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CHEMISTRY
STANDARD LEVEL
PAPER 1

Monday 19 May 2014 (afternoon)

45 minutes

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 maximum mark for this examination paper is *[30 marks]*.

The Periodic Table

Key:

| Atomic number |
| Element |
| Relative atomic mass |

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
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)																

† Lanthanides

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

‡ Actinides

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 mole of hydrated copper(II) sulfate, $CuSO_4 \cdot 5H_2O$, given the following relative atomic mass values?

Element	Cu	S	H	O
Relative atomic mass	64	32	1	16

A. 160

B. 178

C. 186

D. 250

2. An excess of calcium carbonate is added to a solution containing $0.10\,mol$ of $HCl\,(aq)$. What mass of calcium carbonate reacts, and what mass of carbon dioxide is formed?

$$\text{Mass of one mole of } CaCO_3 = 100\,g$$

$$\text{Mass of one mole of } CO_2 = 44\,g$$

$$CaCO_3\,(s) + 2HCl\,(aq) \rightarrow CaCl_2\,(aq) + H_2O\,(l) + CO_2\,(g)$$

	$CaCO_3\,(s)\,/\,g$	$CO_2\,(g)\,/\,g$
A.	10	4.4
B.	10	2.2
C.	5.0	2.2
D.	5.0	4.4

Turn over

3.   For which compounds is the empirical formula the same as the molecular formula?

       I.   Methane

      II.   Ethene

     III.   Ethanol

A.   I and II only

B.   I and III only

C.   II and III only

D.   I, II and III

4.   Some sodium chloride is dissolved in water. Which term describes the role of sodium chloride in this process?

A.   Solute

B.   Solvent

C.   Solution

D.   Saturated

5.   What does $^{52}_{24}X$ represent?

A.   An isotope of Te with 24 neutrons

B.   An isotope of Te with 24 electrons

C.   An isotope of Cr with 28 protons

D.   An isotope of Cr with 28 neutrons

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6. Which species would be deflected most in a mass spectrometer?

  A. $^{24}Mg^{2+}$

  B. $^{24}Mg^{+}$

  C. $^{25}Mg^{2+}$

  D. $^{25}Mg^{+}$

7. Which properties **decrease** down group 1?

  I.   Melting point
  II.   Atomic radius
  III. First ionization energy

  A.   I and II only

  B.   I and III only

  C.   II and III only

  D.   I, II and III

8. Which pair of elements shows the greatest difference in electronegativity?

  A.   Mg and O

  B.   Li and F

  C.   K and F

  D.   Li and I

9. What is the formula of calcium phosphide?

A. $Ca_2(PO_3)_3$

B. Ca_2P_3

C. $Ca_3(PO_4)_2$

D. Ca_3P_2

10. Which properties do typical ionic compounds have?

	Melting point	Conductivity of solid
A.	high	good
B.	low	good
C.	high	poor
D.	low	poor

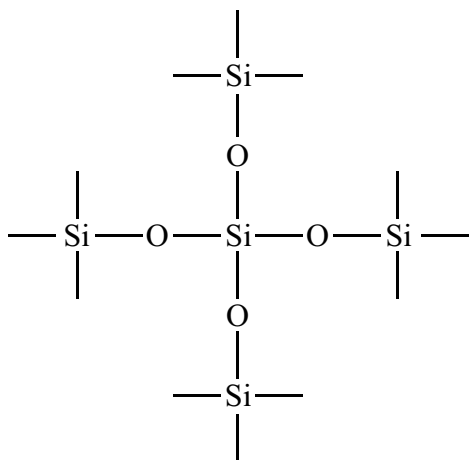**11.** Which compounds contain both ionic **and** covalent bonding?

I. $CaCO_3$
II. NaCl
III. NaOH

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

12. Which pair has the same bond angles?

　　A.　　CH_4 and NH_4^+

　　B.　　NH_3 and H_2O

　　C.　　C_2H_4 and C_2H_2

　　D.　　CO_2 and SO_2

13. Which diagram represents the bonding in SiO_2?

A.

$$
\begin{array}{c}
\quad\ \mid \\
-\!Si\!- \\
\mid \\
O \\
\mid \qquad\qquad\quad \mid \qquad\qquad\quad \mid \\
-Si-O-Si-O-Si- \\
\mid \qquad\qquad\quad \mid \qquad\qquad\quad \mid \\
O \\
\mid \\
-\!Si\!- \\
\mid
\end{array}
$$

B.　　$O\!-\!Si\!-\!O$

C.　　$O\!=\!Si\!=\!O$

D.

　　　　　　　　　　　　　　　　　　　　　　Turn over
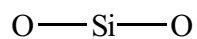
14. The table shows information about temperature increases when an acid and an alkali are mixed.

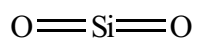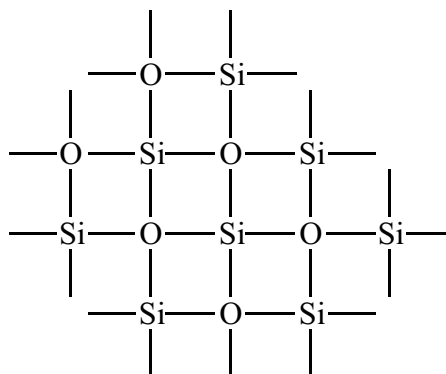| Experiment	Volume and concentration of HCl(aq)	Volume and concentration of NaOH(aq)	Temperature increase / °C
1	$25\,cm^3\ 1.0\,mol\,dm^{-3}$	$25\,cm^3\ 1.0\,mol\,dm^{-3}$	x
2	$50\,cm^3\ 1.0\,mol\,dm^{-3}$	$50\,cm^3\ 1.0\,mol\,dm^{-3}$	y

What is the value of y?

A. $\dfrac{1}{2}x$

B. x

C. $2x$

D. $4x$

15. What is the value of ΔH for the exothermic reaction represented by the diagram below?
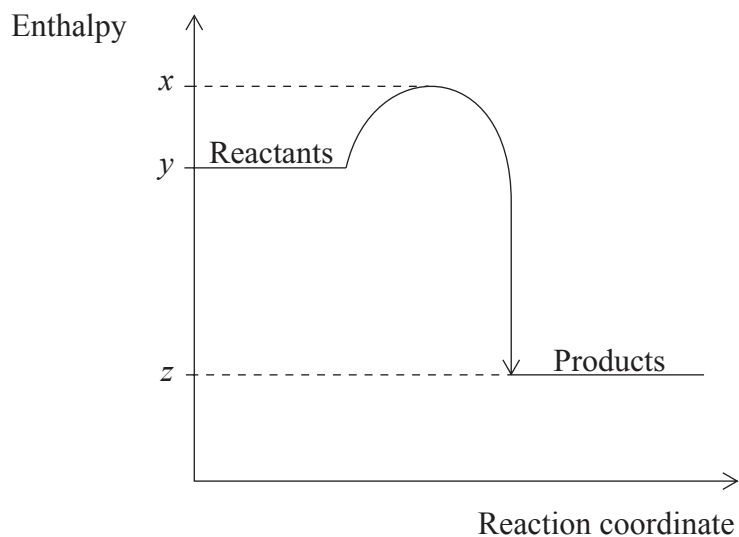
A. $y - z$

B. $z - y$

C. $x - z$

D. $z - x$

**16.** What is the temperature rise when $2100\,J$ of energy is supplied to $100\,g$ of water? (Specific heat capacity of water $= 4.2\,J\,g^{-1}\,K^{-1}$.)

    A. $5\,°C$

    B. $278\,K$

    C. $0.2\,°C$

    D. $20\,°C$

17. Which change increases the rate of a chemical reaction?

    A.   Increasing the size of solid reactant particles

    B.   Decreasing the concentration of aqueous reactants

    C.   Increasing the surface area of a solid reactant

    D.   Decreasing the pressure of gaseous reactants

18. Which is **not** affected by an increase in temperature?

    A.   Rate of reaction

    B.   Collision frequency

    C.   Collision geometry

    D.   % of molecules with $E \geq E_a$

19. What is the equilibrium constant expression, K_c, for this reaction?

$$2NO(g) + H_2(g) \rightleftharpoons N_2O(g) + H_2O(g)$$
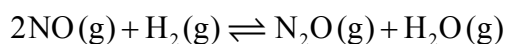
A. $K_c = \dfrac{[N_2O] + [H_2O]}{2[NO] + [H_2]}$

B. $K_c = \dfrac{[NO]^2\,[H_2]}{[N_2O][H_2O]}$

C. $K_c = \dfrac{[2NO] + [H_2]}{[N_2O] + [H_2O]}$

D. $K_c = \dfrac{[N_2O][H_2O]}{[NO]^2\,[H_2]}$

20. Which is **always** correct for a reaction at equilibrium?

	Concentrations of reactants and products	Rates of forward and reverse reactions
A.	continue to change	equal
B.	remain constant	equal
C.	continue to change	different
D.	remain constant	different

21. Which compound reacts with calcium oxide, CaO?

A. K_2O

B. Na_2O

C. SO_2

D. MgO

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22. Which statement explains why ammonia, NH_3, is classified as a Lewis base?

    A.   It can accept a proton.

    B.   It can accept a lone pair of electrons.

    C.   It can donate a lone pair of electrons.

    D.   It can donate a proton.

23. What are the correct oxidation numbers of chromium in $Cr_2O_7^{2-}$ and manganese in $KMnO_4$?

	Chromium in $Cr_2O_7^{2-}$	Manganese in $KMnO_4$
A.	+7	+7
B.	+6	+7
C.	+6	+4
D.	+7	+4

Turn over

24. Zinc is more reactive than copper. In this voltaic cell, which species is reduced and in which direction do negative ions flow in the salt bridge?
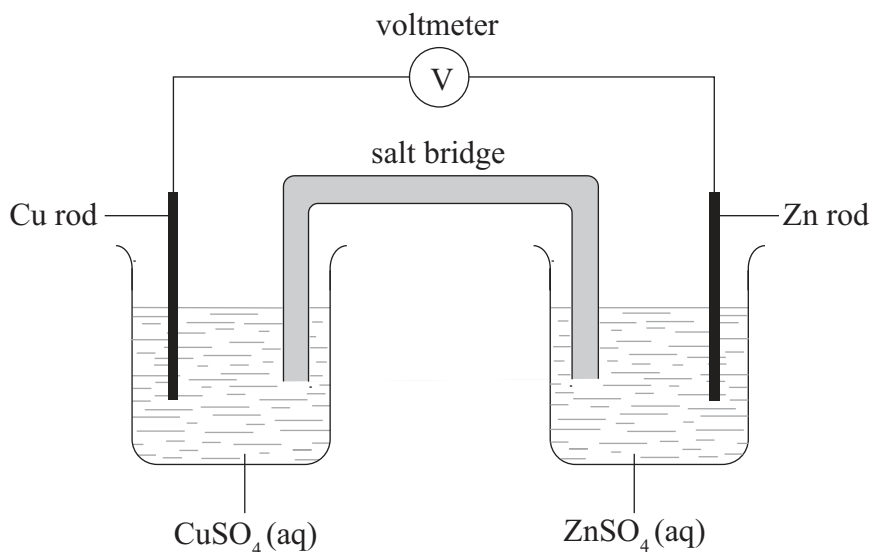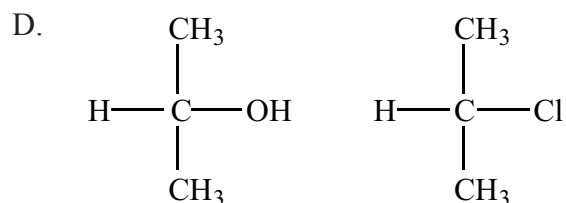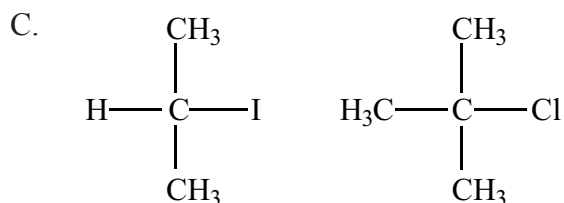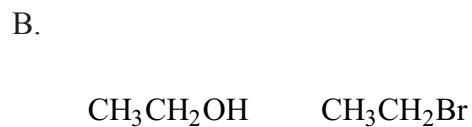

	Species reduced	**Direction of negative ion flow in salt bridge**
A.	Cu^{2+}	from copper half-cell to zinc half-cell
B.	Cu^{2+}	from zinc half-cell to copper half-cell
C.	Zn^{2+}	from copper half-cell to zinc half-cell
D.	Zn^{2+}	from zinc half-cell to copper half-cell

25. Which process occurs when a molten salt is electrolysed?

A.   The metal ion is oxidized and deposited on the negative electrode (cathode).

B.   The metal ion is reduced and deposited on the negative electrode (cathode).

C.   The metal ion is oxidized and deposited on the positive electrode (anode).

D.   The metal ion is reduced and deposited on the positive electrode (anode).

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26. In organic reaction mechanisms, what does a curly arrow represent?

   A.   The movement of a pair of electrons towards a nucleophile

   B.   The movement of a pair of electrons towards a positively charged species

   C.   The movement of a pair of electrons away from a positively charged species

   D.   The movement of a pair of electrons towards a Lewis base

27. Which properties are features of a homologous series?

   I.   Same general formula
   II.   Similar chemical properties
   III. Gradation in physical properties

   A.   I and II only

   B.   I and III only

   C.   II and III only

   D.   I, II and III

28. Which compound is an isomer of octane, C_8H_{18}?

   A. $(CH_3)_2CH(CH_2)_2CH(CH_3)_2$

   B. $(CH_3)_2CHCH_2CHCHCH_2CH_3$

   C. $CH_3(CH_2)_5CH_3$

   D. $(CH_3)_2CH(CH_2)_2CHCHCH_3$

Turn over

29. In which pair are both compounds secondary?

A.

$$H_3C-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-Br \qquad H_3C-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-OH$$

B.

$$CH_3CH_2OH \qquad CH_3CH_2Br$$

C.

$$H-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-I \qquad H_3C-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-Cl$$

D.

$$H-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-OH \qquad H-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-Cl$$
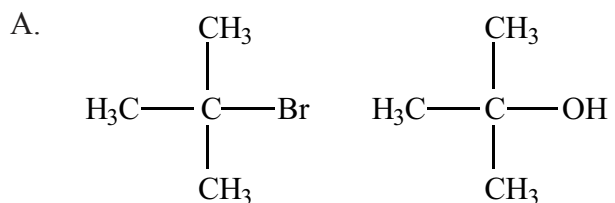
30. Which statement about errors is correct?

A. A random error is always expressed as a percentage.

B. A systematic error can be reduced by taking more readings.

C. A systematic error is always expressed as a percentage.

D. A random error can be reduced by taking more readings.