Anglo-Chinese School
(Independent)

Year 6 Preliminary Examination 2022
INTERNATIONAL BACCALAUREATE DIPLOMA PROGRAMME
CHEMISTRY HIGHER LEVEL

PAPER 1

Monday **12th September 2022** **1 hour**

Additional materials:

Multiple choice answer sheet
Soft clean eraser
Soft pencil (type 2B recommended)

INSTRUCTIONS TO CANDIDATES

Do not open this booklet until you are told to do so.

Write your Candidate number and the subject on the separate answer sheet provided.

There are **forty** questions in this paper. Answer **all** the questions. For each question there are four possible answers, **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice in **soft pencil** on the multiple choice answer sheet.

INFORMATION FOR CANDIDATES

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet. A copy of the periodic table is provided for reference on Page 2 of the examination paper.
Calculators are **not** allowed to be used in this paper.

This question paper consists of 16 printed pages, including the cover page.

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			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** 207.2	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. What mass, measured in g, of hydrogen is formed when 3 mol of aluminium react with excess hydrochloric acid according to the following equation?

$$2Al\ (s) + 6HCl\ (aq) \rightarrow 2AlCl_3\ (aq) + 3H_2\ (g)$$

A. 3.0

B. 4.5

C. 6.0

D. 9.0

2. The volume of an ideal gas at 27.0 °C is increased from 3.00 dm^3 to 6.00 dm^3. At what temperature, in °C, will the gas have the original pressure?

A. 13.5

B. 54.0

C. 327

D. 600

3. Which describes the visible emission spectrum of hydrogen?

A. A series of lines at regular intervals.

B. A series of lines converging at lower energy.

C. A series of lines converging at higher frequency.

D. A series of lines converging at longer wavelength.

4. Which species have the same number of electrons?

I S^{2-}
II Cl^-
III Ne

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

5. Between which ionization energies of aluminium will there be the greatest difference?

A. Between 1st and 2nd ionization energies

B. Between 2nd and 3rd ionization energies

C. Between 3rd and 4th ionization energies

D. Between 4th and 5th ionization energies

6. Which one of the following consists of an acidic oxide, an amphoteric oxide and a basic oxide of period 3 elements?

A. Al_2O_3, MgO and SiO_2

B. Al_2O_3, Na_2O and NO_2

C. CaO, SO_2 and ZnO

D. Cl_2O, SiO_2 and P_4O_{10}

7. Which of the following properties of the halogens generally shows a decreasing trend from fluorine to iodine?

I boiling point
II electronegativity
III oxidizing strength

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

8. Which of these species cannot act as a ligand?

A. CH_4

B. CN^-

C. CO

D. $(CH_3)_3P$

9. Which of the following molecules is polar?

A. Carbon dioxide, CO_2

B. Cis-1,2-dichloroethene, $C_2H_2Cl_2$

C. Tetrachloromethane, CCl_4

D. Trans-1,2-difluoroethene, $C_2H_2F_2$

10. Which of the following compounds has the greatest covalent character in the ionic compound?

A. LiF

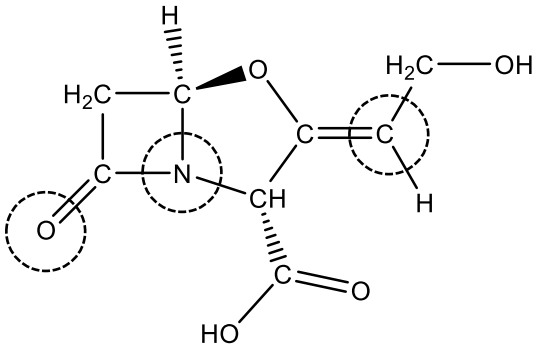
B. LiI

C. CsI

D. CsF

11. Antibiotic-resistant bacterial infections can be treated using a mixture of penicillins and clavulanic acid. The structure of clavulanic acid is shown below.

What is the hybridization of the circled carbon, oxygen and nitrogen atoms?



	Carbon	Oxygen	Nitrogen
A.	sp^2	sp	sp^2
B.	sp^2	sp^2	sp^3
C.	sp^3	sp^3	sp
D.	sp^3	sp^2	sp

12. Which one of the following will **not** form intermolecular hydrogen bonds with its own molecules?

A. CH_3NH_2

B. CH_3CH_2OH

C. CH_3COOCH_3

D. $(COOH)_2$

13. Which of the following compound species has net dipole moment?

A. BF_3

B. $(CH_3)_2CO$

C. XeF_4

D. PCl_5

14. When 25.0 cm^3 of 0.100 mol dm^{-3} NaOH (aq) is mixed with 50.0 cm^3 of 0.050 mol dm^{-3} H_2SO_4 (aq) at the same temperature, a temperature rise, ΔT, is recorded. What is the expression, in kJ mol^{-1}, for the enthalpy of neutralization? (Assume the density of the mixture = 1.00 g cm^{-3} and its specific heat capacity = 4.18 J g^{-1} K^{-1})

A. $-\dfrac{25.0 \times 4.18 \times \Delta T}{25.0 \times 0.100}$

B. $-\dfrac{75.0 \times 4.18 \times \Delta T}{50.0 \times 0.050 \times 1000}$

C. $-\dfrac{50.0 \times 4.18 \times \Delta T \times 1000}{50.0 \times 0.050}$

D. $-\dfrac{75.0 \times 4.18 \times \Delta T}{25.0 \times 0.100}$

15. Which equation represents the average bond enthalpy of the Si−Cl bond in $SiCl_4$?

A. $SiCl_4\ (g) \rightarrow SiCl_3\ (g) + Cl\ (g)$

B. $\frac{1}{4}SiCl_4\ (g) \rightarrow \frac{1}{4}Si\ (g) + Cl\ (g)$

C. $SiCl_4\ (g) \rightarrow SiCl_3\ (g) + \frac{1}{2}Cl_2\ (g)$

D. $SiCl_4\ (g) \rightarrow Si\ (g) + 4Cl\ (g)$

16. The combustion of ascorbic acid is exothermic and occurs according to the following equation:

$$C_6H_8O_6\ (s) + 5O_2\ (g) \rightarrow 6CO_2\ (g) + 4H_2O\ (g)$$

Which is correct for this reaction?

	$\Delta H^{\ominus}$	$\Delta S^{\ominus}$	spontaneity
A	negative	positive	spontaneous
B	negative	positive	non–spontaneous
C	positive	negative	spontaneous
D	positive	positive	non–spontaneous

17. Which ion's hydration energy is the most exothermic?

A. Al^{3+}

B. Br^{-}

C. Na^{+}

D. Se^{2-}

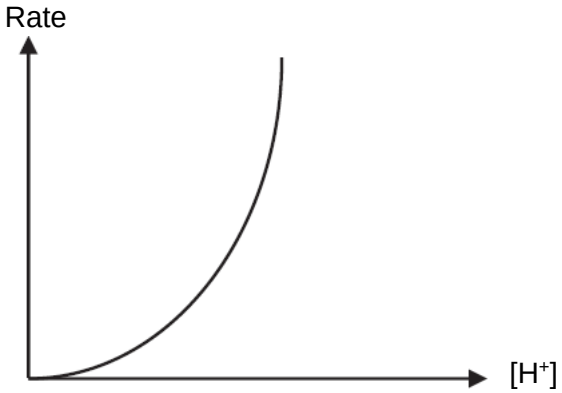
18. Propanone, CH_3COCH_3, reacts with iodine in an acid-catalyzed reaction as shown in the equation below.

$$CH_3COCH_3 + I_2 \xrightarrow{H^+} CH_2ICOCH_3 + HI$$

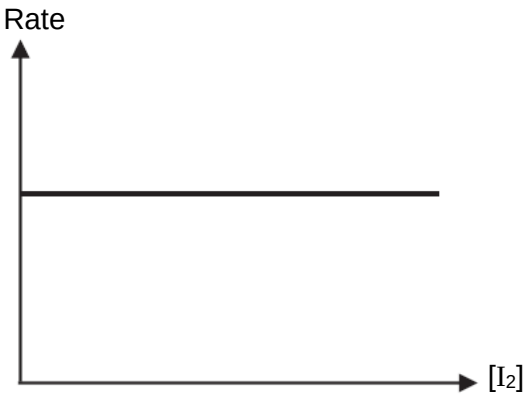
The rate equation for this reaction is rate = $k\,[CH_3COCH_3]\,[H^+]\,[I_2]^0$

Which of the following graphs is correct of the above reaction when propanone, CH_3COCH_3, is in excess?

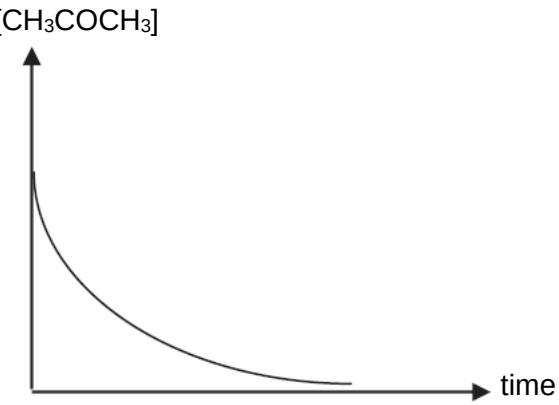
A.



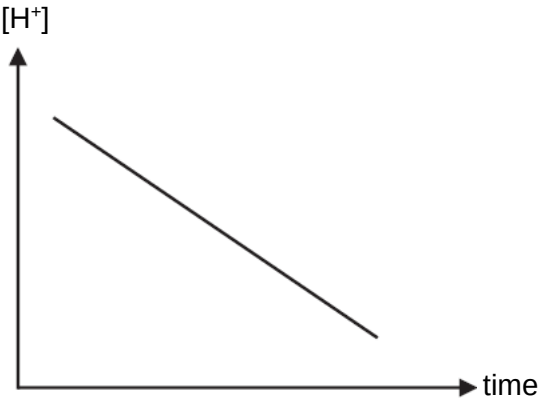
B.



C.



D.



19. Bromine reacts with methanoic acid, HCOOH, in an open beaker to produce hydrobromic acid, HBr, and carbon dioxide gas.

$$Br_2\,(aq) + HCOOH\,(aq) \rightarrow 2HBr\,(aq) + CO_2\,(g)$$

Which of the following methods is not suitable for studying the kinetics of this reaction?

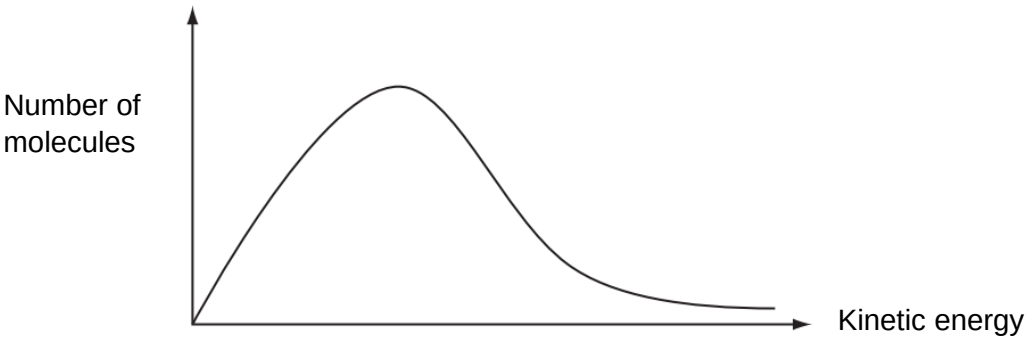
A. Measuring the conductivity of the solution over time.

B. Measuring the change in pressure of the reaction over time.

C. Measuring the change in colour intensity of the mixture over time.

D. Measuring the change of pH of the solution over time.

20. The diagram shows the Maxwell-Boltzmann energy distribution curve of molecular energies at a given temperature.



Which of the factors that affect the rate of a reaction can be explained using such a Boltzmann distribution curve?

I Increasing the concentration of reactants
II Increasing the temperature
III Addition of a catalyst

A. I and II only

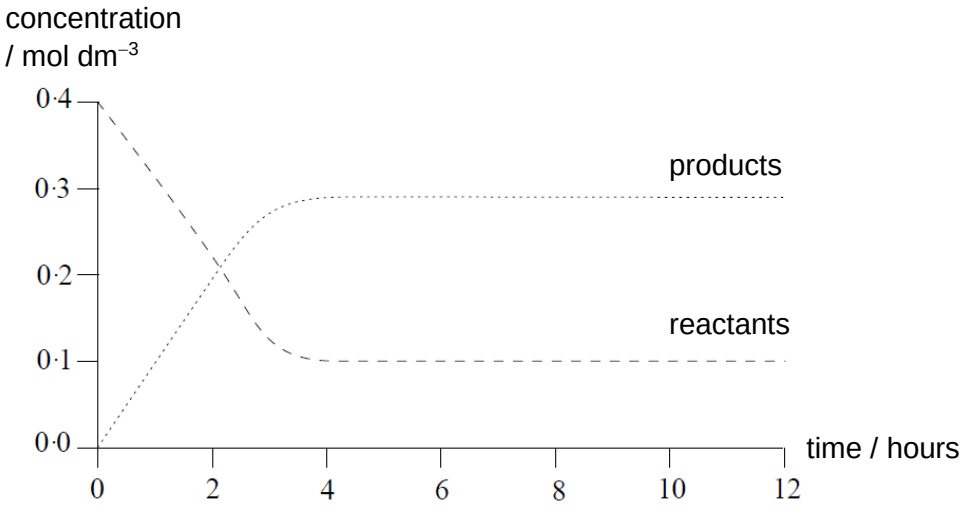
B. I and III only

C. II and III only

D. I, II and III

21. The graph below shows how the concentration of reactants and products change over time for the reversible reaction of ethyl ethanoate with water.

$$CH_3COOC_2H_5 + H_2O \rightleftharpoons CH_3COOH + C_2H_5OH$$



Which of the following can be determined from the graph?

A. The equilibrium concentrations of the reactants and products were 0.2 mol dm^{-3}.

B. The forward reaction stopped after four hours.

C. The system reached equilibrium after two hours.

D. The reaction did not go to completion.

22. Dimerization of brown nitrogen dioxide gas (NO_2) to the colourless dinitrogen tetroxide (N_2O_4) exists in equilibrium.

$$2NO_2\,(g) \rightleftharpoons N_2O_4\,(g) \quad \Delta H = -54.8\ kJ\ mol^{-1}$$

Which of the following change would cause an increase in the equilibrium concentration of N_2O_4 (g)?

A. Introducing a catalyst.

B. Decreasing the temperature in the container.

C. Increasing the volume of the container.

D. Adding argon gas (Ar) at constant volume.

23. What is the equilibrium constant expression for the following chemical reaction?

$$2Cl_2\,(g) + 2H_2O\,(g) \rightleftharpoons 4HCl\,(g) + O_2\,(g)$$

A. $\dfrac{[HCl]\,[Cl_2]}{[HCl]\,[O_2]}$

B. $\dfrac{[HCl]\,[O_2]}{[H_2O]\,[Cl_2]}$

C. $\dfrac{2[H_2O]\,2[Cl_2]}{4[[HCl]\,[O_2]}$

D. $\dfrac{[HCl]^4\,[O_2]}{[H_2O]^2\,[Cl_2]^2}$

24. Which is a conjugate Brønsted-Lowry acid-base pair?

A. NH_3 and NH_4^+

B. HCl and Cl_2

C. H_2SO_4 and SO_4^{2-}

D. NaOH and Na^+

25. 1 cm^3 of aqueous nitric acid of 0.1 mol dm^{-3} is added to 99 cm^3 of water. How will pH of the nitric acid change?

A. Decrease 100 times

B. Increase 100 times

C. Decrease by 2 units

D. Increase by 2 units

26. Ammonia reacts with boron trifluoride to form a compound NH_3BF_3. What is the role of boron trifluoride in this reaction?

A. Brønsted acid

B. Brønsted base

C. Lewis acid

D. Lewis base

27. Which mixture forms a buffer solution?

A. 25.0 cm^3 of 0.1 mol dm^{-3} of NH_3 and 50.0 cm^3 of 0.1 mol dm^{-3} of H_2SO_4

B. 25.0 cm^3 of 0.1 mol dm^{-3} of HCl and 50.0 cm^3 of 0.1 mol dm^{-3} of CH_3COOH

C. 25.0 cm^3 of 0.1 mol dm^{-3} of HCl and 50.0 cm^3 of 0.1 mol dm^{-3} of CH_3COONa

D. 25.0 cm^3 of 0.1 mol dm^{-3} of NH_4Cl and 50.0 cm^3 of 0.1 mol dm^{-3} of NaOH

28. Consider the overall reaction taking place in a voltaic cell.

$$Ag_2O\ (s) + Zn\ (s) + H_2O\ (l) \rightarrow 2Ag\ (s) + Zn(OH)_2\ (s)$$

What is the role of zinc in the cell?

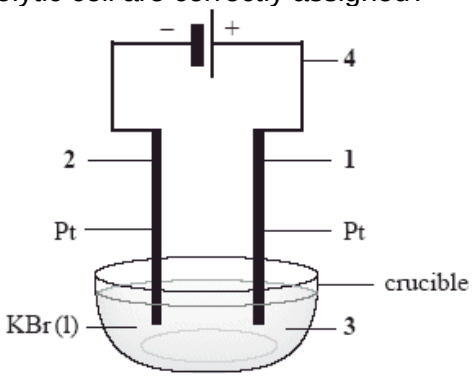
A. The positive electrode and the oxidizing agent.

B. The positive electrode and the reducing agent.

C. The negative electrode and the oxidizing agent.

D. The negative electrode and the reducing agent.

29. Which labels of the electrolytic cell are correctly assigned?



	1	2	3	4
A.	anode	site of reduction	electrolyte	conductor
B.	cathode	site of oxidation	conductor	electrolyte
C.	anode	site of reduction	conductor	electrolyte
D.	cathode	site of oxidation	electrolyte	conductor

30. Consider the following standard electrode potentials.

Zn^{2+} (aq) + $2e^-$ ⇌ Zn (s) $E^\ominus$ = −0.76 V
Cl_2 (g) + $2e^-$ ⇌ $2Cl^-$ (aq) $E^\ominus$ = +1.36 V
Mg^{2+} (aq) + $2e^-$ ⇌ Mg (s) $E^\ominus$ = −2.37 V

What will happen when zinc powder is added to an aqueous solution of magnesium chloride?

A. No reaction will take place.

B. Chlorine gas will be produced.

C. Magnesium metal will form.

D. Zinc chloride will form.

31. The same quantity of electricity was passed through separate molten samples of sodium bromide, NaBr, and magnesium chloride, $MgCl_2$. Which statement is correct about the amount, in mol of products formed?

A. The amount of Mg formed is equal to the amount of Na formed.

B. The amount of Mg formed is equal to the amount of Cl_2 formed.

C. The amount of Mg formed is twice the amount of Cl_2 formed.

D. The amount of Mg formed is twice the amount of Na formed.

32. A voltaic cell is made by connecting two half-cells represented by the half-equations below.

Mn^{2+} (aq) + $2e^-$ ⇌ Mn (s) $E^\ominus$ = –1.19 V
Pb^{2+} (aq) + $2e^-$ ⇌ Pb (s) $E^\ominus$ = –0.13 V

Which statement is correct about this voltaic cell?

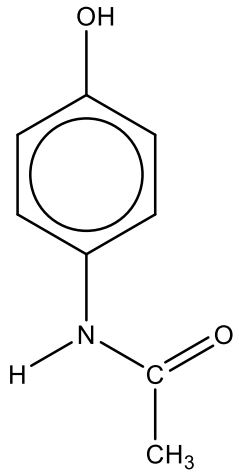
A. Mn is oxidized and the voltage of the cell is 1.06 V.

B. Pb is oxidized and the voltage of the cell is 1.06 V.

C. Mn is oxidized and the voltage of the cell is 1.32 V.

D. Pb is oxidized and the voltage of the cell is 1.32 V.

33. What is the index of hydrogen deficiency (IHD) of paracetamol?



A. 3

B. 4

C. 5

D. 6

34. Which spectra would show the difference between propan-2-ol, $CH_3CH(OH)CH_3$, and propanal, CH_3CH_2CHO?

I mass spectrum
II infrared spectrum
III ^1H NMR spectrum

A. I and II only

B. II and III only

C. I and III only

D. I, II and III

35. One mole of methylcyclobutane reacts with one mole of chlorine gas in the presence of ultraviolet light. Which statement is correct about this reaction?

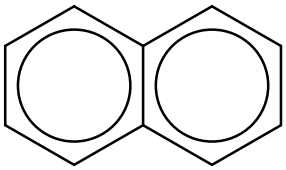
A. Homolytic fission occurs only in the initiation step.

B. Hydrogen is a by-product formed in the reaction.

C. There are only four possible mono-substituted structural isomers.

D. Both the initiation and termination steps of the free-radical substitution mechanism are endothermic.

36. Naphthalene, $C_{10}H_8$, is an aromatic compound with the following structure.



Naphthalene
$C_{10}H_8$

It has similar reactions and reactivity as benzene. Which of the following statements is correct?

A. Naphthalene has 12 π electrons.

B. The carbon atoms in naphthalene are sp^2 hybridized.

C. Naphthalene decolourizes bromine at room temperature.

D. There is a total of four aromatic isomers of molecular formula $C_{10}H_6Cl_2$ with the naphthalene ring structure.

37. Chlorofluorocarbons (CFCs) have been widely used in aerosols and making of plastics. They are known to destroy the ozone molecules. Which of the following can be used to replace CFCs as it is least likely to destroy the ozone layer?

A. $CHBr_3$

B. CF_3CF_3

C. CCl_3CBr_3

D. $CHClFCClF_2$

38. After the reaction of nitrobenzene to phenylamine, using tin and concentrated hydrochloric acid, an excess of sodium hydroxide is added. What is the purpose of adding sodium hydroxide?

A. It is used to form the electrophile for the electrophilic substitution reaction.

B. It is added to precipitate the Sn^{2+} as tin(II) hydroxide.

C. It acts as a drying agent to remove water.

D. It is used for neutralization.

39. A burette reading is recorded as 27.70 ± 0.05 cm^3. Which of the following could be the actual value?

I 27.68 cm^3
II 27.78 cm^3
III 27.74 cm^3

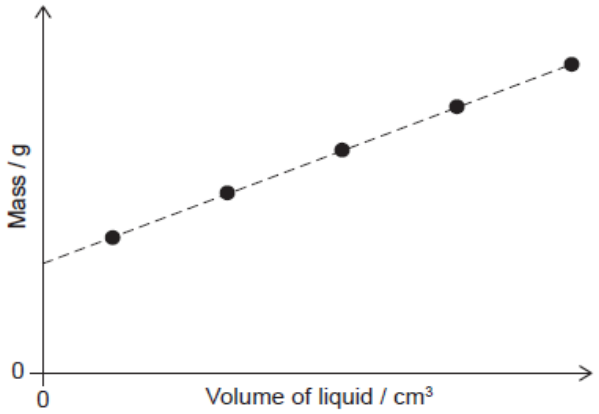
A. I and II only

B. II and III only

C. I and III only

D. I, II and III

40. A liquid was added to a graduated cylinder. What can be deduced from the graph?



	Gradient	y-intercept
A.	Density of liquid	Mass of empty cylinder
B.	Density of liquid	Amount of liquid
C.	Rate of adding liquid	Amount of liquid
D.	Rate of adding liquid	Mass of empty cylinder

End of Paper