



CHEMISTRY
HIGHER LEVEL
PAPER 1

Thursday 10 May 2001 (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.

Periodic Table

		Atomic Number										2																																										
		Atomic Mass																																																				
1	H	1.01											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)	104	Rf	(261)	105	Db	(262)	106	Sg	(263)	107	Bh	(262)	108	Hs	(262)	109	Mt	(262)																												
												†	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. 10.0 cm^3 of $0.200 \text{ mol dm}^{-3} \text{ H}_3\text{PO}_4(\text{aq})$ is converted into $\text{Na}_2\text{HPO}_4(\text{aq})$. What volume (in cm^3) of $0.200 \text{ mol dm}^{-3} \text{ NaOH}(\text{aq})$ is required?
 - A. 10.0
 - B. 13.3
 - C. 20.0
 - D. 30.0

2. The reason for the general increase in ionisation energy of the elements across period 3 of the Periodic Table is the increasing number of
 - A. outer electrons.
 - B. neutrons.
 - C. protons.
 - D. electron sub-levels occupied.

3. Which molecule has the greatest polarity?
 - A. Fluorine
 - B. Hydrogen fluoride
 - C. Hydrogen chloride
 - D. Tetrafluoromethane

4. Which is the best description of metallic bonding?
 - A. The attraction between oppositely charged ions
 - B. The attraction between protons and electrons
 - C. The attraction between positive ions and delocalised electrons
 - D. The attraction between nuclei and electron pairs

5. Which compound is the most soluble in water?

- A. Methane
- B. Propane
- C. Propan-1-ol
- D. Pentan-1-ol

6. Which change will have the greatest effect on the pressure of a fixed mass of an ideal gas?

	Volume	Temperature / K
A.	Doubles	Halves
B.	Doubles	Doubles
C.	Halves	Halves
D.	Halves	Remains constant

7. Which process is endothermic?

- A. $\text{H}_2\text{O}(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l})$
- B. $\text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{O}(\text{s})$
- C. $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{l})$
- D. $\text{H}_2\text{O}(\text{g}) \rightarrow 2\text{H}(\text{g}) + \text{O}(\text{g})$

8. An experiment was carried out to measure the enthalpy change of solution of sodium hydroxide when a small amount of it is dissolved in water. x mol of sodium hydroxide was dissolved in y g of water, giving a temperature rise of z °C. The specific heat capacity of water is c J g⁻¹ K⁻¹. Which expression should be used to calculate the molar enthalpy change (in J mol⁻¹)?

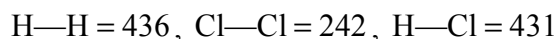
A. $\frac{xyz}{c}$

B. $\frac{xy}{cz}$

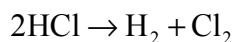
C. $\frac{c}{xyz}$

D. $\frac{cyz}{x}$

9. Some average bond enthalpies (in kJ mol⁻¹) are as follows:



What is the enthalpy change (in kJ) for the decomposition of hydrogen chloride?



- A. -184
- B. +184
- C. +247
- D. -247
10. The reaction between nitrogen and oxygen in the atmosphere under normal conditions is extremely slow. Which statement best explains this?
- A. The concentration of oxygen is much lower than that of nitrogen
- B. The molar mass of nitrogen is less than that of oxygen
- C. The frequency of collisions between nitrogen and oxygen molecules is lower than that between nitrogen molecules themselves
- D. Very few nitrogen and oxygen molecules have sufficient energy to react

11. The position of equilibrium in a reversible reaction is shifted to the right until it reaches equilibrium again. Which statement must be true for the reaction when the new position of equilibrium is reached?

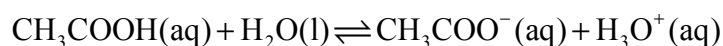
- A. The rate of the forward reaction is greater than the rate of the reverse reaction
- B. The concentrations of reactants and products do not change
- C. The concentrations of reactants and products are equal
- D. The value of K_c is greater than 1

12. Which change will shift the position of equilibrium to the right in this reaction?



- A. Increasing the temperature
- B. Decreasing the pressure
- C. Adding a catalyst
- D. Removing ammonia from the equilibrium mixture

13. Which of the following represents a conjugate acid-base pair in this reaction?



- A. $\text{CH}_3\text{COOH} / \text{H}_2\text{O}$
- B. $\text{CH}_3\text{COOH} / \text{CH}_3\text{COO}^-$
- C. $\text{CH}_3\text{COOH} / \text{H}_3\text{O}^+$
- D. $\text{CH}_3\text{COO}^- / \text{H}_3\text{O}^+$

14. Which statement is **not** correct?
- A. Hydrochloric acid can have a pH value of zero
 - B. pH paper contains more than one indicator
 - C. The pH value of an acidic solution decreases when water is added to it
 - D. Dilute hydrochloric acid conducts electricity
15. Which statement about the MnO_4^- ion is correct?
- A. An acidified solution of MnO_4^- oxidises fluoride ions
 - B. The oxidation number of manganese in MnO_4^- is +5
 - C. An acidified solution of MnO_4^- oxidises bromide ions
 - D. The oxidation number of oxygen in MnO_4^- is +2
16. During the electrolysis of a molten salt, which statement is **not** correct?
- A. The ions only move when a current flows
 - B. Positive ions are attracted to the negative electrode
 - C. Positive ions gain electrons at the negative electrode
 - D. Negative ions lose electrons at the positive electrode
17. Which product is formed from the reaction between CH_3COOH and $\text{CH}_3\text{CH}_2\text{OH}$?
- A. $\text{CH}_3\text{COOCH}_2\text{CH}_3$
 - B. $\text{CH}_3\text{CH}_2\text{COOCH}_2\text{CH}_3$
 - C. $\text{CH}_3\text{CH}_2\text{COOCH}_3$
 - D. $\text{CH}_3\text{COOCH}_3$

18. Which compound is optically active?
- A. $\text{CH}_3\text{COCH}(\text{CH}_3)_2$
 - B. $(\text{CH}_3)_3\text{CCHO}$
 - C. $\text{CH}_3\text{CH}_2\text{COCH}_2\text{CH}_3$
 - D. $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CHO}$
19. In which pair do both types of compound take part in hydrogen bonding?
- A. Alkanals and esters
 - B. Bromoalkanes and alkanals
 - C. Alkanes and alkenes
 - D. Alkanols and amines
20. Which product is formed in the reaction between ethene and bromine?
- A. $\text{CHBr}=\text{CH}_2$
 - B. $\text{CHBr}=\text{CHBr}$
 - C. $\text{CH}_2\text{BrCH}_2\text{Br}$
 - D. $\text{CH}_3\text{CH}_2\text{Br}$
21. The separation of ions in a mass spectrometer depends on
- A. only the charge on the ions.
 - B. only the mass of the ions.
 - C. the mass and the charge of the ions.
 - D. only the velocity of the ions.

22. The electronic configuration of chromium (Cr) is
- A. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^4 4s^2$.
 - B. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$.
 - C. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$.
 - D. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^1 4s^5$.
23. Which could **not** act as a ligand in a complex ion of a d-block element?
- A. Cl^-
 - B. NCl_3
 - C. PCl_3
 - D. PCl_5
24. In which of the following are the compounds BF_3 , CH_4 , CO_2 and SF_6 arranged in **decreasing** order of bond angle?
- A. BF_3, CH_4, CO_2, SF_6
 - B. BF_3, SF_6, CO_2, CH_4
 - C. CO_2, BF_3, CH_4, SF_6
 - D. SF_6, CO_2, CH_4, BF_3

25. Which molecule has the longest nitrogen–nitrogen bond length?

- A. N_2
- B. N_2F_2
- C. N_2H_4
- D. N_2H_2

26. Which species is/are sp^2 hybridised?

- I. C_2H_4
- II. C_2H_6
- III. C_3H_6

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

27. Which species contains no delocalised electrons?

- A. O_3
- B. NO_3^-
- C. CO_3^{2-}
- D. H_2SO_4

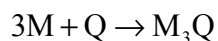
28. In which of the following are the compounds CaF_2 , CaCl_2 , CsF and LiF arranged in **increasing** order of lattice enthalpy?

- A. CaCl_2 , CaF_2 , CsF , LiF
- B. CsF , LiF , CaCl_2 , CaF_2
- C. CaCl_2 , CaF_2 , LiF , CsF
- D. LiF , CaF_2 , CsF , CaCl_2

29. Which reaction has an entropy change closest to zero?

- A. $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$
- B. $\text{Fe}_2\text{O}_3(\text{s}) + 3\text{CO}(\text{g}) \rightarrow 2\text{Fe}(\text{s}) + 3\text{CO}_2(\text{g})$
- C. $\text{NH}_3(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq})$
- D. $\text{P}_4(\text{s}) + 4\text{OH}^-(\text{aq}) + 4\text{H}_2\text{O}(\text{l}) \rightarrow 4\text{H}_2\text{PO}_2^-(\text{aq}) + 2\text{H}_2(\text{g})$

30. The reaction



is first order with respect to M and second order with respect to Q. When $[\text{M}] = 0.100 \text{ mol dm}^{-3}$ and $[\text{Q}] = 0.020 \text{ mol dm}^{-3}$, the rate is $0.010 \text{ mol dm}^{-3} \text{ s}^{-1}$. What is the value of the rate constant, in $\text{mol}^{-2} \text{ dm}^6 \text{ s}^{-1}$?

- A. 10
- B. 100
- C. 250
- D. 500

31. What is the effect of adding a catalyst to a reaction mixture at equilibrium?
- A. It decreases the activation energy of the forward reaction and increases the activation energy of the reverse reaction
 - B. It decreases both the activation energy and the enthalpy change of the forward reaction
 - C. It decreases the activation energies of both forward and reverse reactions
 - D. It decreases the activation energies and enthalpy changes of both forward and reverse reactions
32. 10.0 cm³ of liquid bromine is placed in an empty 100 cm³ bottle, which is then sealed and left to reach equilibrium at room temperature. What happens first?
- A. The rate of evaporation is greater than the rate of condensation
 - B. The rate of condensation is greater than the rate of evaporation
 - C. The rate of evaporation is equal to the rate of condensation
 - D. There is no evaporation or condensation
33. The pH value of a 1.00×10^{-3} mol dm⁻³ solution of sodium hydroxide is
- A. 3.
 - B. 8.
 - C. 11.
 - D. 14.
34. Which salt would form a neutral solution when dissolved in water?
- A. FeCl₃
 - B. Na₂CO₃
 - C. KBr
 - D. NH₄NO₃

35. Which factor does **not** affect the value of the standard electrode potential of a half-cell?
- A. The surface area of the electrode
 - B. The concentration of the solution
 - C. The temperature of the solution
 - D. The material of the electrode
36. The mass of a metal deposited during electrolysis does **not** depend on
- A. the current flowing.
 - B. the voltage between the electrodes.
 - C. the time for which the current passes.
 - D. the charge on the metal ion.
37. The infrared spectrum of a compound shows a broad absorption band at 3325 cm^{-1} and another band at 1060 cm^{-1} , but no absorption around 1700 cm^{-1} . Which type of compound is it most likely to be?
- A. Amine
 - B. Alkanol
 - C. Alkanone
 - D. Alkanoic acid
38. Which is a correct description of a free radical?
- A. It is a negatively charged species formed by the homolytic fission of a covalent bond
 - B. It is a neutral species formed by the heterolytic fission of a covalent bond
 - C. It has an unpaired electron and is formed by the heterolytic fission of a covalent bond
 - D. It has an unpaired electron and is formed by the homolytic fission of a covalent bond

39. Which molecule does **not** act as a nucleophile in a reaction with a halogenoalkane?
- A. Ethane
 - B. Ethanol
 - C. Ethylamine
 - D. Water
40. Alkanols can undergo dehydration reactions. Which products could be obtained from the dehydration of ethanol?
- A. Ethane and ethanal
 - B. Ethene and ethanal
 - C. Ethene and ethoxyethane
 - D. Ethanal and ethanoic acid
-