22106113

CHEMISTRY
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PAPER 1

Wednesday 12 May 2010 (afternoon)

1 hour

INSTRUCTIONS TO CANDIDATES

- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.
- The periodic table is provided for reference on page 2 of this examination paper.

The Periodic Table

1	2		3	4	5	6	7	0
1 **H** 1.01								2 **He** 4.00
3 **Li** 6.94	4 **Be** 9.01		5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
11 **Na** 22.99	12 **Mg** 24.31		13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.06	17 **Cl** 35.45	18 **Ar** 39.95

Atomic Number

Element

Atomic Mass

19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.90	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.71	29 **Cu** 63.55	30 **Zn** 65.37	31 **Ga** 69.72	32 **Ge** 72.59	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.90	36 **Kr** 83.80
37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.94	43 **Tc** 98.91	44 **Ru** 101.07	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.40	49 **In** 114.82	50 **Sn** 118.69	51 **Sb** 121.75	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.30
55 **Cs** 132.91	56 **Ba** 137.34	57 † **La** 138.91	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.85	75 **Re** 186.21	76 **Os** 190.21	77 **Ir** 192.22	78 **Pt** 195.09	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.37	82 **Pb** 207.19	83 **Bi** 208.98	84 **Po** (210)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89 ‡ **Ac** (227)															

†
58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** 146.92	62 **Sm** 150.35	63 **Eu** 151.96	64 **Gd** 157.25	65 **Tb** 158.92	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.04	71 **Lu** 174.97

‡
90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np** (237)	94 **Pu** (242)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (254)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (260)

1. What is the mass, in g, of one molecule of ethane, C_2H_6?

A. 3.0×10^{-23}

B. 5.0×10^{-23}

C.   30

D. 1.8×10^{25}

2. 6.0 mol of aluminium reacts with oxygen to form aluminium oxide. What is the amount of oxygen, in mol, needed for complete reaction?

$$4Al(s) + 3O_2(g) \rightarrow 2Al_2O_3(s)$$
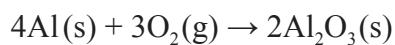
A.   1.5

B.   3.0

C.   4.5

D.   6.0

3. Which of the following is consistent with Avogadro's law?

A. $\dfrac{P}{T} = $ constant (V, n constant)

B. $\dfrac{V}{T} = $ constant (P, n constant)

C. $Vn = $ constant (P, T constant)

D. $\dfrac{V}{n} = $ constant (P, T constant)

4. A sample of element X contains 69 % of ^{63}X and 31 % of ^{65}X. What is the relative atomic mass of X in this sample?

A.   63.0

B.   63.6

C.   65.0

D.   69.0

5.   What is the electron configuration of Fe^{3+}?

   A. $[Ar]4s^2 3d^6$

   B. $[Ar]3d^5$

   C. $[Ar]4s^2 3d^5$

   D. $[Ar]4s^2 3d^3$

6.   Which ion has the largest radius?

   A. Cl^-

   B. K^+

   C. Br^-

   D. F^-

7.   Which oxides produce an acidic solution when added to water?

   I. P_4O_{10}
   II. MgO
   III. SO_3

   A.   I and II only

   B.   I and III only

   C.   II and III only

   D.   I, II and III

8. What is the ligand in the complex $K_3[Fe(CN)_6]$?

    A. CN^-

    B. Fe^{3+}

    C. K^+

    D. $[Fe(CN)_6]^{3-}$

9. Which species have a dative covalent bond?

    I. CO

    II. NH_3

    III. H_3O^+

    A. I and II only

    B. I and III only

    C. II and III only

    D. I, II and III

10. Which substance can form intermolecular hydrogen bonds in the liquid state?

    A. CH_3OCH_3

    B. CH_3CH_2OH

    C. CH_3CHO

    D. $CH_3CH_2CH_3$

11. Which molecule is polar?

    A. CH_2Cl_2

    B. BCl_3

    C. Cl_2

    D. CCl_4

12. The Lewis structure of XeF_2 contains two bonding pairs of electrons and three non-bonding pairs of electrons (lone pairs) around the central xenon atom. What is the shape of XeF_2 molecule?

    A.   Bent

    B.   Trigonal bipyramidal

    C.   Square planar

    D.   Linear

13. How many sigma (σ) bonds are present in $(CH_3)_2C=CClCH_2CH_3$?

    A.   1

    B.   4

    C.   16

    D.   17

14. Which processes are exothermic?

      I.   Ice melting

      II.   Neutralization

      III. Combustion

A.   I and II only

B.   I and III only

C.   II and III only

D.   I, II and III

15. The standard enthalpy changes for the combustion of carbon and carbon monoxide are shown below.

$$C(s) + O_2(g) \rightarrow CO_2(g) \qquad\qquad \Delta H_c^{\ominus} = -394 \text{ kJ mol}^{-1}$$

$$CO(g) + \tfrac{1}{2}O_2(g) \rightarrow CO_2(g) \qquad\qquad \Delta H_c^{\ominus} = -283 \text{ kJ mol}^{-1}$$

What is the standard enthalpy change, in kJ, for the following reaction?

$$C(s) + \tfrac{1}{2}O_2(g) \rightarrow CO(g)$$
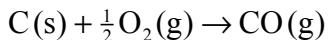
A.   −677

B.   −111

C.   +111

D.   +677

16. Which reaction has the most negative change in entropy?

A. $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$

B. $NH_4Cl(s) \rightarrow NH_3(g) + HCl(g)$

C. $PbCl_2(s) \rightarrow Pb^{2+}(aq) + 2Cl^-(aq)$

D. $C(s) + O_2(g) \rightarrow CO_2(g)$

Turn over
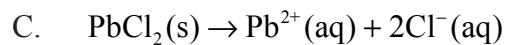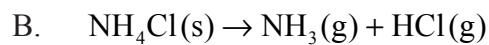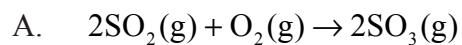
17. What is the standard free energy change, $\Delta G^{\ominus}$, in kJ, for the following reaction?

$$C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(g)$$
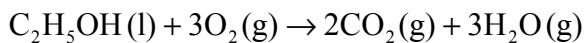
Compound	$\Delta G_f^{\ominus}$ / kJ mol^{-1}
$C_2H_5OH(l)$	−175
$CO_2(g)$	−394
$H_2O(g)$	−229
$O_2(g)$	0

A.   −1650

B.   −1300

C.   − 448

D.   +1300

18. Which unit could be used for the rate of a chemical reaction?

A.   mol

B.   mol dm^{-3}

C.   mol dm^{-3} s^{-1}

D.   dm^3

19. Consider the endothermic reaction below.

$$5CO(g) + I_2O_5(g) \rightleftharpoons 5CO_2(g) + I_2(g)$$
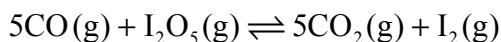
According to Le Chatelier's principle, which change would result in an increase in the amount of CO_2?

A.   Increasing the temperature

B.   Decreasing the temperature

C.   Increasing the pressure

D.   Decreasing the pressure

20. Which combination of ionic radius and ionic charge would result in the highest lattice enthalpy for an ionic compound?

	Ionic radius	Ionic charge
A.	small	high
B.	large	high
C.	small	low
D.	large	low

21. The following data were obtained for the reaction between gases A and B.

Experiment	Initial [A] / $mol\,dm^{-3}$	Initial [B] / $mol\,dm^{-3}$	Initial rate / $mol\,dm^{-3}\,min^{-1}$
1	1.0×10^{-3}	1.0×10^{-3}	2.0×10^{-4}
2	2.0×10^{-3}	1.0×10^{-3}	2.0×10^{-4}
3	2.0×10^{-3}	2.0×10^{-3}	4.0×10^{-4}

Which relationship represents the rate expression for the reaction?

A. $rate = k\,[B]^2$

B. $rate = k\,[A]^2$

C. $rate = k\,[A]$

D. $rate = k\,[B]$

Turn over

22. Consider the following reaction.

$$NO_2(g) + CO(g) \rightarrow NO(g) + CO_2(g)$$
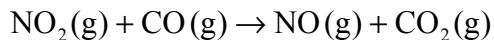
At $T < 227\,°C$ the rate expression is $rate = k[NO_2]^2$. Which of the following mechanisms is consistent with this rate expression?

A. $NO_2 + NO_2 \rightleftharpoons N_2O_4$ *fast*
$N_2O_4 + 2CO \rightarrow 2NO + 2CO_2$ *slow*

B. $NO_2 + CO \rightarrow NO + CO_2$ *slow*

C. $NO_2 \rightarrow NO + O$ *slow*
$CO + O \rightarrow CO_2$ *fast*

D. $NO_2 + NO_2 \rightarrow NO_3 + NO$ *slow*
$NO_3 + CO \rightarrow NO_2 + CO_2$ *fast*

23. 0.50 mol of $I_2(g)$ and 0.50 mol of $Br_2(g)$ are placed in a closed flask. The following equilibrium is established.

$$I_2(g) + Br_2(g) \rightleftharpoons 2IBr(g)$$
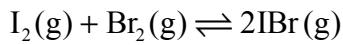
The equilibrium mixture contains 0.80 mol of $IBr(g)$. What is the value of K_c?

A. 0.64

B. 1.3

C. 2.6

D. 64

24. Which species behave as Brønsted-Lowry acids in the following reversible reaction?

$$H_2PO_4^-(aq) + CN^-(aq) \rightleftharpoons HCN(aq) + HPO_4^{2-}(aq)$$
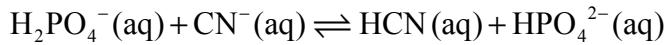
A. HCN and CN^-

B. HCN and HPO_4^{2-}

C. $H_2PO_4^-$ and HPO_4^{2-}

D. HCN and $H_2PO_4^-$

25. Which of the following are weak acids in aqueous solution?

      I. CH_3COOH

      II. H_2CO_3

      III. HCl

A.   I and II only

B.   I and III only

C.   II and III only

D.   I, II and III

26. pK_w for water at $10\,°C = 14.54$. What is the pH of pure water at this temperature?

A.   6.73

B.   7.00

C.   7.27

D.   7.54

27. What is K_b for the aqueous fluoride ion given that K_w is 1.0×10^{-14} and K_a for HF is 6.8×10^{-4} at 298 K?

A. $\dfrac{1}{6.8 \times 10^{-4}}$

B. $(6.8 \times 10^{-4})(1.0 \times 10^{-14})$

C. $\dfrac{1.0 \times 10^{-14}}{6.8 \times 10^{-4}}$

D. 6.8×10^{-4}

28. Which of the following could be added to a solution of ethanoic acid to prepare a buffer?

   A.   Sodium hydroxide

   B.   Hydrochloric acid

   C.   Sodium chloride

   D.   More ethanoic acid

29. Which aqueous solution has a pH less than 7?

   A. $KNO_3(aq)$

   B. $Na_2CO_3(aq)$

   C. $[Fe(H_2O)_6]Cl_3(aq)$

   D. $CH_3COONa(aq)$

30. What is the reducing agent in the reaction below?

$$2MnO_4^-(aq) + Br^-(aq) + H_2O(l) \rightarrow 2MnO_2(s) + BrO_3^-(aq) + 2OH^-(aq)$$
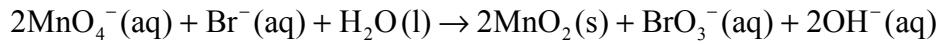
   A. Br^-

   B. BrO_3^-

   C. MnO_4^-

   D. MnO_2

31. Which changes could take place at the positive electrode (cathode) in a voltaic cell?

    I. $Zn^{2+}(aq)$ to $Zn(s)$

    II. $Cl_2(g)$ to $Cl^-(aq)$

    III. $Mg(s)$ to $Mg^{2+}(aq)$

A.   I and II only

B.   I and III only

C.   II and III only

D.   I, II and III

32. Consider the following standard electrode potentials.

$$Cr^{3+}(aq) + 3e^- \rightarrow Cr(s) \qquad E^{\ominus} = -0.74 \text{ V}$$
$$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq) \qquad E^{\ominus} = +0.77 \text{ V}$$
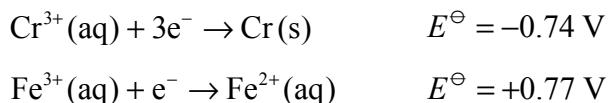
What will be the cell potential, in V, of a voltaic cell in which the following reaction takes place?

$$Cr(s) + 3Fe^{3+}(aq) \rightarrow 3Fe^{2+}(aq) + Cr^{3+}(aq)$$
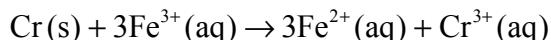
A.   −1.51

B.   −0.03

C.   +0.03

D.   +1.51

33. What is the structural formula of 2,3-dibromo-3-methylhexane?

A. $CH_3CHBrCHBrCH(CH_3)CH_2CH_3$

B. $CH_3CHBrCBr(CH_3)CH_2CH_2CH_3$

C. $CH_3CH_2CHBrCBr(CH_2CH_3)_2$

D. $CH_3CHBrCHBrCH(CH_2CH_3)_2$

34. What organic product is formed in the following reaction?

$$(CH_3CH_2)CH=CH(CH_2CH_3) + H_2O \xrightarrow{H_2SO_4}$$

A. $CH_3(CH_2)_2CH(OH)CH_2CH_3$

B. $CH_3(CH_2)_5CH_3$

C. $CH_3(CH_2)_2CH(OSO_3H)CH_2CH_3$

D. $CH_3(CH_2)_6OH$

35. What happens when a few drops of bromine water are added to excess hex-1-ene and the mixture is shaken?

    I.   The colour of the bromine water disappears.

    II.   The organic product formed does not contain any carbon-carbon double bonds.

    III.   2-bromohexane is formed.

A.   I and II only

B.   I and III only

C.   II and III only

D.   I, II and III

36. What is the IUPAC name for the following compound?

$$CH_3(CH_2)_2COOCH_3$$
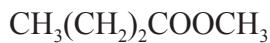
A.   Methyl butanoate

B.   Butyl ethanoate

C.   Butyl methanoate

D.   Methyl propanoate

37. What is the product of the following reaction?

$$CH_3CH_2CH_2CN + 2H_2 \xrightarrow{\text{Ni}}$$

A. $CH_3CH_2CH_2NH_2$

B. $CH_3CH_2CH_2CH_2NH_2$

C. $CH_3CH_2NH_2$

D. $CH_3CH_2CH_2CH_3$

38. How many chiral carbon atoms are present in a molecule of 2,3-dibromobutane?

A. 1

B. 2

C. 3

D. 4

39. How many significant figures are there in 0.00370?

A. 2

B. 3

C. 5

D. 6

Turn over

40. The following diagram shows a set of experimental data points, X, determined when one experimental measurement was repeated three times. The centre of the diagram represents the ideal value calculated from theory. What statement is correct about these measurements?
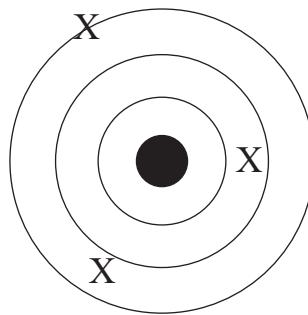
A.   The measurements involve low accuracy and low precision.

B.   The measurements involve low accuracy and high precision.

C.   The measurements involve high accuracy and low precision.

D.   The measurements involve high accuracy and high precision.