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**Chemistry**  
**Higher level**  
**Paper 1**

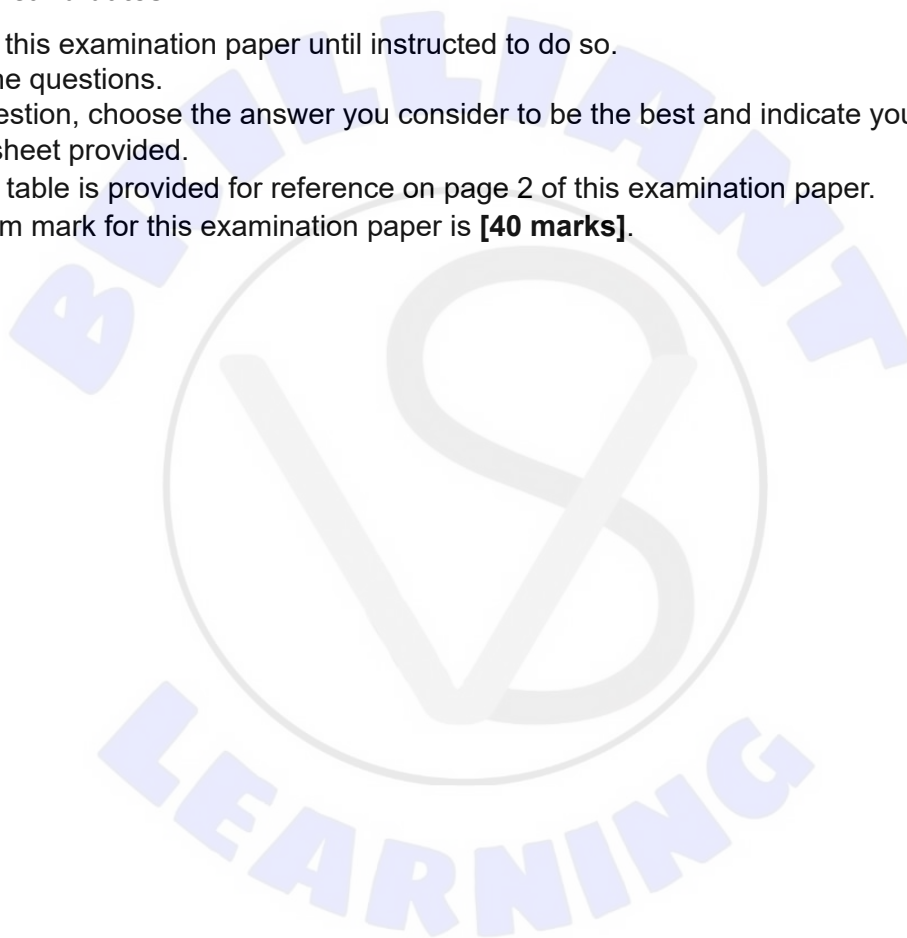
Wednesday 22 May 2019 (afternoon)

1 hour

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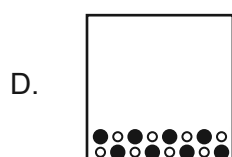
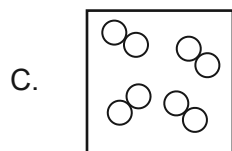
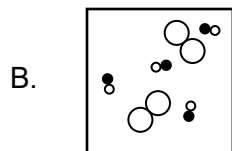
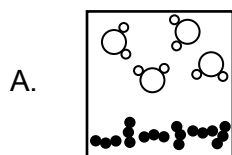
**Instructions to candidates**

- 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.
- The periodic table is provided for reference on page 2 of this examination paper.
- The maximum mark for this examination paper is **[40 marks]**.

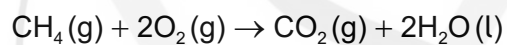




1. Which diagram represents a heterogeneous mixture?



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



A.  $0.5 \text{ dm}^3$

B.  $1 \text{ dm}^3$

C.  $2 \text{ dm}^3$

D.  $6 \text{ dm}^3$

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

A.  $\text{C}_3\text{H}$

B.  $\text{CH}_2$

C.  $\text{C}_2\text{H}_6$

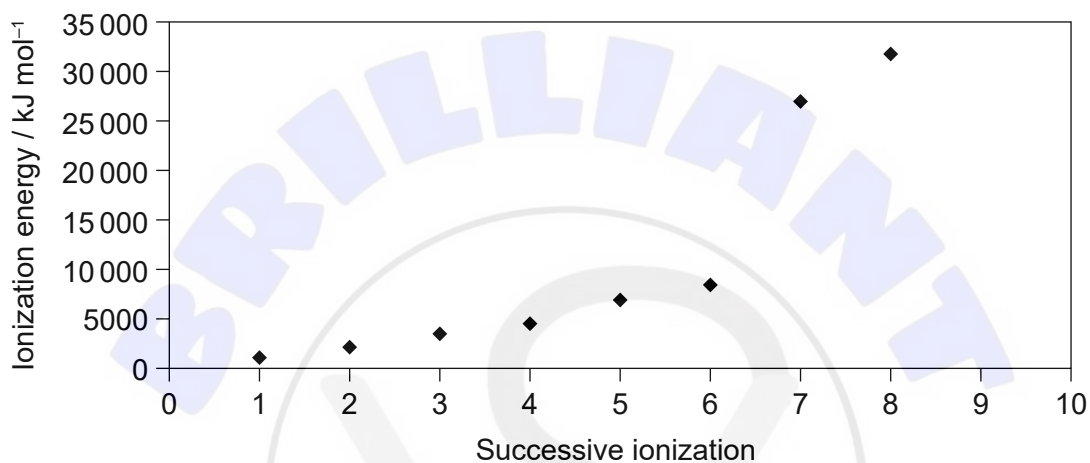
D.  $\text{CH}_4$

Turn over

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

Turn over

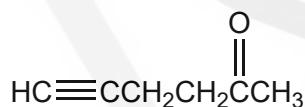
11. Which combination corresponds to a strong metallic bond?

	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.  $\text{OH}^-$
- B.  $\text{H}_2\text{CO}$
- C.  $\text{CO}_2$
- D.  $\text{CO}_3^{2-}$

13. How many carbon atoms are  $\text{sp}^3$ ,  $\text{sp}^2$  and  $\text{sp}$  hybridized in the molecule?

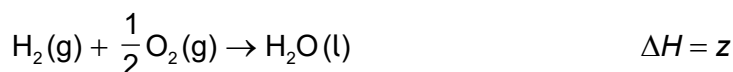
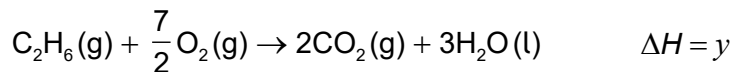
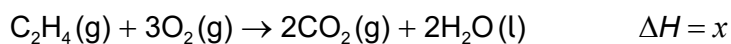
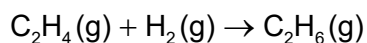


	$\text{sp}^3$	$\text{sp}^2$	$\text{sp}$
A.	3	1	2
B.	2	1	3
C.	3	2	1
D.	3	2	2

14. When equal masses of X and Y absorb the same amount of energy, their temperatures rise by  $5^\circ\text{C}$  and  $10^\circ\text{C}$  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.

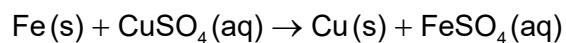
15. What is the enthalpy change of reaction for the following equation?



- 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,  $\text{Br}_2$ ?
- 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.  $\frac{1}{2}\text{Br}_2(\text{l}) \rightarrow \text{Br}(\text{l})$

Turn over

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



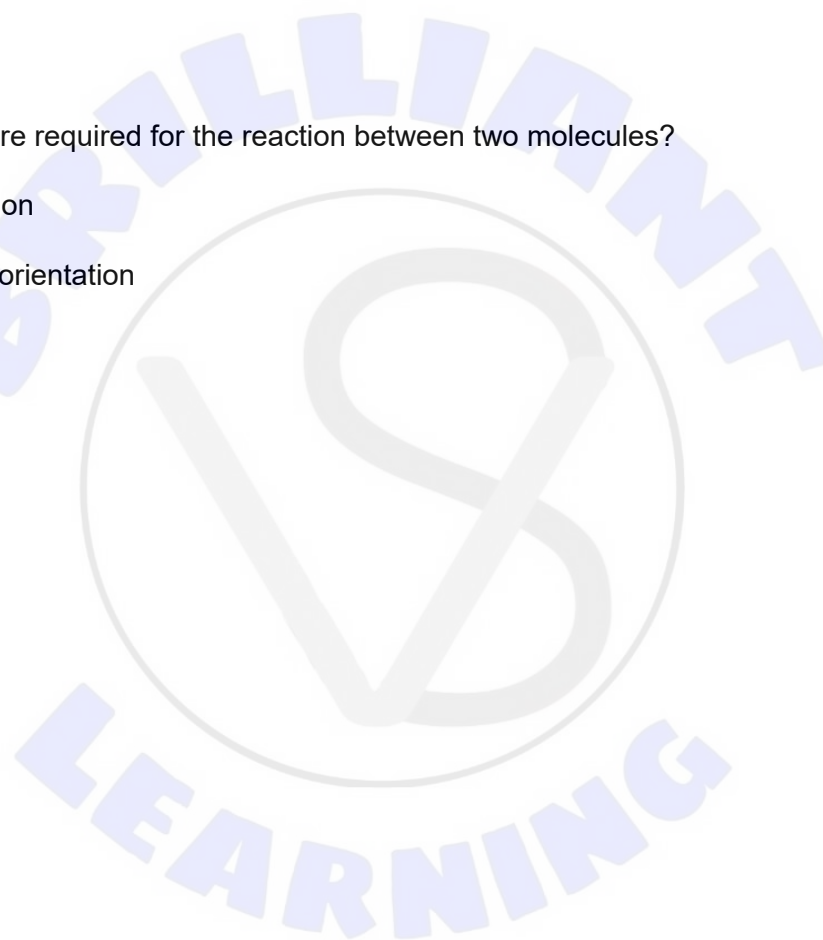
- I. change in volume
- II. change in temperature
- III. change in colour

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

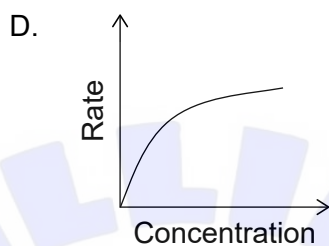
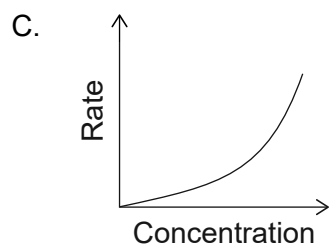
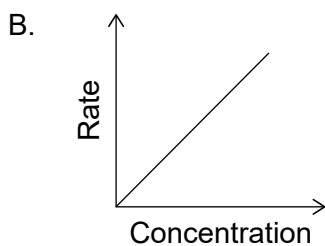
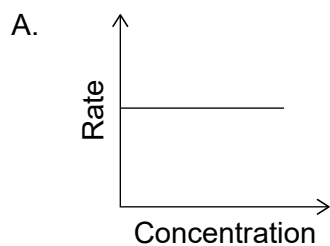
19. Which conditions are required for the reaction between two molecules?

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

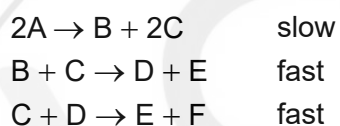
- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III



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



21. Which is correct for the reaction mechanism shown?

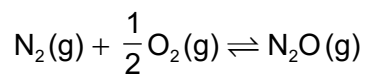


	Equation of overall reaction	Rate equation
A.	$2A \rightarrow E + F$	$\text{rate} = k[A]^2$
B.	$2A \rightarrow 2E + F$	$\text{rate} = k[C][D]$
C.	$2A + B + 2C + D \rightarrow 2E + F$	$\text{rate} = k[A]^2[B][C]^2[D]$
D.	$2A \rightarrow 2E + F$	$\text{rate} = k[A]^2$

Turn over

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  $7.3 \times 10^{34}$ .

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



- A.  $7.3 \times 10^{34}$
- 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,  $\Delta G^\ominus$ ?
- 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  $25^\circ\text{C}$ ?

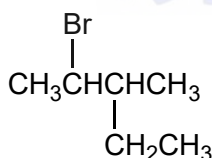
$$K_w = 1.0 \times 10^{-14}$$

- 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.  $\text{AlCl}_3$
- B.  $\text{CH}_3\text{CO}_2\text{H}$
- C. HF
- D.  $\text{CCl}_4$
27. Which has the strongest conjugate base?
- A.  $\text{HCOOH}$  ( $K_a = 1.8 \times 10^{-4}$ )
- B.  $\text{HNO}_2$  ( $K_a = 7.2 \times 10^{-4}$ )
- C.  $\text{HCN}$  ( $K_a = 6.2 \times 10^{-10}$ )
- D.  $\text{HIO}_3$  ( $K_a = 1.7 \times 10^{-1}$ )
28. Which product will be obtained at the anode (positive electrode) when molten NaCl is electrolysed?
- A. Na(l)
- B. Cl(g)
- C.  $\text{Cl}_2$ (g)
- D. Na(s)

Turn over

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?

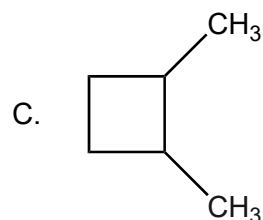
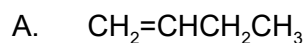


- A. 2-bromo-3-ethylbutane  
B. 3-methyl-4-bromopentane  
C. 2-ethyl-3-bromobutane  
D. 2-bromo-3-methylpentane

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.  $\text{H}_2\text{O}$
  - B.  $\text{C}_6\text{H}_5\text{CH}_3$
  - C.  $\text{CH}_3\text{OH}$
  - D.  $\text{CH}_3\text{NH}_2$
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.

Turn over

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



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

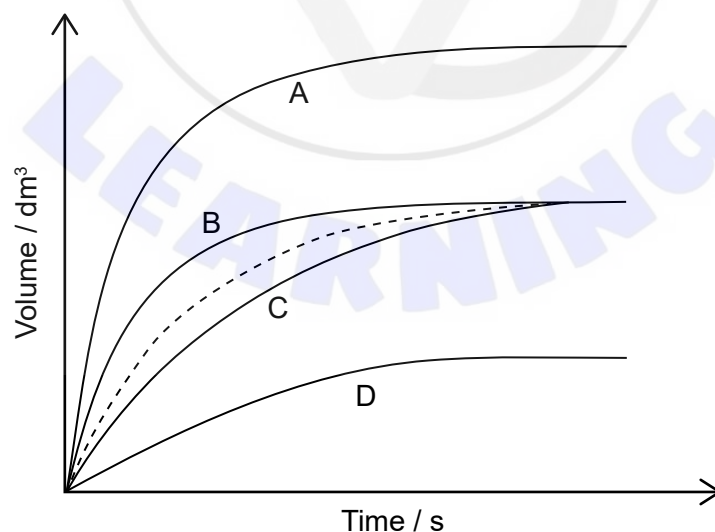
A.  $5.00 \pm 0.1 \text{ g}$

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
- 

