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CHEMISTRY
STANDARD LEVEL
PAPER 1

Monday 9 May 2011 (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 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
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)															

Atomic number

Element

Relative atomic mass

†	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 total number of hydrogen atoms in 1.0 mol of benzamide, $C_6H_5CONH_2$?

A. 7

B. 6.0×10^{23}

C. 3.0×10^{24}

D. 4.2×10^{24}

2. What is the sum of the coefficients for the equation when balanced using the smallest possible whole numbers?

$$\_\_ N_2H_4(g) + \_\_ O_2(g) \rightarrow \_\_ NO_2(g) + \_\_ H_2O(g)$$

A. 5

B. 6

C. 7

D. 8

3. Chloroethene, C_2H_3Cl, reacts with oxygen according to the equation below.

$$2C_2H_3Cl(g) + 5O_2(g) \rightarrow 4CO_2(g) + 2H_2O(g) + 2HCl(g)$$

What is the amount, in mol, of H_2O produced when 10.0 mol of C_2H_3Cl and 10.0 mol of O_2 are mixed together, and the above reaction goes to completion?

A. 4.00

B. 8.00

C. 10.0

D. 20.0

4. A fixed mass of gas has a certain volume at a temperature of 50 °C. What temperature is required to double its volume while keeping the pressure constant?

A. 100 K

B. 323 K

C. 373 K

D. 646 K

5. What is the concentration of NaCl, in mol dm^{-3}, when 10.0 cm^3 of 0.200 mol dm^{-3} NaCl solution is added to 30.0 cm^3 of 0.600 mol dm^{-3} NaCl solution?

A. 0.450

B. 0.300

C. 0.500

D. 0.800

6. Which statements about the isotopes of chlorine, $^{35}_{17}\text{Cl}$ and $^{37}_{17}\text{Cl}$, are correct?

I. They have the same chemical properties.

II. They have the same atomic number.

III. They have the same physical properties.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

7. In the emission spectrum of hydrogen, which electronic transition would produce a line in the visible region of the electromagnetic spectrum?

A. $n = 2 \rightarrow n = 1$

B. $n = 3 \rightarrow n = 2$

C. $n = 2 \rightarrow n = 3$

D. $n = \infty \rightarrow n = 1$

8. Which change explains why the boiling points of the halogens increase as their molecular masses increase?

A. The intermolecular attraction due to temporarily induced dipoles increases.

B. The gravitational attraction between molecules increases.

C. The polarity of the bond within the molecule increases.

D. The strength of the bond within the molecule increases.

9. Which pair of elements has the greatest difference in electronegativity?

A. Cs and F

B. Cs and Cl

C. Cs and Br

D. Cs and I

10. Which molecule has a non-bonding (lone) pair of electrons on the central atom?

A. BF_3

B. SO_2

C. CO_2

D. SiF_4

11. When C_2H_2, C_2H_4 and C_2H_6 are arranged in order of **increasing** carbon-carbon bond strength (weakest bond first), what is the correct order?

A. C_2H_2, C_2H_4, C_2H_6

B. C_2H_2, C_2H_6, C_2H_4

C. C_2H_6, C_2H_4, C_2H_2

D. C_2H_6, C_2H_2, C_2H_4

12. The number of electrons in the valence shell of elements A and B, are 6 and 7 respectively. What is the formula and type of bonding in a compound formed by these elements?

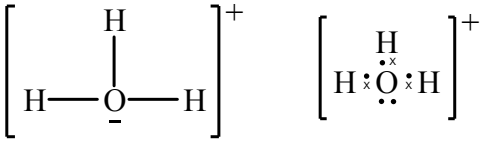
A. A_2B, covalent

B. AB_2, covalent

C. A_2B, ionic

D. AB_2, ionic

13. Lewis structures are represented in different ways in different parts of the world. Two ways of drawing the Lewis structure for H_3O^+ are shown below.



Which statement is correct about H_3O^+?

A. The ion has a tetrahedral shape.

B. The H–O–H bond angle is 120°.

C. The H–O–H bond angle is 90°.

D. The ion has a trigonal pyramidal shape.

14. Which particles are responsible for the conduction of electricity in molten aluminium?

A. Cations

B. Anions

C. Electrons

D. Protons

15. Which processes have a negative enthalpy change?

I. $2CH_3OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 4H_2O(l)$

II. $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$

III. $H_2O(g) \rightarrow H_2O(l)$

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

16. Consider the following reactions.

$$N_2(g) + O_2(g) \rightarrow 2NO(g) \qquad \Delta H^{\ominus} = +180\ \text{kJ}$$

$$2NO_2(g) \rightarrow 2NO(g) + O_2(g) \qquad \Delta H^{\ominus} = +112\ \text{kJ}$$

What is the $\Delta H^{\ominus}$ value, in kJ, for the following reaction?

$$N_2(g) + 2O_2(g) \rightarrow 2NO_2(g)$$

A. $-1 \times (+180) + -1 \times (+112)$

B. $-1 \times (+180) + 1 \times (+112)$

C. $1 \times (+180) + -1 \times (+112)$

D. $1 \quad (+180) + 1 \quad (+112)$

17. At 25 °C, 200 cm^3 of 1.0 $mol\,dm^{-3}$ nitric acid is added to 5.0 g of magnesium powder. If the experiment is repeated using the same mass of magnesium powder, which conditions will result in the same initial reaction rate?

	Volume of HNO_3 / cm^3	**Concentration of HNO_3 / $mol\,dm^{-3}$**	**Temperature / °C**
A.	200	2.0	25
B.	200	1.0	50
C.	100	2.0	25
D.	100	1.0	25

18. For the following reaction $K_c = 1.0 \times 10^{-5}$ at 30 °C.

$$2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$$

Which relationship is correct at equilibrium at this temperature?

A. The concentration of NO equals the concentration of NOCl.

B. The concentration of NOCl is double the concentration of Cl_2.

C. The concentration of NOCl is much greater than the concentration of Cl_2.

D. The concentration of NO is much greater than the concentration of NOCl.

19. The reaction below represents the Haber process for the industrial production of ammonia.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H^{\ominus} = -92 \text{ kJ}$$

The optimum conditions of temperature and pressure are chosen as a compromise between those that favour a high yield of ammonia and those that favour a fast rate of production. Economic considerations are also important.

Which statement is correct?

A. A higher temperature would ensure higher yield and a faster rate.

B. A lower pressure would ensure a higher yield at a lower cost.

C. A lower temperature would ensure a higher yield and a faster rate.

D. A higher pressure would ensure a higher yield at a higher cost.

20. Which is **not** a conjugate acid-base pair?

A. HNO_3 and NO_3^-

B. CH_3COOH and CH_3COO^-

C. H_3O^+ and OH^-

D. HSO_4^- and SO_4^{2-}

21. Which 0.10 mol dm^{-3} solution would have the highest conductivity?

A. HCl

B. NH_3

C. CH_3COOH

D. H_2CO_3

22. The pH of a solution changes from pH = 2 to pH = 5. What happens to the concentration of the hydrogen ions during this pH change?

A. It decreases by a factor of 1000

B. It increases by a factor of 1000

C. It decreases by a factor of 100

D. It increases by a factor of 100

23. What happens to iodine when iodate ions, IO_3^-, are converted to iodine molecules, I_2?

A. It undergoes reduction and its oxidation number changes from –1 to 0

B. It undergoes oxidation and its oxidation number changes from –1 to 0

C. It undergoes reduction and its oxidation number changes from +5 to 0

D. It undergoes oxidation and its oxidation number changes from +5 to 0

24. Consider the following reactions of three unknown metals X, Y and Z.

$$2XNO_3(aq) + Y(s) \rightarrow 2X(s) + Y(NO_3)_2(aq)$$

$$Y(NO_3)_2(aq) + Z(s) \rightarrow \text{No reaction}$$

$$2XNO_3(aq) + Z(s) \rightarrow 2X(s) + Z(NO_3)_2(aq)$$

What is the order of **increasing** reactivity of the metals (least reactive first)?

A. X < Y < Z

B. X < Z < Y

C. Z < Y < X

D. Y < Z < X

25. Which statement about the electrolysis of molten sodium chloride is correct?

A. A yellow-green gas would be produced at the negative electrode.

B. A silvery metal is produced at the positive electrode.

C. Chloride ions are attracted to the positive electrode and undergo oxidation.

D. Sodium ions are attracted to the negative electrode and undergo oxidation.

26. Which organic molecule is **not** a structural isomer of pentan-1-ol?

A. pentan-2-ol

B. 2-methylpentan-2-ol

C. 2-methylbutan-2-ol

D. pentan-3-ol

27. Which of the structures below is an aldehyde?

A. $CH_3CH_2CH_2CH_2OH$

B. $CH_3CH_2COCH_3$

C. $CH_3CH_2COOCH_3$

D. $CH_3CH_2CH_2CH\ O$

28. What product is formed when $CH_3CH(OH)CH_3$ is reacted with acidified potassium dichromate(VI)?

A. CH_3COOCH_3

B. CH_3CH_2CHO

C. CH_3CH_2COOH

D. CH_3COCH_3

29. Which type of reaction occurs when 2-iodo-2-methylpropane, $C(CH_3)_3I$, reacts with aqueous sodium hydroxide, NaOH (aq)?

A. Addition

B. Free-radical substitution

C. S_N1

D. S_N2

30. A piece of metallic aluminium with a mass of 10.044 g was found to have a volume of 3.70 cm^3. A student carried out the following calculation to determine the density.

$$\text{Density (g cm}^{-3}) = \frac{10.044}{3.70}$$

What is the best value the student could report for the density of aluminium?

A. 2.715 g cm^{-3}

B. 2.7 g cm^{-3}

C. 2.71 g cm^{-3}

D. 2.7146 g cm^{-3}