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CHEMISTRY
STANDARD LEVEL
PAPER 1

Tuesday 18 November 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

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)															

†	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. 0.040 mol of $(NH_4)_2Ni(SO_4)_2 \cdot 6H_2O$ is dissolved in water to give 200 cm^3 of aqueous solution. What is the concentration, in mol dm^{-3}, of ammonium ions?

A. 0.00040

B. 0.0080

C. 0.20

D. 0.40

2. When sodium bromate(V), $NaBrO_3$, is heated, it reacts according to the equation below.

$$2NaBrO_3(s) \rightarrow 2NaBr(s) + 3O_2(g)$$

What amount, in mol, of $NaBrO_3$ produces 2.4 dm^3 of oxygen gas, measured at room temperature and pressure? (Molar volume of gas = 24 $dm^3\,mol^{-1}$ at room temperature and pressure.)

A. 0.017

B. 0.067

C. 0.10

D. 0.15

3. Aluminium carbide reacts with water according to the equation below. What is the **sum** of all the coefficients when the equation is balanced?

$$\_\_\_Al_4C_3(s) + \_\_\_H_2O(l) \rightarrow \_\_\_Al(OH)_3(s) + \_\_\_CH_4(g)$$

A. 13

B. 14

C. 19

D. 20

4. At which temperature, in K, assuming constant pressure, is the volume of a fixed mass of gas at 127 °C doubled?

A. 200 K

B. 254 K

C. 400 K

D. 800 K

5. Which ion will show the **least** deflection in a mass spectrometer?

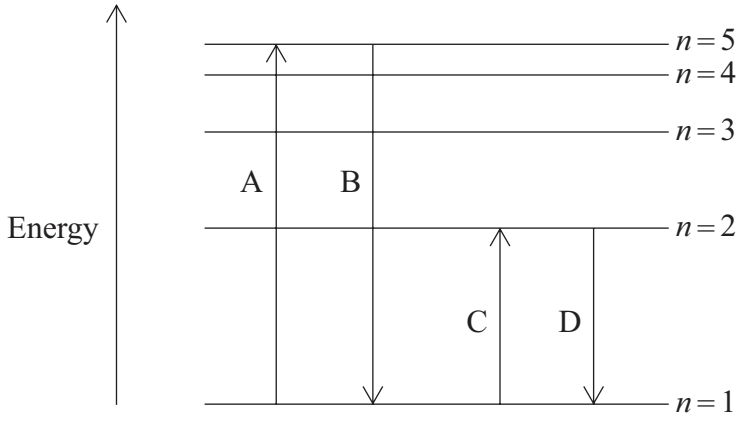
A. $^{35}Cl^{+}$

B. $^{35}Cl^{2+}$

C. $^{35}Cl\ ^{35}Cl^{+}$

D. $^{35}Cl\ ^{37}Cl^{+}$

6. Some possible electron transitions in a hydrogen atom are shown below. Which letter represents the electron transition with the highest energy in the emission spectrum?



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

I. Melting point
II. First ionization energy
III. Electronegativity

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

8. Which period 3 oxide, when added to water, forms an acidic solution?

A. SO_3

B. MgO

C. Na_2O

D. Al_2O_3

9. Which species contains a dative covalent (coordinate) bond?

A. HCN

B. C_2H_2

C. CO_2

D. CO

10. Which diatomic molecule has the strongest bonding between its atoms?

A. H_2

B. N_2

C. O_2

D. F_2

11. Which molecule is non-polar?

A. CCl_4

B. CH_2Cl_2

C. CH_3Cl

D. CO

12. Which process involves the breaking of hydrogen bonds?

A. $2HI(g) \rightarrow H_2(g) + I_2(g)$

B. $CH_4(g) \rightarrow C(g) + 4H(g)$

C. $H_2(l) \rightarrow H_2(g)$

D. $NH_3(l) \rightarrow NH_3(g)$

13. Which species contains a bond angle of approximately 107°?

A. H_2O

B. CF_4

C. NCl_3

D. BF_3

14. The enthalpy change for the reaction between zinc metal and copper(II) sulfate solution is $-217\,\text{kJ}\,\text{mol}^{-1}$. Which statement about this reaction is correct?

A. The reaction is endothermic and the temperature of the reaction mixture initially rises.

B. The reaction is endothermic and the temperature of the reaction mixture initially drops.

C. The reaction is exothermic and the temperature of the reaction mixture initially rises.

D. The reaction is exothermic and the temperature of the reaction mixture initially drops.

15. Consider the following equations.

$$2\text{Fe(s)} + 1\tfrac{1}{2}\text{O}_2\text{(g)} \rightarrow \text{Fe}_2\text{O}_3\text{(s)} \qquad \Delta H^{\ominus} = x$$
$$\text{CO(g)} + \tfrac{1}{2}\text{O}_2\text{(g)} \rightarrow \text{CO}_2\text{(g)} \qquad \Delta H^{\ominus} = y$$

What is the enthalpy change of the reaction below?

$$\text{Fe}_2\text{O}_3\text{(s)} + 3\text{CO(g)} \rightarrow 3\text{CO}_2\text{(g)} + 2\text{Fe(s)}$$

A. $3y - x$

B. $3y + x$

C. $-3y - x$

D. $-3y + x$

16. Consider the following bond enthalpy data.

Bond	Bond enthalpy / kJ mol^{-1}
H–H	436
Cl–Cl	243
H–Cl	432

What is the enthalpy change, in kJ mol^{-1}, of this reaction?

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$$

A. +247

B. –247

C. –185

D. +185

17. Consider the following reaction between hydrogen peroxide, hydrogen ions and iodide ions.

$$H_2O_2(aq) + 2H^+(aq) + 2I^-(aq) \rightarrow I_2(aq) + 2H_2O(l)$$

Which changes could be used to investigate the rate of this reaction?

I. Electrical conductivity

II. Mass of solution

III. Colour intensity

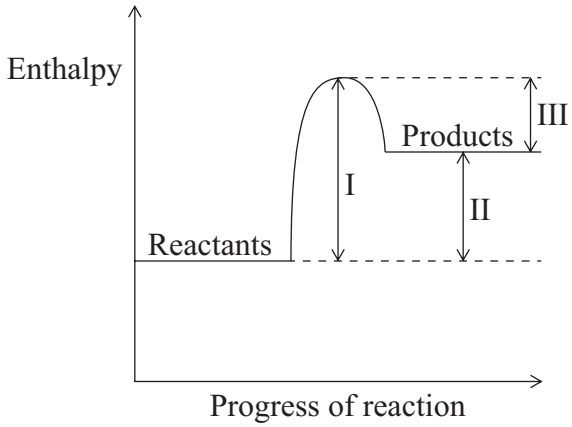
A. I and II only

B. I and III only

C. II and III only

D. I, II and III

18. Which quantity can be changed by the use of a catalyst?



A. I and II only

B. I and III only

C. II and III only

D. I, II and III

19. Which equilibrium reaction shifts to the product side when the temperature is increased at constant pressure **and** to the reactant side when the total pressure is increased at constant temperature?

A. $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ $\Delta H^{\ominus} < 0$

B. $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ $\Delta H^{\ominus} > 0$

C. $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$ $\Delta H^{\ominus} < 0$

D. $PCl_3(g) + Cl_2(g) \rightleftharpoons PCl_5(g)$ $\Delta H^{\ominus} > 0$

20. Which statement correctly describes the effect of a catalyst on the equilibrium below?

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

A. It increases the rates of both forward and reverse reactions equally.

B. It increases the rate of the forward reaction but decreases the rate of the reverse reaction.

C. It increases the value of the equilibrium constant.

D. It increases the yield of NH_3.

21. Which definition of a base is correct?

A. A Lewis base accepts a proton.

B. A Brønsted–Lowry base accepts an electron pair.

C. A Brønsted–Lowry base donates an electron pair.

D. A Lewis base donates an electron pair.

22. A student adds 0.3 g of magnesium metal to equal volumes of hydrochloric acid and ethanoic acid of the same concentrations in separate flasks. Which statement is correct?

A. Hydrochloric acid reacts more rapidly as it has a higher pH than ethanoic acid.

B. A greater total volume of H_2 gas is produced with hydrochloric acid than with ethanoic acid.

C. The same total volume of H_2 gas is produced with both hydrochloric acid and ethanoic acid.

D. Ethanoic acid reacts more slowly because it has a lower pH than hydrochloric acid.

23. Which species of vanadium has a different oxidation number from the rest?

A. VO_2^+

B. VO_3^-

C. V_2O_5

D. VO^{2+}

24. Which statement is correct for the following reaction?

$$2ClO_3^-(aq) + SO_2(aq) + H^+(aq) \rightarrow 2ClO_2(g) + HSO_4^-(aq)$$

A. ClO_3^- is the oxidizing agent and it undergoes reduction.

B. ClO_3^- is the reducing agent and it undergoes oxidation.

C. SO_2 is the oxidizing agent and it undergoes oxidation.

D. SO_2 is the reducing agent and it undergoes reduction.

25. Which statement about an electrolytic cell is correct?

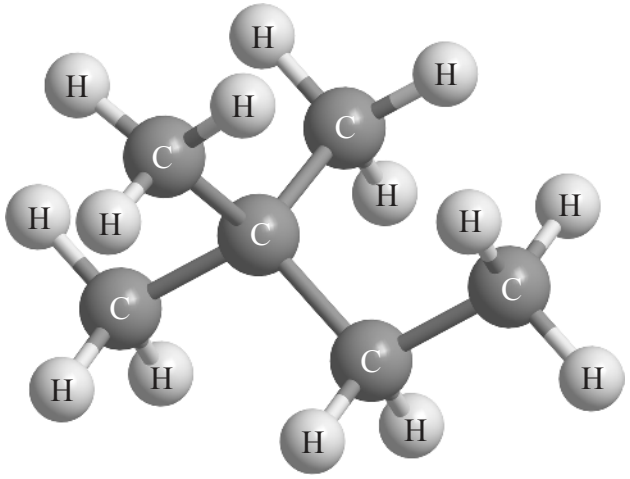
A. Chemical energy is converted to electrical energy.

B. Electrons move through the electrolyte.

C. The cathode is the negative electrode.

D. The negative ions move towards the negative electrode.

26. What is the name of the alkane shown in the diagram below, applying IUPAC rules?



A. Hexane

B. 1,1,1-trimethylpropane

C. Ethylmethylpropane

D. 2,2-dimethylbutane

27. Which structural formula represents a secondary halogenoalkane?

A. $CH_3CHBrCH_2CH_3$

B. $(CH_3)_3CBr$

C. $CH_3(CH_2)_3Br$

D. $(CH_3)_2CHCH_2Br$

28. Which equation represents a propagation step in the reaction of methane with bromine?

A. $CH_4 \rightarrow CH_3\bullet + H\bullet$

B. $CH_4 + Br\bullet \rightarrow CH_3\bullet + HBr$

C. $CH_4 + Br\bullet \rightarrow CH_3Br + H\bullet$

D. $CH_3\bullet + Br\bullet \rightarrow CH_3Br$

29. Chloroethane, C_2H_5Cl, reacts with aqueous sodium hydroxide, NaOH, to form ethanol, C_2H_5OH. Which statement about the mechanism of this reaction is correct?

A. The reaction follows an S_N1 mechanism.

B. Homolytic fission of the carbon-chlorine bond occurs in chloroethane.

C. The reaction is unimolecular.

D. The transition state formed is negatively charged.

30. In an experiment to determine a specific quantity, a student calculated that her experimental uncertainty was 0.9 % and her experimental error was 3.5 %. Which statement is correct?

A. Only random uncertainties are present in this experiment.

B. Both random uncertainties and systematic errors are present in this experiment.

C. Repeats of this experiment would reduce the systematic errors.

D. Repeats of this experiment would reduce both systematic errors and random uncertainties.