XINMIN SECONDARY SCHOOL

新民中学

SEKOLAH MENENGAH XINMIN

Preliminary Examination 2024

CANDIDATE NAME							
CLASS				INDEX NUMBER			

CHEMISTRY 6092/01

Secondary 4 Express **28 August 2024**

Setter: Ms Tiffany Lim
Vetter: Mrs Annie Ng **1 hour**

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, class and index number on the Question Paper and Answer Sheet in the spaces provided.

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

Read the instructions on the Answer Sheet very carefully.

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 printed on page 2.
The use of an approved scientific calculator is expected, where appropriate.

For Examiner's Use	
Total	/40
Parent's Signature	

The Periodic Table of Elements

Group																	
1	2											13	14	15	16	17	18
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24	3	4	5	6	7	8	9	10	11	12	13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

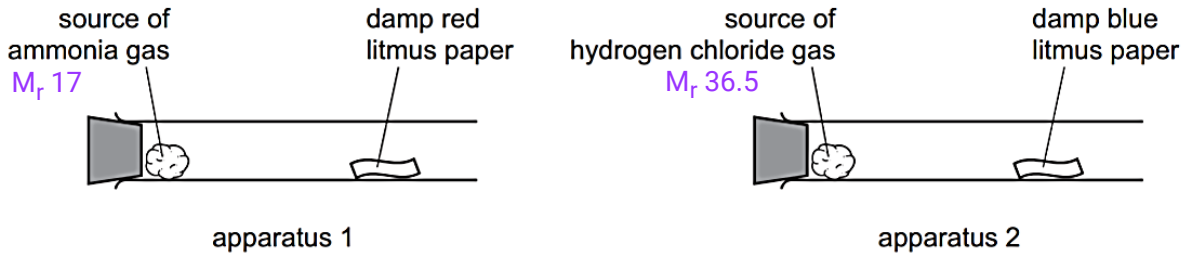
lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

The Avogadro constant, $L = 6.02 \times 10^{23}$ mol^{-1}

1 A student investigated the diffusion of ammonia gas, NH_3, and hydrogen chloride gas, HCl.

Two sets of apparatus were set up as shown below at room temperature and pressure.



The damp red litmus paper in apparatus 1 changed colour after 30 seconds.

How long does it take for the damp blue litmus paper to change colour in apparatus 2?

Heavier M_r, slower rate of diffusion.

In presence of water, HCl (g) dissociates to produce H^+ ions, which turn blue litmus red.

A about 21 seconds

B about 30 seconds

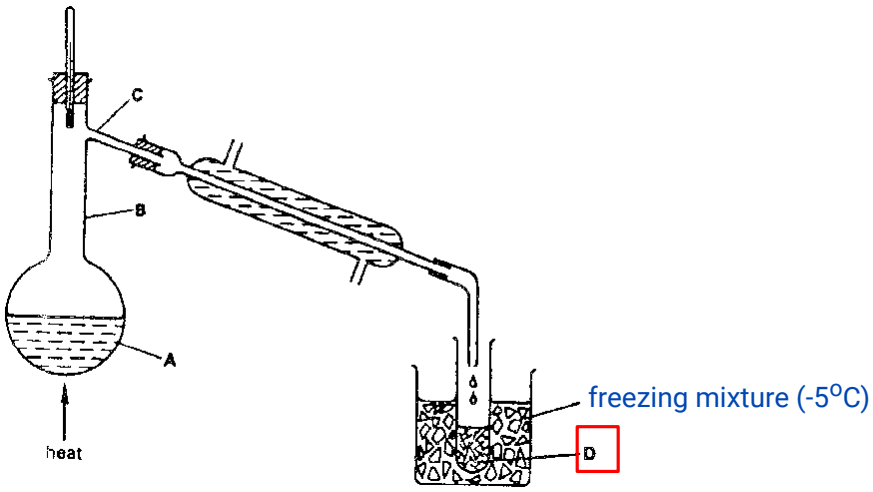
C about 64 seconds

D The blue litmus paper would not change colour.

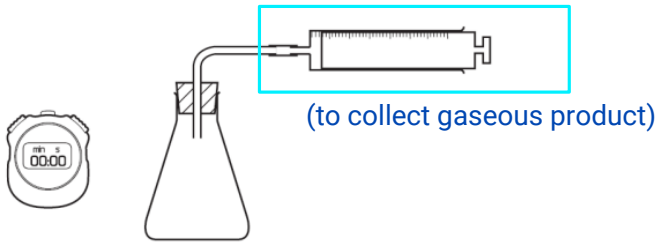
2 Substance X, melts at 10 °C and boils at 50 °C. It can be purified by distillation as shown in the diagram.

At which point will the particles of X be most regularly arranged?

(solid state)



3 A student wishes to follow the rate of a chemical reaction using the apparatus shown below.



Which of the following reactions allows a student to do so?

A $AgNO_3$ + KI

B $CuSO_4$ + NaOH

C HC*l* + Mg

D HC*l* + NaOH

4 Three separation methods are listed below.

1 obtaining water from sodium chloride solution
2 obtaining solid iodine from a mixture of solid iodine and nickel
3 obtaining solid sodium chloride from aqueous sodium chloride

Which techniques would be involved in these separations?

	1	2	3
A	distillation	sublimation	evaporation
B	distillation	sublimation	filtration
C	filtration	crystallisation	evaporation
D	sublimation	crystallisation	filtration

5 Three particles and their nuclide notations are shown.

particle	1	2	3
nuclide notation	$^{40}_{19}X^{+}$	$^{39}_{19}Y$	$^{34}_{16}Z^{2-}$

Which of the following statements is correct about the particles?

A Particle 1 has more electrons than particle 3.

B Particle 1 and 2 have the same number of neutrons.

C Particle 1 and 3 have the same number of electrons.

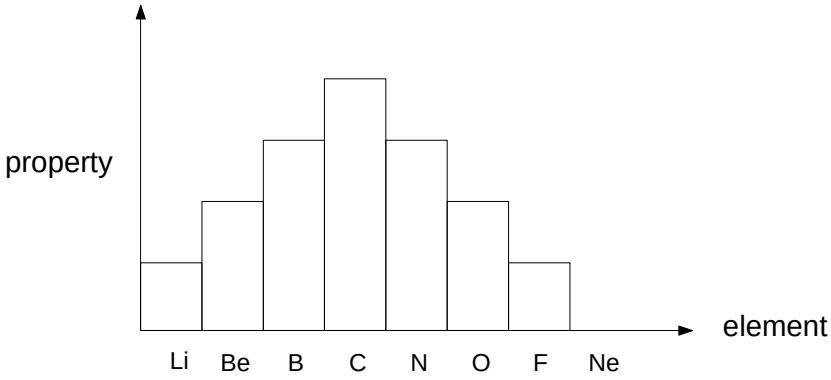
D Particle 2 has fewer neutrons than particle 3.

Particle 1
19p, 21n, 18e

Particle 2
19p, 20n, 19e

Particle 3
16p, 18n, 18e

6 The bar chart shows the period of elements from lithium to neon.



Which property of the elements is shown on the chart?

A number of electron shells

B number of electrons used in bonding

C proton number

D relative atomic mass

7 Three elements W, X, Y, and Z have consecutive, increasing proton (atomic) numbers.

Element Y exists as a colourless, monatomic gas at room temperature.

Which will be the chemical formula of a compound formed between W and chlorine?

Y: Group 18
W: Group16 (non-metal)

A W*Cl*

B W_2Cl

C WCl_2

D W_2Cl_3

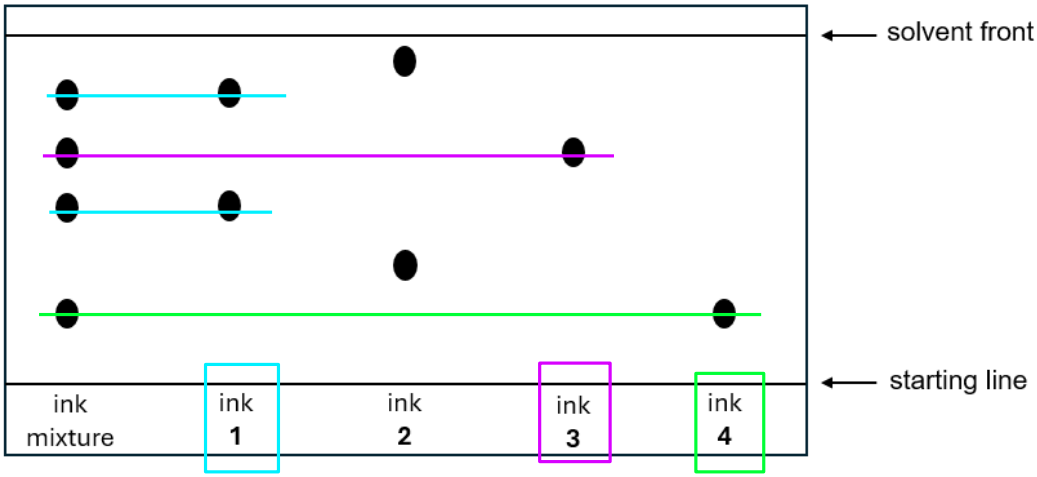
8 The mixtures shown in the table are warmed.

In which mixture does a gas form?

Key: ✓ = gas forms, ✗ = no gas forms

	NH_3 produced NaOH(aq) and $NH_4Cl(s)$	No reaction NaOH(aq) and Mg(s)	No reaction $H_2SO_4(aq)$ and NaCl(s)
A	✓	✓	✗
B	✓	✗	✓
C	✓	✗	✗
D	✗	✗	✓

9 A paper chromatography experiment was carried out to determine the inks present in a mixture, and the results shown below were obtained.



Which statement about the results is **incorrect**?

A Ink 4 is more soluble than ink 3 in the solvent used.

B Inks 1 and 2 contained more than one colour pigment.

C The ink mixture contained inks 1, 3 and 4.

D The R_f value of ink 3 in the solvent used is more than 0.5.

10 An aqueous solution containing two salts is found.

A series of tests is carried out to identify the ions present. The results are shown.

no	description	observations
1	Add dilute nitric acid followed by aqueous barium nitrate.	No effervescence and white precipitate is observed. (presence of sulfate ion)
2a	Add aqueous sodium hydroxide followed by warming.	White precipitate is formed and dissolves in excess sodium hydroxide to form a colourless solution. No effervescence is observed.
2b	Add aluminium foil followed by warming.	Effervescence is observed and gas turns moist red litmus paper blue. (presence of nitrate ion)
3	Add aqueous ammonia.	White precipitate is formed. The mass of the white precipitate decreases by half when excess ammonia is added.

Which of the following salts are present in the aqueous solution?

A zinc sulfate and aluminium nitrate

B zinc sulfate and calcium nitrate

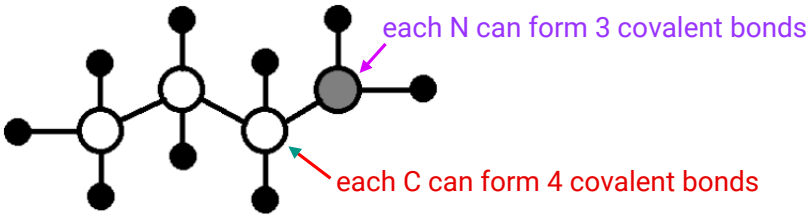
C ammonium chloride and aluminium sulfate

D calcium chloride and ammonium sulfate

Zn^{2+} : white ppt, dissolves in excess NH_3 (aq), producing colourless solution

Al^{3+} : white ppt, insoluble in excess NH_3 (aq)

11 The structure of a molecule of a compound containing carbon, nitrogen and hydrogen is shown below.

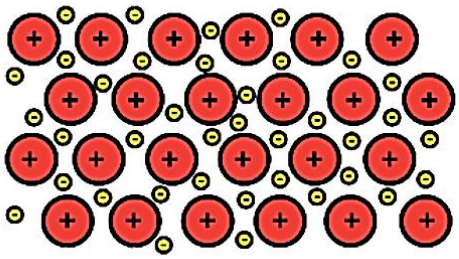


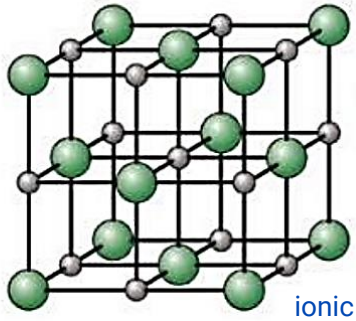
What is the molecular formula of this compound?

A CN_3H_7 **B** CN_3H_9 **C** C_3H_7N **D** C_3H_9N

12 The structures of two materials are shown below.

metallic structure





ionic (crystal) lattice

Which statement is correct?

A Both substances are hard and rigid. (metals are malleable)

B Both substances are pure compounds. (metals are NOT compounds)

C Both substances can conduct electricity in the solid state. (ionic compounds do not conduct electricity as a solid)

D Both substances contain particles held together by strong electrostatic forces of attraction.

13 On adding 50 g of impure limestone, $CaCO_3$ (*Mr* = 100), to excess hydrochloric acid, 6.0 dm^3 of CO_2 was evolved at room temperature and pressure.

What is the percentage purity of the limestone?

A 25% **B** 50% **C** 75% **D** 100%

moles, CO_2 = 6/24 = 0.25 mole

mole ratio CO_2 : $CaCO_3$ = 1 : 1

mass, $CaCO_3$ = 0.25 mole x 100 g/mol = 25g

%purity = (25/50) X 100% = 50%

14 Hydrogen gas reacts with chlorine gas to form hydrogen chloride gas.

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$$

(10 dm^3 excess)

What is the final volume of the gas mixture when 20 dm^3 of hydrogen is reacted with 30 dm^3 of chlorine gas at 100 °C?

(20 dm^3 H_2 needs only 20 dm^3 Cl_2)

A 40 dm^3 **B** 50 dm^3 **C** 60 dm^3 **D** 70 dm^3

mole ratio H_2 (g) : HCl (g) = 1:2 volume of HCl (g) produced = 40 dm^3

volume of gas mixture = 40 dm^3 HCl (g) + 10 dm^3 excess Cl_2 (g)

15 Ammonia and excess carbon dioxide can react to form urea and water in a reaction.

$$2NH_3 + CO_2 \longrightarrow CON_2H_4 + H_2O$$

The percentage yield of this reaction is 80 %.

80% of yield = 60.0g

100% of yield = 75.0g

What is the mass of ammonia required for this reaction to obtain 60.0 g of urea?

[M_r: NH_3, 17; CO_2, 44; CON_2H_4, 60; H_2O, 18]

A 10.6 g **B** 27.2 g **C** 34.0 g **D** 42.5 g

mole ratio NH_3 : urea = 2 : 1

mass, NH_3 required = 2 x [75/M_r of urea] x [M_r of ammonia] = 42.5g

16 Aqueous sodium hydroxide reacts with the solution of a certain metal chloride MCl_x, to form a precipitate of the metal hydroxide according to the following equation.

$$MCl_x + x\text{NaOH} \rightarrow M(OH)_x + x\text{NaCl}$$

(0.03 mole NaOH) (0.015 mole MCl_x)

10.0 cm^3 of 3.0 mol/dm^3 sodium hydroxide solution reacts exactly with 10.0 cm^3 of 1.5 mol/dm^3 MCl_x solution.

What is the formula of the metal chloride?

A MCl **B** MCl_2 **C** MCl_3 **D** MCl_4

(amphoteric oxide - lead(II) oxide, aluminium oxide, zinc oxide)

17 In which equation does the metal oxide act as an acidic oxide?

(reacts with base/alkali to produce salt and water)

A K_2O (s) + H_2O (l) → 2KOH (aq)

B Fe_2O_3 (g) + 3CO (g) → 2Fe (s) + $3CO_2$ (g)

C Al_2O_3 (s) + 6HCl (aq) → 2$AlCl_3$ (aq) + $3H_2O$ (l)

D PbO (s) + H_2O (l) + OH^- (aq) → $Pb(OH)_3^-$ (aq)

OH^- = alkali

18 The table below shows the range of colours of an indicator at different pH values.

pH	colour
0 – 2.5	red
2.6 – 5.0	yellow
5.1 – 7.0	orange
7.1 – 14.0	green

Which pair of substances can be distinguished using the indicator above?

A aqueous ammonia and aqueous potassium hydroxide

B dilute hydrochloric acid and dilute sulfuric acid

C dilute hydrochloric acid and water

D water and aqueous potassium chloride

19 During an electrolysis experiment, the same amount of charge deposited 32.5 g of zinc and 10.2 g of vanadium.

What was the charge on the vanadium ion?

0.5 mole

$Zn^{2+} + 2e^- \rightarrow Zn$

1 mole of Zn needed 2 moles of e^-

0.5 mole of Zn means 1 mole of e^- in circuit.

0.2 mole

A 2+ **B** 3+ **C** 4+ **D** 5+

1 mole of e^- in circuit only deposits 0.2 mole V

Hence charge of V ion = 1/0.2 = +5

20 Three electrolysis cells are set up. Each cell has platinum electrodes.

(inert electrodes)

cell 1:

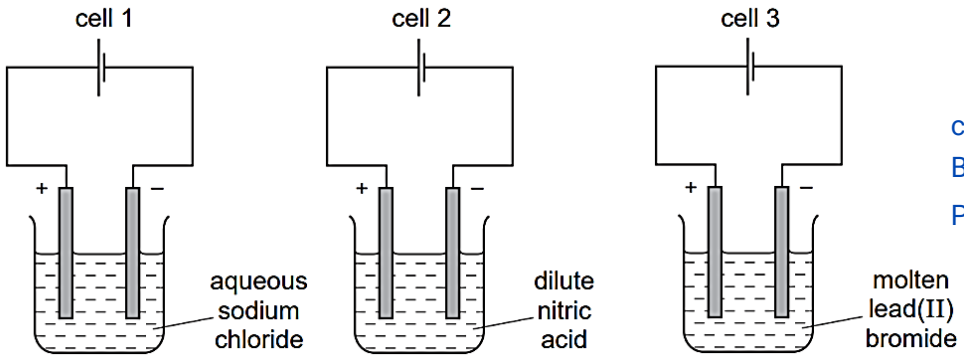
H_2 (g) at cathode

O_2 (g) at anode

cell 2:

H_2 (g) at cathode

O_2 (g) at anode



cell 3:

Br_2 (g) at anode

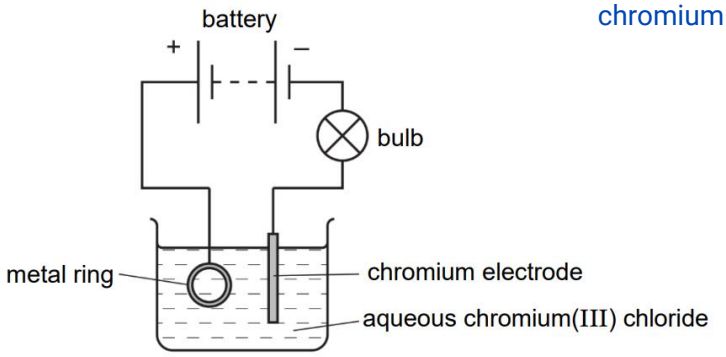
Pb (l) at cathode

In which of these cells is a gas formed at both electrodes?

A 1 and 2 **B** 1 and 3 **C** 2 only **D** 3 only

21 The diagram shows the apparatus used in an attempt to electroplate a metal ring with chromium.

metal ring at cathode
chromium at anode



The experiment did not work.

Which change is needed in the experiment to make it work?

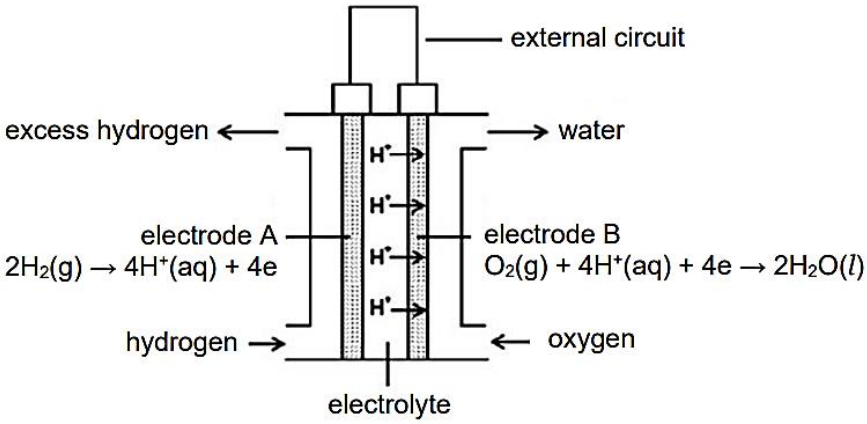
A add solid chromium(III) chloride to the electrolyte

B increase size of the chromium electrode

C increase the temperature of the electrolyte

D switch the ring and the chromium electrode

22 The hydrogen-oxygen fuel cell generates electricity under a continuous supply of hydrogen gas and oxygen gas, as shown in the diagram.

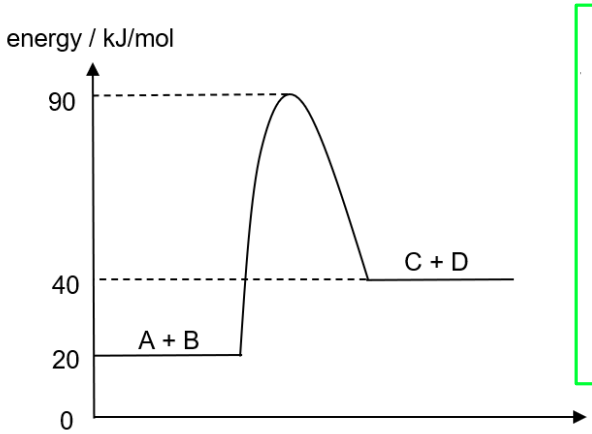


Which of the following correctly shows the direction of electron flow and a suitable electrolyte which can be used in the fuel cell?

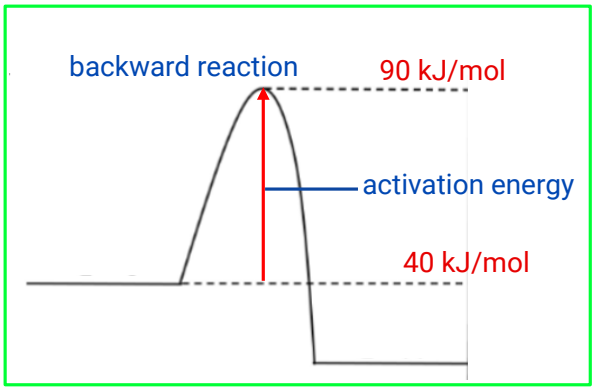
	direction of electron flow	electrolyte
A	from electrode A to B	aqueous sodium hydroxide
B	from electrode B to A	aqueous sodium hydroxide
C	from electrode A to B	dilute sulfuric acid
D	from electrode B to A	dilute sulfuric acid

23 The energy profile diagram of a reversible reaction is shown below.

$A + B \rightleftharpoons C + D$



(working)



What is the value of the activation energy for the backward reaction?

A 20 kJ/mol **B** 50 kJ/mol **C** 70 kJ/mol **D** 90 kJ/mol

24 In which equation is the sign of enthalpy, ΔH, correctly shown?

	equation	ΔH
A	$2AgCl(s) \rightarrow 2Ag(s) + Cl_2(g)$ decomposition, endo (+)	positive
B	$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$ combustion, **exo (-)**	positive
C	$H_2(g) \rightarrow 2H(g)$ bond breaking, **endo (+)**	negative
D	$H_2O(s) \rightarrow H_2O(l)$ melting, **endo (+)**	negative

25 Which equations below represent redox reactions?

1 $H^+ + OH^- \rightarrow H_2O$ (neutralisation, NOT redox)

2 $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$

3 $Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$

A 1 only

B 3 only

C 1 and 2 only

D 2 and 3 only

KI = RA. In OA, KI will turn from colourless to brown.
$KMnO_4$ = OA. In RA, $KMnO_4$ will turn from purple to colourless.

26 Small portions of aqueous potassium iodide and acidified aqueous potassium manganate(VII) were added to four different solutions.

The colour changes seen are shown in the table.

solution number	aqueous potassium iodide	acidified potassium manganate(VII)
1	colourless to brown	purple to colourless
2	colourless to brown	no change observed
3	no change observed	purple to colourless
4	no change observed	no change observed

Which solution(s) contained an oxidising agent?

A 2 only **B** 1 and 2 **C** 1 and 3 **D** 3 and 4

27 Antacid tablets neutralise acids. A student investigated the time taken for an antacid tablet to react completely with excess hydrochloric acid under different conditions. The table below shows the results.

experiment number	volume of acid / cm^3	concentration of acid / mol dm^{-3}	temperature of acid / ^oC	reaction time / s
1	50	1.00	25.0	132
2	50	2.00	25.0	65
3	100	2.00	25.0	65
4	50	2.00	35.0	33

What does the experiment show?

A Increasing the concentration of acid will increase the rate of reaction. (REF: expt 1 & 2. **TRUE**)

B Increasing the temperature of the reaction does not affect the rate of reaction. (REF; expt 2 & 4)

C Increasing the volume of acid will decrease the rate of reaction. (REF: expt 2 & 3)

D The addition of a catalyst will increase the rate of reaction. (no expt to support)

28 A student has five reagents.

- dilute hydrochloric acid
- dilute sulfuric acid
- dilute nitric acid
- solid calcium carbonate
- solid copper(II) carbonate

All **nitrates** are soluble.
All chlorides are soluble except lead(II) chloride, silver chloride.
All sulfates are soluble except lead(II) sulfate, barium sulfate and calcium sulfate.

Salts produced (soluble ones in **bold**):
$CaCl_2$, **$CuCl_2$** , $CaSO_4$, **$CuSO_4$** , **$Ca(NO_3)_2$**, **$Cu(NO_3)_2$**

How many soluble salts can be prepared?

A 3 **B** 4 **C** 5 **D** 6

29 The table below gives some information about four metals P, Q, R and S.

P more reactive than Q

metal	reaction with cold water	reaction with acids	action of heat on carbonate of metal
P	reacts vigorously	reacts vigorously	decomposes to metal oxide
Q	no reaction	reacts moderately	decomposes to metal oxide
R	reacts vigorously	reacts vigorously	no visible reaction
S	no reaction	no reaction	decomposes to metal

What is the order of reactivity of the four metals?

carbonates of reactive metals are thermally stable (i.e. DO NOT DECOMPOSE when heated)

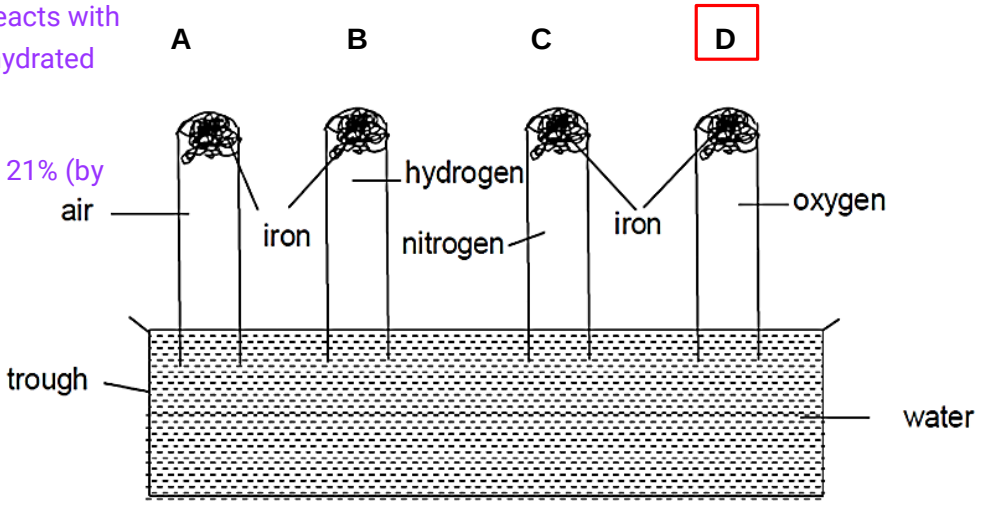
	most reactive → least reactive			
A	P	R	Q	S
B	R	P	Q	S
C	R	Q	P	S
D	S	Q	P	R

30 An experiment was set up as shown in the diagram below.

Which tube will have the highest water level after one month?

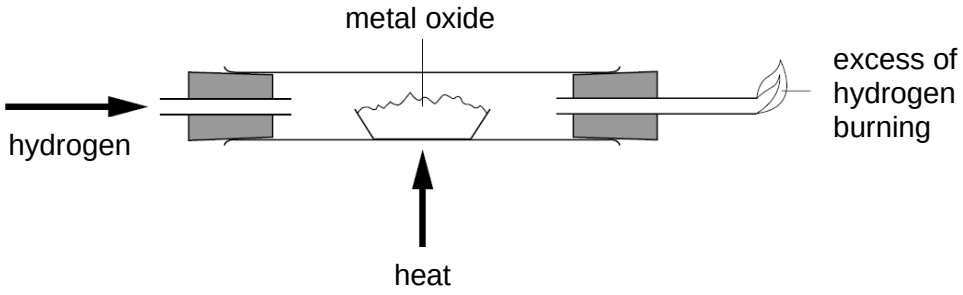
Set up illustrates process of rusting. Rusting occurs when iron reacts with **water and oxygen** to form hydrated iron(III) oxide (rust).

Not (A) as air only contains 21% (by volume) oxygen gas.



(does not occur for metals above **zinc** in reactivity series)

31 The experimental set-up below shows the reduction of a metal oxide by hydrogen.



Which of the following oxides cannot be reduced by the method shown above?

A AgO **B** FeO **C** PbO **D** ZnO

32 Elements X, Y and Z are in the same period of the Periodic Table.

Gaseous X exists as diatomic molecules.
Oxides of Y react with both acid and alkali.
Oxides of Z dissolve in water to form solution with pH > 7.

In which order do the elements appear in the Periodic Table?

A X → Y → Z

B Y → X → Z

C Z → X → Y

D Z → Y → X

X - to **right** of Periodic Table, could be Group 17, or oxygen
Y - metalloid, in **middle** of Periodic Table
Z - oxide is basic (pH > 7), hence Z is a metal, on **left** of Periodic Table

33 In the equation shown, X and Y represent elements in Group 17 of the Periodic Table.

$$X_2(aq) + 2NaY(aq) \rightarrow Y_2(aq) + 2NaX(aq)$$

Halogen X_2 displaces halogen Y_2 from its salt (NaY).
X is more reactive than Y.

Reactivity of halogens decreases down the group.
X must be above Y in Group 17.

	X	Y
1	iodine	chlorine
2	bromine	iodine
3	chlorine	bromine
4	bromine	chlorine

Which pair of elements could be X and Y?

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

34 How many of the following processes will lead to an increase in greenhouse gas emissions?

(produces methane) (produces carbon dioxide) — methane, carbon dioxide

decomposition of vegetation	fermentation of glucose	photosynthesis
polymerisation	respiration	neutralisation

A 1 **B** 2 **C** 3 **D** 4

35 Which of the following statements about a homologous series is correct?

A The melting and boiling point increases with increasing relative molecular mass.

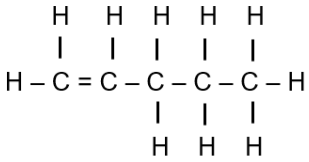
B The members have similar physical properties. (down series, **gradual change** in physical properties)

C The members have the same molecular formula. (same **general** formula)

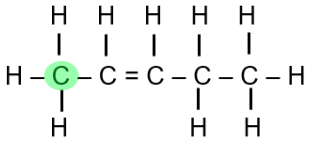
D The relative molecular masses of consecutive members differ by 12. (differs by CH_2, mass diff **14**)

36 How many different isomers of C_5H_{10} are shown below?

structure 1

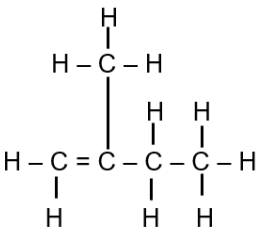


structure 2

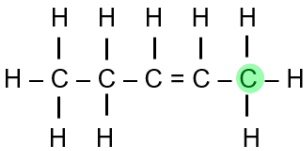


reflect laterally

structure 3



structure 4



Structures 2 and 4 are of the same isomer.

A 0 **B** 2 **C** 3 **D** 4

37 When crude oil is fractionally distilled, which list best describes the mixture of compounds collected at the bottom of the fractionating column? (heavier, high(est) bp, very viscous)

A Short chain molecules, low viscosity, high flammability

B Short chain molecules, low boiling point, low flammability

C Long chain molecules, high flammability, high boiling point

D Long chain molecules, high viscosity, high boiling point

38 The following chemicals are available in the laboratory.

1 aqueous bromine → decolourises in unsaturated hydrocarbon

2 Universal Indicator solution → alkenes are neutral compounds

3 magnesium powder → acid + metal -> salt + H_2 (g)

4 sodium carbonate → acid + carbonate -> salt + H_2O + CO_2 (g)

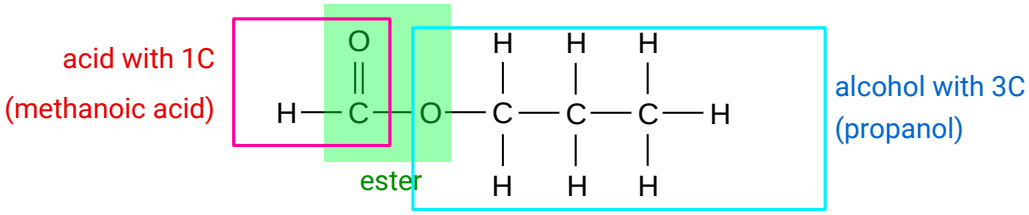
propene = **un**saturated, hydrocarbon

propanoic acid = carboxylic **acid**

Which of these chemicals can be used to distinguish between propene and propanoic acid?

A All of them **B** 1 only **C** 1 and 4 only **D** 1, 2 and 3 only

39 The structure of a compound associated with the smell of raspberries is shown below.



Which reactants are suitable for synthesising the above compound in the laboratory?

A butanol and methanoic acid

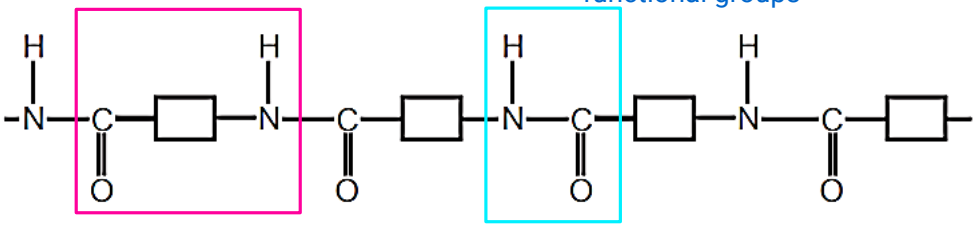
B methanol and butanoic acid

C methanol and propanoic acid

D propanol and methanoic acid

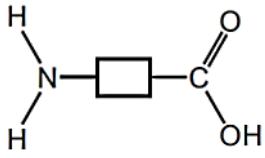
40 The partial structure of a polymer is shown below.

amide linkage, made from **-NH_2** and **-COOH** functional groups

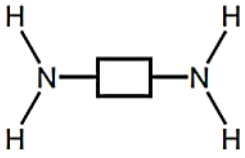


Which monomers would form the above polymer?

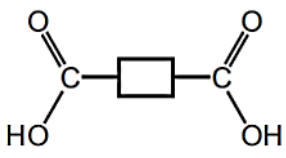
1



2



3



A 1 only **B** 1 and 2 only **C** 2 and 3 only **D** 1, 2 and 3

End of Paper