SECTION ONE - Multiple Choice   25% [50 marks]

Answer all the questions on the separate Multiple Choice Answer Sheet provided. For each question shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. If you make a mistake, place a cross through that square then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Suggested working time: 50 minutes

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1.   Consider the following system at equilibrium.

$$Pb^{2+}_{(aq)} + 2\,Br^-_{(aq)} \rightarrow PbBr_{2(s)} + heat$$
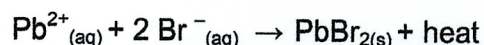
Which one of the following changes would cause the concentration of lead(II) ions to be lowered (compared to the original concentration) once equilibrium is re-established?
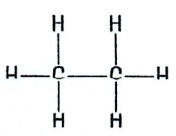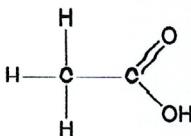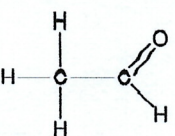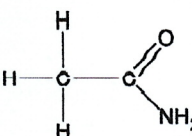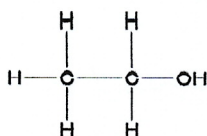
(a)   Adding potassium iodide solution.
(b)   Stirring the mixture.
(c)   Warming the system.
(d)   Adding solid lead(II) bromide to the system.

2.   The five (5) substances named below were dissolved in water and the pH of each was determined by adding a few drops of universal indicator. For which of these substances is the observed pH **unable** to be explained by the Arrhenius theory of acids and bases?

          (i)   Hydrochloric acid, HCl
          (ii)   Ethanoic acid, CH_3COOH
          (iii)   Ammonia, NH_3
          (iv)   Calcium carbonate, $CaCO_3$
          (v)   Sodium hydroxide, NaOH

(a)   (ii) and (iii)
(b)   (i) and (iv)
(c)   (iii) and (iv)
(d)   (iv) and (v)

3.   In which of the following is there an element with the same oxidation number as sulfur in HSO_4^- ?

(a) P_4O_{10}
(b) $K_2Cr_2O_7$
(c) $KMnO_4$
(d) VO^{2+}

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Questions 4 and 5 refer to the information below.

Consider the following five (5) organic compounds.

| (i)	(ii)	(iii)	(iv)	(v)
CH_3CH_3	CH_3COOH	CH_3CHO	CH_3CONH_2	CH_3CH_2OH

4.   Which of the following lists contain compounds that **all** have the ability to form hydrogen bonds?

(a)   all of (i), (ii), (iii), (iv) and (v)
(b)   (ii), (iii), and (iv) only
(c)   (i), (ii), (iii) and (v) only
(d)   (ii), (iv) and (v) only

5.   Which of the following statements regarding the five compounds is **not** correct?

(a) CH_3CONH_2 is water-soluble.
(b) CH_3COOH is miscible with CH_3CH_2OH.
(c) CH_3CH_3 has the highest boiling point.
(d) CH_3CHO is able to form dipole-dipole forces.

6.   Consider the following equation.

$$2NH_{3(g)} \rightleftharpoons N_{2(g)} + 3H_{2(g)} \qquad \Delta H = + 91 \text{ kJ/mol}$$
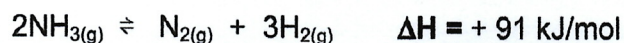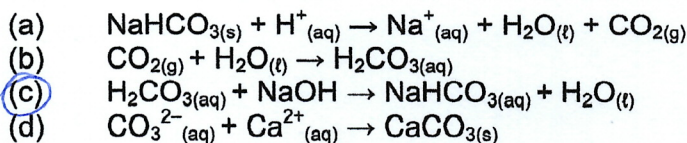
Which of the following changes will increase the concentration of the product, but decrease the yield of the reaction?

(a)   Addition of a catalyst and an increase in the vessel temperature
(b)   A decrease in the volume of the reaction vessel
(c)   A decrease in the temperature of the reaction vessel
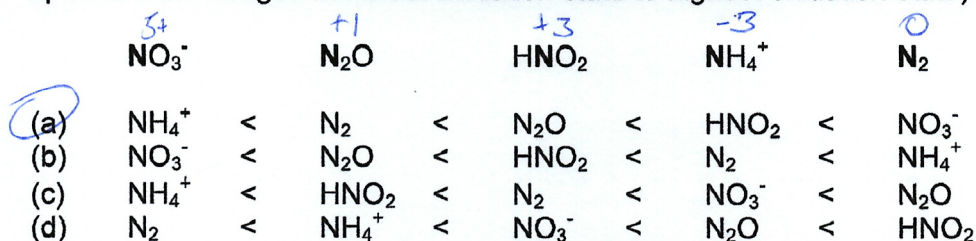(d)   An increase in the volume of the reaction vessel

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7.   What energy change occurs when 1.5 g of hydrogen gas reacts with 7.0 g of oxygen according to the following equation?

$$2H_{2(g)} + O_{2(g)} \rightleftharpoons 2H_2O_{(g)} \qquad \Delta H = -572 \text{ kJ/mol}$$
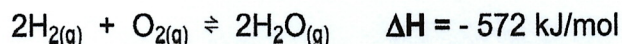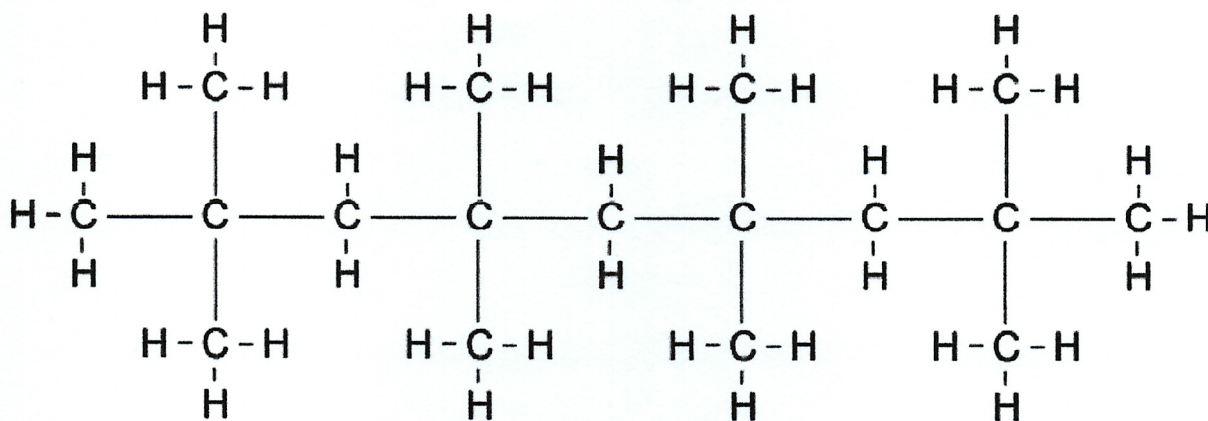
(a)   429 kJ of energy absorbed
(b)   429 kJ of energy released
(c)   125 kJ of energy released
(d)   215 kJ of energy released

8.   In which one of the following reactions is the carbon-containing species acting as a Bronsted-Lowry acid?

(a) $NaHCO_{3(s)} + H^+_{(aq)} \rightarrow Na^+_{(aq)} + H_2O_{(\ell)} + CO_{2(g)}$
(b) $CO_{2(g)} + H_2O_{(\ell)} \rightarrow H_2CO_{3(aq)}$
(c) $H_2CO_{3(aq)} + NaOH \rightarrow NaHCO_{3(aq)} + H_2O_{(\ell)}$
(d) $CO_3^{2-}{}_{(aq)} + Ca^{2+}{}_{(aq)} \rightarrow CaCO_{3(s)}$

9.   Rank the following substances in order of increasing **nitrogen** oxidation number (i.e. from species with nitrogen in lowest oxidation state to highest oxidation state).

$\overset{5+}{NO_3^-} \qquad \overset{+1}{N_2O} \qquad \overset{+3}{HNO_2} \qquad \overset{-3}{NH_4^+} \qquad \overset{0}{N_2}$

(a) $NH_4^+ \ < \ N_2 \ < \ N_2O \ < \ HNO_2 \ < \ NO_3^-$
(b) $NO_3^- \ < \ N_2O \ < \ HNO_2 \ < \ N_2 \ < \ NH_4^+$
(c) $NH_4^+ \ < \ HNO_2 \ < \ N_2 \ < \ NO_3^- \ < \ N_2O$
(d) $N_2 \ < \ NH_4^+ \ < \ NO_3^- \ < \ N_2O \ < \ HNO_2$

10.   Consider the section of the polymer below.

Which one of the following is the correct name for the monomer used to synthesise this polymer?

(a)   but-1-ene
(b)   but-2-ene
(c)   2-methylpropene
(d)   2,2-dimethylethene

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11.   Which one of the following 1.0 mol L^{-1} solutions will have the lowest pH?

   (a)   sodium hydrogencarbonate
   (b)   ammonium chloride
   (c)   sodium ethanoate
   (d)   sodium hydrogenphosphate

Questions 12, 13 and 14 relate to the equilibrium system below.

At temperatures greater than 1000 °C, gaseous octasulfur (S_8) can undergo an endothermic decomposition to form gaseous disulfur (S_2) as shown in the equation below.

$$S_{8(g)} \rightleftharpoons 4\ S_{2(g)}$$
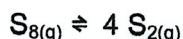
Some $S_8(g)$ was placed in an empty rigid container and allowed to establish equilibrium at 1052°C. At this temperature the value of K for this equilibrium system is 324.

12.   Once the system has established equilibrium, which of the following statements are **correct**?

   (i)   The total pressure inside the container will be constant.
   (ii)   The pressure inside the container will be higher than initially.
   (iii)   The colour of the gaseous mixture will be constant.
   (iv)   The rates of the forward and reverse reactions will be equal.
   (v)   The concentration of S_8 and S_2 will be equal.

   (a)   (i), (iii) and (iv) only
   (b)   (ii), (iv) and (v) only
   (c)   (i), (ii), (iii) and (iv) only
   (d)   (i), (ii), (iii), (iv) and (v)

13.   Which of the following statements regarding K for this equilibrium system is **correct**?

   (a)   At equilibrium there is a higher concentration of $S_8(g)$ present than $S_2(g)$.
   (b)   If the temperature of the system was decreased the value of K would increase.
   (c)   The equilibrium constant expression can be written $K = \dfrac{[S_8]}{[S_2]}$
   (d)   The equilibrium constant expression can be written $K = \dfrac{[S_2]^4}{[S_8]}$

14.   Once the system had established equilibrium, various changes were imposed on the system and the effects of these changes were predicted using Le Chatelier's principle. Which of the following is **not** correct (i.e. the predicted effect on the equilibrium position does **not** match the imposed change stated)?

	Imposed change	Effect on equilibrium position
(a)	Pressure increase	←
(b)	Removal of S_2	←
(c)	Temperature increase	→
(d)	Addition of S_8	→

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Questions 15 and 16 refer to the information below.

There are several different types of fuel cells, which mostly differ in terms of the fuel being utilised. One of the most common fuel cells is the hydrogen / oxygen fuel cell. A partially completed sketch of an hydrogen / oxygen fuel cell operating with an acid electrolyte is shown in the diagram below. The only overall chemical product of the hydrogen / oxygen fuel cell is water.
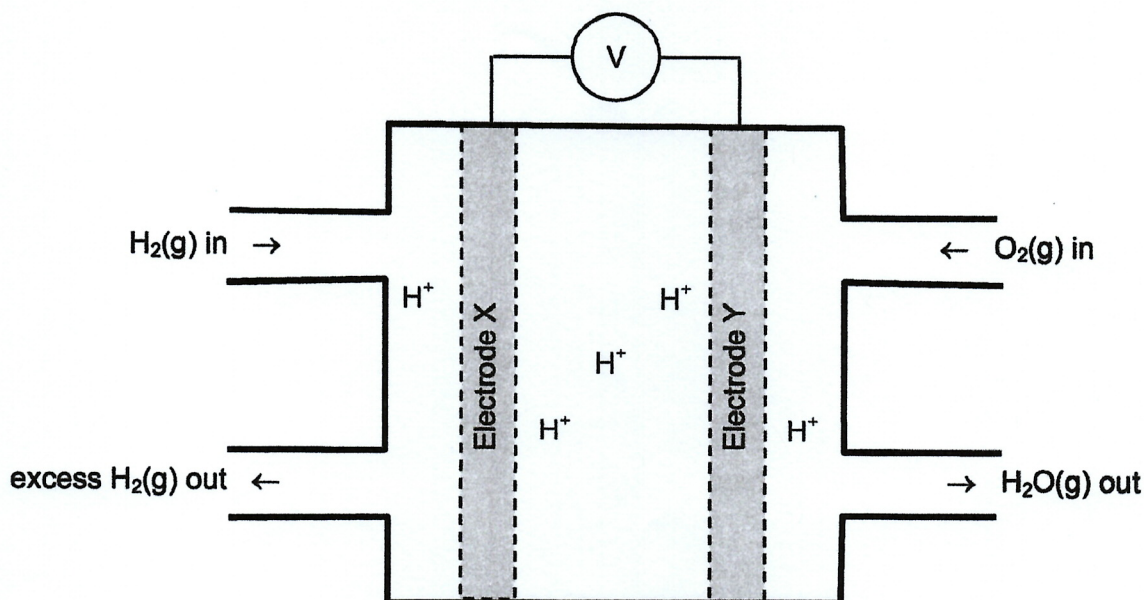
15. Which of the following statements are **correct**, regarding **fuel cells in general**?

    (i) Fuel cells involve a redox reaction.
    (ii) Fuel cells require continuous input of reactants to operate.
    (iii) Fuel cells are a type of galvanic cell.
    (iv) Fuel cells are a type of secondary cell.
    (v) Fuel cells do not produce any sources of pollution.

    (a) (i), (ii) and (iii) only
    (b) (i), (ii) and (v) only
    (c) (ii), (iii) and (iv) only
    (d) (i), (ii), (iii) and (v) only

16. Which of the following statements is **correct,** regarding the **hydrogen/oxygen fuel cell** shown in the diagram above?

    (a) Reduction occurs at X.
    (b) Electrons move from Y to X.
    (c) Cations move towards Y.
    (d) The EMF of this cell under standard conditions is 1.15 volts.

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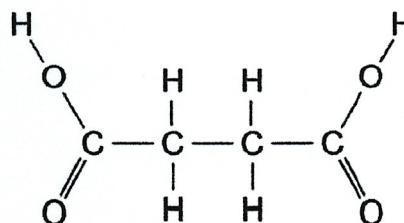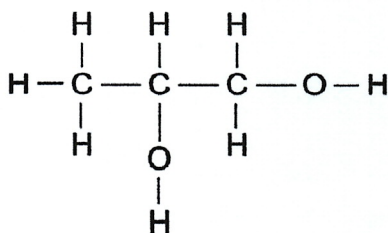17.   The molecule that could be oxidised to form propanoic acid is

       (a) CH_3CH_2OH
       (b) CH_3CH_2COOH
       (c) $(CH_3)_2CHOH$
       (d) $CH_3CH_2CH_2OH$

18.   Which of the following will form a buffer solution

              i. $NH_{3(aq)}$ / $NH_4Cl_{(aq)}$
              ii. $NH_{3(aq)}$ / $HCl_{(aq)}$
              iii. $HCl_{(aq)}$ / $NH_4Cl_{(aq)}$
              iv. $H_2PO_4^-{}_{(aq)}$ / $HPO_4^{2-}{}_{(aq)}$
              v. $H_2SO_{4(aq)}$ / $HSO_4^-{}_{(aq)}$

       (a)   i and iv only
       (b)   i, iv and v only
       (c)   i,ii and iv only
       (d)   iv only

19.   The following substances were reacted together

       Which one of the following would be the type of product produced?

       (a)   a soap
       (b)   a fatty acid
       (c)   a polyester
       (d)   a protein

20.   Consider the dipeptide below:

 $HOOCCH(CH_3)NHCOCH(CH_2OH)NH_2$

       Use your data sheet to identify which pair of amino acids below would form this peptide.

       (a)   alanine and valine
       (b)   valine and threonine
       (c)   glycine and serine
       (d)   serine and alanine

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21.   Which of the following statements about volumetric analysis is INCORRECT?

    (a)   All titrations need an indicator added in order to detect the end point.
    (b)   The end point can occur after the equivalence point
    (c)   Pipettes deliver an aliquot
    (d)   Rinsing the burette with the solution it will deliver will not alter the result

22.   The equation for the autoionisation of water is shown below, along with two values for K_w at two corresponding temperatures.

$$H_2O(l) \ + \ H_2O(l) \ \rightleftharpoons \ H_3O^+(aq) \ + \ OH^-(aq)$$
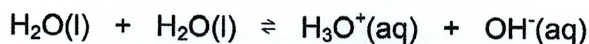
$K_w = 1.0 \times 10^{-14}$ at 25 °C
$K_w = 2.9 \times 10^{-14}$ at 40 °C

Considering the information provided, which of the following statements is **not** correct?

    (a)   The autoionisation of water is an endothermic process.
    (b)   The concentration of H_3O^+ in water at 40 °C is higher than water at 25 °C.
    (c)   The pH of water at 40 °C is lower than water at 25 °C.
    (d)   The water at 40 °C is slightly more acidic than water at 25 °C.

23.   Which one of the following are NOT bonds between sections of a protein that contribute to the tertiary structure of the protein?

    (a)   C=O bonds
    (b)   hydrogen bonds
    (c)   S-S bonds
    (d)   dispersion forces

24.   Which of the following reactions will occur spontaneously?

    i. $2\,I^-_{(aq)} + Br_{2(aq)} \rightarrow 2\,Br^-_{(aq)} + I_{2(aq)}$
    ii. $Cu_{(s)} + 2\,HCl_{(aq)} \rightarrow CuCl_{2(aq)} + H_{2(aq)}$
    iii. $Sn_{(s)} + Cd^{2+}_{(aq)} \rightarrow Sn^{2+}_{(aq)} + Cd_{(s)}$
    iv. $H_2O_{2(aq)} + Ni^{2+}_{(aq)} \rightarrow O_{2(g)} + 2\,H^+_{(aq)} + Ni_{(s)}$

    (a)   i and iv only
    (b)   i only
    (c)   iii and iv
    (d)   iv only

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25.   Which one of the following pairs of compounds would from propyl methanoate when warmed
       with concentrated sulfuric acid?

       (a) CH_4 and CH_3CH_2COOH
       (b) CH_3OH and $CH_3CH_2CH_2OH$
       (c) CH_3OH and CH_3CH_2COOH
       (d) $HCOOH$ and $CH_3CH_2CH_2OH$

END OF SECTION ONE

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