

Chemistry
Standard level
Paper 1

Monday 14 November 2016 (morning)

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]**.

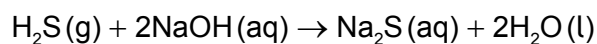
The Periodic Table

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
1	1 H 1.01																	2 He 4.00	
2	3 Li 6.94	4 Be 9.01															8 O 16.00	9 F 19.00	10 Ne 20.18
3	11 Na 22.99	12 Mg 24.31															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 207.2	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 change of state is exothermic?

- A. $\text{CO}_2(\text{s}) \rightarrow \text{CO}_2(\text{g})$
- B. $\text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{O}(\text{g})$
- C. $\text{NH}_3(\text{g}) \rightarrow \text{NH}_3(\text{l})$
- D. $\text{Fe}(\text{s}) \rightarrow \text{Fe}(\text{l})$

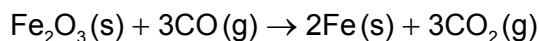
2. Which volume, in cm^3 , of 0.20 mol dm^{-3} $\text{NaOH}(\text{aq})$ is needed to neutralize 0.050 mol of $\text{H}_2\text{S}(\text{g})$?



- A. 0.25
 - B. 0.50
 - C. 250
 - D. 500
3. The complete combustion of 15.0 cm^3 of a gaseous hydrocarbon **X** produces 60.0 cm^3 of carbon dioxide gas and 75.0 cm^3 of water vapour. What is the molecular formula of **X**? (All volumes are measured at the same temperature and pressure.)
- A. C_4H_6
 - B. C_4H_8
 - C. C_4H_{10}
 - D. C_6H_{10}

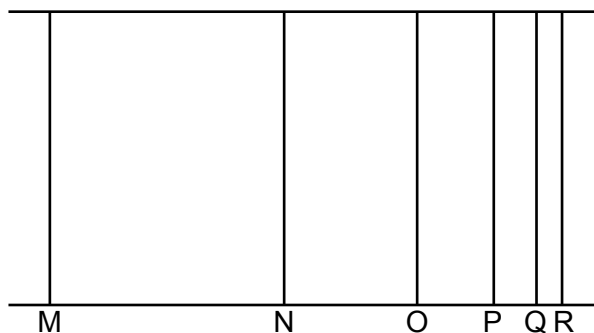
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4. 5.0 mol of $\text{Fe}_2\text{O}_3(\text{s})$ and 6.0 mol of $\text{CO}(\text{g})$ react according to the equation below. What is the limiting reactant and how many moles of the excess reactant remain unreacted?



	Limiting reactant	Moles of excess reactant remaining
A.	CO	2.0
B.	CO	3.0
C.	Fe_2O_3	1.0
D.	Fe_2O_3	2.0

5. Which is correct for the line emission spectrum for hydrogen?



- A. Line M has a higher energy than line N.
- B. Line N has a lower frequency than line M.
- C. Line M has a longer wavelength than line N.
- D. Lines converge at lower energy.
6. What is the condensed electron configuration of the Fe^{2+} ion?
- A. $[\text{Ar}]3\text{d}^6$
- B. $[\text{Ar}]3\text{d}^44\text{s}^2$
- C. $[\text{Ar}]3\text{d}^54\text{s}^1$
- D. $[\text{Ar}]3\text{d}^64\text{s}^2$

7. Which equation represents the first electron affinity of chlorine?

- A. $\text{Cl}(\text{g}) + \text{e}^- \rightarrow \text{Cl}^-(\text{g})$
- B. $\frac{1}{2} \text{Cl}_2(\text{g}) + \text{e}^- \rightarrow \text{Cl}^-(\text{g})$
- C. $\text{Cl}^+(\text{g}) + \text{e}^- \rightarrow \text{Cl}(\text{g})$
- D. $\text{Cl}(\text{g}) \rightarrow \text{Cl}^+(\text{g}) + \text{e}^-$

8. Which solution forms when phosphorus(V) oxide, P_4O_{10} , reacts with water?

	Product	pH of solution
A.	H_3PO_3	< 7
B.	H_3PO_3	> 7
C.	H_3PO_4	< 7
D.	H_3PO_4	> 7

9. Which pair of molecules has the same bond angles?

- A. PCl_3 and BCl_3
- B. SO_2 and CO_2
- C. H_2O and NH_3
- D. CCl_4 and SiH_4

10. The $\text{C}=\text{N}$ bond has a bond length of 130 pm and an average bond enthalpy of 615 kJ mol^{-1} . Which values would be most likely for the $\text{C}-\text{N}$ bond?

	Bond length / pm	Average bond enthalpy / kJ mol^{-1}
A.	147	286
B.	147	890
C.	116	286
D.	116	890

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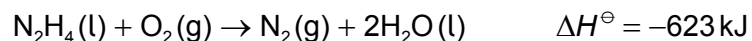
11. Between which pair of molecules can hydrogen bonding occur?

- A. CH₄ and H₂O
- B. CH₃OCH₃ and CF₄
- C. CH₄ and HF
- D. CH₃OH and H₂O

12. Which substance has a giant covalent structure?

	Melting point / °C	Solubility in water	Electrical conductivity in the molten state
A.	186	high	none
B.	801	high	good
C.	1083	low	good
D.	1710	low	none

13. Hydrazine reacts with oxygen.



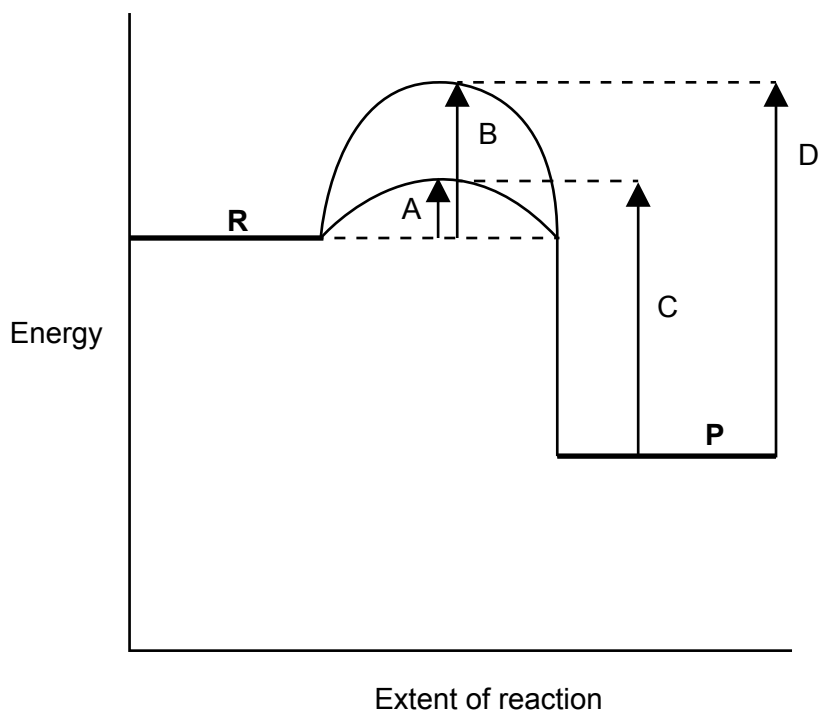
What is the standard enthalpy of formation of N₂H₄(l) in kJ? The standard enthalpy of formation of H₂O(l) is –286 kJ.

- A. –623 – 286
- B. –623 + 572
- C. –572 + 623
- D. –286 + 623

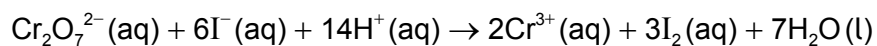
14. In which reaction do the reactants have a lower potential energy than the products?
- A. $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$
- B. $\text{HBr}(\text{g}) \rightarrow \text{H}(\text{g}) + \text{Br}(\text{g})$
- C. $\text{Na}^+(\text{g}) + \text{Cl}^-(\text{g}) \rightarrow \text{NaCl}(\text{s})$
- D. $\text{NaOH}(\text{aq}) + \text{HCl}(\text{aq}) \rightarrow \text{NaCl}(\text{aq}) + \text{H}_2\text{O}(\text{l})$
15. 5.35g of solid ammonium chloride, $\text{NH}_4\text{Cl}(\text{s})$, was added to water to form 25.0g of solution. The maximum decrease in temperature was 14 K. What is the enthalpy change, in kJ mol^{-1} , for this reaction? (Molar mass of $\text{NH}_4\text{Cl} = 53.5 \text{ g mol}^{-1}$; the specific heat capacity of the solution is $4.18 \text{ J g}^{-1} \text{ K}^{-1}$)
- A. $\Delta H = + \frac{25.0 \times 4.18 \times (14 + 273)}{0.1 \times 1000}$
- B. $\Delta H = - \frac{25.0 \times 4.18 \times 14}{0.1 \times 1000}$
- C. $\Delta H = + \frac{25.0 \times 4.18 \times 14}{0.1 \times 1000}$
- D. $\Delta H = + \frac{25.0 \times 4.18 \times 14}{1000}$

Turn over

16. For the reaction $R \rightarrow P$, which letter represents the activation energy for the catalysed **reverse** reaction?

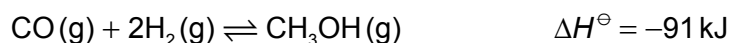


17. Which experimental methods could be used to observe the progress of the following reaction?



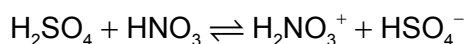
- I. Change in colour
 - II. Change in mass
 - III. Change in electrical conductivity
- A. I and II only
 - B. I and III only
 - C. II and III only
 - D. I, II and III

18. What happens when the temperature of the following equilibrium system is increased?

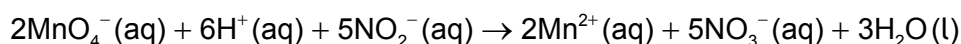


	Position of equilibrium	Reaction rates of forward and reverse reactions
A.	shifts to the left	increase
B.	shifts to the left	decrease
C.	shifts to the right	decrease
D.	shifts to the right	increase

19. Which species behave as Brønsted–Lowry bases in the following reaction?



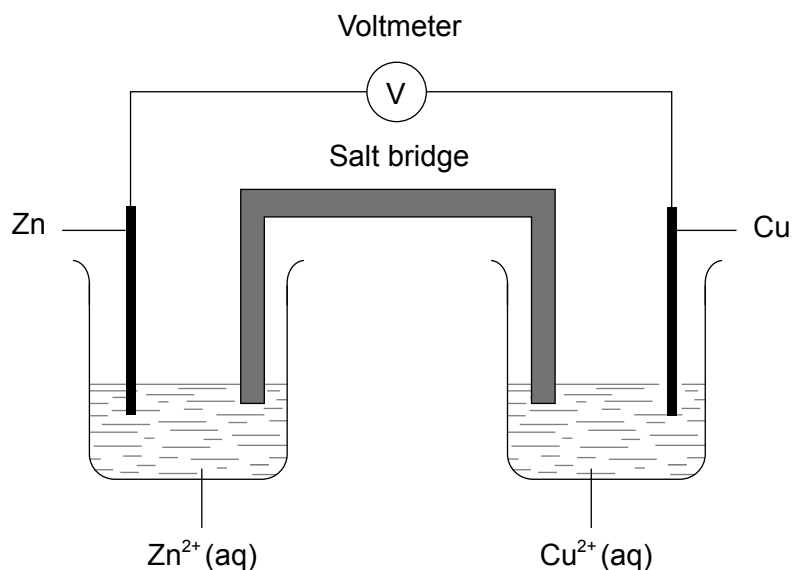
- A. HNO_3 and HSO_4^-
 B. HNO_3 and H_2NO_3^+
 C. H_2SO_4 and HSO_4^-
 D. H_2NO_3^+ and HSO_4^-
20. What occurs when solid sodium hydrogen carbonate reacts with aqueous sulfuric acid?
- A. Bubbles of sulfur dioxide form.
 B. Bubbles of both hydrogen and carbon dioxide form.
 C. Bubbles of hydrogen form.
 D. Bubbles of carbon dioxide form.
21. Which is a correct statement for the reaction below?



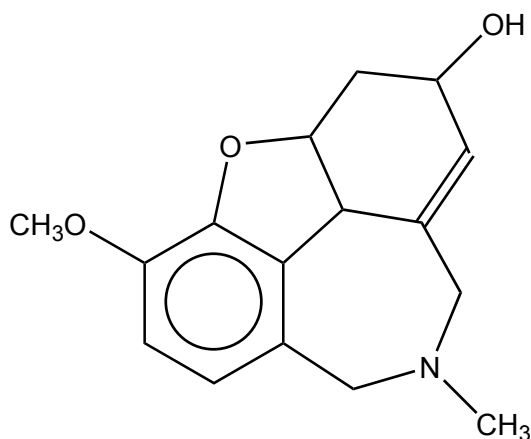
- A. MnO_4^- is the reducing agent and the oxidation number of Mn increases.
 B. MnO_4^- is the oxidizing agent and the oxidation number of Mn decreases.
 C. NO_2^- is the reducing agent and the oxidation number of N decreases.
 D. NO_2^- is the oxidizing agent and the oxidation number of N increases.

Turn over

22. A voltaic cell is constructed from zinc and copper half-cells. Zinc is more reactive than copper. Which statement is correct when this cell produces electricity?

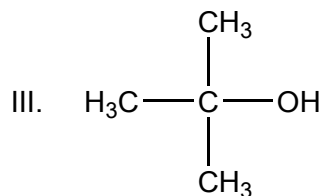
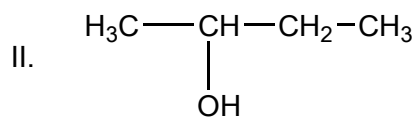
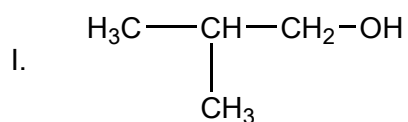


- A. Electrons flow from the copper half-cell to the zinc half-cell.
- B. The concentration of $\text{Cu}^{2+}(\text{aq})$ increases.
- C. Electrons flow through the salt bridge.
- D. Negative ions flow through the salt bridge from the copper half-cell to the zinc half-cell.
23. The structure of a drug used to treat symptoms of Alzheimer's disease is shown below. Which functional groups are present in this molecule?



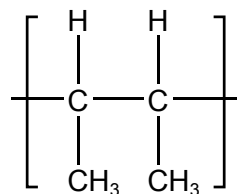
- A. Hydroxyl and ester
- B. Hydroxide and ether
- C. Hydroxyl and ether
- D. Hydroxide and ester

24. Which alcohols are oxidized by acidified potassium dichromate(VI) solution when heated?



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

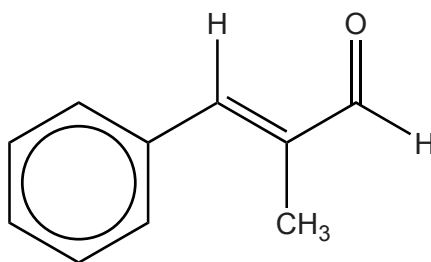
25. Which monomer is used to form the polymer with the following repeating unit?



- A. $\text{CH}_3\text{CH}=\text{CHCH}_3$
- B. $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$
- C. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$
- D. $(\text{CH}_3)_2\text{C}=\text{CH}_2$

Turn over

26. Which type of reaction occurs when methanol and propanoic acid react together in the presence of a catalyst?
- A. Addition
 - B. Condensation
 - C. Redox
 - D. Neutralization
27. A student carried out a titration to determine the concentration of an acid and found that his value had good precision but poor accuracy. Which process explains this outcome?
- A. Consistently overshooting the volume of solution from the burette into the flask.
 - B. Collection of insufficient titration data.
 - C. Reading the meniscus in the burette at a different angle each time.
 - D. Forgetting to rinse the flask after one of the titrations.
28. What is the index of hydrogen deficiency (IHD) for this molecule?



- A. 3
 - B. 4
 - C. 5
 - D. 6
29. What is always correct about the molecular ion, M^+ , in a mass spectrum of a compound?
- A. The M^+ ion peak has the smallest m/z ratio in the mass spectrum.
 - B. The m/z ratio of the M^+ ion peak gives the relative molecular mass of the molecule.
 - C. The M^+ ion is the most stable fragment formed during electron bombardment.
 - D. The M^+ ion peak has the greatest intensity in the mass spectrum.

30. A student measured the change in mass on heating a sample of calcium carbonate, $\text{CaCO}_3(\text{s})$. What is the mass loss?

Mass before heating:	$2.347 \text{ g} \pm 0.001$
Mass after heating:	$2.001 \text{ g} \pm 0.001$

- A. $0.346 \text{ g} \pm 0.001$
 - B. $0.346 \text{ g} \pm 0.002$
 - C. $0.35 \text{ g} \pm 0.002$
 - D. $0.35 \text{ g} \pm 0.001$
-