

**CHEMISTRY
HIGHER LEVEL
PAPER 1**

Tuesday 18 May 2004 (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

Atomic Number		Element																
		Atomic Mass																
1 H 1.01																		2 He 4.00
3 Li 6.94	4 Be 9.01																9 F 19.00	
11 Na 22.99	12 Mg 24.31																17 Cl 35.45	
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)																

†

‡

1. How many hydrogen atoms are contained in one mole of ethanol, $\text{C}_2\text{H}_5\text{OH}$?

- A. 5
- B. 6
- C. 1.0×10^{23}
- D. 3.6×10^{24}

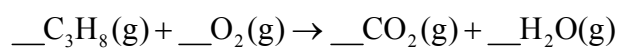
2. The percentage by mass of the elements in a compound is

$$\text{C} = 72\%, \quad \text{H} = 12\%, \quad \text{O} = 16\%.$$

What is the mole ratio of C : H in the empirical formula of this compound?

- A. 1 : 1
- B. 1 : 2
- C. 1 : 6
- D. 6 : 1

3. What is the coefficient for $\text{O}_2(\text{g})$ when the equation below is balanced?



- A. 2
- B. 3
- C. 5
- D. 7

4. How many protons, neutrons and electrons are there in the species $^{26}\text{Mg}^{2+}$?

	Protons	Neutrons	Electrons
A.	10	14	12
B.	12	14	10
C.	12	26	10
D.	14	12	12

5. What is the total number of p orbitals containing one or more electrons in germanium (atomic number 32)?

- A. 2
- B. 3
- C. 5
- D. 8

6. Which of the physical properties below decrease with increasing atomic number for both the alkali metals and the halogens?

- I. Atomic radius
- II. Ionization energy
- III. Melting point

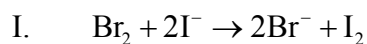
- A. I only
- B. II only
- C. III only
- D. I and III only

7. Which of the following oxides is (are) gas(es) at room temperature?



- A. I only
- B. III only
- C. I and II only
- D. II and III only

8. Which of the reactions below occur as written?

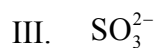


- A. I only
- B. II only
- C. Both I and II
- D. Neither I nor II

9. Based on electronegativity values, which bond is the most polar?



10. Which of the following species is (are) planar (has (have) all the atoms in one plane)?



- A. I only
- B. II only
- C. I and II only
- D. II and III only

11. Which substance is most soluble in water (in mol dm^{-3}) at 298 K ?

- A. CH_3CH_3
- B. CH_3OCH_3
- C. $\text{CH}_3\text{CH}_2\text{OH}$
- D. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$

12. What is the molecular shape and the hybridization of the nitrogen atom in NH_3 ?

	Molecular shape	Hybridization
A.	tetrahedral	sp^3
B.	trigonal planar	sp^2
C.	trigonal pyramidal	sp^2
D.	trigonal pyramidal	sp^3

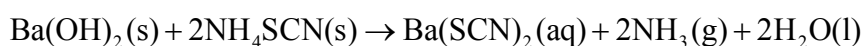
13. Which statement about sigma and pi bonds is correct?

- A. Sigma bonds are formed only by s orbitals and pi bonds are formed only by p orbitals.
- B. Sigma bonds are formed only by p orbitals and pi bonds are formed only by s orbitals.
- C. Sigma bonds are formed by either s or p orbitals, pi bonds are formed only by p orbitals.
- D. Sigma and pi bonds are formed by either s or p orbitals.

14. For which set of conditions does a fixed mass of an ideal gas have the greatest volume?

	Temperature	Pressure
A.	low	low
B.	low	high
C.	high	high
D.	high	low

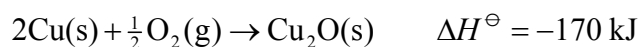
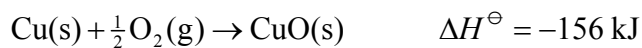
15. When the solids $\text{Ba}(\text{OH})_2$ and NH_4SCN are mixed, a solution is produced and the temperature drops.



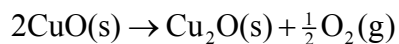
Which statement about the energetics of this reaction is correct?

- A. The reaction is endothermic and ΔH is negative.
- B. The reaction is endothermic and ΔH is positive.
- C. The reaction is exothermic and ΔH is negative.
- D. The reaction is exothermic and ΔH is positive.

16. Using the equations below



what is the value of ΔH^\ominus (in kJ) for the following reaction?



- A. 142
- B. 15
- C. -15
- D. -142

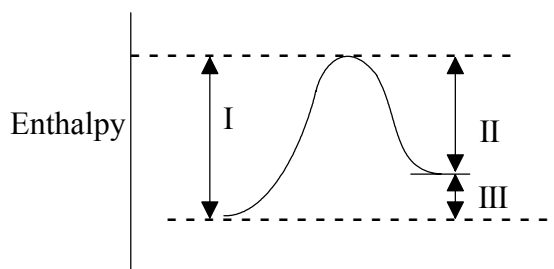
17. Which reaction has the most negative ΔH^\ominus value?

- A. $\text{LiF(s)} \rightarrow \text{Li}^+(\text{g}) + \text{F}^-(\text{g})$
- B. $\text{Li}^+(\text{g}) + \text{F}^-(\text{g}) \rightarrow \text{LiF(s)}$
- C. $\text{NaCl(s)} \rightarrow \text{Na}^+(\text{g}) + \text{Cl}^-(\text{g})$
- D. $\text{Na}^+(\text{g}) + \text{Cl}^-(\text{g}) \rightarrow \text{NaCl(s)}$

18. Which reaction occurs with the largest increase in entropy?

- A. $\text{Pb(NO}_3)_2(\text{s}) + 2\text{KI(s)} \rightarrow \text{PbI}_2(\text{s}) + 2\text{KNO}_3(\text{s})$
- B. $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO(s)} + \text{CO}_2(\text{g})$
- C. $3\text{H}_2(\text{g}) + \text{N}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$
- D. $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightarrow 2\text{HI(g)}$

19. Which of the quantities in the enthalpy level diagram below is (are) affected by the use of a catalyst?



- A. I only
- B. III only
- C. I and II only
- D. II and III only
20. What is the definition of *half-life* for a first order reaction?
- A. The time required for the quantity of a reactant to decrease by half.
- B. Half the time required for a reactant to be completely used up.
- C. Half the time required for a reaction to reach its maximum rate.
- D. The time required for a reaction to reach half of its maximum rate.
21. Values of a rate constant, k , and absolute temperature, T , can be used to determine the activation energy of a reaction by a graphical method. Which graph produces a straight line?
- A. k versus T
- B. k versus $\frac{1}{T}$
- C. $\ln k$ versus T
- D. $\ln k$ versus $\frac{1}{T}$

22. In the reaction below

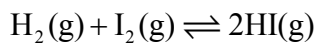


which of the following changes will increase the amount of ammonia at equilibrium?

- I. Increasing the pressure
- II. Increasing the temperature
- III. Adding a catalyst

- A. I only
- B. II only
- C. I and II only
- D. II and III only

23. For the reaction below



at a certain temperature, the equilibrium concentrations are (in mol dm^{-3}):

$$[\text{H}_2] = 0.30, [\text{I}_2] = 0.30, [\text{HI}] = 3.0$$

What is the value of K ?

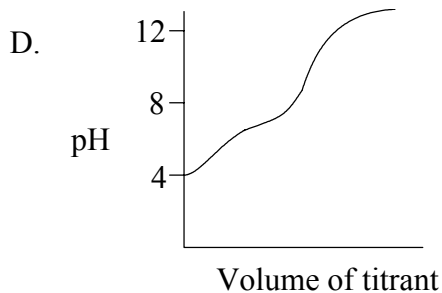
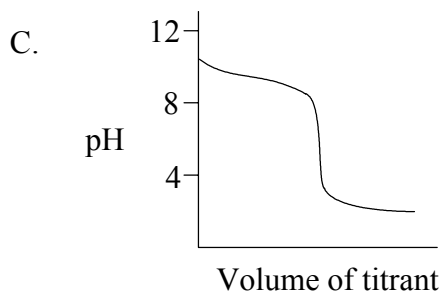
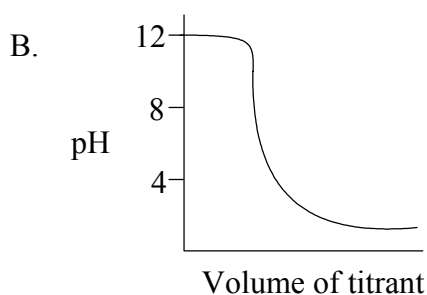
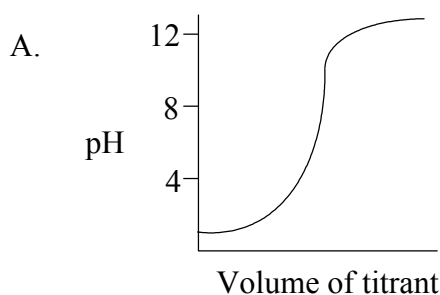
- A. 5.0
- B. 10
- C. 15
- D. 100

24. A buffer solution can be prepared by adding which of the following to 50 cm^3 of 0.10 mol dm^{-3} $\text{CH}_3\text{COOH(aq)}$?
- I. 50 cm^3 of 0.10 mol dm^{-3} $\text{CH}_3\text{COONa(aq)}$
 - II. 25 cm^3 of 0.10 mol dm^{-3} NaOH(aq)
 - III. 50 cm^3 of 0.10 mol dm^{-3} NaOH(aq)
- A. I only
 - B. I and II only
 - C. II and III only
 - D. I, II and III
25. Which equation represents an acid-base reaction according to the Lewis theory **but not** according to the Brønsted-Lowry theory?
- A. $\text{CO}_3^{2-}(\text{aq}) + 2\text{H}^+(\text{aq}) \rightarrow \text{H}_2\text{O(l)} + \text{CO}_2(\text{g})$
 - B. $\text{Cu}^{2+}(\text{aq}) + 4\text{NH}_3(\text{aq}) \rightarrow \text{Cu}(\text{NH}_3)_4^{2+}(\text{aq})$
 - C. $\text{BaO(s)} + \text{H}_2\text{O(l)} \rightarrow \text{Ba}^{2+}(\text{aq}) + 2\text{OH}^-(\text{aq})$
 - D. $\text{NH}_3(\text{g}) + \text{HCl(g)} \rightarrow \text{NH}_4\text{Cl(s)}$
26. What is the concentration of OH^- ions (in mol dm^{-3}) in an aqueous solution in which $[\text{H}^+] = 2.0 \times 10^{-3}\text{ mol dm}^{-3}$? ($K_w = 1.0 \times 10^{-14}\text{ mol}^2\text{ dm}^{-6}$)
- A. 2.0×10^{-3}
 - B. 4.0×10^{-6}
 - C. 5.0×10^{-12}
 - D. 2.0×10^{-17}

27. What is the relationship between K_a and pK_a ?

- A. $pK_a = -\log K_a$
- B. $pK_a = \frac{1.0 \times 10^{-14}}{K_a}$
- C. $pK_a = \log K_a$
- D. $pK_a = \frac{1.0}{K_a}$

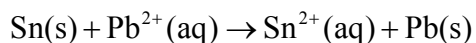
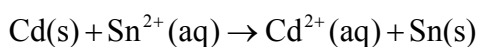
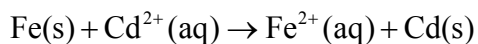
28. Which curve is produced by the titration of a 0.1 mol dm^{-3} weak base with 0.1 mol dm^{-3} strong acid?



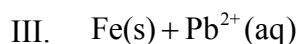
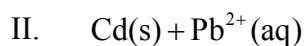
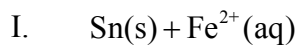
29. What happens to the $\text{Cr}^{3+}(\text{aq})$ ion when it is converted to $\text{CrO}_4^{2-}(\text{aq})$?

- A. Its oxidation number decreases and it undergoes reduction.
- B. Its oxidation number decreases and it undergoes oxidation.
- C. Its oxidation number increases and it undergoes reduction.
- D. Its oxidation number increases and it undergoes oxidation.

30. The following reactions are spontaneous as written.

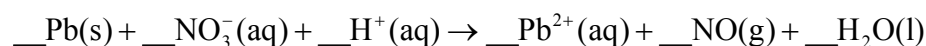


Which of the following pairs will react spontaneously?



- A. I only
- B. II only
- C. III only
- D. II and III only

31. What is the coefficient for H^+ when the equation below is balanced?



- A. 2
- B. 4
- C. 6
- D. 8

32. Which combination of signs for E^\ominus and ΔG^\ominus correspond to a spontaneous electrochemical reaction?

	E^\ominus	ΔG^\ominus
A.	+	+
B.	+	–
C.	–	–
D.	–	+

33. Which of the following factors affect the amount of product formed during electrolysis?

- I. The current used
- II. The duration of electrolysis
- III. The charge on the ion

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

34. Which statement about neighbouring members of all homologous series is correct?

- A. They have the same empirical formula.
- B. They differ by a CH_2 group.
- C. They possess different functional groups.
- D. They differ in their degree of unsaturation.

35. Which compound can exist as optical isomers?

- A. $\text{H}_2\text{NCH}_2\text{COOH}$
- B. $\text{CH}_2\text{ClCH}_2\text{Cl}$
- C. CH_3CHBrI
- D. HCOOCH_3

36. Which product is formed by the reaction between CH_2CH_2 and HBr ?

- A. $\text{CH}_3\text{CH}_2\text{Br}$
- B. CH_2CHBr
- C. BrCHCHBr
- D. CH_3CHBr_2

37. How many lines are present in the ^1H NMR spectrum of $\text{C}(\text{CH}_3)_4$?

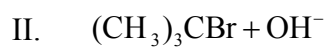
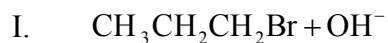
- A. 1
- B. 3
- C. 4
- D. 12

38. In which of the following ways does benzene, C_6H_6 , react?

- I. Combustion
- II. Hydrogenation
- III. Substitution

- A. I only
- B. I and II only
- C. I and III only
- D. I, II and III

39. Which reaction(s) involve(s) the formation of a positive ion?



- A. I only
- B. II only
- C. Both I and II
- D. Neither I nor II

40. What is the major product formed when a mixture of $\text{CH}_3\text{CH}_2\text{OH}$ and concentrated H_2SO_4 is heated strongly?

- A. CH_3CH_3
 - B. $\text{CH}_3\text{CH}_2\text{SO}_4$
 - C. CH_3COOH
 - D. CH_2CH_2
-