

**CHEMISTRY  
HIGHER LEVEL  
PAPER 1**

Monday 20 May 2002 (afternoon)

1 hour

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**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		Atomic Mass																	
1 <b>H</b> 1.01																			
3 <b>Li</b> 6.94	4 <b>Be</b> 9.01																		
11 <b>Na</b> 22.99	12 <b>Mg</b> 24.31																		
19 <b>K</b> 39.10	20 <b>Ca</b> 40.08	21 <b>Sc</b> 44.96	22 <b>Ti</b> 47.90	23 <b>V</b> 50.94	24 <b>Cr</b> 52.00	25 <b>Mn</b> 54.94	26 <b>Fe</b> 55.85	27 <b>Co</b> 58.93	28 <b>Ni</b> 58.71	29 <b>Cu</b> 63.55	30 <b>Zn</b> 65.37	31 <b>Ga</b> 69.72	32 <b>Ge</b> 72.59	33 <b>As</b> 74.92	34 <b>Se</b> 78.96	35 <b>Br</b> 79.90	36 <b>Kr</b> 83.80		
37 <b>Rb</b> 85.47	38 <b>Sr</b> 87.62	39 <b>Y</b> 88.91	40 <b>Zr</b> 91.22	41 <b>Nb</b> 92.91	42 <b>Mo</b> 95.94	43 <b>Tc</b> 98.91	44 <b>Ru</b> 101.07	45 <b>Rh</b> 102.91	46 <b>Pd</b> 106.42	47 <b>Ag</b> 107.87	48 <b>Cd</b> 112.40	49 <b>In</b> 114.82	50 <b>Sn</b> 118.69	51 <b>Sb</b> 121.75	52 <b>Te</b> 127.60	53 <b>I</b> 126.90	54 <b>Xe</b> 131.30		
55 <b>Cs</b> 132.91	56 <b>Ba</b> 137.34	57 † <b>La</b> 138.91	72 <b>Hf</b> 178.49	73 <b>Ta</b> 180.95	74 <b>W</b> 183.85	75 <b>Re</b> 186.21	76 <b>Os</b> 190.21	77 <b>Ir</b> 192.22	78 <b>Pt</b> 195.09	79 <b>Au</b> 196.97	80 <b>Hg</b> 200.59	81 <b>Tl</b> 204.37	82 <b>Pb</b> 207.19	83 <b>Bi</b> 208.98	84 <b>Po</b> (210)	85 <b>At</b> (210)	86 <b>Rn</b> (222)		
87 <b>Fr</b> (223)	88 <b>Ra</b> (226)	89 ‡ <b>Ac</b> (227)	104 <b>Rf</b> (261)	105 <b>Db</b> (262)	106 <b>Sg</b> (263)	107 <b>Bh</b> (262)	108 <b>Hs</b> (262)	109 <b>Mt</b> (262)											

1. A compound that contains only carbon, hydrogen and oxygen has the following percentage by mass:  
carbon 60 %, hydrogen 8 %, oxygen 32 %.

What is a possible molecular formula?

- A.  $\text{C}_5\text{H}_8\text{O}_2$
- B.  $\text{C}_5\text{H}_4\text{O}$
- C.  $\text{C}_6\text{HO}_3$
- D.  $\text{C}_7\text{HO}_4$
2. Which sample contains the smallest amount of oxygen?
- A. 0.3 mol  $\text{H}_2\text{SO}_4$
- B. 0.6 mol  $\text{O}_3$
- C. 0.7 mol  $\text{HCOOH}$
- D. 0.8 mol  $\text{H}_2\text{O}$
3. 6.4 g of copper wire is added to  $0.10 \text{ dm}^3$  of  $1.0 \text{ mol dm}^{-3}$  aqueous  $\text{AgNO}_3$  to form metallic silver and aqueous copper(II) nitrate. When the reaction is complete,
- A. excess copper wire remains.
- B. all the copper wire dissolves and some silver ions are left in solution.
- C. all the copper wire dissolves and no silver ions are left in solution.
- D. the mass of metallic silver formed is equal to the mass of copper wire that reacts.
4. 2.02 g of  $\text{KNO}_3$  ( $M_r = 101$ ) is dissolved in sufficient water to prepare  $0.500 \text{ dm}^3$  of solution. What is the concentration of this solution in  $\text{mol dm}^{-3}$ ?
- A. 0.02
- B. 0.04
- C. 0.10
- D. 0.20

5. Copper consists of the isotopes  $^{63}\text{Cu}$  and  $^{65}\text{Cu}$  and has a relative atomic mass of 63.55. What is the most likely composition?

	$^{63}\text{Cu}$	$^{65}\text{Cu}$
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- |    |      |      |
|----|------|------|
| A. | 30 % | 70 % |
| B. | 50 % | 50 % |
| C. | 55 % | 45 % |
| D. | 70 % | 30 % |
6. Which of the following atoms has/have one or more unpaired electrons?

- I. Iron
- II. Copper
- III. Zinc

- A. I only
  - B. III only
  - C. I and II only
  - D. I, II and III
7. Atomic line spectra provide information about the ...**I**... in atoms through the ...**II**....

**I**

**II**

- |    |                     |                        |
|----|---------------------|------------------------|
| A. | energy levels       | distance between lines |
| B. | atomic mass         | pattern of the lines   |
| C. | number of electrons | number of lines        |
| D. | nuclear charge      | intensity of the lines |

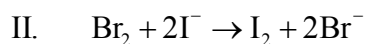
8. In which pair is the first species larger than the second?

- A. Cl and  $\text{Cl}^-$
- B.  $\text{Na}^+$  and Na
- C. Na and K
- D. Si and Cl

9. The oxides of the elements of the third period ( $\text{Na} \rightarrow \text{Cl}$ ) become more ...**I**... and produce more ...**II**... solutions when added to water.

- |    | <b>I</b> | <b>II</b> |
|----|----------|-----------|
| A. | ionic    | acidic    |
| B. | ionic    | alkaline  |
| C. | covalent | acidic    |
| D. | covalent | alkaline  |

10. Which of the following reactions is/are spontaneous?



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

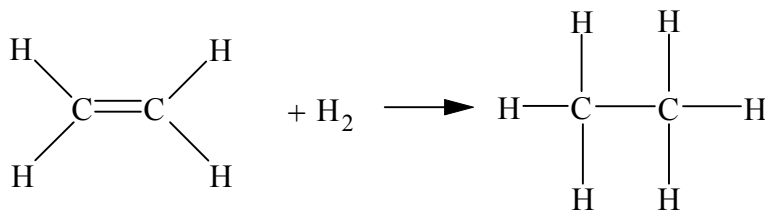
11. When the Lewis structure for  $\text{HCOOCH}_3$  is drawn, how many bond pairs and how many lone pairs of electrons are present?

	<b>Bond pairs</b>	<b>Lone pairs</b>
--	-------------------	-------------------

- |    |   |   |
|----|---|---|
| A. | 8 | 4 |
| B. | 7 | 5 |
| C. | 7 | 4 |
| D. | 5 | 5 |
12. The carbon–carbon–carbon bond angle in  $\text{CH}_3\text{CHCH}_2$  is closest to
- A.  $180^\circ$ .
- B.  $120^\circ$ .
- C.  $109^\circ$ .
- D.  $90^\circ$ .
13. The delocalisation of electrons is most likely to be significant in
- A.  $\text{CO}_2$ .
- B.  $\text{SO}_2$ .
- C.  $\text{HCOOH}$ .
- D.  $\text{TiO}_2$ .
14. The shape of the triiodide ion,  $\text{I}_3^-$ , is best described as
- A. bent.
- B. linear.
- C. T-shaped.
- D. triangular.

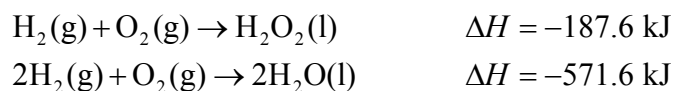
15. What occurs during the change from a liquid to a solid at a fixed temperature?
- A. The particles become smaller and heat is released.
  - B. The particles get closer together and heat is absorbed.
  - C. The particles become more ordered and heat is released.
  - D. The attractive forces between the particles become stronger and heat is absorbed.
16. The molar mass of an unknown gas is to be determined by weighing a sample. As well as its mass, which of the following must be known?
- I. Pressure
  - II. Temperature
  - III. Volume
- A. I only
  - B. II only
  - C. I and II only
  - D. I, II and III
17. A mixture of 0.6 mol  $\text{N}_2$ , 0.4 mol  $\text{O}_2$  and 0.2 mol  $\text{H}_2$  has a total pressure of 2.0 atmospheres. What is the partial pressure of  $\text{N}_2$  in atmospheres?
- A. 0.5
  - B. 0.6
  - C. 1.0
  - D. 1.2

18. What is the value of  $\Delta H$  (in  $\text{kJ mol}^{-1}$ ) for the reaction below?



Bond Energies / $\text{kJ mol}^{-1}$	H—H	C—C	C=C	C—H
	436	348	612	412

- A. 124
- B. 101
- C. -101
- D. -124
19. Using the information below:



what is the value of  $\Delta H$  (in kJ) for the following reaction?



- A. -196.4
- B. -384.0
- C. -759.2
- D. -946.8
20. For which of the following is the change in entropy,  $\Delta S$ , closest to zero?
- A.  $\text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{O}(\text{g})$
- B.  $\text{Mg}(\text{s}) + \text{Cl}_2(\text{g}) \rightarrow \text{MgCl}_2(\text{s})$
- C.  $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightarrow 2\text{HI}(\text{g})$
- D.  $\text{Mg}(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{MgO}(\text{s}) + \text{H}_2(\text{g})$



21. When  $\Delta G^\ominus$  for a reaction is negative, the reaction is

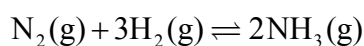
- A. fast.
- B. endothermic.
- C. reversible.
- D. spontaneous.

22.  $\text{CaCO}_3(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$

Which change will increase the rate of the above reaction when 50 cm<sup>3</sup> of 1.0 mol dm<sup>-3</sup> HCl is added to 1.0 g of CaCO<sub>3</sub>?

- A. The volume of HCl is increased.
- B. The concentration of HCl is decreased.
- C. The size of the CaCO<sub>3</sub> solid particles is decreased.
- D. The pressure of the CO<sub>2</sub> is increased.

23. Which statement(s) about the following reaction at 100 °C is/are correct?



- I. Every collision between N<sub>2</sub> and H<sub>2</sub> molecules is expected to produce NH<sub>3</sub>.
- II. This reaction must involve a collision between one N<sub>2</sub> and three H<sub>2</sub> molecules.

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

24. The rate of a chemical reaction increases with increasing temperature. This increase in reaction rate is due to

- I. an increase in the collision rate.
- II. a decrease in the activation energy.
- III. an increase in the number of molecules that react.

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

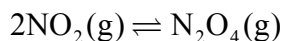
25. For a gaseous reaction, the equilibrium constant expression is:

$$K_c = \frac{[\text{O}_2]^5 [\text{NH}_3]^4}{[\text{NO}]^4 [\text{H}_2\text{O}]^6}.$$

Which equation corresponds to this equilibrium expression?

- A.  $4\text{NH}_3 + 5\text{O}_2 \rightleftharpoons 4\text{NO} + 6\text{H}_2\text{O}$
- B.  $4\text{NO} + 6\text{H}_2\text{O} \rightleftharpoons 4\text{NH}_3 + 5\text{O}_2$
- C.  $8\text{NH}_3 + 10\text{O}_2 \rightleftharpoons 8\text{NO} + 12\text{H}_2\text{O}$
- D.  $2\text{NO} + 3\text{H}_2\text{O} \rightleftharpoons 2\text{NH}_3 + \frac{5}{2}\text{O}_2$

26. The reaction



is exothermic. Which of the following could be used to shift the equilibrium to the right?

- I. Increasing the pressure
- II. Increasing the temperature

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

27. Which combination is correct?

	$\Delta H_{\text{vaporisation}}$	Boiling point	Intermolecular forces
A.	large	high	strong
B.	large	low	weak
C.	small	low	strong
D.	small	high	weak

28. Solutions **P**, **Q**, **R** and **S** have the following properties:

**P**: pH = 8

**Q**:  $[\text{H}^+] = 1 \times 10^{-3} \text{ mol dm}^{-3}$

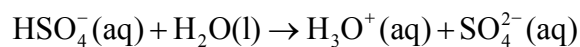
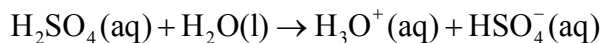
**R**: pH = 5

**S**:  $[\text{H}^+] = 2 \times 10^{-7} \text{ mol dm}^{-3}$

When these solutions are arranged in order of increasing acidity (least acidic first), the correct order is

- A. **P, S, R, Q.**
- B. **Q, R, S, P.**
- C. **S, R, P, Q.**
- D. **R, P, Q, S.**

29. The ionisation of sulfuric acid is represented by the equations below:



What is the conjugate base of  $\text{HSO}_4^-(\text{aq})$ ?

- A.  $\text{H}_2\text{O}(\text{l})$
- B.  $\text{H}_3\text{O}^+(\text{aq})$
- C.  $\text{H}_2\text{SO}_4(\text{aq})$
- D.  $\text{SO}_4^{2-}(\text{aq})$
30. What are the  $[\text{H}^+]$  and  $[\text{OH}^-]$  in a  $0.10 \text{ mol dm}^{-3}$  solution of a weak acid ( $K_a = 1.0 \times 10^{-7}$ )?

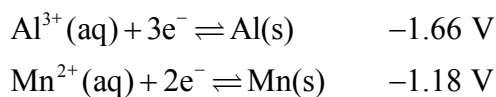
	$[\text{H}^+]$	$[\text{OH}^-]$
--	----------------	-----------------

- |    |                      |                       |
|----|----------------------|-----------------------|
| A. | $1.0 \times 10^{-1}$ | $1.0 \times 10^{-13}$ |
| B. | $1.0 \times 10^{-3}$ | $1.0 \times 10^{-11}$ |
| C. | $1.0 \times 10^{-4}$ | $1.0 \times 10^{-10}$ |
| D. | $1.0 \times 10^{-6}$ | $1.0 \times 10^{-8}$  |
31. Which of the following combinations will form a buffer solution?
- I.  $20 \text{ cm}^3$   $0.10 \text{ mol dm}^{-3}$   $\text{CH}_3\text{COOH}$  and  $10 \text{ cm}^3$   $0.10 \text{ mol dm}^{-3}$   $\text{CH}_3\text{COONa}$
- II.  $20 \text{ cm}^3$   $0.10 \text{ mol dm}^{-3}$   $\text{CH}_3\text{COOH}$  and  $10 \text{ cm}^3$   $0.10 \text{ mol dm}^{-3}$   $\text{NaOH}$
- A. I only
- B. II only
- C. Both I and II
- D. Neither I nor II

32. Which of the following changes represents a reduction reaction?

- A.  $\text{Mn}^{2+}(\text{aq}) \rightarrow \text{MnO}_4^{-}(\text{aq})$
- B.  $\text{CrO}_4^{2-}(\text{aq}) \rightarrow \text{Cr}^{3+}(\text{aq})$
- C.  $2\text{CrO}_4^{2-}(\text{aq}) \rightarrow \text{Cr}_2\text{O}_7^{2-}(\text{aq})$
- D.  $\text{MnO}_2(\text{s}) \rightarrow \text{MnO}_4^{2-}(\text{aq})$

33. The standard electrode potentials for Al and Mn are given below:



What is the potential of a cell prepared with these metals in contact with  $1.0 \text{ mol dm}^{-3}$  solutions of their ions?

- A. 0.22 V
- B. 0.48 V
- C. 2.84 V
- D. 3.43 V

34. When an aqueous solution of copper(II) chloride is electrolysed using carbon electrodes, the products are

- |    | <b>negative electrode</b> | <b>positive electrode</b> |
|----|---------------------------|---------------------------|
| A. | hydrogen gas              | chlorine gas              |
| B. | hydrogen gas              | oxygen gas                |
| C. | copper metal              | oxygen gas                |
| D. | copper metal              | chlorine gas              |

35. The following compounds have similar molar masses. Which compound has the highest boiling point?

- A.  $\text{CH}_3\text{COOH}$
- B.  $\text{C}_2\text{H}_5\text{OCH}_3$
- C.  $\text{CH}_3\text{COCH}_3$
- D.  $\text{C}_2\text{H}_5\text{Cl}$

36. Which molecule possesses a chiral centre?

- A.  $\text{NH}_2\text{CH}_2\text{COOH}$
- B.  $\text{CH}_3\text{CH}(\text{NH}_2)\text{COOH}$
- C.  $\text{CH}_3\text{C}(\text{NH}_2)_2\text{COOH}$
- D.  $(\text{CH}_3)_2\text{C}(\text{NH}_2)\text{COOH}$

37. Which reaction occurs at room temperature?

- A.  $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2 + \text{OH}^- \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{OH} + \text{NH}_2^-$
- B.  $\text{CH}_3\text{CH}_2\text{CH}_2\text{OCH}_3 + \text{CN}^- \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{OCN} + \text{CH}_3^-$
- C.  $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br} + \text{OH}^- \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{OH} + \text{Br}^-$
- D.  $(\text{CH}_3)_3\text{COH} + \text{Cl}^- \rightarrow (\text{CH}_3)_3\text{CCl} + \text{OH}^-$

38. Which compound will undergo oxidation when treated with acidified potassium dichromate(VI)?

- A.  $\text{CH}_3\text{CH}_2\text{CHO}$
- B.  $\text{CH}_3\text{COCH}_3$
- C.  $\text{CH}_3\text{COOH}$
- D.  $(\text{CH}_3)_3\text{COH}$

39. Which compound reacts by electrophilic substitution?

- A. 1-Bromobutane
- B. Cyclohexane
- C. Methylbenzene
- D. Propanone

40. The mass spectrum of  $\text{CH}_3\text{COOC}_2\text{H}_5$  is **not** expected to show a major ion peak at which m/e ratio?

- A. 88
  - B. 32
  - C. 29
  - D. 15
-