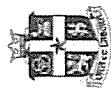


Teacher:

CANDIDATE SESSION NUMBER				
0	2	5	0	1
2	1	2		

EXAMINATION CODE				
8	8	2	1	-
6	1	0	1	

NAME: _____



ST JOSEPH'S INSTITUTION
Y6 PRELIMINARY EXAMINATION 2021

CHEMISTRY
HIGHER LEVEL
PAPER 1
Wednesday

30 June 2021
1 hour
1300 – 1400 h

INSTRUCTIONS TO CANDIDATES

- Write your session number in the boxes above.
- Write your teacher's name on the top right-hand corner of the question paper.
- 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]**.

2

The Periodic Table

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H 1.01	2 He 4.00																
3 Li 6.94	4 Be 9.01																
11 Na 22.99	12 Mg 24.31																
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 83.80
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
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)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (267)	105 Db (268)	106 Sg (269)	107 Bh (270)	108 Hs (271)	109 Mt (272)	110 Ds (281)	111 Rg (281)	112 Cn (285)	113 Nh (286)	114 Fl (289)	115 Uup (288)	116 Uub (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)				

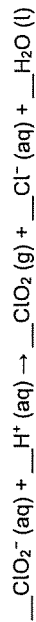
This question paper consists of 15 printed pages including the Cover Sheet.

[Turn over]

1. 5.0 cm^3 of 2.00 mol dm^{-3} sodium carbonate solution, $\text{Na}_2\text{CO}_3(\text{aq})$, was added to a volumetric flask and the volume was made up to 500 cm^3 with water. What is the concentration, in mol dm^{-3} , of the solution?

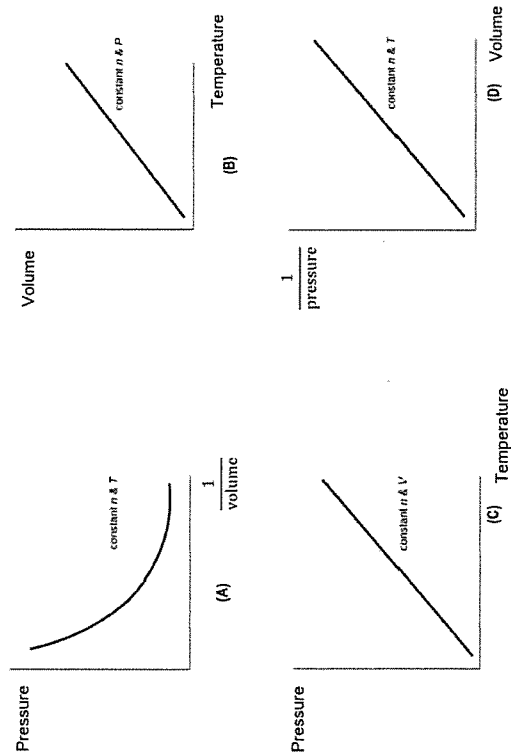
- A. 0.005
B. 0.004
C. 0.020
D. 0.010

2. What is the coefficient for H^+ when the equation below is balanced?

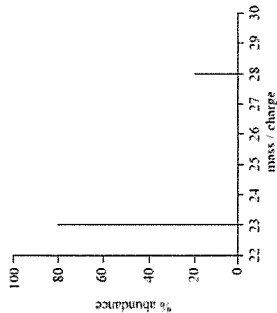


- A. 2
B. 4
C. 6
D. 8

3. Which of the following graphs correctly describe the behaviour of an ideal gas with temperature measured in $^\circ\text{C}$?



4. What is the relative atomic mass of an element with this mass spectrum?



- A. 24.0
B. 25.0
C. 26.0
D. 27.0

5. Which statement is correct for the emission spectrum of the hydrogen atom?

- A. The lines converge at low frequencies.
B. The lines are evenly spaced out.
C. The lines corresponding to the greatest emission of energy is in the ultraviolet region.
D. The lines are produced when the electrons move from lower to higher energy levels.

6. The successive ionization energies of element X are shown in the following table:

Ionization energy/ kJ mol^{-1}	1 st	2 nd	3 rd	4 th	5 th
	760	1540	3300	4390	8950

What is the most likely formula for an oxide of X?

- A. X_2O
B. XO
C. XO_2
D. X_2O_3

7. Which is correct about the element Indium (In) ($Z = 49$)?

	Number of electrons in highest main energy level	Number of electrons in all the p orbitals
A.	3	5
B.	13	12
C.	3	19
D.	13	26

8. Which statement is correct for a periodic trend?

- A. Ionisation energy increases from Li to Cs
 B. Melting point increases from Li to Cs
 C. Ionisation energy increases from Na to Cl
 D. Melting point increases from Na to Cl

9. Which series is arranged in order of increasing radius?

- A. $\text{Ca}^{2+} < \text{Cl}^- < \text{K}^+$
 B. $\text{K}^+ < \text{Ca}^{2+} < \text{Cl}^-$
 C. $\text{Ca}^{2+} < \text{K}^+ < \text{Cl}^-$
 D. $\text{Cl}^- < \text{K}^+ < \text{Ca}^{2+}$

10. Which combination is correct for the complex ion in $[\text{Co}(\text{NH}_3)_4(\text{H}_2\text{O})\text{Cl}]\text{Br}$?

	Oxidation state of Cobalt	Types of ligands in complex	Overall charge of the complex
A.	+1	3	0
B.	+2	2	-1
C.	+2	3	+1
D.	+3	4	+2

11. Which diatomic molecule has the strongest bonding between its atoms?

- A. H_2
 B. N_2
 C. O_2
 D. F_2

12. When the species BF_2^+ , BF_3 and BF_4^- are arranged in order of increasing F–B–F bond angle, what is the correct order?

- A. BF_3 , BF_4^- , BF_2^+
 B. BF_4^- , BF_3 , BF_2^+
 C. BF_2^+ , BF_4^- , BF_3
 D. BF_2^+ , BF_3 , BF_4^-

13. Which statements correctly describe the chlorite ion, ClO_2^- ?

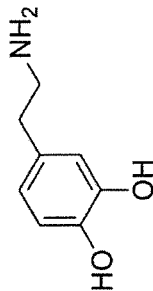
- I. It can be represented by resonance structures.
 II. It has two lone pairs of electrons on the Cl atom.
 III. The Cl atom is sp^2 hybridized.

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

14. What is the molecular geometry and the Cl–I–Cl bond angle in the ICl_4^- ion?

- A. Square planar, 90°
 B. Square pyramidal, 90°
 C. Tetrahedral, 109°
 D. Trigonal pyramidal, 107°

15. How many sigma (σ) and pi (π) bonds are there in dopamine?



	sigma (σ)	pi (π)
A.	9	6
B.	12	3
C.	15	6
D.	22	3

16. Which statements about exothermic reactions are correct?

- I. They have negative ΔH values.
- II. The bond enthalpies of the products are higher than the reactants.
- III. The products are energetically more stable than the reactants.

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

17. Using the equations below:



What is ΔH (in kJ) for the following reaction: $2\text{CuO (s)} \rightarrow \text{Cu}_2\text{O (s)} + \frac{1}{2}\text{O}_2\text{ (g)}$

- A. 142
- B. 15
- C. -15
- D. -142

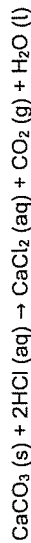
18. In which reaction will the entropy of the system increase significantly?

- A. $\text{HCl (g)} + \text{NH}_3\text{ (g)} \rightarrow \text{NH}_4\text{Cl (s)}$
- B. $\text{N}_2\text{ (g)} + 3\text{H}_2\text{ (g)} \rightarrow 2\text{NH}_3\text{ (g)}$
- C. $2\text{H}_2\text{ (g)} + \text{O}_2\text{ (g)} \rightarrow 2\text{H}_2\text{O (l)}$
- D. $2\text{C (s)} + \text{O}_2\text{ (g)} \rightarrow 2\text{CO (g)}$

19. Which reaction has the most negative ΔH value?

- A. $\text{MgS (s)} \rightarrow \text{Mg}^{2+}\text{ (g)} + \text{S}^{2-}\text{ (g)}$
- B. $\text{Mg}^{2+}\text{ (g)} + \text{S}^{2-}\text{ (g)} \rightarrow \text{MgS (s)}$
- C. $\text{NaCl (s)} \rightarrow \text{Na}^+\text{ (g)} + \text{Cl}^-\text{ (g)}$
- D. $\text{Na}^+\text{ (g)} + \text{Cl}^-\text{ (g)} \rightarrow \text{NaCl (s)}$

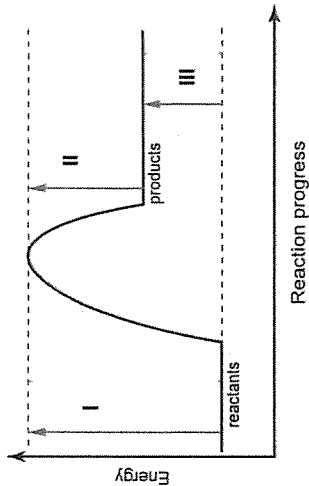
20. Several reactions of calcium carbonate with dilute hydrochloric acid are carried out at the same temperature.



Which reaction has the greatest rate?

	Concentration of HCl (aq)	Surface area of same mass of CaCO_3 (s)
A.	higher	larger
B.	lower	smaller
C.	lower	larger
D.	higher	smaller

21. Which of the quantities in the energy profile diagram below is (are) affected by the use of a catalyst?



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

22. The activation energy of a reaction can be obtained from the rate constant, k and the absolute temperature. Which graph of these quantities produce a straight line?

- A. k against T
B. k against $\frac{1}{T}$
C. $\ln k$ against T
D. $\ln k$ against $\frac{1}{T}$

23. The reaction $2X(g) + Y(g) \rightarrow 3Z(g)$ has the rate expression: $\text{rate} = k[X]^2[Y]^0$. The concentration of X is increased by a factor of three and the concentration of Y is increased by a factor of two. By what factor will the reaction rate increase?

- A. 6
B. 9
C. 12
D. 18

24. If the equilibrium is established by initially adding 0.10 mole of A and B to a 1 L container, then which of the following must be true once the reaction mixture achieves equilibrium?



- A. $[A] = [B]$
B. $[B] = 2[C]$
C. $[A] < [B]$
D. $[A] > [B]$

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



	Position of equilibrium	Relative rates of forward and reverse reactions
A.	shifts to the left	increase
B.	shifts to the left	no change
C.	shifts to the right	decrease
D.	no change	no change

26. Which is correct for an isolated system at equilibrium?

	Gibbs Free Energy	Entropy
A.	maximum	minimum
B.	minimum	maximum
C.	maximum	maximum
D.	minimum	minimum

27. All the following species are Lewis bases **except**

- A. OH^-
- B. F^-
- C. NH_3
- D. Cu^+

28. Which of these oxides contribute to acid deposition?

- I. SO_3
- II. NO_2
- III. CO_2

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

29. Which change in $[\text{H}^+]$ causes the biggest increase in pH?

- A. A change in $[\text{H}^+]$ (aq) from 1×10^{-3} to 1×10^{-2} mol dm^{-3}
- B. A change in $[\text{H}^+]$ (aq) from 1×10^{-3} to 1×10^{-4} mol dm^{-3}
- C. A change in $[\text{H}^+]$ (aq) from 1×10^{-4} to 1×10^{-2} mol dm^{-3}
- D. A change in $[\text{H}^+]$ (aq) from 1×10^{-4} to 1×10^{-6} mol dm^{-3}

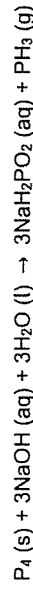
30. Which mixture would produce a basic buffer when dissolved in 1 dm^3 of water?

- A. 0.30 mol of NH_3 (aq) and 0.15 mol of HCl (aq)
- B. 0.30 mol of NaOH (aq) and 0.15 mol of HCl (aq)
- C. 0.30 mol of NH_3 (aq) and 0.15 mol of H_2SO_4 (aq)
- D. 0.30 mol of NaOH (aq) and 0.15 mol of H_2SO_4 (aq)

31. Which of the following aqueous solutions will react with zinc metal?

- A. Ammonia
- B. Ammonium nitrate
- C. Sodium chloride
- D. Sodium ethanoate

32. White phosphorus reacts with cold sodium hydroxide and water according to the equation below:



Which statement about the above reaction is correct?

- A. Phosphorus is simultaneously oxidised and reduced.
- B. Sodium hydroxide acts as an oxidising agent.
- C. The oxidation number of oxygen increases from -2 to 0 .
- D. The oxidation number of the phosphorus in both products is -3 .

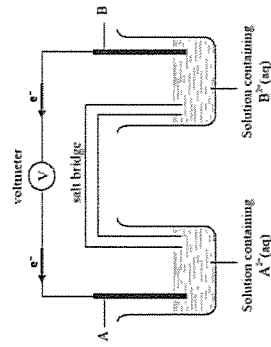
33. What occurs during the electrolysis of a molten salt?

- A. Electricity is produced by a spontaneous redox reaction.
- B. Electricity is used to cause a non-spontaneous redox reaction to occur.
- C. Electrons flow through the molten salt.
- D. Electrons are removed from both ions of the molten salt.

34. Which components are used to make the standard hydrogen electrode?

- A. H_2 (g), 1 mol dm^{-3} dilute H_2SO_4 , Pt (s)
- B. H_2 (g), 1 mol dm^{-3} dilute H_2SO_4 , Cu (s)
- C. H_2 (g), 1 mol dm^{-3} dilute HNO_3 , Pt (s)
- D. H_2 (g), 1 mol dm^{-3} dilute HNO_3 , Cu (s)

35. A standard voltaic cell is made and shown below.



Which statement is correct?

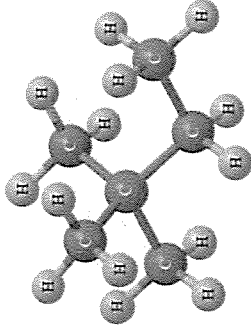
- Positive ions flow through the salt bridge from A to B.
- Negative ions flow through the salt bridge from A to B.
- Metal A is a stronger reducing agent than metal B.
- $B^{2+}(aq)$ is a stronger oxidising agent than $A^{2+}(aq)$.

36. Which properties are features of a homologous series?

- Similar chemical properties
- Same type of intermolecular forces
- Same empirical formula

- I and II
- I and III
- II and III
- I, II and III

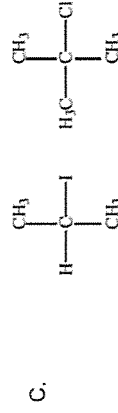
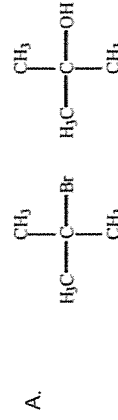
37. The following is a three-dimensional representation of an organic molecule.



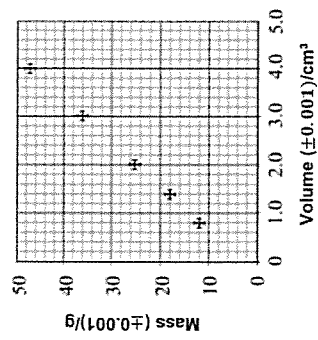
Which statement is correct?

- The IUPAC name of the molecule is 2-methylpentane.
- All the bond angles are approximately 90° .
- One possible isomer is hexane.
- The boiling point of this compound would be higher than hexane.

38. In which pair do both compounds contain secondary carbon atom?



39. The volume and mass of different objects made from the same element X, are measured independently. A graph of mass against volume, with error bars is displayed.



Which statement best describes the experimental results?

- A. The mass of an object is proportional to its volume.
- B. Measurements show a significant systematic error but small random error.
- C. Measurements show a significant random error but small systematic error.
- D. Measurements are precise but not accurate.

40. A student obtained the following data to calculate P , the pressure of an ideal gas, using $PV = nRT$.

$$V = 20.0 \text{ cm}^3 \pm 0.5 \text{ cm}^3$$

$$T = 50 \text{ }^\circ\text{C} \pm 1 \text{ }^\circ\text{C}$$

$$n = 0.5 \text{ mol}$$

$$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$$

What is the percentage uncertainty in the calculated value of P ?

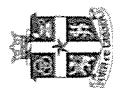
- A. 0.5
- B. 1.5
- C. 2.0
- D. 4.5

Teacher:

NAME: _____

CANDIDATE SESSION NUMBER					
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EXAMINATION CODE					
8	8	2	1	-	6
1	0	2	1	0	2



ST JOSEPH'S INSTITUTION
Y6 PRELIMINARY EXAMINATION 2021

CHEMISTRY
HIGHER LEVEL
PAPER 2
Wednesday

30 June 2021
2 hour 15 minutes
1445 – 1700 h

INSTRUCTIONS TO CANDIDATES

- Write your session number in the boxes above.
- Write your teacher's name on the top right-hand corner of the question paper.
- Do not open this examination paper until instructed to do so.
- Answer all questions.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- A clean copy of the **chemistry data booklet** is required for this paper.
- Do not write anything in ink in the data booklet. All pencil marks must be erased at the end of the exam.
- The maximum mark for this examination paper is **[90 marks]**.

Answer **all** questions. Answers must be written within the answer boxes provided.

1. 2.67 g of manganese(IV) oxide was added to 200.0 cm³ of 2.00 mol dm⁻³ HCl/ resulting in the formation of chlorine gas, manganese(II) chloride and water.

(a) Write a balanced reaction. [1]

.....

(b) Calculate the amount, in mol, of manganese(IV) oxide added. [1]

.....

(c) Determine the limiting reactant, showing your calculations. [2]

.....

(d) Determine the excess amount, in mol, of the other reactant. [1]

.....

(e) Calculate the volume of chlorine, in dm³, produced if the reaction is conducted at standard temperature and pressure (STP). Use section 2 of the data booklet. [1]

.....

This question paper consists of 22 printed pages including the Cover Sheet.

Turn over

2. (a) Germanium is a metalloid found in group 14 of the periodic table. It forms compounds with oxidation states of +2 and +4. Complete the table below to show the sub-atomic particles for an isotope of germanium. [1]

Isotope	Protons	Neutrons	Electrons
^{74}Ge			

- (b) State the full electron configuration of the Germanium(II) ion. [1]

.....

- (c) Deduce the total **maximum** number of electrons present in the fourth main energy level. [1]

.....

- (d) Lead is a metal in group 14. Lead(II) ions emit blue light in a flame test with a wavelength of 525 nm. Calculate the frequency of the blue light (in Hertz). Refer to sections 1 and 2 of the data booklet. [1]

.....

- (e) Calculate the energy (in Joules) of one photon of that blue light. [2]

.....

Turn over

3. (a) Astatine is the last member of group 17 below iodine. It is predicted to be a black and stable solid containing diatomic molecules. If chlorine gas, $\text{Cl}_2(\text{g})$ is bubbled into a solution of potassium astatide, $\text{KAt}(\text{aq})$, predict any change that may be observed. [1]

.....

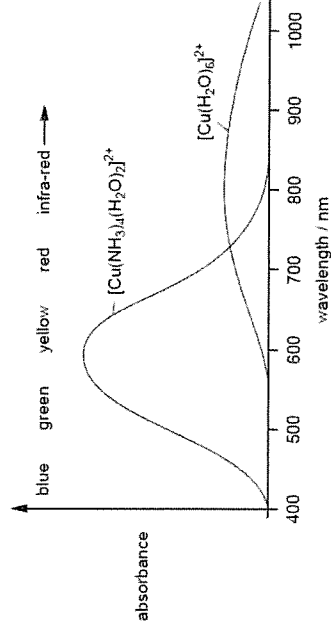
- (b) State the half equation for the reduction reaction. [1]

.....

- (c) Arrange At^- , At^+ and At in order of increasing radius. [1]

.....

- (d) The following graph shows the absorbance spectra of two complexes containing copper(II) ions.



(This question continues on the following page)

(Question 3 continued)

- (i) State the type of transitions responsible for the colour of the complex ions of transition metals. [1]

.....
.....

- (ii) Deduce the colour of $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$ (aq). Refer to the graph above and the colour wheel in section 17 of the data booklet. [1]

.....
.....

- (iii) State which ligand, NH_3 or H_2O , causes the smaller energy gap in the two complexes. [1]

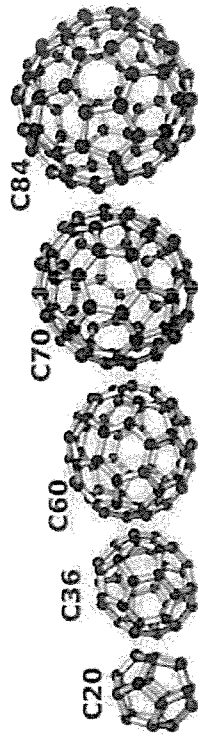
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- (iv) State the type of reaction involved in the conversion from $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ to $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$. [1]

.....

Turn over

4. Fullerenes are molecular forms of pure carbon prepared by heating graphite to a high temperature in an atmosphere of helium gas and rapidly cooling the vapour. The diagram below shows the shapes of selected fullerenes.



Fullerene	Sublimation point/ $^{\circ}\text{C}$	Molar mass/ g mol^{-1}
C_{60}	450	720.6
C_{70}	530	840.7
C_{84}	650	1008.4

- (a) Deduce the formula of a fullerene molecule with a molar mass of $336.28 \text{ g mol}^{-1}$. [1]

.....

- (b) Suggest the function of helium gas (a noble gas) in the synthesis of carbon-60. [1]

.....

- (c) Graphene and diamond are two other forms of pure carbon. State the hybridisation of the carbon atoms in both graphite and diamond. [2]

.....
.....

(This question continues on the following page)

(Question 4 continued)

- (d) Compare the formation of sigma and pi bonds between two carbons in a planar molecule. [2]

.....

.....

.....

.....

- (e) Explain why C_{60} is insoluble in water. Refer to the polarity and intermolecular forces of the two substances. [2]

.....

.....

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- (f) State and explain the trend in the sublimation points of fullerenes with increasing molar mass. [2]

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(Question 4 continued)

- (g) (i) A student measures the sublimation point of C_{60} and determines it to be 500°C . Calculate the percentage error (to 2 s.f.) compared to the literature value of 450°C . [1]

.....

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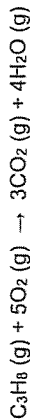
- (ii) The temperature probe used to measure the sublimation point is placed in a mixture of pure ice and pure water. The probe measures a value of 5°C . State the type of error present. [1]

.....

.....

.....

5. An equation for the combustion of propane is given below.



- (a) Determine the standard enthalpy change, $\Delta H^\ominus$, for this reaction, using section 11 of the data booklet. [3]

- (b) Calculate the standard enthalpy change, $\Delta H^\ominus$, for this reaction using section 12 of the data booklet. [2]

- (c) Outline why no value is listed in the section 12 of the data booklet for $\text{O}_2(\text{g})$. [1]

(This question continues on the following page)

Turn over

(Question 5 continued)

- (d) Outline why the value of enthalpy of reaction calculated from bond enthalpies is less accurate. [1]

- (e) Predict, giving a reason, whether the entropy change, $\Delta S^\ominus$, for this reaction is negative or positive. [1]

- (f) Calculate $\Delta S^\ominus$ for the reaction in $\text{J K}^{-1} \text{mol}^{-1}$ using section 12 of the data booklet. [2]

The standard molar entropy for oxygen gas is $205 \text{ J K}^{-1} \text{mol}^{-1}$.

(This question continues on the following page)

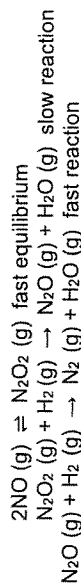
(Question 5 continued)

- (g) Calculate the standard Gibbs free energy change, ΔG° , in kJ, for the reaction at 5 °C, using your answers to (b) and (f). Use section 1 of the data booklet.

(If you did not obtain an answer to (b) or (f) use values of –1952 kJ and +113 J K⁻¹ respectively, although these are not the correct answers.)

[3]

6. The reaction between hydrogen and nitrogen monoxide is thought to proceed by the mechanism shown below:



- (a) (i) State the overall equation for the reaction.

[1]

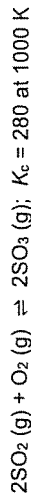
- (ii) Deduce the rate expression consistent with this mechanism.

[1]

- (iii) Explain how you would attempt to confirm this rate expression, giving the results you would expect.

[3]

7. (a) This homogenous reaction is used in the manufacture of sulfuric acid.

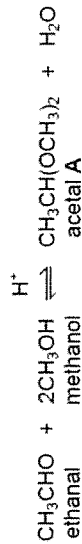


0.250 mol of sulfur dioxide, 0.400 mol of oxygen and 0.600 mol of sulfur trioxide were mixed in a 1.00 dm³ flask at 1000 K.

Predict the direction of the reaction (using the reaction quotient Q) and showing your working and reasoning.

[3]

- (b) Acetals are compounds formed when aldehydes are reacted with an alcohol in the presence of an acid catalyst.



In an experiment, the concentrations of the reactants (ethanal and methanol) and products (acetal and water) were measured.

	[CH ₃ CHO] / mol dm ⁻³	[CH ₃ OH] / mol dm ⁻³	[H ⁺] / mol dm ⁻³	[acetal] / mol dm ⁻³	[H ₂ O] / mol dm ⁻³
Initial	0.20	0.10	0.05	0.00	0.00
Change					
Equilibrium				0.025	

Complete the table above.

[2]

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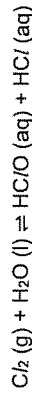
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(Question 7 continued)

- (c) Calculate the equilibrium constant for the above reaction. [1]

- (d) State the effect of removing the catalyst on the value of K_c. [1]

8. (a) Chlorine gas reacts with water to produce hypochlorous acid and hydrochloric acid.



- (i) Hypochlorous acid is considered a weak acid. Outline what is meant by the term weak acid. [1]

- (ii) State the formula of the conjugate base of hypochlorous acid. [1]

- (iii) Calculate the concentration of H⁺ (aq) in a HClO (aq) solution with a pH = 3.61. [1]

(This question continues on the following page)

(Question 8 continued)

- (b) The equation for the first dissociation of citric acid in water is



$$K_a = 5.01 \times 10^{-4} \text{ at } 298 \text{ K}$$

Outline **two** laboratory methods of distinguishing between solutions of citric acid and hydrochloric acid of equal concentration, stating the expected observations.

[2]

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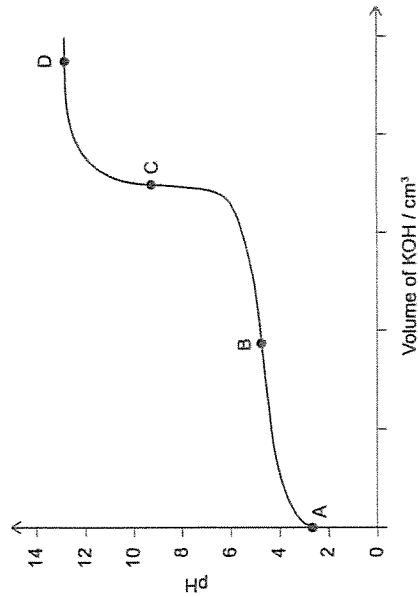
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- (c) A student performed a titration to determine the concentration of ethanoic acid, CH_3COOH , in vinegar using potassium hydroxide and obtained the following pH curve.



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Turn over

(Question 8 continued)

- (i) Identify the **major** species, other than water molecules and potassium ions, at these points.

[2]

B:

C:

- (ii) State a suitable indicator for this titration. Use section 22 of the data booklet.

[1]

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- (iii) Suggest, giving a reason, which point on the curve is considered a buffer region.

[1]

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- (iv) State the K_a expression for ethanoic acid.

[1]

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(This question continues on the following page)

(Question 8 continued)

- (v) Calculate the K_b of the conjugate base of ethanoic acid at 298 K using sections 2 and 21 of the data booklet. [1]

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9. Consider the following half-cell reactions and their standard electrode potentials.

	$E^\ominus / \text{V}$
$\text{Mn}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Mn}(\text{s})$	-1.18
$\text{Ni}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Ni}(\text{s})$	-0.26
$\text{I}_2(\text{aq}) + 2\text{e}^- \rightleftharpoons 2\text{I}^-(\text{aq})$	+0.54

- (a) Deduce a balanced equation for the overall reaction when the standard nickel and iodine half-cells are connected. [1]

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- (b) Predict, giving a reason, the direction of movement of electrons when the standard nickel and manganese half-cells are connected. [2]

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(This question continues on the following page)

Turn over

(Question 9 continued)

- (c) Calculate the cell potential, in V, when the standard iodine and manganese half-cells are connected. [1]

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- (d) Identify the strongest reducing agent in the table above. [1]

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- (e) State and explain the products of electrolysis of a concentrated aqueous solution of sodium chloride using inert electrodes. Your answer should include half-equations for the reaction at each electrode. [4]

Positive electrode (anode):

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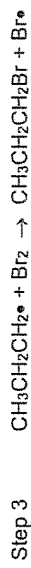
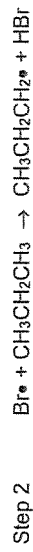
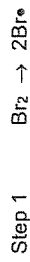
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Negative electrode (cathode):

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10. The reaction of bromine with propane is similar to that of chlorine with methane. Three steps in the mechanism for the bromination of propane to form 1-bromopropane are shown below.



- (a) State the type of mechanism shown by the reaction between bromine and propane. [1]

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- (b) State an essential condition for Step 1 to occur. [1]

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- (c) State the name of the type of step illustrated by steps 2 and 3. [1]

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- (d) Name the type of step where radicals combine to form molecules. Write an equation to show how a hexane molecule (an alkane) can be formed. [2]

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(This question continues on the following page)

Turn over

(Question 10 continued)

- (e) State the general formula for the alkane homologous series. [1]

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- (f) Draw a displayed structural formula for 2-bromo-2-chloro-1,1,1-trifluoroethane. [1]

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