Chemistry
Standard level
Paper 1

IB Chemistry SL prediction paper 1

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 (not provided).
- The periodic table is provided for reference on page 2 of this examination paper.
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- The maximum mark for this examination paper is **[30 marks]**.

18 pages

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 **H** 1.01						Atomic number **Element** Relative atomic mass											2 **He** 4.00
2	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
3	11 **Na** 22.99	12 **Mg** 24.31											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.07	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** 207.20	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 **Uut** (286)	114 **Uuq** (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. How many molecules are present in 0.250 mol of water, H_2O?

A. 6.02×10^{22}.

B. 1.51×10^{23}.

C. 3.01×10^{23}.

D. 6.02×10^{23}.

2. Which nuclear symbol represents the isotope of carbon that contains seven neutrons?

A. $^{12}_{6}C$.

B. $^{13}_{6}C$.

C. $^{14}_{6}C$.

D. $^{19}_{6}C$.

3. What is the ground-state electron configuration of a sulfur atom, S?

A. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$.

B. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3\ 3d^1$.

C. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$.

D. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$.

4. A 4.50 g sample of ethanol, C_2H_5OH, is completely burned. How many moles of CO_2 are produced?

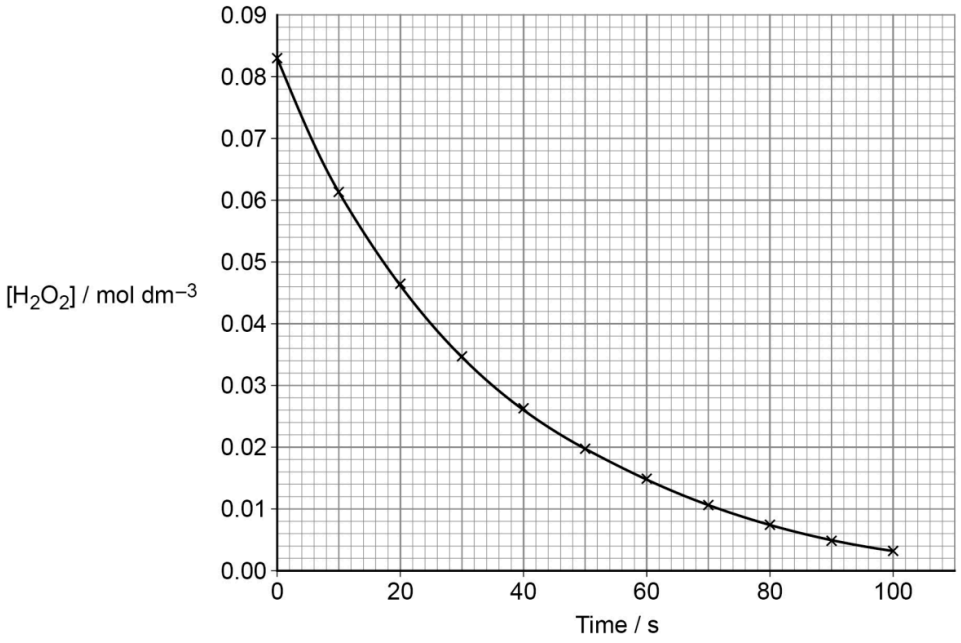
A. 0.065 mol.

B. 0.098 mol.

C. 0.196 mol.

D. 0.326 mol.

5. The diagram below shows how the concentration of hydrogen peroxide varies with time during its decomposition.



Using the curve, what is the approximate initial rate of decomposition of H_2O_2 over the first 10 s?

A. 2.3×10^{-4} mol dm^{-3} s^{-1}.

B. 2.3×10^{-3} mol dm^{-3} s^{-1}.

C. 2.3×10^{-2} mol dm^{-3} s^{-1}.

D. 2.3×10^{-1} mol dm^{-3} s^{-1}.

6. Which molecule has a trigonal pyramidal shape according to VSEPR theory?

A. BF_3.

B. CH_4.

C. NH_3.

D. CO_2.

7. Which property of metals is most directly explained by the “sea of delocalised electrons”?

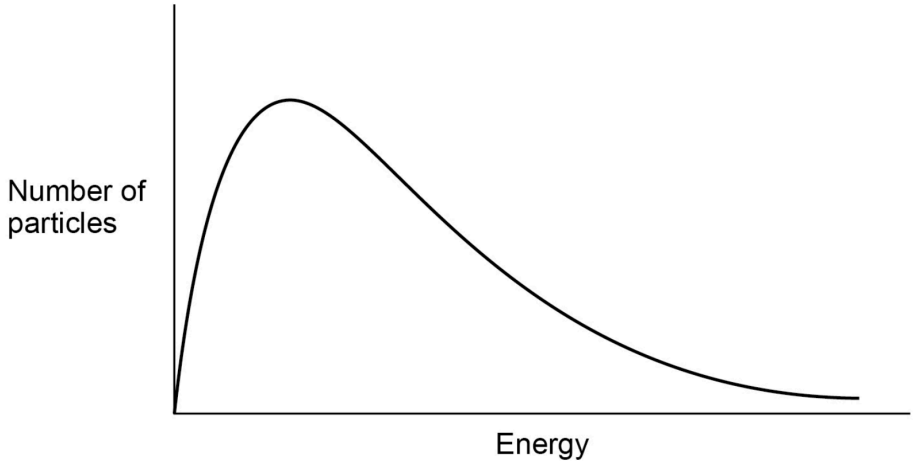
A. High density.

B. Electrical conductivity in the solid state.

C. Formation of basic oxides.

D. Low first-ionisation energies.

8. The curve below depicts a Maxwell–Boltzmann distribution of molecular kinetic energies at temperature T.



Which change would produce a new curve whose peak is lower and shifted to higher energies while the total area under the curve remains unchanged?

A. Decreasing the temperature of the gas.

B. Adding a solid catalyst to the gas.

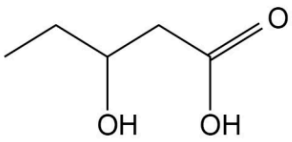
C. Increasing the temperature of the gas.

D. Doubling the pressure of the gas at constant temperature.

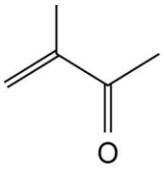
9. Which row correctly compares the electrical conductivity and hardness of graphite and diamond at room temperature?

	Electrical conductivity	**Hardness**
A.	Graphite: good Diamond: poor	Graphite: soft Diamond: very hard
B.	Graphite: good Diamond: good	Graphite: very hard Diamond: soft
C.	Graphite: poor Diamond: good	Graphite: soft Diamond: very hard
D.	Graphite: poor Diamond: poor	Graphite: very hard Diamond: hard

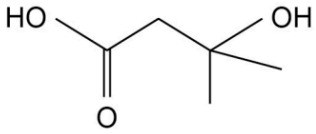
10. The figure presents four skeletal formulae for liquids J, K, L and M.



Liquid **J**



Liquid **K**



Liquid **L**

Liquid **M**

Which is the correct IUPAC name for liquid M?

A. Butanal.

B. Pentanal.

C. 1-Butanol.

D. Propanal.

11. Under which conditions does a real gas deviate most from ideal behaviour?

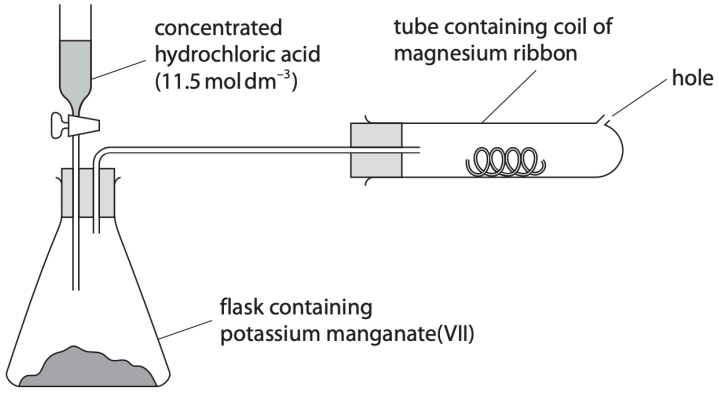
A. High T, low P.

B. High T, high P.

C. Low T, low P.

D. Low T, high P.

12. The apparatus below is used to react chlorine gas with a heated coil of magnesium ribbon to form magnesium chloride.



If the magnesium coil has a mass of 0.12 g and reacts completely, what mass of $MgCl_2(s)$ is produced?

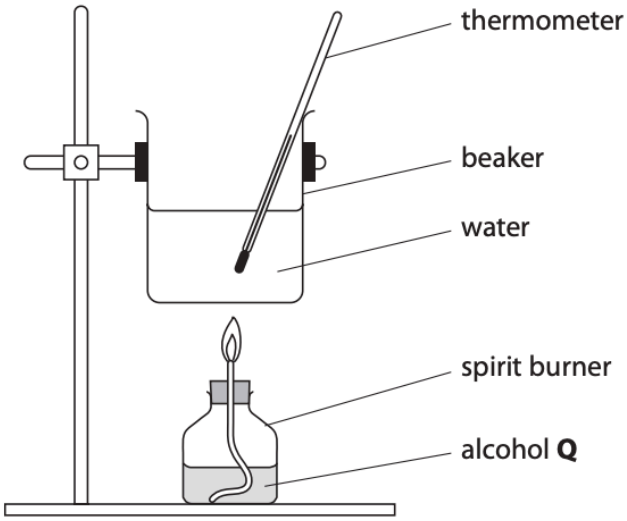
A. 0.10 g.

B. 0.40 g.

C. 0.47 g.

D. 0.70 g.

13. The apparatus below shows a spirit-burner used to heat water in a simple calorimetry experiment.



Data

Mass of spirit burner + alcohol **Q** before combustion	= 20.24 g
Mass of spirit burner + alcohol **Q** after combustion	= 19.48 g
Mass of water in the beaker	= 500 g
Temperature of the water before the experiment	= 17.8 °C
Temperature of the water at the end of the experiment	= 28.7 °C
Specific heat capacity of water	= 4.18 $J g^{-1} °C^{-1}$

Using the data supplied, what is the experimental enthalpy change of combustion of alcohol Q per gram of fuel burned? *(Assume all heat lost to the surroundings other than the water is negligible.)*

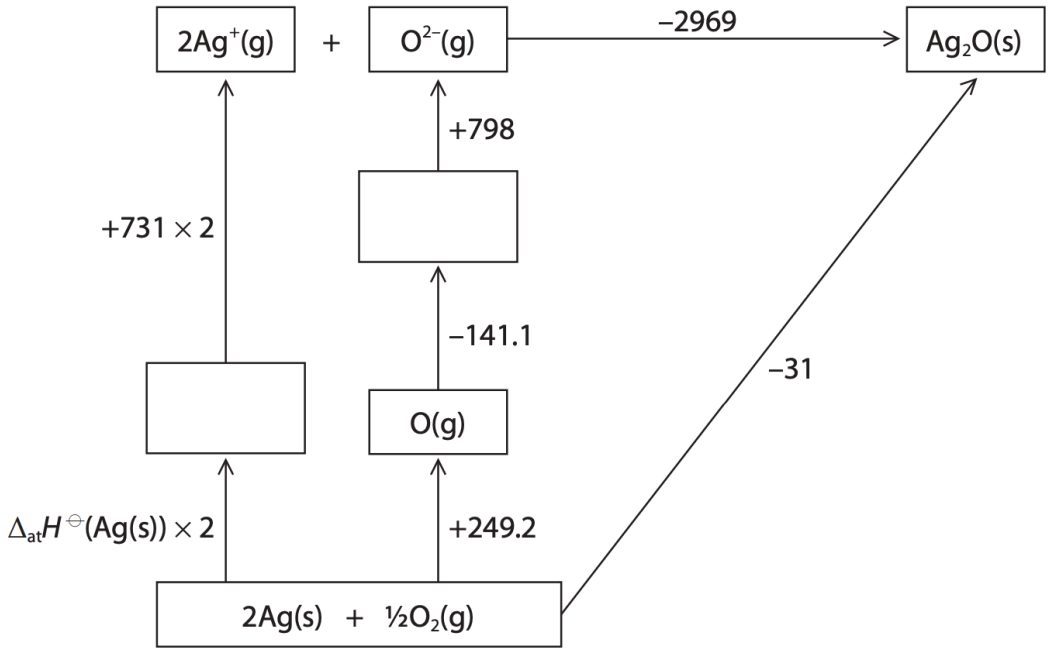
A. 3.0×10^{1} kJ g^{-1}.

B. 3.0×10^{2} kJ g^{-1}.

C. 1.4×10^{1} kJ g^{-1}.

D. 1.4×10^{2} kJ g^{-1}.

14. The Born–Haber cycle below is for the formation of silver(I) oxide, $Ag_2O(s)$. The step ($\Delta_a H^\circ$ (Ag)) is left blank.



Using the data in the diagram, what is the standard enthalpy of atomisation of silver, $\Delta_a H^\circ$ (Ag)?

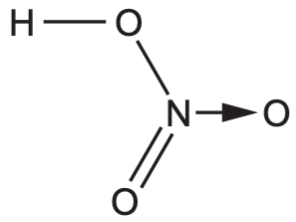
A. +142 kJ mol^{-1}.

B. +250 kJ mol^{-1}.

C. +285 kJ mol^{-1}.

D. +570 kJ mol^{-1}.

15. The diagram shows the skeletal formula of nitric acid with the bonding around the central nitrogen atom clearly displayed.



Nitric acid

Using VSEPR theory, what are the approximate values of the H-O-N and O-N-O bond angles in nitric acid?

A. 104° and 120°.

B. 120° and 120°.

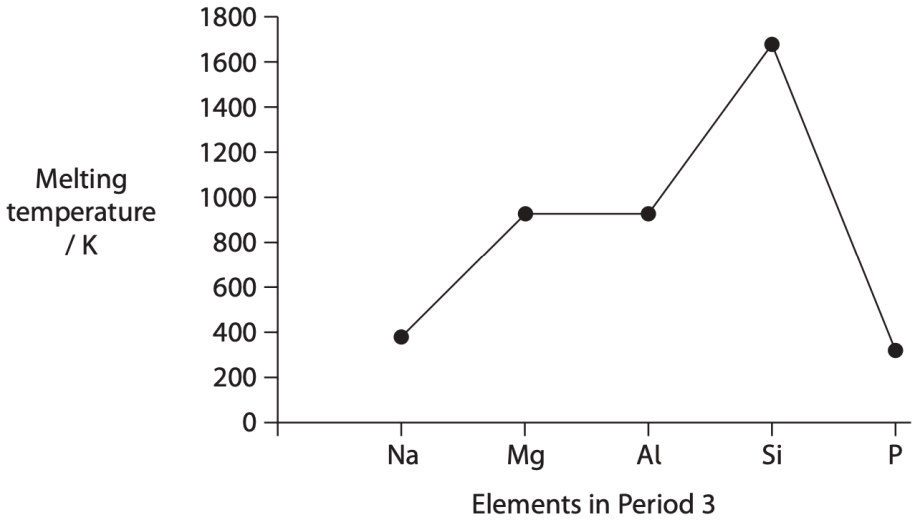
C. 104° and 104°.

D. 109.5° and 120°.

16. For 2 $NO_2(g) \rightleftharpoons N_2O_4(g)$ the forward reaction is exothermic. How do Kc and the equilibrium position change when the temperature is increased?

	Kc	Equilibrium position
A.	Increases	Shifts right
B.	Increases	Shifts left
C.	Decreases	Shifts right
D.	Decreases	Shifts left

17. The graph below shows the melting temperatures of elements Na to P across Period 3.



Which element's high melting point is primarily due to a giant covalent (network) structure?

A. Na.

B. Mg.

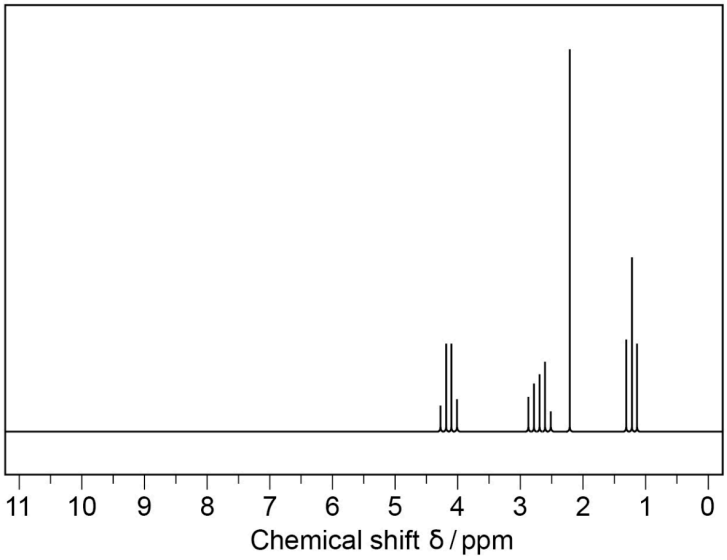
C. Si.

D. P.

18. Which fuel releases the greatest energy per mole of CO_2 produced on complete combustion?

	Fuel	ΔHc / kJ mol^{-1}	CO_2 per mol fuel
A.	Methane, CH_4	–890	1
B.	Ethanol, C_2H_5OH	–1370	2
C.	Propane, C_3H_8	–2220	3
D.	Octane, C_8H_{18}	–5470	8

19. The ^1H NMR spectrum of compound Z in $CDCl_3$ is shown below.



How many different proton environments are present in compound Z?

A. 2.

B. 3.

C. 4.

D. 5.

20. Which species acts as a Brønsted–Lowry base in the equilibrium below?

A. NH_4^+.

B. HCO_3^-.

C. NH_3.

D. H_2CO_3.

21. A 0.010 mol dm^{-3} solution of ethanoic acid (Ka = 1.8 × 10^{-5} mol dm^{-3}) is prepared at 298 K. What is its pH?

A. 2.68.

B. 3.38.

C. 4.74.

D. 5.28.

22. In acidic solution ClO_2 is reduced by SO_3^{2-} to Cl^- while SO_3^{2-} is oxidised to SO_4^{2-}. Which equation is correctly balanced?

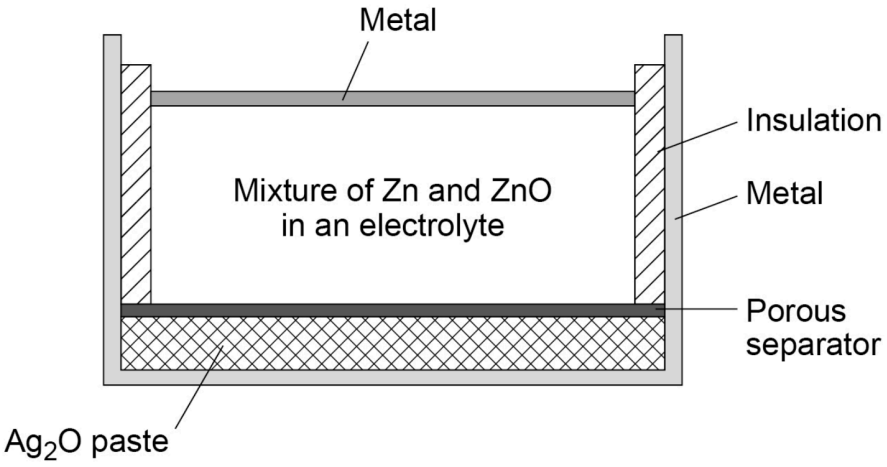
A. $2\ ClO_2 + SO_3^{2-} + H_2O \rightarrow 2\ Cl^- + SO_4^{2-} + 2\ H^+$.

B. $2\ ClO_2 + SO_3^{2-} \rightarrow 2\ Cl^- + SO_4^{2-}$.

C. $2\ ClO_2 + SO_3^{2-} + 4\ H^+ \rightarrow 2\ Cl^- + SO_4^{2-} + 2\ H_2O$.

D. $2\ ClO_2 + SO_3^{2-} + 2\ H^+ \rightarrow 2\ Cl^- + SO_4^{2-} + H_2O$.

23. The cross-section below represents a rechargeable silver–zinc cell containing a Zn/ZnO paste and an Ag_2O paste separated by a porous barrier.



While the cell is discharging, which row correctly states the direction of electron flow in the external circuit and the half-reaction occurring at the silver electrode?

	Electron flow (external circuit)	**Half-reaction at silver electrode**
A.	Ag → Zn	$Ag_2O(s) + H_2O(l) + 2e^- \rightarrow 2Ag(s) + 2OH^-(aq)$
B.	Zn → Ag	$Ag_2O(s) + H_2O(l) + 2e^- \rightarrow 2Ag(s) + 2OH^-(aq)$
C.	Ag → Zn	$Ag(s) + 2OH^-(aq) \rightarrow Ag_2O(s) + H_2O(l) + 2e^-$
D.	Zn → Ag	$Ag(s) + 2OH^-(aq) \rightarrow Ag_2O(s) + H_2O(l) + 2e^-$

24. Which reagent converts an alkene directly to a vicinal dihalogenoalkane under standard laboratory conditions?

A. $Br_2(l)$ in the dark.

B. $Br_2(l)$ with UV light.

C. HBr(g) with peroxide.

D. Cold, dilute $KMnO_4(aq)$.

25. Cold, dilute alkaline $KMnO_4(aq)$ reacts with but-2-ene. Which statement describes the stereochemistry of the main product?

A. Racemic mixture of butane-2,3-diol.

B. Syn addition yielding meso-butane-2,3-diol only.

C. Anti addition yielding a racemic mixture.

D. Syn addition yielding a racemic mixture.

26. Which species acts as a Lewis base and a bidentate ligand in transition-metal complexes?

A. CN^-.

B. NH_3.

C. $C_2O_4^{2-}$.

D. H_2O.

27. Which compound is correctly classified as an **ester**?

A. CH_3COCH_3.

B. CH_3CH_2COOH.

C. CH_3COOCH_3.

D. $CH_3CH_2OCH_3$.

28. Which element is correctly matched with its periodic-table classification?

A. Silicon – transition metal.

B. Bromine – halogen.

C. Strontium – lanthanoid.

D. Argon – alkali metal.

29. Using the data below, calculate the standard enthalpy change, ΔH°, for this reaction:

$4\ NH_3(g) + 5\ O_2(g) \rightarrow 4\ NO(g) + 6\ H_2O(l)$

Species	**ΔHf° / kJ mol^{-1}**
$NH_3(g)$	–46
$NO(g)$	+90
$H_2O(l)$	–286

A. –906 kJ.

B. –1170 kJ.

C. –1260 kJ.

D. –1368 kJ.

30. In a coffee-cup calorimeter 1.500 g of KOH is dissolved in 100.0 g of water, raising the temperature from 22.5 °C to 29.8 °C. Assuming c = 4.18 J g^{-1} K^{-1} for the solution, what is ΔHsol of KOH in kJ mol^{-1}?

A. –39.9.

B. –56.5.

C. –78.8.

D. –116.