Name: _____( ) Class: 306

CHIJ KATONG CONVENT

END-OF-YEAR EXAMINATIONS 2016

Secondary Three Express

CHEMISTRY (WITH SPA)

5073

Duration: 2 hour 15 minutes

Class: 306

Additional materials: Optical Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your name, registration number and class on all the work you hand in.
You may use a soft pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid/ tape.
The use of an approved scientific calculator is expected, where appropriate.

Section A
Answer **all** questions.
Indicate your answers on the Optical Answer Sheet provided.

Section B
Answer **all** questions.
Write your answers in the spaces provided.

Section C
Answer **all** questions.
Write your answers in the spaces provided.

At the end of the examination, hand in:
(a) Optical Answer Sheet;
(b) Section A question paper;
(c) Section B;
(d) Section C **separately**.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 21.

FOR EXAMINER'S USE	
Section A	/ 20
Section B	/ 50
Section C	/ 30
TOTAL	/ 100

This question paper consists of 21 printed pages.

Name:_____( ) Class: 306

Section A [20 marks]

Answer **all** the questions in this section.
Indicate your answers on the Optical Answer Sheet provided.

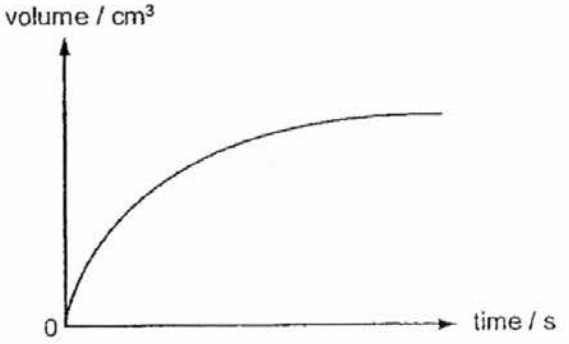
1 The rate of diffusion of soluble substances X (M_r = 59.5) and Y (M_r = 160) in water at 25 °C and 50 °C were compared.

Which substance would have the fastest rate of diffusion?

A solid X at 25 °C
B solid X at 50 °C
C solid Y at 25 °C
D solid Y at 50 °C

2 A student measured the rate of reaction between calcium carbonate and dilute hydrochloric acid.

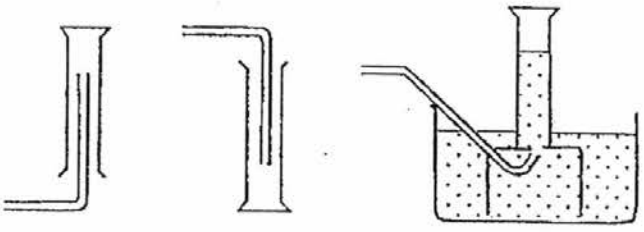
A graph showing the volume of gas produced against time is shown.



Which apparatus were used to measure the variables shown on the graph?

A burette and pipette
B gas syringe and stopwatch
C mass balance and gas syringe
D pipette and stopwatch

3 The diagrams show three methods of collecting gases.



I II III

Ammonia gas is highly soluble in water and has a low density.

Which method(s) is/ are suitable for collecting ammonia gas?

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

4 The boiling point of solid X is 948 °C and it is soluble in water.

What is the most likely boiling point of water if it contains a small quantity of X?

A 98 °C
B 102 °C
C 946 °C
D 950 °C

5 Which set of substances contains an element, a compound and a mixture?

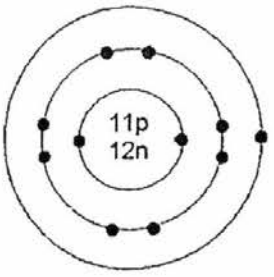
A carbon dioxide, steel, graphite
B dry air, tap water, petrol
C ethanol, crude oil, steel
D iodine, copper, ice

6 Some brown powder is placed in a test tube. After water is added, the test tube is shaken and the contents are then filtered. A black solid is left on the filter paper. After evaporating the filtrate, orange crystals are left behind.

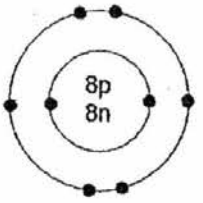
What do these observations suggest?

A The black solid is an element.
B The brown powder is a compound.
C The brown powder is a mixture.
D The orange crystals is a mixture.

7 The diagrams show the structures of the atoms of two elements, P and Q.



P



Q

What is the relative molecular mass of the compound formed when these two elements combine?

A 24
B 40
C 55
D 62

8 Antimony oxide has the formula Sb_2O_3 while sodium phosphate has the formula Na_3PO_4.

What is the formula of antimony phosphate?

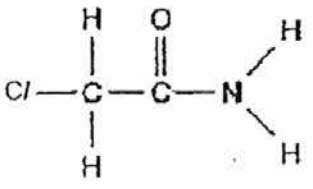
A $SbPO_4$
B Sb_2PO_4
C $Sb_2(PO_4)_3$
D Sb_3PO_4

9 The elements L, M and N in the Periodic Table have consecutive increasing atomic numbers.

Given element N is a noble gas, which is the symbol for the ion of element L?

A L^+
B L^{2+}
C L^-
D L^{2-}

10 The diagram shows the structure of a molecule.



How many valence electrons of the atoms are not used in covalent bonding?

A 6
B 8
C 10
D 12

11 Element X reacts with dilute hydrochloric acid to form a salt and hydrogen gas.

Which types of bonding are present in element X and the salt produced?

	type of bonding	
	element X	salt produced
A	covalent	covalent
B	covalent	ionic
C	metallic	covalent
D	metallic	ionic

12 What is the number of aluminium ions, Al^{3+}, present in 0.3 moles of aluminium oxide, Al_2O_3?

A 1.8×10^{23}
B 3.6×10^{23}
C 5.4×10^{23}
D 3.0×10^{24}

13 The table gives information about three indicators.

indicator	colour at pH 1	pH at which colour changes	colour at pH 12
congo red	blue	5	red
phenolphthalein	colourless	10	red
thymol blue	red	3	yellow

Which set of colours would be obtained when each indicator was added separately to distilled water?

	congo red	phenolphthalein	thymol blue
A	blue	colourless	yellow
B	blue	red	red
C	red	colourless	red
D	red	colourless	yellow

14 The pH of an aqueous solution of hydrochloric acid is 2.

What will be the pH of the acid after the addition of 10 g of sodium chloride?

A pH 1
B pH 2
C pH 7
D pH 9

15 Which pair of salts can be prepared using the same method?

A aluminium sulfate and ammonium sulfate
B barium sulfate and barium chloride
C calcium nitrate and copper(II) chloride
D lead(II) chloride and zinc sulfate

16 The equation shows the reaction between $X(OH)_2$ and sulfuric acid.

$$X(OH)_2(s) + H_2SO_4(aq) \rightarrow XSO_4(aq) + 2H_2O(l)$$

Which metal could X be?

A barium
B calcium
C lead
D magnesium

17 Which statement explains why aluminium is a better conductor of electricity than magnesium?

A Aluminium has a higher density than magnesium.
B Aluminium has a higher melting point than magnesium.
C Aluminium has more free electrons than the same number of atoms of magnesium.
D Auminium has more mobile ions than the same number of atoms of magnesium.

18 X, Y and Z are metals. Red hot carbon will reduce both the oxides of X and Y but not the oxide of Z. The metal Y can remove the oxygen from the oxide of metal X.

Which option shows the order of increasing reactivity for the three metals?

A X, Y, Z
B X, Z, Y
C Z, X, Y
D Z, Y, X

19 L, M, N are three elements found in the third period of the Periodic Table. The properties of their oxides are shown in the table.

oxides	properties
oxide of L	forms a salt with aqueous sodium hydroxide
oxide of M	soluble in hydrochloric acid but insoluble in aqueous sodium hydroxide
oxide of N	soluble in hydrochloric acid and sodium hydroxide

Which option shows the order of decreasing proton numbers for the three elements?

A L, M, N
B L, N, M
C M, N, L
D N, M, L

20 A new element with the chemical symbol Jj has been discovered. An atom of Jj has seven valence electrons.

Which statements best describe the properties of Jj?

I It conducts electricity.
II It exists as diatomic molecules.
III It forms positive ions with the chemical symbol Jj^+.
IV It forms a covalent compound with hydrogen.

A I and II only
B II and III only
C II and IV only
D III and IV only

Section B [50 marks]

Answer **all** the questions in this section.
Write your answers in the spaces provided.

21 In the Olympic games, athletes are chosen at random to undergo drug tests. The athlete's urine sample was tested against known drugs that are banned using paper chromatography. In an investigation, an athlete's urine, sample U, is tested against three known drugs X, Y and Z.

The first test is done using water as the solvent. The result is shown in Fig. 21.1. The second test is carried out using hexane as the solvent. The result is shown in Fig. 21.2.

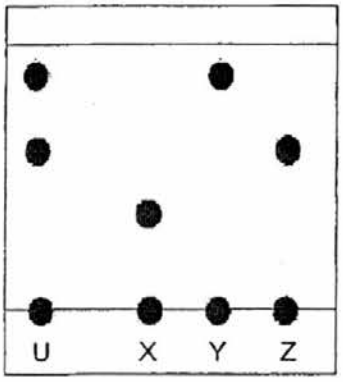


Fig. 21.1

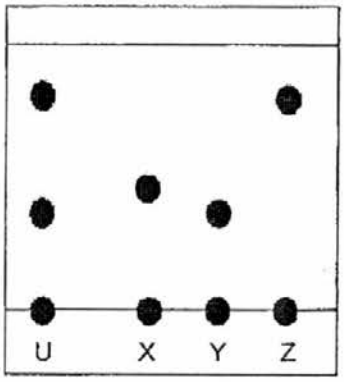


Fig. 21.2

(a) With reference to Fig. 21.1 and 21.2, state and explain if the athlete consumed the banned drugs.

.....

..... [1]

(b) Explain why the spots on the two chromatograms are at different positions even though the urine sample U and the known drugs used are the same.

.....

..... [1]

(c) State and explain a precaution that should be taken to ensure proper separation will take place on the paper chromatogram.

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..... [2]

21 (d) The experiment was repeated, using 2-methylphenol as the solvent. Drug X produces a spot which has a R_f value of 0.45. Drug Y produces a spot which is 1 cm further from spot X as measured from the baseline. Drug Y has a R_f value of 0.55.

Calculate the distance travelled by drug Y and the distance travelled by the solvent respectively.

[2]

[Total: 6]

22 Two isotopes of sulfur are $^{32}_{16}S$ and $^{33}_{16}S$.

(a) Define *isotopes*.

.....

..... [1]

(b) Complete the table for $^{33}_{16}S$.

number of neutrons	
number of protons	
electronic configuration	

[3]

(c) Sulfur forms simple molecules which have a relative molecular mass of 256.

Suggest the formula of a sulfur molecule.

..... [1]

(d) (i) Explain why sulfur has a low melting point.

.....

..... [1]

(ii) Explain why sulfur does not conduct electricity.

.....

..... [1]

22 **(e)** Sulfur reacts with sodium to form sodium sulfide.

Write the formula and the electronic configuration of the positive and negative ions in sodium sulfide.

positive ion:

formula ..... and electronic configuration ..... [1]

negative ion:

formula ..... and electronic configuration ..... [1]

(f) Sulfur reacts with hydrogen to form hydrogen sulfide, H_2S.

Draw the 'dot and cross' diagram to show the bonding in hydrogen sulfide. Show only the valence electrons.

[2]

[Total: 11]

23 Ammonium nitrate is commonly used as a fertiliser. When heated, ammonium nitrate decomposes into nitrous oxide and water vapour.

$$NH_4NO_3(s) \rightarrow N_2O(g) + 2H_2O(g)$$

(a) 4.0 g of ammonium nitrate was heated.

Calculate the total volume of gases produced, measured at room temperature and pressure.

[2]

23 **(b)** Another compound can also be used as a fertiliser.

This fertiliser has the following composition by mass.

element	percentage/ %
Ca	17.1
H	1.7
P	26.5
O	54.7

(i) Calculate the empirical formula of this compound.

[3]

(ii) Suggest the formula of the anion present in the fertiliser.

..... [1]

(c) Describe how a pure and dry sample of ammonium nitrate crystals can be prepared from aqueous ammonia and dilute nitric acid.

.....

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.....

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..... [6]

[Total: 12]

24 Weak acids dissociate according to the general equation:

$$HA \rightleftharpoons H^+ + A^-$$

where HA is the undissociated acid molecule, H^+ is hydrogen ion and A^- is the anion from the acid.

The strength of a weak acid is determined by the extent of the molecule dissociating. The acid dissociation constant (K_a) measures the strength of an acid in a solution using the following equation:

$$K_a = \text{concentration of } H^+ \times \frac{\text{concentration of } A^-}{\text{concentration of HA}}$$

Table 24.1 shows the K_a values of some common weak acids.

Table 24.1

acid	K_a
formic acid, HCOOH	1.78×10^{-4}
acetic acid, CH_3COOH	1.74×10^{-5}
lactic acid, $CH_3CH(OH)COOH$	1.38×10^{-4}

(a) Explain what is meant by a *weak acid.*

.....

..... [1]

(b) Based on the equation given and the information in Table 24.1, state which of the acids is the weakest. Explain your answer.

.....

.....

..... [2]

(c) Using the kinetic particle theory, state and explain how the K_a value of a weak acid changes with temperature.

.....

.....

.....

.....

..... [3]

[Total: 6]

25 Cement comprises a mixture of quicklime, clay, calcium sulfate and other mineral additives. Table 25.1 shows the typical constituents of a type of cement know as Portland cement.

Table 25.1

constituents of cement	mass / %
calcium oxide	64
silicon dioxide	22
aluminium(III) oxide	6
iron(III) oxide	4.5
calcium sulfate	3.5

(a) Workers are advised to wear protective coverings when handling the wet cement to prevent damage to their skin.

Using the information given in Table 25.1, suggest the kind of damage that can occur. Explain your answer.

.....

.....

.....

..... [3]

(b) The main raw material used to manufacture Portland cement is limestone. It is ground and heated strongly in a kiln together with small amounts of other minerals.

Explain the purpose of using limestone as a raw material.

.....

.....

..... [2]

(c) (i) In a naturally occurring process, silicon dioxide reacts with water to form a weak acid called silicic acid, H_4SiO_4. This causes an alkali-silica reaction (ASR) to occur over time in concrete. During the reaction, a crystalline salt, CaH_2SiO_4, formed from the reaction between silicic acid and the basic cement expands as it absorbs water. This exerts a great outward pressure from the inside of the concrete and causes it to crack.

State the name of the alkali involved in the ASR.

..... [1]

(ii) Write a balanced chemical equation, with state symbols, for the formation of the crystalline salt.

..... [2]

[Total: 8]

26 The first ionization energy is defined as the energy required to remove the most loosely bound electron in an atom to form an ion with a +1 charge. Table 26.1 shows the first ionisation energy for the elements in Group I.

Table 26.1

element	ionisation energy/ MJ mol^{-1}
lithium	0.526
sodium	0.502
potassium	0.425
rubidium	0.409
francium	0.382

(a) Describe and explain the trend in the first ionisation energy down Group I.

.....

.....

.....

.....

.....

..... [3]

(b) Describe the relationship between the first ionisation energy and the reactivity of Group I metals.

.....

..... [1]

(c) Predict the general trend of first ionisation energy for the elements across Period 2. Explain your answer.

.....

.....

.....

.....

.....

..... [3]

[Total: 7]

Name:_____( ) Class: 306

Section C [30 marks]

Answer **all** the questions in this section.
Write your answers on the lined paper provided.

27 **(a)** Silicon carbide has been mass produced since 1893 for its use in the manufacturing industry. Fig. 27.1 shows part of the structure of silicon carbide.

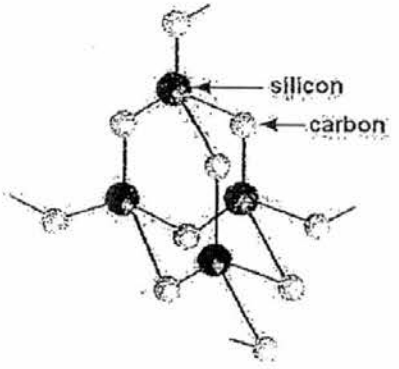

Fig. 27.1

(i) Based on the structure shown in Fig. 27.1, state and explain one physical property that allows silicon carbide to be used as ceramic plates in bulletproof vests.

.....

.....

.....

.....

.....

..... [3]

(ii) Predict the electrical conductivity of silicon carbide. Explain your answer.

.....

.....

.....

..... [2]

27 **(b)** Part of the structure of palladium chloride is shown in Fig. 27.2.

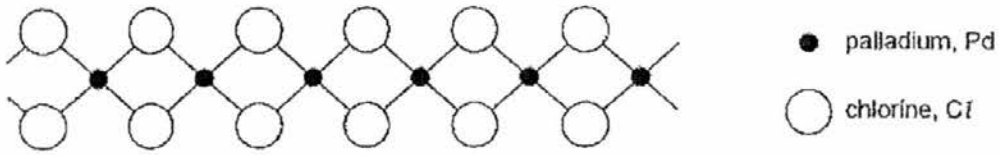

Fig. 27.2

(i) Deduce the empirical formula for palladium chloride.

..... [1]

(ii) Using your answer in **(b)(i)**, draw a 'dot and cross' diagram to show the bonding in palladium chloride. Show only the valence electrons.

[2]

(iii) Would you expect palladium chloride to have a high or low melting point? Explain your answer.

.....

.....

.....

..... [2]

[Total: 10]

28 **(a)** The relative atomic mass of magnesium can be determined in the laboratory by finding the volume of hydrogen gas given off when magnesium reacts with hydrochloric acid.

$$Mg + 2HCl \rightarrow MgCl_2 + H_2$$

0.036 g of magnesium reacts at room temperature and pressure with excess hydrochloric acid to produce 36 cm^3 of hydrogen.

(i) Write the ionic equation for the reaction between magnesium and hydrochloric acid.

..... [1]

(ii) Show by calculation that the relative atomic mass of magnesium is 24.

[2]

(b) Magnesium reacts with oxygen in air to produce magnesium oxide.

$$2Mg + O_2 \rightarrow 2MgO$$

Given that the yield of the reaction is 65%, calculate the mass of magnesium oxide formed when 12 kg of magnesium burns in excess air.

[2]

28 (c) Aqueous potassium hydroxide, of concentration 0.150 mol/dm^3, is added to 25.0 cm^3 of sulfuric in a flask.

Fig. 28.1 shows how the pH of the mixture in the flask changes as aqueous potassium hydroxide is added to it.

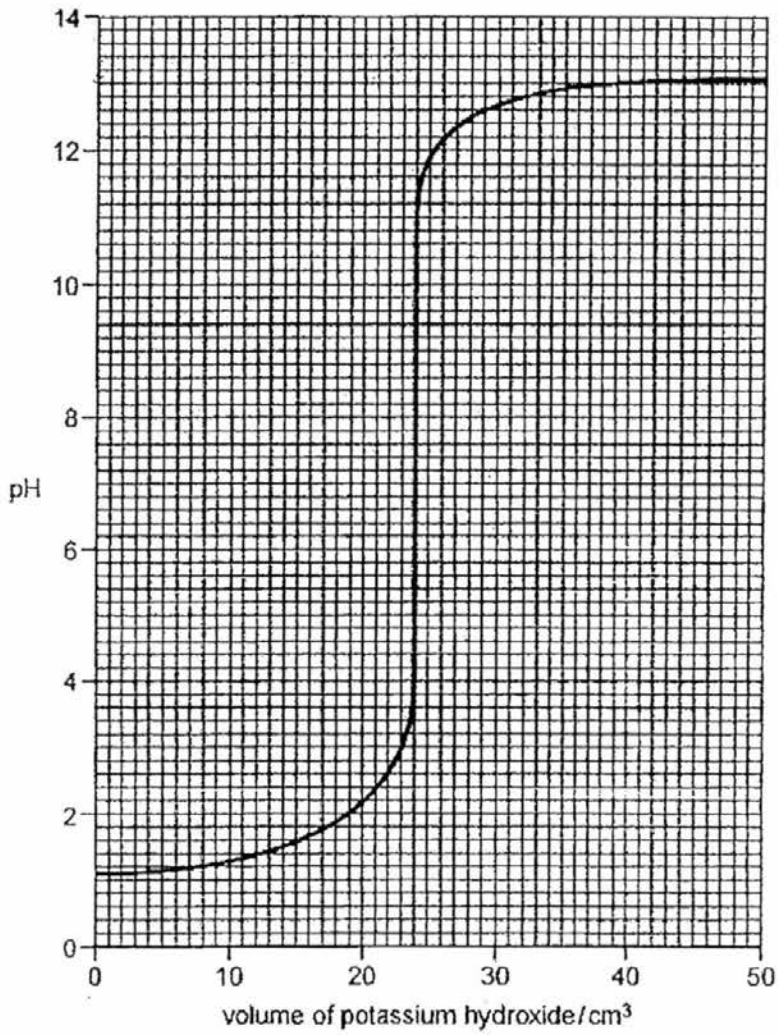

Fig. 28.1

(i) Using Fig. 28.1, deduce the volume of aqueous potassium hydroxide required to neutralise 25.0 cm^3 of sulfuric acid.

..... [1]

28 (c) (ii) Calculate the concentration of the sulfuric acid used used for the neutralisation reaction.

[2]

(iii) The experiment was repeated using nitric acid instead of sulfuric acid.

Would you expect a change in the volume of aqueous potassium hydroxide required to neutralise the nitric acid? Explain your answer.

.....

.....

.....

..... [2]

[Total: 10]

29 Aluminium and iron are both pure metals.

Iron rust in the presence of oxygen and water. Rusting involves a series of reactions.

Initially, iron atoms lose electrons to form iron(II) ions.

$$Fe(s) \rightarrow Fe^{2+}(aq) + 2e^-$$

At the same time, oxygen and water molecules react to form hydroxide ions.

$$O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-(aq)$$

Iron(II) ions then react with hydroxide ions to form solid iron(II) hydroxide. Finally, the iron(II) hydroxide is oxidised to give hydrated iron(III) hydroxide (rust).

(a) (i) Write the ionic equation for the reaction between iron(II) ions and hydroxide ions.

..... [1]

(ii) Explain why aluminium does not corrode even though it undergoes a series of reactions similar to that of iron when exposed to oxygen and water.

.....

..... [1]

29 **(b)** Table 29.1 shows part of the reactivity series.

Table 29.1

metal	relative reactivity
zinc	most reactive
iron	↓
tin	least reactive

(i) Explain how does plating iron with zinc or tin prevents it from rusting.

.....

..... [1]

(ii) Describe and explain what would happen if an iron object plated with tin is scratched.

.....

.....

.....

..... [2]

(iii) Describe and explain what would happen if an iron object plated with zinc is scratched.

.....

.....

.....

..... [2]

(c) Steel is an alloy of iron and carbon.

Describe and explain how changes in the carbon content can affect the strength of steel.

.....

.....

.....

.....

.....

..... [3]

[Total: 10]

The Periodic Table of the Elements

Group																	
I	II										III	IV	V	VI	VII	0
							1 H hydrogen 1									4 He helium 2
7 Li lithium 3	9 Be beryllium 4										11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12										27 Al aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	64 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	– Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La lanthanum 57 *	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	– Po polonium 84	– At astatine 85	– Rn radon 86
– Fr francium 87	– Ra radium 88	– Ac actinium 89 †															

*58-71 Lanthanoid series
†90-103 Actinoid series

140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	– Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	162 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	– Pa protactinium 91	238 U uranium 92	– Np neptunium 93	– Pu plutonium 94	– Am americium 95	– Cm curium 96	– Bk berkelium 97	– Cf californium 98	– Es einsteinium 99	– Fm fermium 100	– Md mendelevium 101	– No nobelium 102	– Lr lawrencium 103

Key: a / X / b — a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

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

CHIJ KATONG

3E Chemistry EOY 2016 Mark Scheme

1.	B	2.	B	3.	A	4.	B	5.	A
6.	C	7.	D	8.	A	9.	D	10.	D
11.	D	12.	B	13.	D	14.	B	15.	C
16.	D	17.	C	18.	A	19.	B	20.	C

21a	Yes, sample U contains two spots at the same position as drugs Y and Z; A: same distance/ R_f values	1
21b	The substances have different solubility in different solvent;	1
21c	Starting line should be drawn in pencil; Pencil lead is insoluble in water and will not undergo separation/pen ink is soluble in water and will undergo separation; OR Water/solvent level should be below the starting line; To prevent sample spots from dissolving into solvent pool/sample spots will dissolve into solvent and no separation would be carried out;	1 1 1 1
21d	distance travelled by Y = 5.5 cm; distance travelled by solvent = 10 cm;	1 1
22a	Atoms of the same element with the same number of proton but different number of neutrons;	1
22b	<table><tr><td>number of neutrons</td><td>17</td></tr><tr><td>number of protons</td><td>16</td></tr><tr><td>electronic configuration</td><td>2, 8, 6</td></tr></table>	1 for each correct answer
22c	S_8;	1
22di	Little energy needed to overcome the weak intermolecular forces between sulfur molecules;	1
22dii	No mobile electrons to conduct electricity;	1
22e	Positive ion Na^+ and 2, 8; Negative ion S^{2-} and 2, 8, 8;	 1 1
22f		1 for correct

		arrangement of atoms 1 for correct arrangement of electrons -1m if wrong/missing key
23a	No. of mole of ammonium nitrate = 4.0/80 = 0.05 mol; No. of mole of gases = 3 x 0.05 = 0.15 mol Volume of gases = 0.15 x 24 = 3.6 dm^3/3600 cm^3;	1 1
23b	<table><tr><td></td><td>Ca</td><td>H</td><td>P</td><td>O</td></tr><tr><td>Mole ratio</td><td>$\frac{17.1}{40}$ / 0.4275</td><td>$\frac{1.7}{1}$ / 1.7</td><td>$\frac{26.5}{31}$ / 0.8548</td><td>$\frac{54.7}{16}$ / 3.419</td></tr><tr><td>Simplified ratio</td><td>$\frac{0.4275}{0.4275}$ / 1</td><td>$\frac{1.7}{0.4275}$ / 4</td><td>$\frac{0.8548}{0.4275}$ / 2</td><td>$\frac{3.419}{0.4275}$ / 8</td></tr></table> Empirical formula: $CaH_4P_2O_8$ or $Ca(H_2PO_4)_2$ formula of anion: $H_2PO_4^-$/$H_4P_2O_8^{2-}$/PO_4^{3-};	1 for mole ratio row 1 for simplified ratio row 1 for empirical formula 1
23c	Carry out titration with aqueous ammonia/add acid to aqueous ammonia using a burette or vice versa with an indicator; Note volume of acid/alkali used/find the end-point; Repeat experiment without the use of indicator (using same volumes); Heat the resultant solution until saturation; Cool to allow for crystallisation to take place; Filter to collect the crystals, wash with a little distilled water and dry between pieces of filter paper;	1 1 1 1 1 1
24a	A weak acid is one that is partially ionised in aqueous solution; A: partially dissociated in water/solution/solvent	1
24b	Acetic acid; It has the lowest K_a value, suggesting that it has the <u>least H^+ ions</u> after dissociation; A: lowest K_a value, smallest extent of dissociation	1 1
24c	As temperature increases, acetic acid molecules gain kinetic energy and dissociate more readily; Concentration of ions increases while concentration of undissociated molecules decreases; K_a increases; OR	1 1 1

	As temperature decreases, acetic acid molecules lose kinetic energy and dissociate less readily; Concentration of ions decreases while concentration of undissociated molecules increases; K_a decreases;	1 1 1
25a	The workers can suffer from chemical burns/skin will be burnt by strong alkali; Calcium oxide dissolves readily in water to form calcium hydroxide/a strong alkali/is alkaline; Strong alkalis are <u>corrosive</u>; A: skin irritation/ skin will be corroded R: skin will be burnt/ skin infection	1 1 1
25b	Limestone is added to provide calcium oxide for the manufacturing of Portland cement; Limestone will decompose when heated strongly in the kiln;	1 1
25ci	Calcium hydroxide; R: calcium oxide	1
25cii	$Ca(OH)_2(aq) + H_4SiO_4(aq) \rightarrow CaH_2SiO_4(s) + 2H_2O(l)$;	2 (1 for correct balanced eqn, 1 for correct state symbols)
26a	First ionisation energy decreases down Group I; Down the group, valence electron is found further away from the nucleus/ valence electron not as strongly attracted to the nucleus; Lesser energy is energy needed to overcome electrostatic forces of attraction between nucleus and valence electrons;	1 1 1
26b	As first ionisation energy decreases, reactivity of elements in Group I metals increases;	1
26c	First ionisation energy increases across Period 2; Across the period, nuclear charge increases /valence electron is more strongly attracted to the nucleus; More energy is required to overcome these electrostatic forces of attraction;	1 1 1
27ai	Hard; Silicon carbide has a giant molecular structure in which silicon and carbon atoms are held together by strong <u>covalent bonds</u>; A lot of energy is needed to overcome these strong attractive forces; A: strong, particles instead of atoms R: break/ difficult to overcome, molecules/ ions instead of atoms	1 1 1

	**marks will be awarded for explanation only if property stated is high melting and/ or boiling point	
27aii	Does not conduct electricity in any state; All valence electrons are used in bonding, no mobile electrons to conduct electricity; A: 0 conductivity/ poor electrical conductivity/ low electrical conductivity A: delocalised electrons R: heat conductivity R: any mention of ions	1 1
27bi	$PdCl_2$;	1
27bii		1 for each type of ion correctly drawn, ratio must be 1:2 -1m for missing/wrong key
27biii	High melting point; A lot of energy required to overcome the strong electrostatic forces of attraction between oppositely charged ions;	1 1
28ai	$Mg(s) + 2H^+(aq) \rightarrow Mg^{2+}(aq) + H_2(g)$;	1 (no state symbols/ wrong state symbols no mark)
28aii	No. of mole of H_2 = 36/24000 = 0.0015 mol No. of mole of Mg = no. of mole of H_2 = 0.0015 mol; Ar of Mg = 0.036/0.0015 = 24 (shown);	 1 1
28b	No. of mole of Mg = 12000/24 = 500 mol No. of mole of Mg = no. of mole of MgO = 500 mol; Mass of MgO formed = 65 % x 500 x 40 = 13000 g/13 kg; R: ½ mol or 0.5 mol instead of 500 mol	 1 1
28ci	24 cm^3;	1
28cii	No. of mole of KOH = 0.150 x (24/1000) = 0.0036 mol; No. of mole of H_2SO_4 = ½ x 0.0036 = 0.0018 mol Conc. of H_2SO_4 = 0.0018/(25/1000) = 0.072 mol/dm^3;	1 (allow ECF) 1
28ciii	Yes, volume of potassium hydroxide required will be lesser/halved; as nitric acid has lesser/ half the amount of H^+ ions compared to sulfuric acid;	1 1

	A: 1 mol required for nitric acid but 2 mol required for sulfuric acid A: nitric acid and sulfuric acid have different concentration of H^+ ions (1m only) R: different pH, different strength thus different volumes R: sulfuric acid low pH/ nitric acid higher pH, thus smaller volume needed R: sulfuric acid stronger acid/ nitric acid weaker acid R: different number of mole and concentration R: nitric acid is a weak acid	
29ai	$Fe^{2+}(aq) + 2OH^-(aq) \rightarrow Fe(OH)_2(s)$;	1
29aii	An inert/protective layer of aluminium oxide will be formed; A: prevents water and oxygen from being exposed to iron R: air and oxygen	1
29bi	The layer of zinc or tin acts as a barrier to keep oxygen and/or water away from the iron;	1
29bii	Iron will start to rust/corrode faster than usual; Iron is <u>more reactive</u> than tin, iron will corrode in place of tin/corrode more readily; A: if faster not mentioned	1 1
29biii	Iron will not rust; Zinc is <u>more reactive</u> than iron, zinc will corrode in place of iron/corrode more readily;	1 1
29c	As carbon content increases, strength of steel increases; Increase in carbon content results in greater disruption to the regular arrangement of the iron atoms; More difficult for atoms to slide past each other when a force is applied; R: strong and malleable to strong but brittle R: harder (question stated strength)	1 1 1