**A-LEVEL CHEMISTRY**

**PAPER 1**

**PRACTICE PAPER 1**

Answer all questions

Max 105 marks

2 hours

|  |  |  |
| --- | --- | --- |
|  | Name …………………………………………………………….. |  |
|  | Mark ……../105 ……....% Grade ……… |  |

|  |  |
| --- | --- |
| **1.** |  |
|  | (2 marks) |
|  | **(Total 9 marks)** |
| **2.** | ………………………………………………………………………………………………………………………………………………………………………………...………………………………………………………………………………………………………………………………………………………………………………...………………………………………………………………………………………………………………………………………………………………………………...**(Total 6 marks)** |
| **3.** | **(Total 6 marks)** |

**4.** The oxides nitrogen monoxide (NO) and nitrogen dioxide (NO2) both contribute to atmospheric pollution.

The table gives some data for these oxides and for oxygen.

|  |  |  |
| --- | --- | --- |
|   | **Sϴ / JK–1 mol–1** | **∆Hfϴ / kJ mol–1** |
| O2(g) | 211 | 0 |
| NO(g) | 205 | +90 |
| NO2(g) | 240 | +34 |

Nitrogen monoxide is formed in internal combustion engines. When nitrogen monoxide comes into contact with air, it reacts with oxygen to form nitrogen dioxide.

NO(g)    +    O2(g)        NO2(g)

(a)     Calculate the enthalpy change for this reaction.

........................................................................................................................

........................................................................................................................

........................................................................................................................

........................................................................................................................

 **(2)**

(b)     Calculate the entropy change for this reaction.

........................................................................................................................

........................................................................................................................

........................................................................................................................

........................................................................................................................

 **(2)**

(c)     Calculate the temperature below which this reaction is spontaneous.

........................................................................................................................

........................................................................................................................

........................................................................................................................

........................................................................................................................

........................................................................................................................

**(2)**

(d)     Suggest **one** reason why nitrogen dioxide is **not** formed by this reaction in an internal combustion engine.

........................................................................................................................

........................................................................................................................

**(1)**

(e)     Write an equation to show how nitrogen monoxide is formed in an internal combustion engine.

........................................................................................................................

**(1)**

(f)      Use your equation from part (e) to explain why the free-energy change for the reaction to form nitrogen monoxide stays approximately constant at different temperatures.

........................................................................................................................

........................................................................................................................

........................................................................................................................

........................................................................................................................

 **(2)**

**(Total 10 marks)**

**5.**      (a)     By reference to the forces between molecules, explain why ammonia is very soluble in water.

......................................................................................................................

......................................................................................................................

**(2)**

(b)     Aqueous solutions of ammonia have a pH greater than 7.

(i)      Write an equation for the reaction of ammonia with water.

.............................................................................................................

(ii)     Explain why the pH of a solution containing 1.0 mol dm–3 of ammonia is less than
14 at 298 K.

.............................................................................................................

.............................................................................................................

**(3)**

(c)     An ammonium ion in aqueous solution can behave as a Brønsted–Lowry acid. State what is meant by the term *Brønsted–Lowry acid*.

.....................................................................................................................................

**(1)**

(d)     State what is meant by the term *buffer solution*. Identify a reagent which could be added to a solution of ammonia in order to form a buffer solution.

*Buffer solution* ..............................................................................................

......................................................................................................................

*Reagent* ........................................................................................................

**(3)**

(e)     An acidic buffer solution is obtained when sodium ethanoate is dissolved in aqueous ethanoic acid.

(i)      Calculate the pH of the buffer solution formed at 298 K when 0.125 mol of sodium ethanoate is dissolved in 250 cm3 of a 1.00 mol dm–3 solution of ethanoic acid.
The acid dissociation constant, *K*a, for ethanoic acid is 1.70 × 10–5 mol dm–3 at 298 K.

.............................................................................................................

.............................................................................................................

.............................................................................................................

.............................................................................................................

.............................................................................................................

.............................................................................................................

(ii)     Write an ionic equation for the reaction which occurs when a small volume of dilute hydrochloric acid is added to this buffer solution.

.............................................................................................................

**(5)**

**(Total 14 marks)**

**6.** In order to obtain a pH curve, you are provided with a conical flask containing 25.0 cm3 of a 0.100 mol dm–3 carboxylic acid solution and a burette filled with 0.100 mol dm–3 sodium hydroxide solution. You are also provided with a calibrated pH meter.

(a)     State why calibrating a pH meter just before it is used improves the accuracy of the pH measurement.

........................................................................................................................

........................................................................................................................

**(1)**

(b)     Describe how you would obtain the pH curve for the titration.

........................................................................................................................

........................................................................................................................

........................................................................................................................

........................................................................................................................

........................................................................................................................

........................................................................................................................

........................................................................................................................

........................................................................................................................

........................................................................................................................

........................................................................................................................

**(5)**

**(Total 6 marks)**

 **7.** One cell that has been used to provide electrical energy is the Daniell cell. This cell uses copper and zinc.

(a)     The conventional representation for the Daniell cell is

Zn(s) | Zn2+(aq) | | Cu2+(aq) | Cu(s)

The e.m.f. of this cell under standard conditions is +1.10 V.

Deduce the half-equations for the reactions occurring at the electrodes.

At Zn electrode ..............................................................................................

At Cu electrode ..............................................................................................

**(2)**

(b)     A Daniell cell was set up using 100 cm3 of a 1.0 mol dm–3 copper(II) sulfate solution. The cell was allowed to produce electricity until the concentration of the copper(II) ions had decreased to 0.50 mol dm–3.

Calculate the decrease in mass of the zinc electrode. Show your working.

........................................................................................................................

........................................................................................................................

........................................................................................................................

........................................................................................................................

........................................................................................................................

**(3)**

(c)     You are provided with the Daniell cell referred to in part (b), including a zinc electrode of known mass.

Briefly outline how you would carry out an experiment to confirm your answer to part (b).

........................................................................................................................

........................................................................................................................

........................................................................................................................

........................................................................................................................

........................................................................................................................

........................................................................................................................

**(3)**

**(Total 8 marks)**

**8.** The data in the table below show the melting points of oxides of some Period 3 elements.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Na2O | P4O10 | SO2 |
| Tm/K | 1548 | 573 | 200 |

(a)     In terms of structure and bonding, explain why

(i)      sodium oxide has a high melting point

...............................................................................................................

...............................................................................................................

...............................................................................................................

 **(2)**

(ii)     sulfur dioxide has a low melting point.

...............................................................................................................

...............................................................................................................

...............................................................................................................

...............................................................................................................

 **(2)**

(b)     Explain why the melting point of P4O10 is higher than the melting point of SO2

........................................................................................................................

........................................................................................................................

........................................................................................................................

 **(2)**

(c)     Write equations for the reactions of Na2O and P4O10 with water. In each case give the approximate pH of the resulting solution.

Equation for Na2O..........................................................................................

pH ....................................

Equation for P4O10.........................................................................................

pH ....................................

 **(4)**

(d)     Write an equation for the acid–base reaction that occurs when Na2O reacts with P4O10 in the absence of water.

........................................................................................................................

**(1)**

**(Total 11 marks)**

**9.**          Transition metals and their complexes have characteristic properties.

(a)     Give the electron configuration of the Zn2+ ion.
Use your answer to explain why the Zn2+ ion is **not** classified as a transition metal ion.

Electron configuration ..................................................................................

Explanation ..................................................................................................

......................................................................................................................

**(2)**

(b)     In terms of bonding, explain the meaning of the term *complex*.

......................................................................................................................

......................................................................................................................

......................................................................................................................

......................................................................................................................

**(2)**

(c)     Identify **one** species from the following list that does **not** act as a ligand. Explain your answer.

H2          O2–          O2          CO

**Not** a ligand..................................................................................................

Explanation ...................................................................................................

**(2)**

(d)     The element palladium is in the d block of the Periodic Table. Consider the following palladium compound which contains the sulfate ion.

[Pd(NH3)4]SO4

(i)      Give the oxidation state of palladium in this compound.

.............................................................................................................

**(1)**

(ii)     Give the names of two possible shapes for the complex palladium ion in this compound.

Shape 1 ..............................................................................................

Shape 2 ..............................................................................................

**(2)**

**(Total 9 marks)**

**10.** Consider the following reaction scheme that starts from aqueous [Cu(H2O)6]2+ ions.

 
green-blue precipitate

For each of the reactions **1** to **4**, identify a suitable reagent, give the formula of the copper-containing species formed and write an equation for the reaction.

(a)     Reaction **1**

Reagent ........................................................................................................

Copper-containing species ...........................................................................

Equation ........................................................................................................

**(3)**

(b)     Reaction **2**

Reagent ........................................................................................................

Copper-containing species ...........................................................................

Equation ........................................................................................................

**(3)**

(c)     Reaction **3**

Reagent ........................................................................................................

Copper-containing species ...........................................................................

Equation ........................................................................................................

**(3)**

(d)     Reaction **4**

Reagent ........................................................................................................

Copper-containing species ...........................................................................

Equation ........................................................................................................

**(3)**

**(Total 12 marks)**

|  |  |
| --- | --- |
| **11.** |  |
|  | (a) |  |
|  | (b) |  |
|  | (c) |  |
|  | (d) |  |
|  | (e) |  |
|  | (f) |  |
|  | (g) |  |
|  | (h) |  |
|  | (i) |  |
|  | (j) | **(Total 14 marks)** |