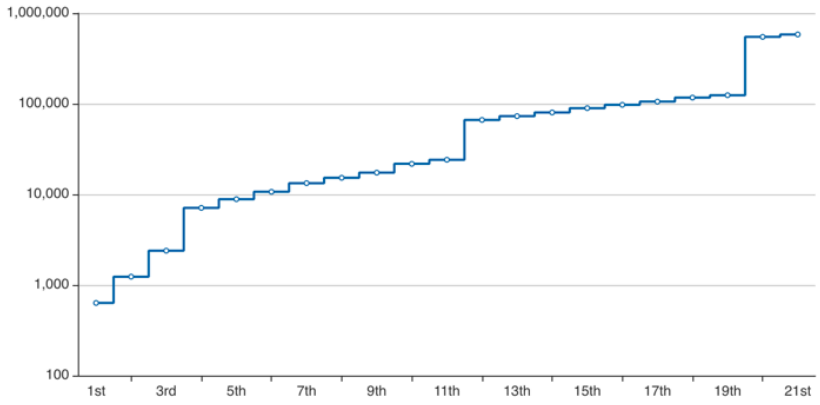
Test: Term 2 Test 2 (2019)

Name and chemistry block: _____

There is a total of 40 points, and is to be completed within 60 min. Calculators and Data Booklets are allowed.

[1] 1. Which element gives the following successive ionization energy graph?



A. B

B. Al

C. Sc

D. Ga

[1] 2. Which has the most **unpaired** electrons?

A. N^{2-}

B. N

C. Cu^{2+}

D. Cu

[1] 3. Which species **do not** satisfy the “octet rule”?

A. BF_4^-

B. NF_3

C. PF_4^+

D. CF_2

[1] 4. Which pair of chemicals can react with one another?

A. $F_2 + Br_2$

B. $F_2 + NaBr$

C. $NaF + Br_2$

D. $NaF + NaBr$

[1] 5. Which molecule has a V-shaped/bent molecular geometry?

A. NO

B. NO_2^+

C. NO_2^-

D. N_2O

[1] 6. Which pair of chemicals react the most vigorously?

A. $Li_{(s)} + LiCl_{(s)}$

B. $Na_{(s)} + NaCl_{(s)}$

C. $Li_{(s)} + HCl_{(aq)}$

D. $Na_{(s)} + HCl_{(aq)}$

[1] 7. An alloy is

A. A homogenous mixture of two or more metals.

B. A heterogenous mixture of two or more metals.

C. A homogenous mixture of a metal with other metals or non-metals.

D. A heterogenous mixture of a metal with other metals or non-metals.

[1] 8. Which functional groups contain a C=O bond?

I Ketone

II Ether

III Amine

A. I only

B. I & II

C. I & III

D. I, II, and III

9. The hydrogen absorption spectra in the **visible** range is shown in Figure 1.

Figure 1 Hydrogen absorption spectra in visible range.

[1] (a) Which is a suitable label for the axis?

A. E $(\frac{kJ}{mol})$

B. λ (nm)

C. ν (Hz)

D. f (s^{-1})

[1] (b) The line labeled with * represents the transition:

A. n=2 $\longrightarrow$ n=4

B. n=2 $\longrightarrow$ n=3

C. n=1 $\longrightarrow$ n=3

D. n=1 $\longrightarrow$ n=2

10. The half-life of ^{63}Ni is 100 years.

[1] (a) How many neutrons is in an atom of ^{63}Ni?

(a) _____

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[1] (b) Starting with 1,000,000 atoms of ^{63}Ni in 2020, estimate the number remaining in *3*020.

(b) _____

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11. Hydrazine N_2H_4 is a highly toxic, dangerously unstable compound used in some rocket fuels.

[2] (a) i. Draw a Lewis structure for hydrazine $N_2H_{4(l)}$. Annotate the diagram with bond dipoles.

[1] ii. α) Identify the **electron domain geometry** of the nitrogen atoms.

α) _____

[1] β) Identify the **molecular geometry** of the nitrogen atoms.

β) _____

[1] iii. Estimate[1] the bond angle around a nitrogen atom.

iii. _____

[1] iv. Explain whether hydrazine is expected to be a polar molecule.

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[1] Give an educated guess of a single value. Do **not** give a range like $< 360°$

(b) Hydrazine decomposes to give nitrogen gas $N_{2(g)}$ and hydrogen gas $H_{2(g)}$ via the reaction

$$N_2H_{4(l)} \longrightarrow N_{2(g)} + 2\,H_{2(g)}$$

The enthalpy of reaction ΔH°_{rxn} is -50.6 kJ/mol.

At SATP, 100.0 g of hydrazine is decomposed in a calorimeter surrounded by 500.0 cm^3 chamber filled with water.

[2] i. Calculate the number of moles in 100.0 g of hydrazine.

i. _____

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[1] ii. Calculate the heat released when 100.0 g of hydrazine decomposes. (If you were unable to completed the last question[2] you may use a value of 5.00 mol although this is not the correct answer.)

ii. _____

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[2] iii. Deduce the temperature of the water after the hydrazine completely decomposes. (If you were unable to complete the last question, you may use a value of 1.00×10^2 kJ although that is not the correct answer.)

iii. _____

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[2] In other words, if you completed the last question, use that value.

[1] iv. State **one** assumption in the previous calculation, other than "no heat loss to surroundings".

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12. Lithium is a flammable metal, with important applications in glass, steel production, and in lithium-ion batteries.

(a) Lithium exists as two stable isotopes, ^{6}Li (5%) and ^{7}Li (95% abundance).

[1] i. Sketch a mass spectra for naturally occurring lithium. Label both axes.

[1] ii. Calculate the relative atomic mass of lithium.

ii. _____

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[1] (b) Formulate an equation for the **second** ionization energy of lithium.

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[1] (c) Sketch a graph for the successive ionization energies of lithium. Use a logarithmic scale for energy. Label the axes.

[2] (d) Explain, giving **two** reasons, why lithium has lower density (0.534 g/cm^3) than beryllium (1.85 g/cm^3).

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[2] (e) Explain, using a chemical equation, why water-based fire extinguishers **cannot** be used to put out a lithium fire.

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13. Aspirin and ibuprofen are medications used to treat pain and inflammation. Aspirin's 3D structure is shown in Figure 2.

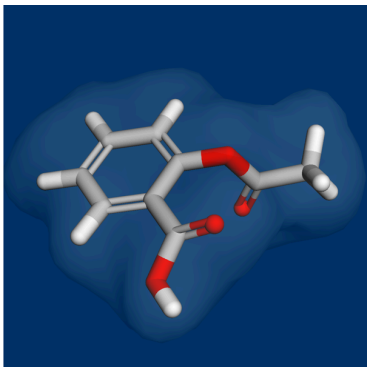

Figure 2 3D structure of aspirin.

[1] (a) Draw a **skeletal** (simplified) structural formula of aspirin.

[2] (b) State **two** functional groups present in aspirin. Do not include "alkane" as one of your answers.

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[1] (c) Figure 3 shows the 3D structure and skeletal structure of ibuprofen.

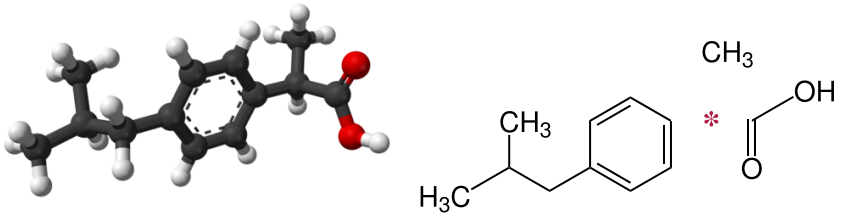

Figure 3 Structures of ibuprofen.

Using appropriate bonds to represent the 3D shape, complete the structure at the starred * carbon.

14. Figure 4 shows the first ionization energy and electron affinity for the element sodium to potassium.

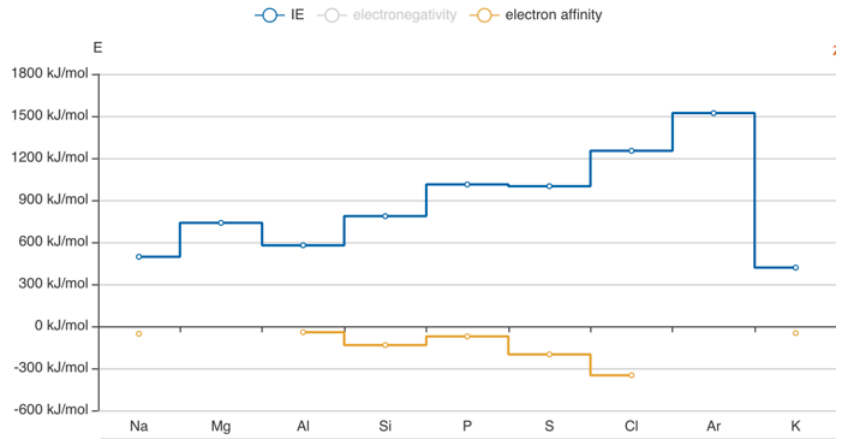

Figure 4 Periodic trends

By referring to their electron configurations, explain:

[1] (a) Why I.E. decreases from Mg to Al.

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[1] (b) Why I.E. decreases from P to S.

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[1] (c) Why I.E. increases from S to Ar.

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[1] (d) Why no E.A. is available for Ar.

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