-$ **+7**

b. $\underline{\mathbf{P}}_4O_6$ **+3**

c. $Li_3\underline{\mathbf{N}}$ **−3**

d. $\underline{\mathbf{N}}H_4^+$ **−3**

. . . . . .

e. Balance the following oxidation–reduction reaction that occur in an aqueous acidic solution (4 marks)

$As_2O_3(s) + ClO^-(aq) \rightarrow H_3AsO_4(aq) + Cl^-(aq)$

$As_2O_3 \rightarrow 2H_3AsO_4$

$+5H_2O \quad +4H^+$

$+4e^-$

$As_2O_3 + 5H_2O \rightarrow 2H_3AsO_4 + 4H^+ + 4e^-$

$ClO^- \rightarrow Cl^-$

$+2H^+ \quad +H_2O$

$+2e^-$

$ClO^- + 2H^+ + 2e^- \rightarrow Cl^- + H_2O$

$\downarrow \times 2$

$2ClO^- + 4H^+ + 4e^- \rightarrow 2Cl^- + 2H_2O$

$As_2O_3 + 5H_2O + 2ClO^- + 4H^+ \rightarrow 2H_3AsO_4 + 4H^+ + 2Cl^- + 2H_2O$

$As_2O_3 + 3H_2O + 2ClO^- \rightarrow 2H_3AsO_4 + 2Cl^-$

$As_2O_3(s) + 2ClO^- + 3H_2O(l) \rightarrow 2H_3AsO_4 + 2Cl^-$

f. Circle the reactant that is being reduced: $As_2O_3(s)$ | $ClO^-(aq)$ (1 mark)

g. Circle the oxidizing agent : $As_2O_3(s)$ | $ClO^-(aq)$ (1 mark)

Question 7

Photosynthesis uses λ = 660 nm light to convert CO_2 and H_2O into glucose and O_2.

a. Calculate the frequency (ν) of this light. (2 marks)

$$c = \lambda \nu$$

$$\nu = \frac{c}{\lambda} = \frac{2.9979\times10^{8}\,m/s}{660\times10^{-9}\,m} = 4.54\times10^{14}\,s^{-1}\text{ or Hz}$$

answer: ___ **4.54×10^{14} Hz** ___

. . . . . .

A carbon–oxygen double bond (C=O) in a certain organic molecule absorbs radiation that has a frequency of $\nu = 6.0\times10^{13}\,s^{-1}$.

b. What is the energy for one mole of photons of this radiation? (2 marks)

$$E = h \nu$$

$$E_{photon} = (6.626\times10^{-34}\text{ J.s})(6.0\times10^{13}\,s^{-1}) = 3.98\times10^{-20}\text{ J/photon}$$

$$\text{Energy for 1 mol photon} = (3.98\times10^{-20}\text{ J/photon})(6.022\times10^{23}\,mol^{-1})$$

$E = 2.4\times10^{4}$ J/mol

answer: ____**E = 24 kJ/mol** ___

c. To what region of the electromagnetic spectrum does this radiation (part b) belong? (1 mark)

$$\lambda = \frac{c}{\nu} = \frac{2.9979\times10^{8}\,m/s}{6\times10^{13}\,s^{-1}} = 5.0\times10^{-6}\text{ m or } 5.0\,\mu m \quad \text{therefore:} \quad \textbf{Infrared}$$

d. A carbon–oxygen bond in a different molecule absorbs radiation at a frequency $\nu = 5.4\times10^{13}\,s^{-1}$.

Is this radiation more or less energetic than the radiation of part b? (circle one) (1 mark)

more energetic | less energetic

lower frequency = less energetic

Question 8

Alpha radiation (α) is in fact a very high energy particle produced during standard radioactive decay. Calculate the mass of an alpha particle traveling at 4.000% of the speed of light, with a deBroglie wavelength of $\lambda = 8.315\times10^{-15}$ m. (Provide a mass with 4 sig.fig. including the units) (3 marks)

$$\lambda = \frac{h}{p} = \frac{h}{mv}$$

$$m = \frac{h}{\lambda v} = \frac{(6.626\times10^{-34}\ kg\cdot m^2\cdot s)}{(8.315\times10^{-15}\ m)\left(\frac{4.000}{100}\cdot 2.998\times10^{8}\ m/s\right)} = 6.645\times10^{-27}\ kg$$

answer: _ **6.645×10^{-27} kg** _

Question 9

An excited hydrogen atom with an electron in the principal quantum level n = 5 level emits light at a frequency of 2.34×10^{14} Hz after the electron transition to another level. Find the final level of the electron (or n_{final} value) (4 marks)

$$E_{photon} = h\nu = (6.626\times10^{-34}\ J\cdot s)(2.34\times10^{14}\ s^{-1}) = 1.55\times10^{-19}\ J$$

$$\Delta E_{atom} = E_f - E_i$$

$$-1.55\times10^{-19}\ J = -\frac{B}{n^2} - \frac{-B}{5^2}$$

negative
photon emitted

$$-1.55\times10^{-19}\ J = -B\left(\frac{1}{n^2} - \frac{1}{25}\right)$$

$$\frac{-1.55\times10^{-19}\ J}{-2.18\times10^{-18}\ J} = \frac{1}{n^2} - \frac{1}{25} \Rightarrow n = \sqrt{\left(0.0711 + \frac{1}{25}\right)^{-1}}$$

$$n = 3$$

answer: _____ **n = 3** _____