Chemistry
Standard level
Paper 1A

Tuesday June 11 2024

30 minutes [Paper 1A and Paper 1B]

Instructions to candidates

- Answer all questions.
- For each question, choose the answer you consider to be the best.
- A calculator is required for this paper.
- A clean copy of the **chemistry data booklet** is required for this paper.
- The maximum mark for paper 1A is **[17 marks]**.
- The maximum mark for paper 1A and paper 1B is **[27 marks]**.

6 pages

Section A

1. Which technique is used to purify a solid obtained from a chemical reaction?

    A.   distillation

    B.   evaporation

    C.   recrystallization

    D.   filtration

2. Ice containing only the isotope ^2H sinks and does not melt when dropped into ordinary distilled water maintained at $3°C$.

    Which statement is correct?

    A.   The isotope ^2H has a high natural abundance.

    B. $^2H_2O(s)$ has a higher melting point than normal ice.

    C. $^2H_2O(s)$ has a lower density than normal ice-cold water.

    D. ^2H_2O has different chemical properties from normal water.

3. Which electron transition in the hydrogen atom emits radiation with the highest energy?

    A. $n = 1$ to $n = 2$ absorbs

    B. $n = 2$ to $n = 3$ absorbs

    C. $n = 2$ to $n = 1$

    D. $n = 3$ to $n = 2$ shorter distance than C

4. A container holds 30 g of argon and 60 g of neon.

    What is the ratio of number of atoms of argon to number of atoms of neon in the container?

    A.   0.25

    B.   0.50

    C.   2.0

    D.   4.0

$$\frac{m}{M} = \frac{N}{N_A}$$

$$N = \frac{m}{M} N_A$$

$$N_{Ar} = \frac{30}{39.95} N_A$$

$$N_{Ne} = \frac{60}{20.18} N_A$$

OR : $N = n N_A$
- Get moles at each and ratio
- N_A doesn't matter because it cancels out.

$$\frac{30}{39.95} N_A : \frac{60}{20.18} N_A$$

$$\cong 0.25$$

5. A gas storage tank of fixed volume V contains N molecules of an ideal gas at 300 K with a pressure of 40 kPa. $\frac{N}{4}$ molecules are removed, and the temperature is changed to 450 K. What is the new pressure of the gas in kPa?

A. 15

B. 30

C. 45

D. 60

6. What is the formula of the compound formed between magnesium ions and hydrogencarbonate ions?

A. $MgHCO_3$

B. $Mg(HCO_3)_2$

C. $Mg(HCO_3)_3$

D. $Mg_3(HCO_3)_2$

7. Which species contains a coordination bond?

A. CO_2

B. HCN

C. NO_2^+

D. NO_3^-

8. Which properties depend on the movement of the delocalized electrons in a metal?

I. Electrical conductivity
II. Thermal conductivity
III. Density

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

9. Which substance, made from two elements with electronegativities E_X and E_Y, is an alloy?

(handwritten: ionic, metal)

	Average electronegativity $\dfrac{E_X + E_Y}{2}$	Electronegativity difference $E_X - E_Y$ *(handwritten: > 1.7)*
A. *(X)*	2.5	2.5 *(←)*
B.	2.5	1.0
C.	3.5	0.2
D. *(circled)*	1.2	0.2

10. What is the explanation for the malleability of metals?

A. The bonds are strong.

B. The bonds are weak.

C. The bonds involve free electrons.

D. The bonds do not have a specific direction. ✓

11. In which block of the periodic table would element 119 be placed, if it is found in the future?

A. s

B. p

C. d

D. f *(X)*

12. The block structure of the periodic table groups elements according to which characteristic?

A. atomic number

B. atomic mass

C. electron configuration ✓

D. reactivity

13. What is the amount, in mol, of H_2O produced for a reaction between 10.0 mol of C_2H_3Cl and 10.0 mol of O_2 if the yield is 90 %?

$$2C_2H_3Cl(g) + 5O_2(g) \rightarrow 4CO_2(g) + 2H_2O(g) + 2HCl(g)$$

A. 3.60 ✓

B. 4.00

C. 9.00

D. 10.00

(handwritten: Limiting Reagent)

(handwritten:
$5 : 2$
$1 : \frac{2}{5}$
$\dfrac{10 \cdot 2}{5} = 4\,mol$
$4\,mol \cdot 0.90 = 3.60\,mol$ *)*

14. The complete combustion of $20.0\,cm^3$ of a gaseous hydrocarbon, C_xH_y, produces $80.0\,cm^3$ of gaseous products. This volume reduces to $40.0\,cm^3$ when the water vapour present condenses. All volumes are measured at the same temperature and pressure.
What is the molecular formula of the hydrocarbon?

A. CH_4 $C_xH_y + O_2 \rightarrow CO_2 + H_2O$

B. C_2H_2

C. C_2H_4

D. C_3H_6

15. The diagram shows the energy profile of a reaction.
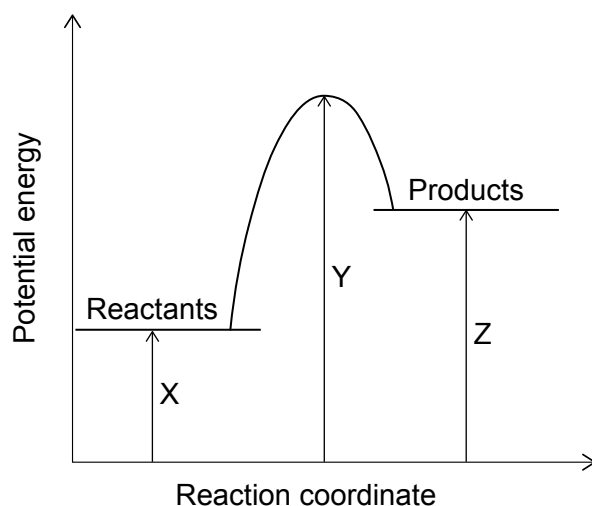
Which combination is correct?

	Activation energy of forward reaction	Activation energy of reverse reaction
A.	X	Z
B.	Y – X	Y – Z
C.	Y	Y
D.	Y – X	Z – X

16. What is the main reason for an increase in rate of reaction when the temperature is raised?

A. A greater proportion of collisions are successful.

B. ✗ Particles collide more frequently.

C. The bonds in the reactants are weakened.

D. The activation energy of the reaction decreases.

17. What is the equilibrium constant expression for the following reaction?

$$2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$$

A. $\dfrac{[SO_2]^2[O_2]}{[SO_3]^2}$ ✓
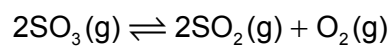
$$K_c = \frac{Products}{Reactants}$$

B. $\dfrac{[SO_2]^2 + [O_2]}{[SO_3]^2}$

C. $\dfrac{[SO_3]^2}{[SO_2]^2[O_2]}$

D. $\dfrac{2[SO_2][O_2]}{2[SO_3]}$

Chemistry
Standard level
Paper 1B

Tuesday June 11 2024

30 minutes [Paper 1A and Paper 1B]

Instructions to candidates

- 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.
- The maximum mark for paper 1B is **[10 marks]**.
- The maximum mark for paper 1A and paper 1B is **[27 marks]**.

4 pages

Section B

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

1.   A student investigates the effect of exposure to the air on the ascorbic acid (vitamin C) concentration in a specific orange juice. Equal volumes of orange juice are sealed into identical flasks and placed in a refrigerator for two weeks. The samples in the refrigerator are exposed to the air by removing the stopper for a different number of hours each day as shown.
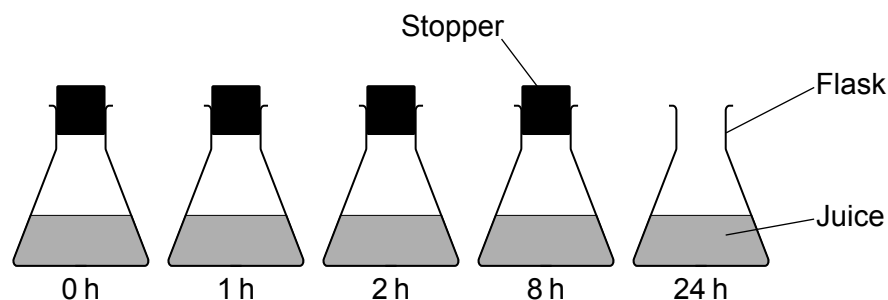
(a)   Identify **two** variables that are controlled.   [1]

> The properties of the flasks, and the temperature inside the refrigerator.

(b)   The concentration of ascorbic acid is determined by titration with a standard iodine solution. Every few days, 10.00 cm^3 of orange juice is removed from each sample, diluted to 100.0 cm^3, and titrated.

(i)   Suggest why the juice is diluted before titration.   [1]

> to minimize the effects of possible impurities from air exposure.

(ii)   Identify a possible systematic error with this method regarding the sample that is exposed for zero hours.   [1]

> Juice can never be exposed to air for zero hours. In production or at some point in time It must've had air exposure.

(iii)   Suggest how an additional flask could be set up to verify whether the systematic error in (ii) has occurred.   [1]

> Setup an identical flask that isn't exposed to air during the 24 hours and then compare the two zero-hour trials. If their acid concentrations are different then there is a systematic error.

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(Question 1 continued)

(c)   The following data are collected during a titration.

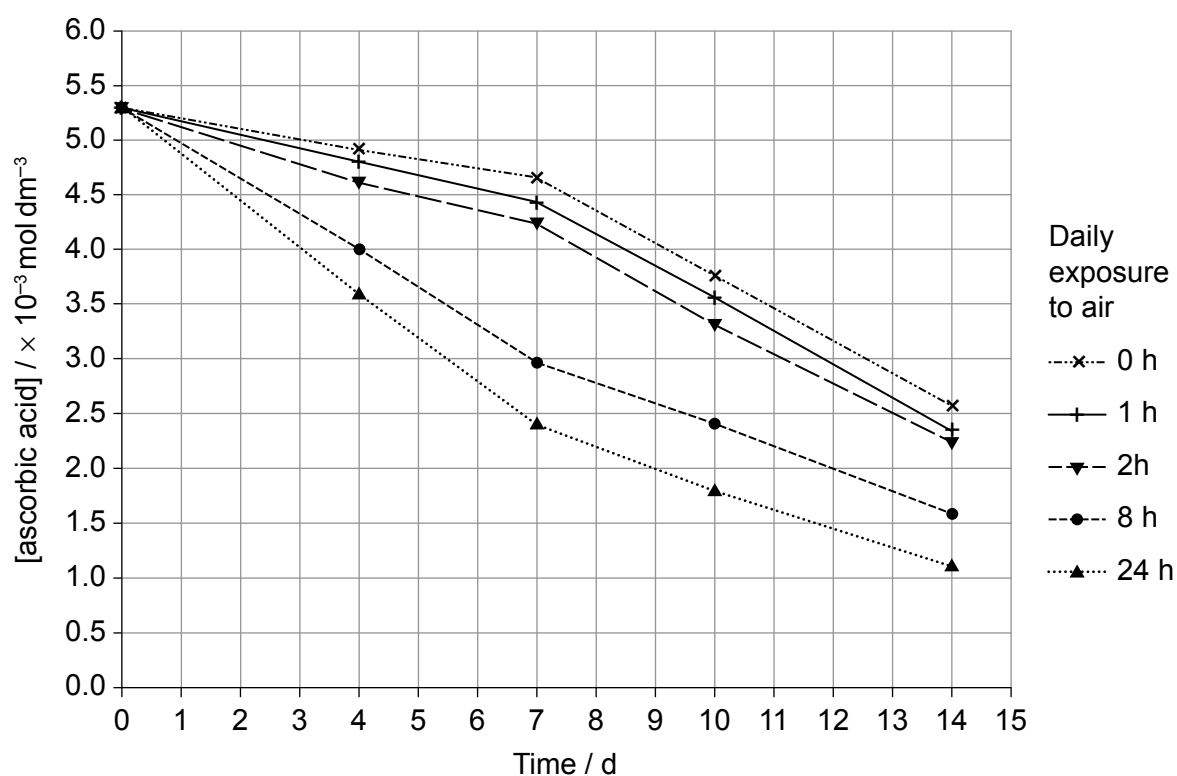Final burette reading $= 16.10 \pm 0.05\,cm^3$

Initial burette reading $= 1.10 \pm 0.05\,cm^3$

Calculate the percentage uncertainty of the titre.   [1]

$$\frac{0.05}{16.10} + \frac{0.05}{1.10} = 0.004856 \quad \% \text{ Uncertainty of titre} = 4.86\%$$

(d)   The following graph shows the student's results.

(i)   Calculate the average rate of decrease in ascorbic acid concentration for the 24 h
       sample over the period of 14 days, including units.   [2]

$$\frac{1.1 - 5.3}{14} = -0.3 \cdot 10^{-3}\,mol\,dm^{-3}\,d^{-1}$$

(This question continues on the following page)

(Question 1 continued)

(ii) The student's hypothesis is: "A lower ascorbic acid concentration will be found in juice exposed to the air for longer, due to oxidation of ascorbic acid by oxygen."

Discuss whether or not the data support the hypothesis. [2]

Agreed. The 24 hour sample ended with a concentration of 1.01×10^{-3} mol dm^{-3}, while the 2 hour sample ended with a concentration of about 2.025×10^{-3} mol dm^{-3}.

(iii) State the implications of the results of the experiment for avoiding loss of vitamin C in the storage of orange juice. [1]

Orange juice should be stored with as little exposure to air as possible to slow loss of vitamin C over time.