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Chemistry
Higher level
Paper 1

Wednesday 22 May 2019 (afternoon)

1 hour

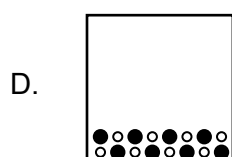
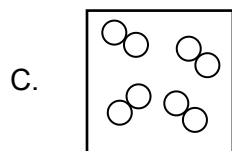
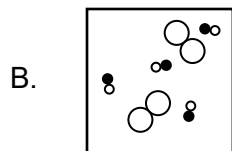
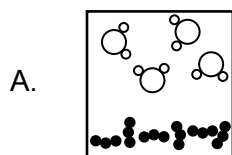
Instructions to candidates

- 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 maximum mark for this examination paper is **[40 marks]**.

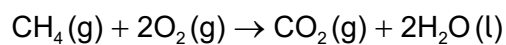
The Periodic Table

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | | | |
|---|---------------------------|---------------------------|-----------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|------------------------|--------------------------|--------------------------|
| 1 | 1 H 1.01 | Atômico number | | | | | | | | | | | | | | | | | 2 He 4.00 | | |
| 2 | 3 Li 6.94 | 4 Be 9.01 | Element | | | | | | | | | | | | | | | | | 9 F 19.00 | 10 Ne 20.18 |
| 3 | 11 Na 22.99 | 12 Mg 24.31 | Relative atomic mass | | | | | | | | | | | | | | | | | 17 Cl 35.45 | 18 Ar 39.95 |
| 4 | 19 K 39.10 | 20 Ca 40.08 | 21 Sc 44.96 | 22 Ti 47.87 | 23 V 50.94 | 24 Cr 52.00 | 25 Mn 54.94 | 26 Fe 55.85 | 27 Co 58.93 | 28 Ni 58.69 | 29 Cu 63.55 | 30 Zn 65.38 | 31 Ga 69.72 | 32 Ge 72.63 | 33 As 74.92 | 34 Se 78.96 | 35 Br 79.90 | 36 Kr 83.90 | | | |
| 5 | 37 Rb 85.47 | 38 Sr 87.62 | 39 Y 88.91 | 40 Zr 91.22 | 41 Nb 92.91 | 42 Mo 95.96 | 43 Tc (98) | 44 Ru 101.07 | 45 Rh 102.91 | 46 Pd 106.42 | 47 Ag 107.87 | 48 Cd 112.41 | 49 In 114.82 | 50 Sn 118.71 | 51 Sb 121.76 | 52 Te 127.60 | 53 I 126.90 | 54 Xe 131.29 | | | |
| 6 | 55 Cs 132.91 | 56 Ba 137.33 | 57 † La 138.91 | 72 Hf 178.49 | 73 Ta 180.95 | 74 W 183.84 | 75 Re 186.21 | 76 Os 190.23 | 77 Ir 192.22 | 78 Pt 195.08 | 79 Au 196.97 | 80 Hg 200.59 | 81 Tl 204.38 | 82 Pb 207.2 | 83 Bi 208.98 | 84 Po (209) | 85 At (210) | 86 Rn (222) | | | |
| 7 | 87 Fr (223) | 88 Ra (226) | 89 † Ac (227) | 104 Rf (267) | 105 Db (268) | 106 Sg (269) | 107 Bh (270) | 108 Hs (269) | 109 Mt (278) | 110 Ds (281) | 111 Rg (281) | 112 Cn (285) | 113 Unt (286) | 114 Uug (289) | 115 Uup (288) | 116 Uuh (293) | 117 Uus (294) | 118 Uuo (294) | | | |
| † | 58 Ce 140.12 | 59 Pr 140.91 | 60 Nd 144.24 | 61 Pm (145) | 62 Sm 150.36 | 63 Eu 151.96 | 64 Gd 157.25 | 65 Tb 158.93 | 66 Dy 162.50 | 67 Ho 164.93 | 68 Er 167.26 | 69 Tm 168.93 | 70 Yb 173.05 | 71 Lu 174.97 | | | | | | | |
| ‡ | 90 Th 232.04 | 91 Pa 231.04 | 92 U 238.03 | 93 Np (237) | 94 Pu (244) | 95 Am (243) | 96 Cm (247) | 97 Bk (247) | 98 Cf (251) | 99 Es (252) | 100 Fm (257) | 101 Md (258) | 102 No (259) | 103 Lr (262) | | | | | | | |

1. Which diagram represents a heterogeneous mixture?



2. What volume of carbon dioxide, $\text{CO}_2(\text{g})$, can be obtained by reacting 1 dm^3 of methane, $\text{CH}_4(\text{g})$, with 1 dm^3 of oxygen, $\text{O}_2(\text{g})$?



A. 0.5 dm^3

B. 1 dm^3

C. 2 dm^3

D. 6 dm^3

3. What is the empirical formula of a hydrocarbon with 75% carbon and 25% hydrogen by mass?

A. C_3H

B. CH_2

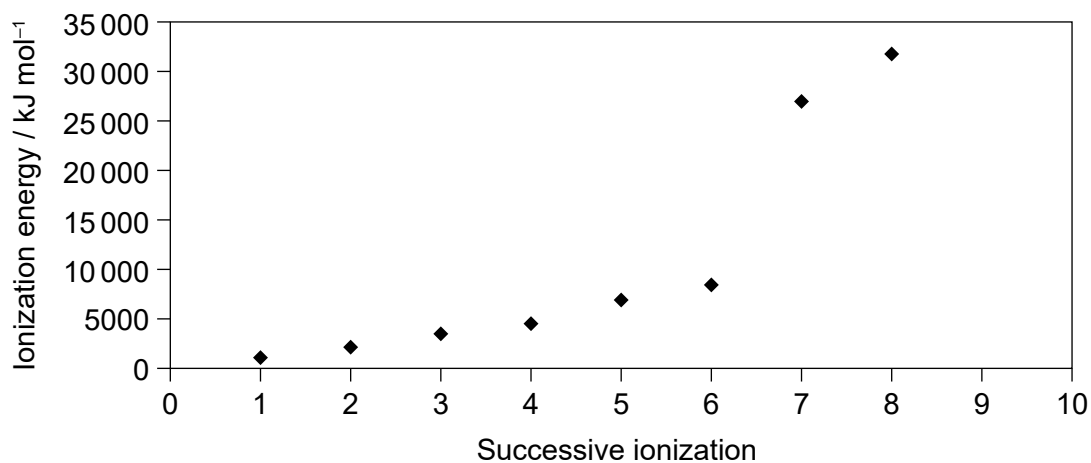
C. C_2H_6

D. CH_4

4. What is the ground state electron configuration of an atom of chromium, Cr ($Z = 24$)?

- A. $[\text{Ar}]3d^6$
- B. $[\text{Ar}]4s^23d^4$
- C. $[\text{Ar}]4s^13d^5$
- D. $[\text{Ar}]4s^24p^4$

5. Which element is represented by the first eight successive ionization energies on the graph?



- A. Mg
- B. S
- C. Cl
- D. Ar

6. Which describes an atom of bismuth, Bi ($Z = 83$)?

| | Principal energy level number | Number of valence electrons |
|----|-------------------------------|-----------------------------|
| A. | 5 | 3 |
| B. | 5 | 5 |
| C. | 6 | 5 |
| D. | 6 | 15 |

7. Which series represents atoms in order of decreasing atomic radius?
- A. $N > C > Be > Mg$
 - B. $Mg > N > C > Be$
 - C. $Be > C > N > Mg$
 - D. $Mg > Be > C > N$
8. Which electrons are removed from iron ($Z = 26$) to form iron(II)?
- A. two 3d electrons
 - B. two 4s electrons
 - C. one 4s electron and one 3d electron
 - D. two 4p electrons
9. What is the order of increasing boiling point?
- A. $CH_3CH_2CH_2CH_3 < CH_3CH(OH)CH_3 < CH_3COCH_3 < CH_3CO_2H$
 - B. $CH_3CH_2CH_2CH_3 < CH_3COCH_3 < CH_3CH(OH)CH_3 < CH_3CO_2H$
 - C. $CH_3CO_2H < CH_3COCH_3 < CH_3CH(OH)CH_3 < CH_3CH_2CH_2CH_3$
 - D. $CH_3CH_2CH_2CH_3 < CH_3COCH_3 < CH_3CO_2H < CH_3CH(OH)CH_3$
10. What is the IUPAC name of $NiCO_3$?
- A. nickel(II) carbonate
 - B. nickel carbonate
 - C. nickel(I) carbonate
 - D. nitrogen(I) carbonate

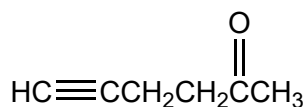
11. Which combination corresponds to a strong metallic bond?

| | Charge on the metal ion | Radius of ion |
|----|-------------------------|---------------|
| A. | large | large |
| B. | large | small |
| C. | small | small |
| D. | small | large |

12. Which species has delocalized electrons?

- A. OH^-
- B. H_2CO
- C. CO_2
- D. CO_3^{2-}

13. How many carbon atoms are sp^3 , sp^2 and sp hybridized in the molecule?

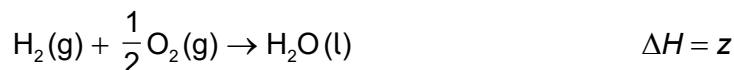
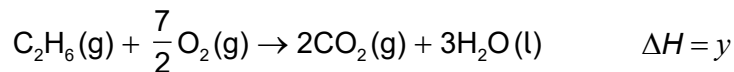
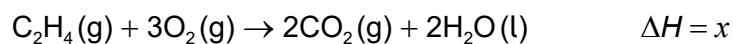
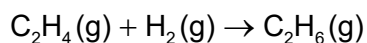


| | sp^3 | sp^2 | sp |
|----|---------------|---------------|-------------|
| A. | 3 | 1 | 2 |
| B. | 2 | 1 | 3 |
| C. | 3 | 2 | 1 |
| D. | 3 | 2 | 2 |

14. When equal masses of X and Y absorb the same amount of energy, their temperatures rise by 5°C and 10°C respectively. Which is correct?

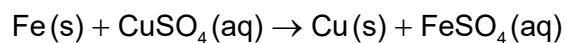
- A. The specific heat capacity of X is twice that of Y.
- B. The specific heat capacity of X is half that of Y.
- C. The specific heat capacity of X is one fifth that of Y.
- D. The specific heat capacity of X is the same as Y.

15. What is the enthalpy change of reaction for the following equation?



- A. $x + y + z$
- B. $-x - y + z$
- C. $x - y - z$
- D. $x - y + z$
16. Which is correct for the reaction $\text{H}_2\text{O}(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l})$?
- A. Enthalpy increases and entropy increases.
- B. Enthalpy decreases and entropy increases.
- C. Enthalpy increases and entropy decreases.
- D. Enthalpy decreases and entropy decreases.
17. Which equation represents the standard enthalpy of atomization of bromine, Br_2 ?
- A. $\frac{1}{2}\text{Br}_2(\text{l}) \rightarrow \text{Br}(\text{g})$
- B. $\text{Br}_2(\text{l}) \rightarrow 2\text{Br}(\text{g})$
- C. $\text{Br}_2(\text{l}) \rightarrow 2\text{Br}(\text{l})$
- D. $\frac{1}{2}\text{Br}_2(\text{l}) \rightarrow \text{Br}(\text{l})$

18. Which properties can be monitored to determine the rate of the reaction?



- I. change in volume
- II. change in temperature
- III. change in colour

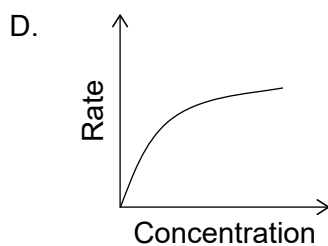
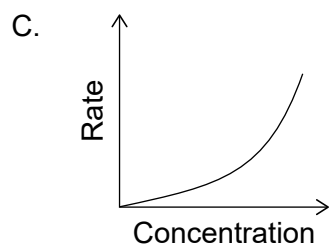
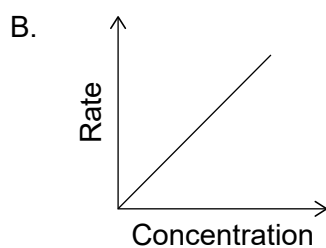
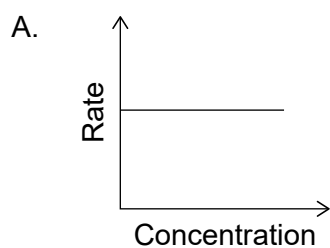
- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

19. Which conditions are required for the reaction between two molecules?

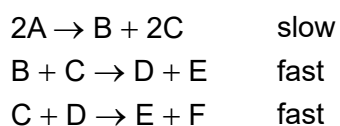
- I. a collision
- II. $E \geq E_a$
- III. proper orientation

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

20. Which graph is obtained from a first order reaction?



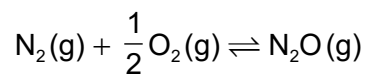
21. Which is correct for the reaction mechanism shown?



| | Equation of overall reaction | Rate equation |
|----|--------------------------------------|-----------------------------------|
| A. | $2A \rightarrow E + F$ | $\text{rate} = k[A]^2$ |
| B. | $2A \rightarrow 2E + F$ | $\text{rate} = k[C][D]$ |
| C. | $2A + B + 2C + D \rightarrow 2E + F$ | $\text{rate} = k[A]^2[B][C]^2[D]$ |
| D. | $2A \rightarrow 2E + F$ | $\text{rate} = k[A]^2$ |

22. K_c for $2\text{N}_2\text{O}(\text{g}) \rightleftharpoons 2\text{N}_2(\text{g}) + \text{O}_2(\text{g})$ is 7.3×10^{34} .

What is K_c for the following reaction, at the same temperature?



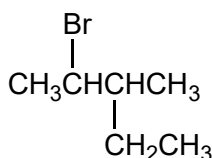
- A. 7.3×10^{34}
- B. $\frac{1}{\sqrt{7.3 \times 10^{34}}}$
- C. $\frac{2}{7.3 \times 10^{34}}$
- D. $\frac{1}{2 \times 7.3 \times 10^{34}}$
23. Which is correct for a reaction with a positive change in Gibbs free energy, ΔG^\ominus ?
- A. The formation of reactants is favoured.
- B. The formation of products is favoured.
- C. The reaction is at equilibrium.
- D. The reaction is spontaneous.
24. Which solution is basic at 25°C ?

$$K_w = 1.0 \times 10^{-14}$$

- A. $[\text{H}^+] = 1.0 \times 10^{-3} \text{ mol dm}^{-3}$
- B. $[\text{OH}^-] = 1.0 \times 10^{-13} \text{ mol dm}^{-3}$
- C. solution of $\text{pH} = 4.00$
- D. $[\text{H}_3\text{O}^+] = 1.0 \times 10^{-13} \text{ mol dm}^{-3}$

25. With which do most acids react?
- I. sodium hydrogen carbonate
 - II. magnesium
 - III. calcium sulfate
- A. I and II only
 - B. I and III only
 - C. II and III only
 - D. I, II and III
26. Which is a Lewis acid but not a Brønsted–Lowry acid?
- A. AlCl_3
 - B. $\text{CH}_3\text{CO}_2\text{H}$
 - C. HF
 - D. CCl_4
27. Which has the strongest conjugate base?
- A. HCOOH ($K_a = 1.8 \times 10^{-4}$)
 - B. HNO_2 ($K_a = 7.2 \times 10^{-4}$)
 - C. HCN ($K_a = 6.2 \times 10^{-10}$)
 - D. HIO_3 ($K_a = 1.7 \times 10^{-1}$)
28. Which product will be obtained at the anode (positive electrode) when molten NaCl is electrolysed?
- A. Na(l)
 - B. Cl(g)
 - C. Cl_2 (g)
 - D. Na(s)

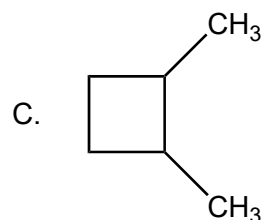
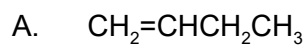
29. Where does oxidation occur in a voltaic cell?
- A. positive electrode and anode
 - B. negative electrode and anode
 - C. positive electrode and cathode
 - D. negative electrode and cathode
30. Which factors affect the amount of product formed at the cathode during electrolysis of molten salts?
- I. current
 - II. time
 - III. charge on the cation
- A. I and II only
 - B. I and III only
 - C. II and III only
 - D. I, II and III
31. Which is **not** a requirement of the standard hydrogen electrode (SHE)?
- A. $V = 1 \text{ dm}^3$
 - B. $p(\text{H}_2) = 100 \text{ kPa}$
 - C. use of platinum as the electrode material
 - D. $[\text{H}_3\text{O}^+] = 1 \text{ mol dm}^{-3}$
32. What is the IUPAC name of the following molecule?



- A. 2-bromo-3-ethylbutane
- B. 3-methyl-4-bromopentane
- C. 2-ethyl-3-bromobutane
- D. 2-bromo-3-methylpentane

33. Which is a major product of the electrophilic addition of hydrogen chloride to propene?
- A. $\text{ClCH}_2\text{CH}=\text{CH}_2$
 - B. $\text{CH}_3\text{CH}(\text{Cl})\text{CH}_3$
 - C. $\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$
 - D. $\text{CH}_3\text{CH}=\text{CHCl}$
34. Which alcohol would produce a carboxylic acid when heated with acidified potassium dichromate(VI)?
- A. propan-2-ol
 - B. butan-1-ol
 - C. 2-methylpropan-2-ol
 - D. pentan-3-ol
35. Which solvent is aprotic?
- A. H_2O
 - B. $\text{C}_6\text{H}_5\text{CH}_3$
 - C. CH_3OH
 - D. CH_3NH_2
36. Which statement is **not** correct regarding benzene?
- A. It is planar.
 - B. The ring contains delocalized electrons.
 - C. It always reacts in the same way as alkenes.
 - D. The carbon–carbon bond has a bond order of 1.5.

37. Which compound can exist as *cis*- and *trans*-isomers?



38. How should a measurement of 5.00 g from a balance be recorded?

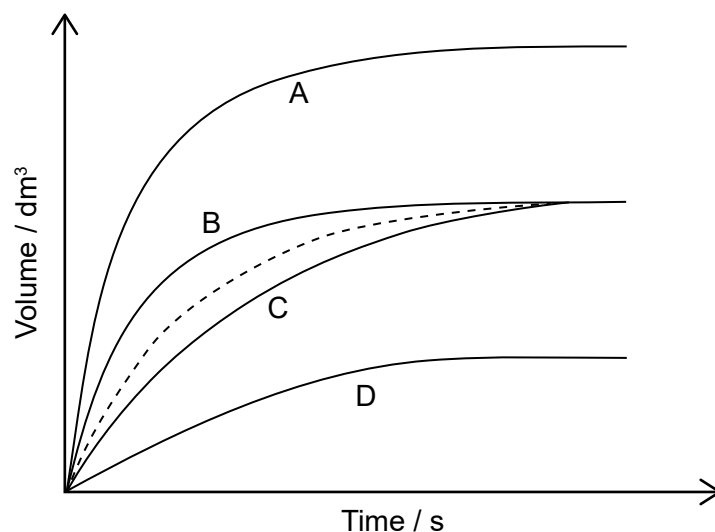
A. $5.00 \pm 0.1 \text{ g}$

B. $5.00 \pm 0.01 \text{ g}$

C. $5.00 \pm 1 \text{ g}$

D. $5.00 \pm 0.001 \text{ g}$

39. The dotted line represents the formation of oxygen, $\text{O}_2(\text{g})$, from the uncatalysed complete decomposition of hydrogen peroxide, $\text{H}_2\text{O}_2(\text{aq})$.



Which curve represents a catalysed reaction under the same conditions?

40. Which can be identified using infrared (IR) spectroscopy?
- A. functional groups
 - B. molar mass
 - C. 3-D configuration
 - D. bond angle
-