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CHEMISTRY
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PAPER 1

Monday 7 November 2011 (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 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. How many oxygen **atoms** are in 0.100 mol of $CuSO_4 \cdot 5H_2O$?

   A. 5.42×10^{22}

   B. 6.02×10^{22}

   C. 2.41×10^{23}

   D. 5.42×10^{23}

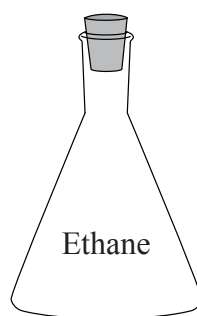2. What is the sum of the coefficients when the following equation is balanced using whole numbers?

   $$\_\_\_ Fe_2O_3(s) + \_\_\_ CO(g) \rightarrow \_\_\_ Fe(s) + \_\_\_ CO_2(g)$$
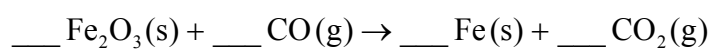
   A. 5

   B. 6

   C. 8

   D. 9

3. Four identical containers under the same conditions are filled with gases as shown below. Which container and contents will have the highest mass?
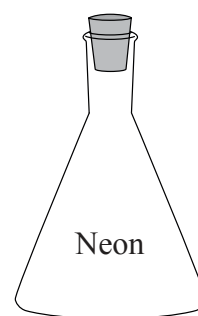

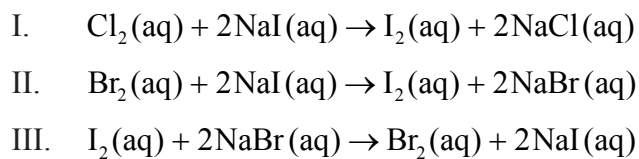 | Nitrogen | Oxygen | Ethane | Neon |
   |:---:|:---:|:---:|:---:|
   | A | B | C | D |

Turn over
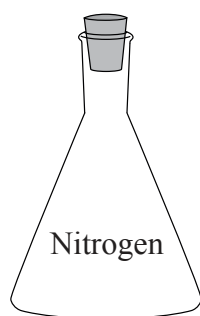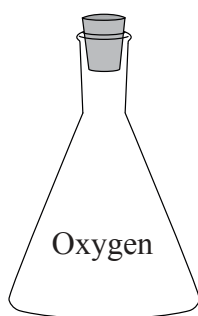
4. 1.0 dm^3 of an ideal gas at 100 kPa and 25 °C is heated to 50 °C at constant pressure. What is the new volume in dm^3?

    A.   0.50

    B.   0.90

    C.   1.1

    D.   2.0

5. What is the amount, in moles, of sulfate ions in 100 cm^3 of 0.020 mol dm^{-3} FeSO$_4$(aq)?

    A. 2.0×10^{-3}

    B. 2.0×10^{-2}

    C. 2.0×10^{-1}

    D.   2.0

6. Which shows the sub-levels in order of **increasing** energy in the fourth energy level of an atom?

    A.   f < d < p < s

    B.   p < d < f < s

    C.   d < f < p < s

    D.   s < p < d < f

7. Which physical property of elements is represented by y on the graph below?
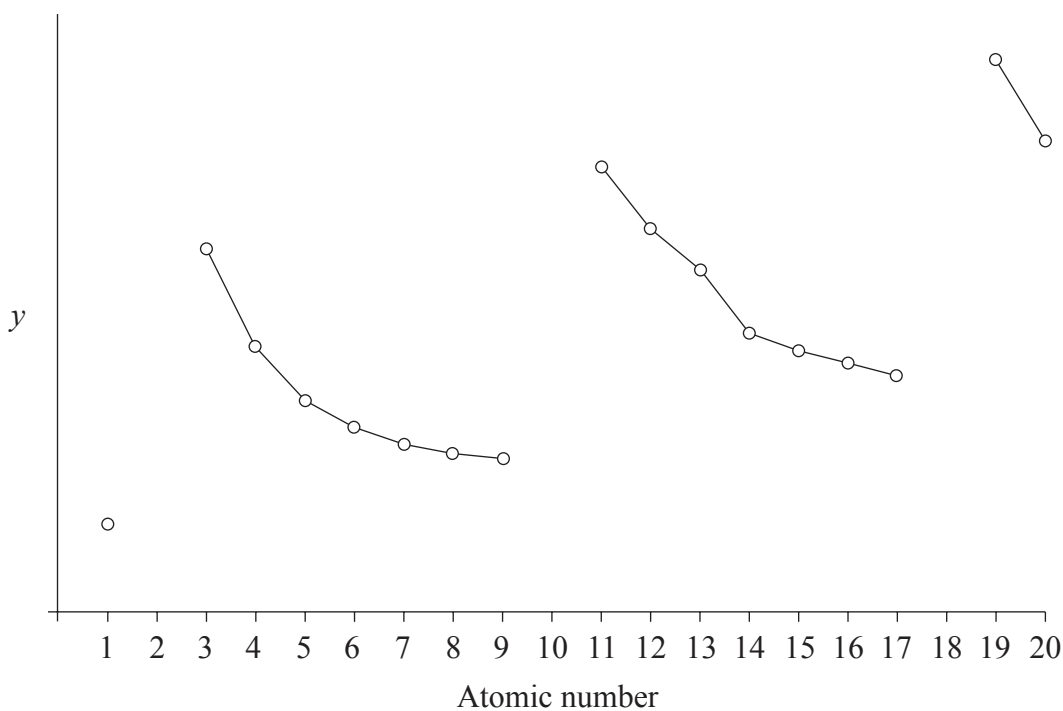
A.   First ionization energy

B.   Ionic radius

C.   Atomic radius

D.   Electronegativity

8. Which of the following redox reactions take place?

I. $Cl_2(aq) + 2NaI(aq) \rightarrow I_2(aq) + 2NaCl(aq)$

II. $Br_2(aq) + 2NaI(aq) \rightarrow I_2(aq) + 2NaBr(aq)$

III. $I_2(aq) + 2NaBr(aq) \rightarrow Br_2(aq) + 2NaI(aq)$

A.   I and II only

B.   I and III only

C.   II and III only

D.   I, II and III

9.   Which metals are considered to be transition elements?

       I.   Ti

      II.   Zn

      III. Fe

    A.   I and II only

    B.   I and III only

    C.   II and III only

    D.   I, II and III

10.   Which bonds are arranged in order of **increasing** polarity?

    A.   H–F < H–Cl < H–Br < H–I

    B.   H–I < H–Br < H–F < H–Cl

    C.   H–I < H–Br < H–Cl < H–F

    D.   H–Br < H–I < H–Cl < H–F

11.   Which row correctly describes the bonding type and melting point of carbon and carbon dioxide?

	Carbon		Carbon dioxide	
A.	covalent bonding	high melting point	covalent bonding	low melting point
B.	ionic bonding	low melting point	ionic bonding	high melting point
C.	ionic bonding	high melting point	ionic bonding	low melting point
D.	covalent bonding	low melting point	covalent bonding	high melting point

12. What is the correct order of **increasing** boiling points?

    A. $CH_3CH_3 < CH_3CH_2Cl < CH_3CH_2Br < CH_3CH_2I$

    B. $CH_3CH_2Cl < CH_3CH_2Br < CH_3CH_3 < CH_3CH_2I$

    C. $CH_3CH_2I < CH_3CH_2Br < CH_3CH_2Cl < CH_3CH_3$

    D. $CH_3CH_2Br < CH_3CH_2Cl < CH_3CH_2I < CH_3CH_3$

13. What are the correct formulas of the following ions?

	Nitrate	**Phosphate**	**Carbonate**	**Ammonium**
A.	NO_3^-	PO_4^{3-}	CO_3^-	NH_3^+
B.	NO_3^{2-}	PO_3^{2-}	CO_3^{2-}	NH_3^+
C.	NO_3^-	PO_4^{3-}	CO_3^{2-}	NH_4^+
D.	NO_3^{2-}	PO_3^{2-}	CO_3^{2-}	NH_4^+

14. Which statements about hybridization are correct?

    I.   The hybridization of carbon in diamond is sp^3.

    II.   The hybridization of carbon in graphite is sp^2.

    III.   The hybridization of carbon in C_{60} fullerene is sp^3.

    A.   I and II only

    B.   I and III only
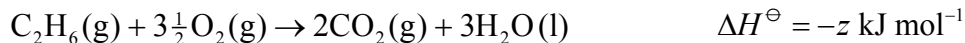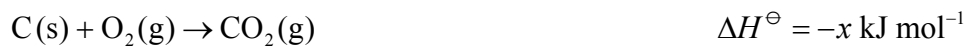
    C.   II and III only

    D.   I, II and III

15. A student measured the temperature of a reaction mixture over time using a temperature probe. By considering the graph, which of the following deductions can be made?
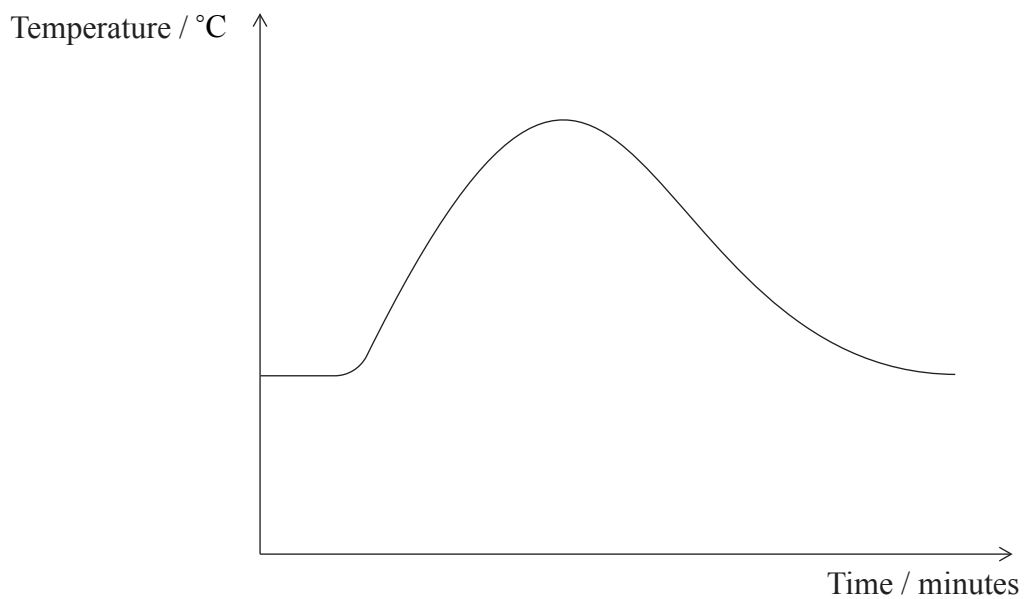

I.   The reaction is exothermic.

II.   The products are more stable than the reactants.

III. The reactant bonds are stronger than the product bonds.

A.   I and II only

B.   I and III only

C.   II and III only

D.   I, II and III

16. Consider the following enthalpy of combustion data.

$$C(s) + O_2(g) \rightarrow CO_2(g) \qquad\qquad \Delta H^{\ominus} = -x \text{ kJ mol}^{-1}$$

$$H_2(g) + \tfrac{1}{2}O_2(g) \rightarrow H_2O(l) \qquad\qquad \Delta H^{\ominus} = -y \text{ kJ mol}^{-1}$$

$$C_2H_6(g) + 3\tfrac{1}{2}O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l) \qquad \Delta H^{\ominus} = -z \text{ kJ mol}^{-1}$$

What is the enthalpy of formation of ethane in kJ mol^{-1}?

$$2C(s) + 3H_2(g) \rightarrow C_2H_6(g)$$
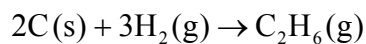
A. $[(-x) + (-y)] - (-z)$

B. $(-z) - [(-x) + (-y)]$

C. $[(-2x) + (-3y)] - (-z)$

D. $(-z) - [(-2x) + (-3y)]$

17. Which row of the table correctly represents the equations for the lattice enthalpy of substance XY and the electron affinity of atom Y?

	Lattice enthalpy	**Electron affinity**
A.	$X^+(g) + Y^-(g) \rightarrow XY(g)$	$Y^-(g) + e^- \rightarrow Y^{2-}(g)$
B.	$X^+(g) + Y^-(g) \rightarrow XY(s)$	$Y(g) + e^- \rightarrow Y^-(g)$
C.	$X^+(g) + Y^-(g) \rightarrow XY(s)$	$Y(s) + e^- \rightarrow Y^-(s)$
D.	$X^+(g) + Y^-(g) \rightarrow XY(g)$	$Y(g) + e^- \rightarrow Y^-(g)$

18. Which factors will increase the entropy of this system?

$$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$$

  I.   Increasing the temperature without changing the volume of the container.

  II.   Decreasing the concentration of the gas without changing the volume of the container.

  III. Increasing the pressure without changing the volume of the container.

A.   I and II only

B.   I and III only

C.   II and III only

D.   I, II and III

19. A student added 0.20 g of calcium carbonate powder to 100 cm^3 of 1.0 mol dm^{-3} hydrochloric acid (an excess) and measured the volume of the gas that was evolved. The graph of the results is shown below.
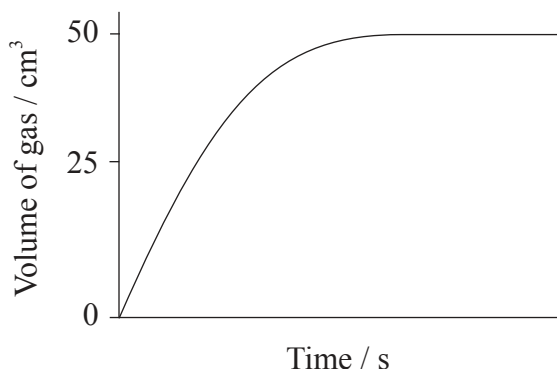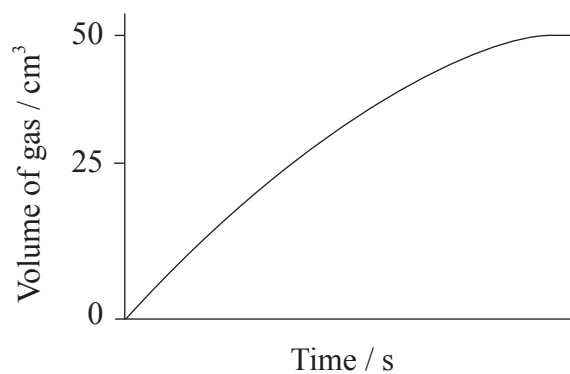

Which graph would be obtained if 0.20 g of calcium carbonate powder is added to 100 cm^3 of 0.5 mol dm^{-3} hydrochloric acid (an excess)?
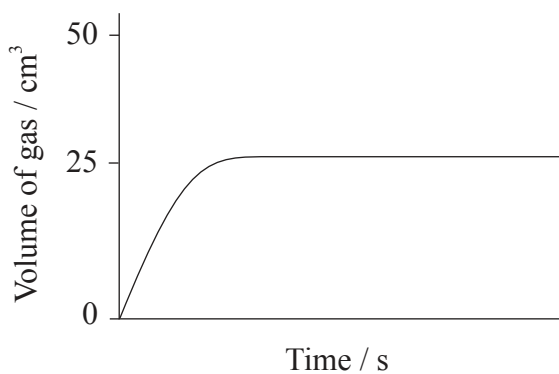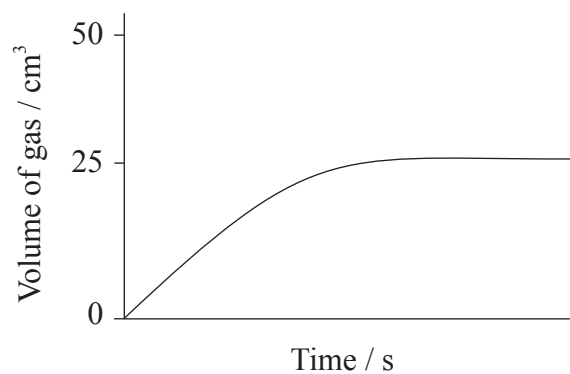
A.

B.

C.

D.

Turn over
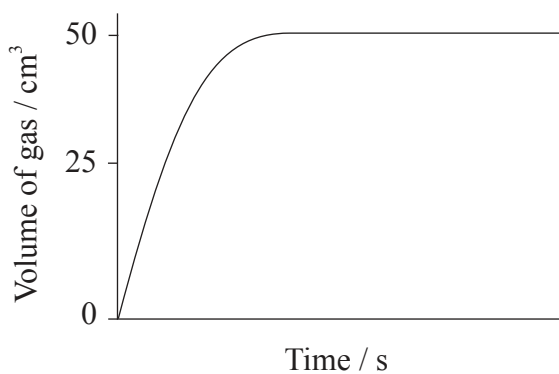
20. Which statement about the kinetic theory is **not** correct?

    A.   The particles in ice vibrate about fixed points.

    B.   The particles in steam have more energy than the particles in ice.

    C.   All the particles in water have the same amount of energy at 298 K.

    D.   Evaporation of water occurs at all temperatures between 273 K and 373 K when the atmospheric pressure is 101 kPa.

21. The rate expression for the reaction between iodine and propanone with an acid catalyst is found to be:
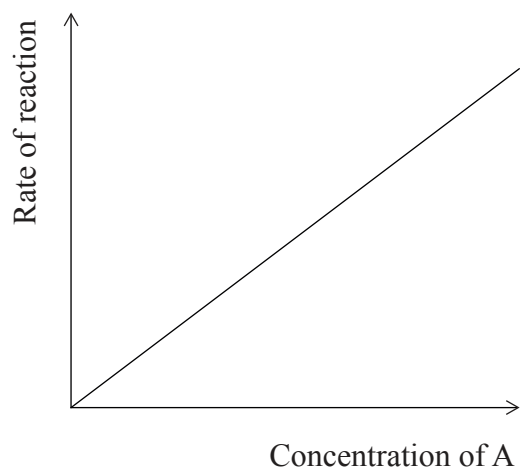
$$\text{rate} = k\,[H^+]^1\,[I_2]^0\,[CH_3COCH_3]^1$$
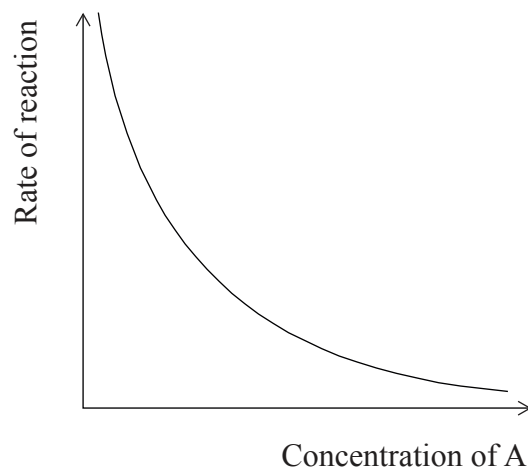
What is the overall order of the reaction?

    A.   0

    B.   1

    C.   2

    D.   3

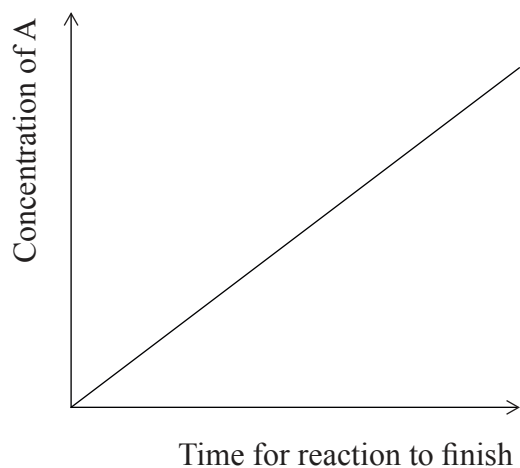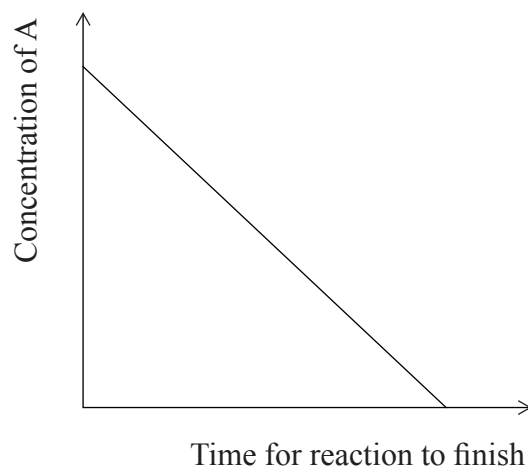**22.** Which graph represents a reaction that is first order with respect to reactant A.

A.

Rate of reaction vs Concentration of A

B.

Rate of reaction vs Concentration of A

C.

Concentration of A vs Time for reaction to finish

D.

Concentration of A vs Time for reaction to finish

23. Which are characteristics of a dynamic equilibrium?

      I.   Amounts of products and reactants are constant.

      II.   Amounts of products and reactants are equal.

      III.   The rate of the forward reaction is equal to the rate of the backward reaction.

    A.   I and II only

    B.   I and III only

    C.   II and III only

    D.   I, II and III

24. Four identical sealed containers are prepared each containing 10 cm³ of an organic compound and at the temperature shown below. Which container will have the highest vapour pressure?

	Substance	Temperature / °C
A.	C_2H_5OH	15
B.	C_2H_5OH	30
C.	CH_3OCH_3	15
D.	CH_3OCH_3	30

25. Which descriptions are correct for both a Brønsted–Lowry acid and a Lewis acid?

	Brønsted–Lowry acid	Lewis acid
A.	proton donor	electron pair donor
B.	proton donor	electron pair acceptor
C.	proton acceptor	electron pair donor
D.	proton acceptor	electron pair acceptor

26. What is the pH of the solution formed when 10 cm³ of HCl(aq) with pH 1.0 is added to 990 cm³ of water?

A. 1.5

B. 2.0

C. 2.5

D. 3.0

27. Consider the equation for the dissociation of water:

$$H_2O\,(l) \rightleftharpoons H^+\,(aq) + OH^-\,(aq) \qquad \Delta H^{\ominus} = +57.3\,kJ\,mol^{-1}$$
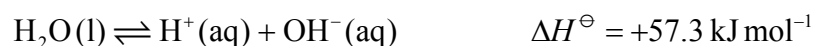
Which statement is correct?

A. The pH of pure water is always 7.

B. At temperatures above 298 K the pH of pure water is below 7.

C. At temperatures above 298 K the pH of pure water is above 7.

D. K_w decreases with increasing temperature.

28. Which combination of $1\,mol\,dm^{-3}$ solutions produces an acidic buffer?

A. $50\,cm^3\,HCl\,(aq)$ and $150\,cm^3\,NH_3\,(aq)$

B. $100\,cm^3\,CH_3COOH\,(aq)$ and $50\,cm^3\,HCl\,(aq)$

C. $100\,cm^3\,CH_3COOH\,(aq)$ and $50\,cm^3\,NaOH\,(aq)$

D. $50\,cm^3\,CH_3COOH\,(aq)$ and $50\,cm^3\,NaOH\,(aq)$

29. Which salt dissolves in water to form an acidic solution?

A. Potassium ethanoate

B. Calcium ethanoate

C. Ammonium chloride

D. Sodium carbonate

30. What is the correct **decreasing** order of reactivity of the metals X, Y and Z based on the following equations?

$$XCl + Y \rightarrow YCl + X$$

$$YCl + Z \rightarrow YCl + Z$$

$$ZCl + X \rightarrow XCl + Z$$
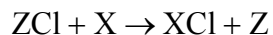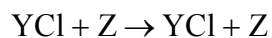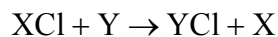
A. X > Y > Z

B. Y > Z > X

C. Z > Y > X

D. Y > X > Z

31. Four electrolytic cells are constructed. Which cell would produce the greatest mass of metal at the negative electrode (cathode)?

	Electrolyte	**Current / A**	**Time / s**
A.	$1.0 \text{ mol dm}^{-3} \text{ CuSO}_4 \text{(aq)}$	1.0	500
B.	$1.0 \text{ mol dm}^{-3} \text{ AgNO}_3 \text{(aq)}$	2.0	250
C.	$1.0 \text{ mol dm}^{-3} \text{ CuSO}_4 \text{(aq)}$	1.0	750
D.	$1.0 \text{ mol dm}^{-3} \text{ AgNO}_3 \text{(aq)}$	1.5	250

32. Which is **not** a requirement for the standard hydrogen electrode?

A. Pressure of 101 kPa

B. 1 mol dm^{-3} sulfuric acid

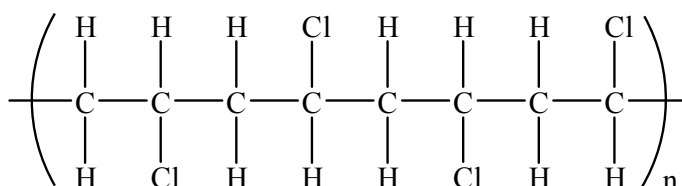C. Temperature of 298 K

D. An inert electrode such as platinum

33. Which molecule contains an ester group?

    A. CH_3CH_2COOH

    B. CH_3COOCH_3

    C. $CH_3COCH_2CH_2OH$

    D. $OHCCH_2CHO$

34. Which compound is produced in the reaction between but-2-ene and steam?

    A. $CH_3CHOHCHOHCH_3$

    B. $CH_2OHCH_2CH_2CH_2OH$

    C. $CH_3CH_2CHOHCH_3$

    D. $CH_3CH_2CH_2CH_2OH$

35. From which monomer is this polymer made?
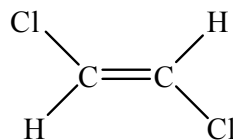
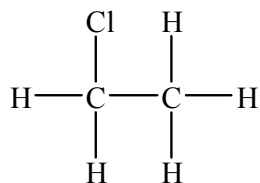   A.   B.
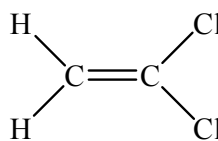
    C.   D.

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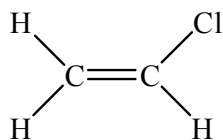
36. Which compound is the major product of the reaction when 1-bromobutane is heated with concentrated sodium hydroxide in ethanol?

    A. $CH_3CHOHCH_2CH_3$

    B. $CH_3CHCHCH_3$

    C. $CH_3CH_2CH_2CH_2OH$

    D. $CH_2CHCH_2CH_3$

37. Which halogenoalkane reacts fastest with sodium hydroxide?

    A.   1-iodobutane

    B.   1-chlorobutane

    C.   2-chloro-2-methylpropane

    D.   2-iodo-2-methylpropane

38. Which molecule exhibits optical isomerism?

    A.   3-iodopentane

    B.   2-iodo-2-methylpropane

    C.   1,3-diiodopropane

    D.   2-iodobutane

39. What is the most likely use for the organic product of the following reaction?

$$CH_3CH_2CH_2OH + CH_3CH_2CH_2COOH \rightarrow$$

    A.   Catalyst

    B.   Pesticide

    C.   Detergent

    D.   Perfume

40. A student heated a solid in a crucible. The student measured the mass of the solid and crucible before and after heating and recorded the results.

Mass of crucible and solid before heating = 101.692 g

Mass of crucible and solid after heating   = 89.312 g

What value should the student record for the mass lost in grams?

A.   12.4

B.   12.38

C.   12.380

D.   12.3800