

Helping you Achieve Highest Grades in IB

IB Chemistry SL

Question Paper

Fully in-lined with the First Teaching in 2023 & First
Assessment Examinations in 2025 & Beyond

Paper: 1 (Multiple-Choice Questions)
- All Topics

Marks: 380

Total Marks: / 380

Suitable for Students sitting the 2026 exams onwards
However, students in HL might find it useful

Questions

21N.1A.SL.TZ0.6

How many p-orbitals are occupied in a phosphorus atom? [1]

- A. 2
- B. 3
- C. 5
- D. 6

19M.1A.SL.TZ1.26

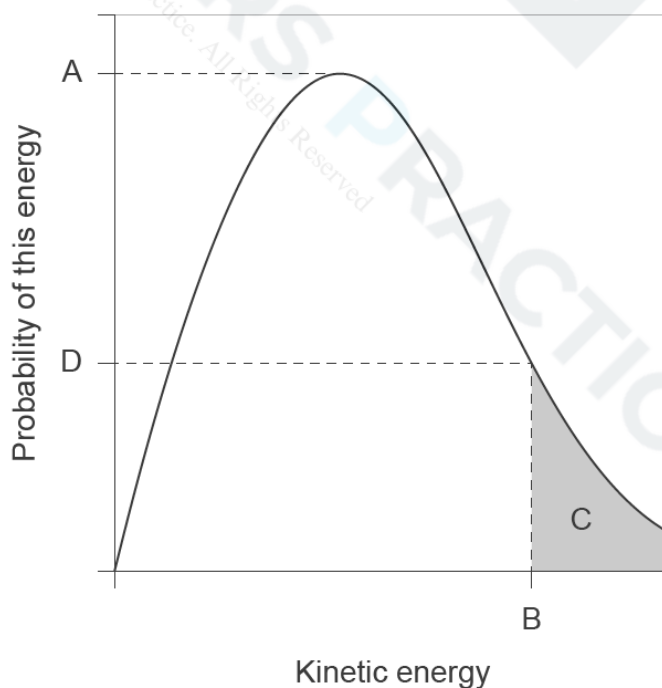
What is the mechanism of the reaction between alkenes and halogens in the absence of light?

- A. radical substitution
- B. electrophilic substitution
- C. electrophilic addition
- D. nucleophilic substitution

[1]

21M.1A.SL.TZ1.17

On the following Maxwell-Boltzmann distribution, which letter represents activation energy?



- A. A
- B. B
- C. C
- D. D

[1]

21N.1A.SL.TZ0.18

Which combination has the greatest rate of reaction at room temperature? [1]

	Zinc	CuSO ₄ (aq)
A.	1.00 g Zn powder	50.0 cm ³ of 0.200 mol dm ⁻³ CuSO ₄ (aq)
B.	1.00 g Zn powder	100.0 cm ³ of 0.100 mol dm ⁻³ CuSO ₄ (aq)
C.	1.00 g Zn strip	50.0 cm ³ of 0.200 mol dm ⁻³ CuSO ₄ (aq)
D.	1.00 g Zn strip	100.0 cm ³ of 0.100 mol dm ⁻³ CuSO ₄ (aq)

23M.1A.SL.TZ2.39

Which technique is best for determining bond lengths within a molecule? [1]

- A. ¹H NMR spectroscopy
- B. infrared spectroscopy
- C. mass spectroscopy
- D. X-ray crystallography

19M.1A.SL.TZ2.1

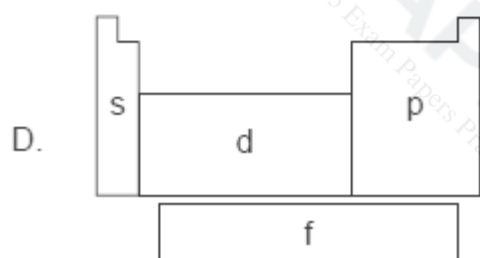
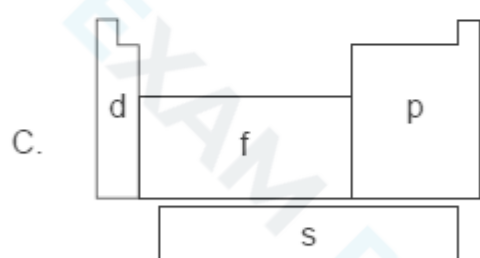
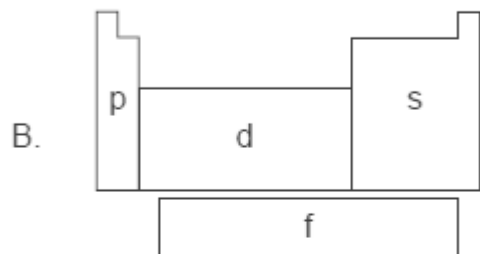
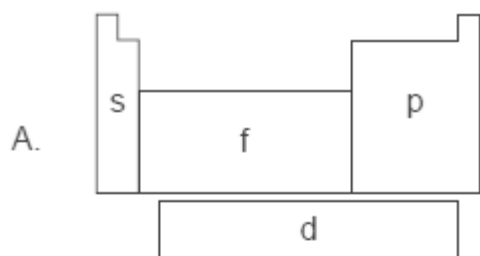
How many moles of magnesium hydroxide are produced with 0.50 mol of ammonia? [1]



- A. 0.25
- B. 0.33
- C. 0.75
- D. 1.5

23M.1A.SL.TZ1.7

What is the correct labelling of the blocks of the periodic table? [1]



19M.1A.SL.TZ2.12

Which compound has hydrogen bonds between its molecules? [1]

- A. CH_4
- B. CH_4O
- C. CH_3Cl
- D. CH_2O

22M.1A.SL.TZ2.12

What is the main interaction between liquid CH_4 molecules? [1]

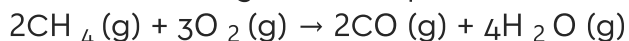
- A. London (dispersion) forces
- B. Dipole–dipole forces
- C. Hydrogen bonding
- D. Covalent bonding

19M.1A.SL.TZ2.14



Methane undergoes incomplete combustion.

[1]



What is the enthalpy change, in kJ, using the bond enthalpy data given below?

Bond	Average bond enthalpy / kJ mol^{-1}
C-H	414
O-H	463
O=O	498
C $\equiv$ O	1077

- A. $[2(1077) + 4(463)] - [2(414) + 3(498)]$
B. $[2(414) + 3(498)] - [2(1077) + 4(463)]$
C. $[8(414) + 3(498)] - [2(1077) + 8(463)]$
D. $[2(1077) + 8(463)] - [8(414) + 3(498)]$

19M.1A.SL.TZ1.3

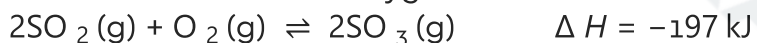
What is the empirical formula of a hydrocarbon with 75 % carbon and 25 % hydrogen by mass?

- A. C_3H
B. CH_2
C. C_2H_6
D. CH_4

[1]

21M.1A.SL.TZ2.23

Sulfur dioxide reacts with oxygen to form sulfur trioxide. [1]



Which change increases the value of K_c ?

- A. increasing the temperature
B. decreasing the temperature
C. decreasing $[\text{SO}_2(\text{g})]$
D. decreasing $[\text{SO}_3(\text{g})]$

22M.1A.SL.TZ1.2

Which sample contains the fewest moles of HCl? [1]

$$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}.$$

Molar volume of an ideal gas at STP = $22.7 \text{ dm}^3 \text{ mol}^{-1}$.

- A. 10.0 cm^3 of 0.1 mol dm^{-3} HCl (aq)
- B. 6.02×10^{24} molecules of HCl (g)
- C. 0.365 g of HCl (g)
- D. 2.27 dm^3 of HCl (g) at STP

23M.1A.SL.TZ1.1

What are the units of molar mass? [1]

- A. amu
- B. g
- C. mol g^{-1}
- D. g mol^{-1}

19M.1A.SL.TZ2.11

Which molecule contains an incomplete octet of electrons? [1]

- A. NF_3
- B. BF_3
- C. BrF
- D. SF_2

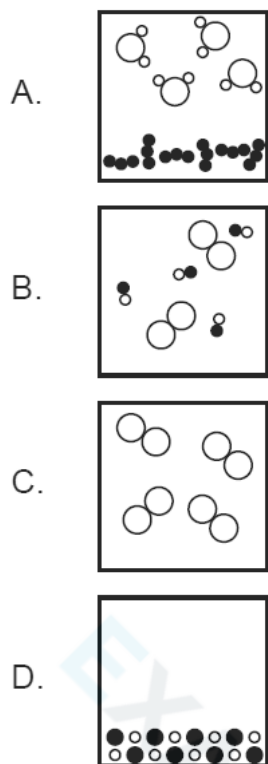
SPM.1A.SL.TZ0.18

Which is a renewable energy source? [1]

- A. natural gas
- B. uranium
- C. coal
- D. wood

19M.1A.SL.TZ1.1

Which diagram represents a heterogeneous mixture? [1]



23M.1A.SL.TZ1.30

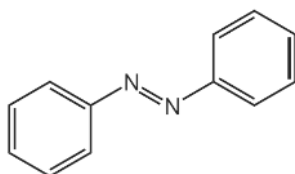
Which technique is most likely to be used for identification of functional groups? [1]

- A. Combustion analysis
- B. Determination of melting point
- C. Infra-red (IR) spectroscopy
- D. Mass spectroscopy (MS)

21N.1A.SL.TZ0.9

Which molecule has the **weakest** nitrogen to nitrogen bond? [1]

- A. N_2
- B. N_2H_2
- C. N_2H_4
- D.



21M.1A.SL.TZ1.10

Which compound contains both ionic and covalent bonds? [1]

- A. MgO
- B. CH_2Cl_2
- C. CH_3COOH

D. NaOH

22M.1A.SL.TZ1.17

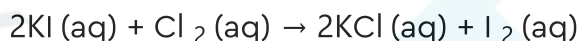
A student was investigating rates of reaction. In which of the following cases would a colorimeter show a change in absorbance?

- A. $\text{KBr (aq)} + \text{Cl}_2 \text{ (aq)}$
- B. $\text{Cu (s)} + \text{Na}_2\text{SO}_4 \text{ (aq)}$
- C. $\text{HCl (aq)} + \text{NaOH (aq)}$
- D. $(\text{CH}_3)_3\text{COH (aq)} + \text{K}_2\text{Cr}_2\text{O}_7 \text{ (aq)}$

[1]

21N.1A.SL.TZ0.17

Which instrument would best monitor the rate of this reaction? [1]



- A. Balance
- B. Colorimeter
- C. Volumetric flask
- D. Gas syringe

SPM.1A.SL.TZ0.8

Which properties depend on the movement of the delocalized electrons in a metal? [1]

- 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

21M.1A.SL.TZ2.21

Which statements are correct about the action of a catalyst in a chemical reaction? [1]

- I. It increases the energy of each collision.
- II. It alters the mechanism of the reaction.
- III. It remains unchanged at the end of the reaction.

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

SPM.1A.SL.TZ0.1



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

- A. distillation
- B. evaporation
- C. recrystallization
- D. filtration

19M.1A.SL.TZ2.5

Which is correct for ${}^{34}_{16}\text{S}^{2-}$? [1]

	Protons	Neutrons	Electrons
A.	16	18	14
B.	18	16	18
C.	16	18	16
D.	16	18	18

21M.1A.SL.TZ2.29

How should the difference between 27.0 ± 0.3 and 9.0 ± 0.2 be shown? [1]

- A. 18.0 ± 0.1
- B. 18.0 ± 0.3
- C. 18.0 ± 0.5
- D. 18.0 ± 0.6

19M.1A.SL.TZ1.2

What is the sum of the coefficients when the equation is balanced with the smallest whole numbers?

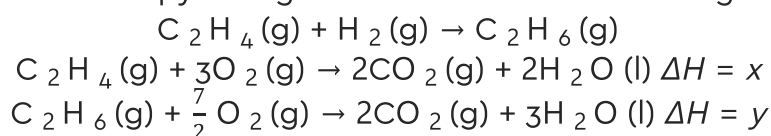


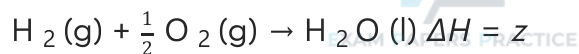
- A. 4
- B. 6
- C. 8
- D. 9

[1]

19M.1A.SL.TZ1.15

What is the enthalpy change of reaction for the following equation? [1]





- A. $x + y + z$
- B. $-x - y + z$
- C. $x - y - z$
- D. $x - y + z$

23M.1A.SL.TZ1.14

What is the enthalpy of combustion of propan-1-ol, in kJ mol^{-1} , according to the following calorimetry data?

Mass of water in calorimeter	75 g
Amount of propan-1-ol burned	0.015 mol
Temperature rise	24 °C
Specific heat capacity of water	$4.2 \text{ J g}^{-1} \text{ K}^{-1}$

- A. $\frac{-0.015 \times 4.2 \times 24}{-75 \times 4.2 \times 24}$
- B. $\frac{-0.015 \times 4.2 \times 24}{-75 \times 4.2 \times 24}$
- C. $\frac{-0.015 \times 4.2 \times 24}{-75 \times 4.2 \times 24}$
- D. $\frac{-0.015 \times 4.2 \times 24}{-75 \times 4.2 \times 24}$

[1]

19M.1A.SL.TZ1.6

What is the ground state electron configuration of an atom of chromium, Cr ($Z = 24$)? [1]

- A. $[\text{Ar}]3\text{d}^6$
- B. $[\text{Ar}]4\text{s}^2 3\text{d}^4$
- C. $[\text{Ar}]4\text{s}^1 3\text{d}^5$
- D. $[\text{Ar}]4\text{s}^2 4\text{p}^4$

20N.1A.SL.TZ0.9

Which formula is correct? [1]

- A. NH_4PO_4
- B. NH_4PO_4
- C. NH_3PO_4
- D. NH_3PO_4

20N.1A.SL.TZ0.11

Which combination correctly describes the geometry of the carbonate ion, CO_3^{2-} ? [1]



	Electron domain geometry around C	Molecular geometry around C
A.	Trigonal planar	Trigonal pyramidal
B.	Tetrahedral	Trigonal planar
C.	Trigonal planar	Trigonal planar
D.	Tetrahedral	Trigonal pyramidal

21M.1A.SL.TZ2.16

Which change causes the greatest increase in the initial rate of reaction between nitric acid and magnesium?



	[HNO ₃]	Size of metal pieces
A.	doubled	halved
B.	doubled	doubled
C.	halved	halved
D.	halved	doubled

[1]

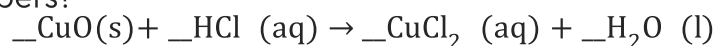
SPM.1A.SL.TZ0.7

Which species contains a coordination bond? [1]

- A. CO₂
- B. HCN
- C. NO₂⁺
- D. NO₃⁻

21M.1A.SL.TZ1.4

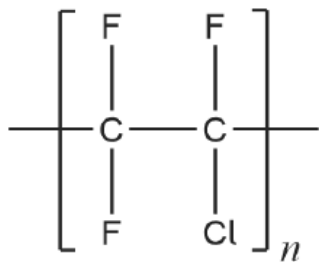
What is the coefficient of HCl (aq) when the equation is balanced using the smallest possible whole numbers?



- A. 1
- B. 2
- C. 3
- D. 4

[1]

Which monomer would produce the polymer shown? [1]



- A. $\text{CF}_3\text{CCl}_2\text{F}$
- B. CF_3CClHF
- C. CF_2CClF
- D. CF_2CF_2

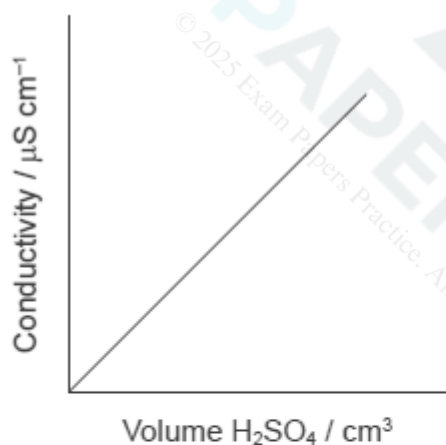
22M.1A.SL.TZ2.30

20 cm^3 of 1 mol dm^{-3} sulfuric acid was added dropwise to 20 cm^3 of 1 mol dm^{-3} barium hydroxide producing a precipitate of barium sulfate.

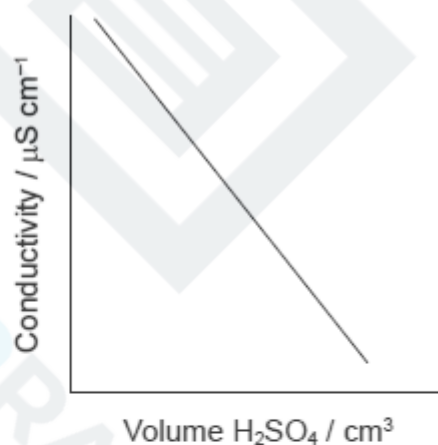


Which graph represents a plot of conductivity against volume of acid added?

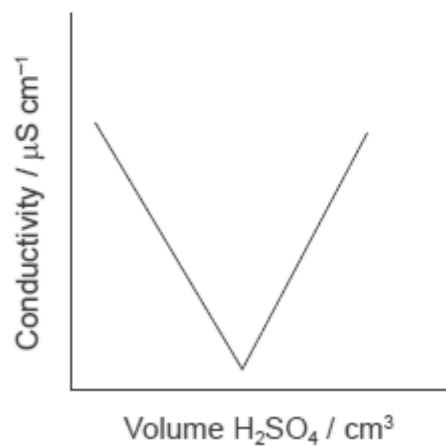
A.



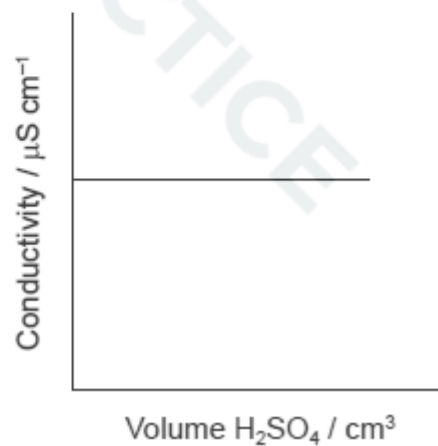
B.



C.



D.



[1]

Which products are formed from the neutralization of nitric acid by calcium hydroxide?

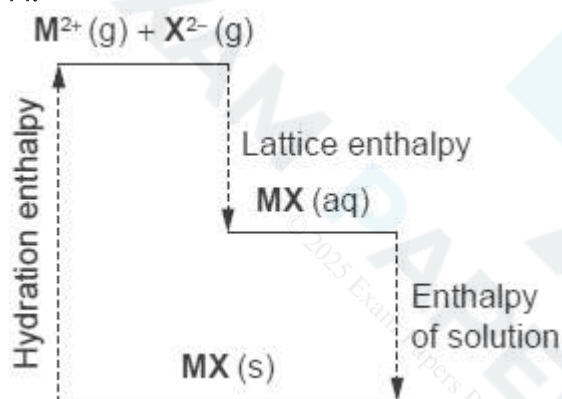
- A. Calcium oxide and ammonia
- B. Calcium nitrate and water
- C. Calcium nitrate and ammonia
- D. Calcium nitrate and hydrogen

[1]

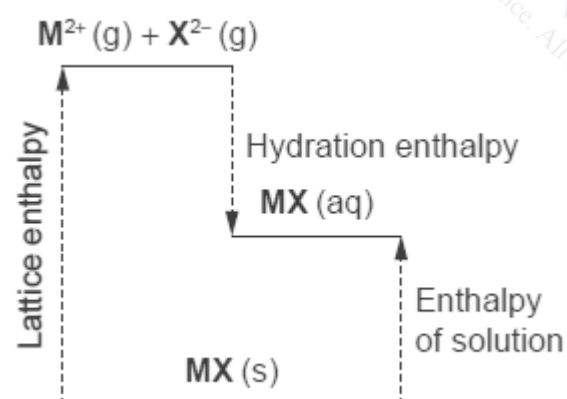
23M.1A.SL.TZ1.16

Which diagram shows the enthalpy changes for dissolving a solid, **MX**, in water, if the process increases the temperature of the solution?

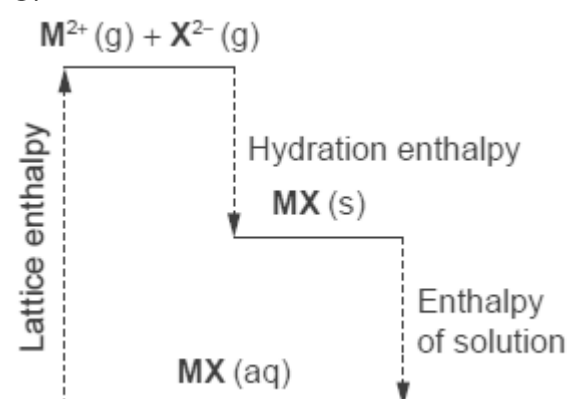
A.



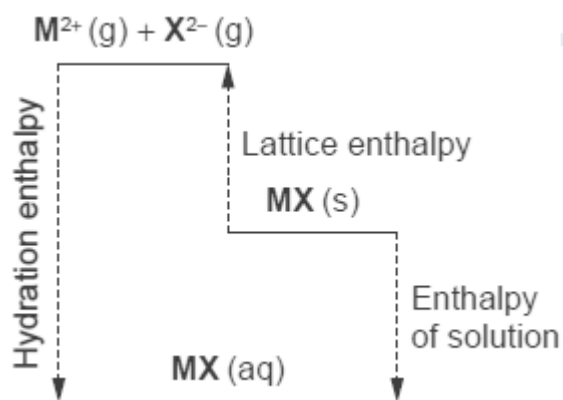
B.



C.



D.



[1]

21M.1A.SL.TZ2.26

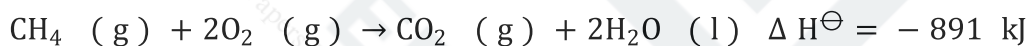
Which is correct?

[1]

- A. Electrophiles are Brønsted–Lowry acids.
- B. Nucleophiles are Brønsted–Lowry acids.
- C. Electrophiles are Lewis acids.
- D. Nucleophiles are Lewis acids.

20N.1A.SL.TZ0.15

Which statements about bond strength and activation energy are correct for this reaction?



	Relative bond strength	Relative magnitude of activation energy, E_a
A.	products < reactants	forward > reverse
B.	products > reactants	forward < reverse
C.	products > reactants	forward > reverse
D.	products < reactants	forward < reverse

[1]

20N.1A.SL.TZ0.34

Which molecule can be oxidized to a carboxylic acid by acidified potassium dichromate(VI)?

- A. Propan-1-ol
- B. Propan-2-ol
- C. 2-methylpropan-2-ol
- D. Propanone

[1]

22M.1A.SL.TZ2.19

Which of the $0.001 \text{ mol dm}^{-3}$ solutions is most likely to have a pH of 11.3? [1]

- A. $\text{Ca}(\text{OH})_2 (\text{aq})$
- B. $\text{H}_3\text{PO}_4 (\text{aq})$
- C. $\text{NaOH} (\text{aq})$
- D. $\text{NH}_4\text{OH} (\text{aq})$

20N.1A.SL.TZ0.20

Which of these acids has the weakest conjugate base? [1]

- A. HCl
- B. CH_3COOH
- C. NH_4Cl
- D. $\text{C}_6\text{H}_5\text{COOH}$

22M.1A.SL.TZ2.9

In which of the following compounds does ionic bonding predominate? [1]

- A. HCl
- B. NaF
- C. NH_4Br
- D. NaOH

23M.1A.SL.TZ2.20

What is the hydroxide ion concentration in a solution of $\text{pH} = 4$ at 298 K? [1]

- A. 4
- B. 10
- C. 10^{-4}
- D. 10^{-10}

19M.1A.SL.TZ1.13

When equal masses of X and Y absorb the same amount of energy, their temperatures rise by 5°C and 10°C respectively. Which is correct?

- A. The specific heat capacity of X is twice that of Y.
- B. The specific heat capacity of X is half that of Y.
- C. The specific heat capacity of X is one fifth that of Y.
- D. The specific heat capacity of X is the same as Y.

[1]

19M.1A.SL.TZ2.4

Which is correct for $^{34}_{16}\text{S}^{2-}$?

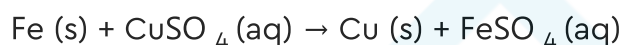
[1]



	Protons	Neutrons	Electrons
A.	16	18	14
B.	18	16	18
C.	16	18	16
D.	16	18	18

19M.1A.SL.TZ1.16

Which properties can be monitored to determine the rate of the reaction? [1]



I. change in volume

II. change in temperature

III. change in colour

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

21M.1A.SL.TZ1.1

Which contains the most atoms of oxygen? [1]

A. 64 g of O_2

B. 1.2×10^{24} molecules of O_2

C. 64 g of $\text{C}_3\text{H}_5\text{O}_3$

D. 1.2×10^{24} molecules of $\text{C}_3\text{H}_5\text{O}_3$

23M.1A.SL.TZ1.18

What happens to the average kinetic energy, KE, of the particles in a gas when the absolute temperature is doubled?

$$\text{KE} = \frac{1}{2} mv^2$$

A. Increases by a factor of 2

B. Decreases by a factor of 2

C. Increases by a factor of 4

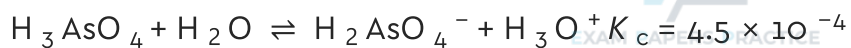
D. Decreases by a factor of 4

[1]

22M.1A.SL.TZ2.20

What is the strongest acid in the equation below?

[1]



- A. H_3AsO_4
- B. H_2O
- C. H_2AsO_4^-
- D. H_3O^+

19M.1A.SL.TZ1.9

What is the order of increasing boiling point?

[1]

- A. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3 < \text{CH}_3\text{CH}(\text{OH})\text{CH}_3 < \text{CH}_3\text{COCH}_3 < \text{CH}_3\text{CO}_2\text{H}$
- B. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3 < \text{CH}_3\text{COCH}_3 < \text{CH}_3\text{CH}(\text{OH})\text{CH}_3 < \text{CH}_3\text{CO}_2\text{H}$
- C. $\text{CH}_3\text{CO}_2\text{H} < \text{CH}_3\text{COCH}_3 < \text{CH}_3\text{CH}(\text{OH})\text{CH}_3 < \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$
- D. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3 < \text{CH}_3\text{COCH}_3 < \text{CH}_3\text{CO}_2\text{H} < \text{CH}_3\text{CH}(\text{OH})\text{CH}_3$

19M.1A.SL.TZ2.28

The following data were recorded for determining the density of three samples of silicon, Si.

Mass / g $\pm 0.01 \text{ g}$	Volume / cm^3 $\pm 0.1 \text{ cm}^3$
5.61	2.8
4.32	1.7
6.37	2.8

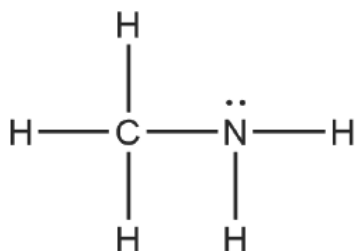
Which average density value, in g cm^{-3} , has been calculated to the correct number of significant figures?

- A. 2
- B. 2.3
- C. 2.27
- D. 2.273

[1]

21M.1A.SL.TZ1.9

The Lewis structure of methylamine is shown. [1]

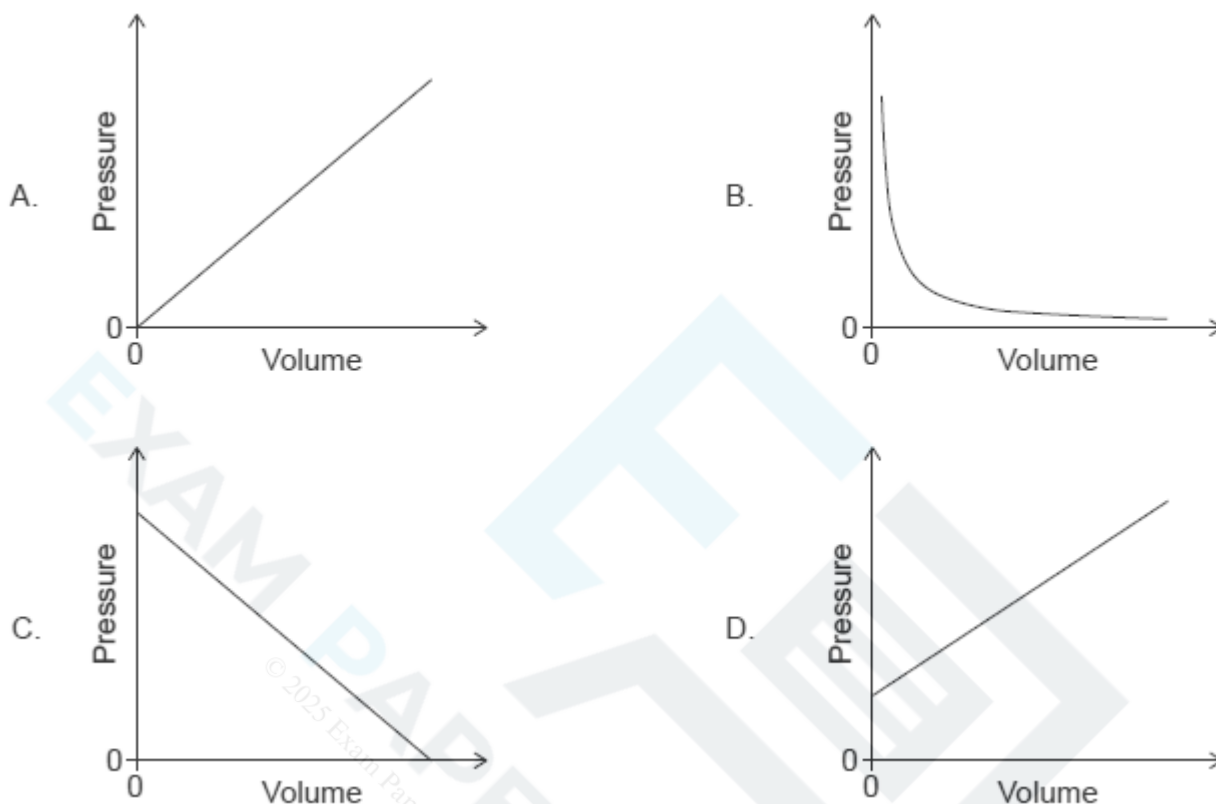


What is the molecular geometry around N?

- A. Square planar
- B. Tetrahedral
- C. Trigonal planar

21N.1A.SL.TZ0.29

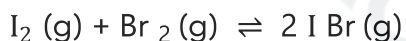
Which graph shows the relationship between the pressure and volume of a sample of gas at constant temperature?



[1]

22M.1A.SL.TZ2.23

0.50 mol of $I_2(g)$ and 0.50 mol of $Br_2(g)$ are placed in a closed flask. The following equilibrium is established.



The equilibrium mixture contains 0.80 mol of $IBr(g)$. What is the value of K_c ?

- A. 0.64
- B. 1.3
- C. 2.6
- D. 64

[1]

23M.1A.SL.TZ1.8

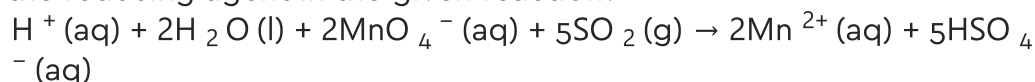
What can be deduced from the period number of an element? [1]

- . Highest occupied energy level
- . Number of sub-levels in the outer shell
- . Number of outer electrons

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

22N.1A.SL.TZ0.22

Which substance is the reducing agent in the given reaction?



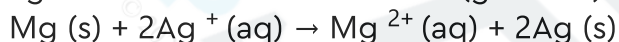
- A. H^+
- B. H_2O
- C. MnO_4^-
- D. SO_2

[1]

19M.1A.SL.TZ2.23

The following reaction occurs in a voltaic (galvanic) cell.

[1]



Which reaction takes place at each electrode?

	Anode (negative electrode)	Cathode (positive electrode)
A.	$\text{Ag}(\text{s}) \rightarrow \text{Ag}^+(\text{aq}) + \text{e}^-$	$\text{Mg}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Mg}(\text{s})$
B.	$\text{Ag}^+(\text{aq}) + \text{e}^- \rightarrow \text{Ag}(\text{s})$	$\text{Mg}(\text{s}) \rightarrow \text{Mg}^{2+}(\text{aq}) + 2\text{e}^-$
C.	$\text{Mg}(\text{s}) \rightarrow \text{Mg}^{2+}(\text{aq}) + 2\text{e}^-$	$\text{Ag}^+(\text{aq}) + \text{e}^- \rightarrow \text{Ag}(\text{s})$
D.	$\text{Mg}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Mg}(\text{s})$	$\text{Ag}(\text{s}) \rightarrow \text{Ag}^+(\text{aq}) + \text{e}^-$

23M.1A.SL.TZ1.27

The orange colour disappears when bromine water is added to compound X in the dark. Which compound is X?

- A. Ethene
- B. Ethane
- C. Ethanol
- D. Ethanoic acid

[1]

19M.1A.SL.TZ1.24

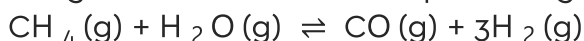
Which solution is basic at 25 °C? [1]

$$K_w = 1.0 \times 10^{-14}$$

- A. $[H^+] = 1.0 \times 10^{-3} \text{ mol dm}^{-3}$
- B. $[OH^-] = 1.0 \times 10^{-13} \text{ mol dm}^{-3}$
- C. solution of pH = 4.00
- D. $[H_3O^+] = 1.0 \times 10^{-13} \text{ mol dm}^{-3}$

21M.1A.SL.TZ1.18

Which changes produce the greatest increase in the percentage conversion of methane?



	Pressure	Proportion of H ₂ O(g)
A.	Doubled	Halved
B.	Doubled	Doubled
C.	Halved	Doubled
D.	Halved	Halved

[1]

21M.1A.SL.TZ2.5

What is represented by "2-" in ${}^A_ZX^{2-}$? [1]

- A. loss of electron
- B. gain of electron
- C. loss of proton
- D. gain of proton

22N.1A.SL.TZ0.5

Which quantities are different between two species represented by the notation ${}^{128}_{52}\text{Te}$ and ${}^{128}_{53}\text{I}$?

- A. The number of protons only
- B. The number of protons and electrons only
- C. The number of protons and neutrons only
- D. The number of protons, neutrons and electrons

[1]

21M.1A.SL.TZ2.18

What effect does a catalyst have on the position of equilibrium and the value of the equilibrium constant, K_c , for an exothermic reaction?



	Position of equilibrium	Value of equilibrium constant
A.	moves to products	increases
B.	stays the same	increases
C.	stays the same	stays the same
D.	moves to products	stays the same

[1]

23M.1A.SL.TZ1.15

Which allotrope, oxygen or ozone, has the stronger bond between O atoms, and which absorbs higher frequency UV radiation in the atmosphere?

Stronger bond between O atoms**Absorbs higher frequency UV**

- | | | |
|----|--------|--------|
| A. | ozone | ozone |
| B. | ozone | oxygen |
| C. | oxygen | oxygen |
| D. | oxygen | ozone |

[1]

23M.1A.SL.TZ1.32

Which formula represents an ether? [1]

- A. $\text{C}_6\text{H}_5\text{OH}$
B. CH_3CHO
C. CH_3COCH_3
D. CH_3OCH_3

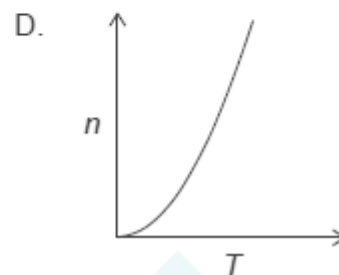
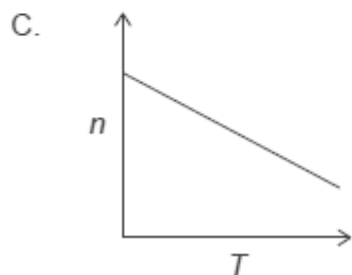
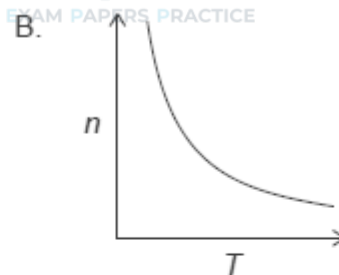
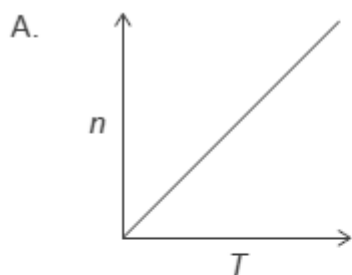
19M.1A.SL.TZ1.35

Which solvent is aprotic? [1]

- A. H_2O
B. $\text{C}_6\text{H}_5\text{CH}_3$
C. CH_3OH
D. CH_3NH_2

22M.1A.SL.TZ2.3

Which graph represents the relationship between the amount of gas, n , and the absolute temperature, T , with all other variables in the ideal gas equation, $PV = nRT$, held constant?



[1]

21M.1A.SL.TZ1.20

Which solution has a pH of 9? [1]

- A. $1.0 \times 10^{-9} \text{ mol dm}^{-3} \text{ HCl (aq)}$
- B. $1.0 \times 10^{-5} \text{ mol dm}^{-3} \text{ KOH (aq)}$
- C. $1.0 \times 10^{-9} \text{ mol dm}^{-3} \text{ KOH (aq)}$
- D. $1.0 \times 10^{-5} \text{ mol dm}^{-3} \text{ HCl (aq)}$

22N.1A.SL.TZ0.10

Which molecule is polar? [1]

- A. BeH_2
- B. AlH_3
- C. PH_3
- D. SiH_4

20N.1A.SL.TZ0.6

What is the correct trend going down groups 1 **and** 17? [1]

- A. Melting points increase
- B. Boiling points decrease
- C. Electronegativities increase
- D. Ionization energies decrease

SPM.1A.SL.TZ0.30

Which species can act as an electrophile? [1]

- A. CH_4

- B. Cl_2
 C. Cl^-
 D. OH^-

23M.1A.SL.TZ1.21

Which change involves oxidation of N?

- A. NH_3 to N_2
 B. NO_2 to NO
 C. N_2 to AlN
 D. NO_2 to N_2O_4

22M.1A.SL.TZ2.27

Which reaction mechanisms are typical for alcohols and halogenoalkanes? [1]

	Alcohols	Halogenoalkanes
A.	Electrophilic addition	Electrophilic addition
B.	Electrophilic addition	Nucleophilic substitution
C.	Nucleophilic substitution	Electrophilic addition
D.	Nucleophilic substitution	Nucleophilic substitution

21M.1A.SL.TZ2.12

Which is the correct order based on **increasing** strength? [1]

- A. covalent bonds < hydrogen bonds < dipole–dipole forces < dispersion forces
 B. dipole–dipole forces < dispersion forces < hydrogen bonds < covalent bonds
 C. dispersion forces < dipole–dipole forces < hydrogen bonds < covalent bonds
 D. dispersion forces < dipole–dipole forces < covalent bonds < hydrogen bonds

21M.1A.SL.TZ2.27

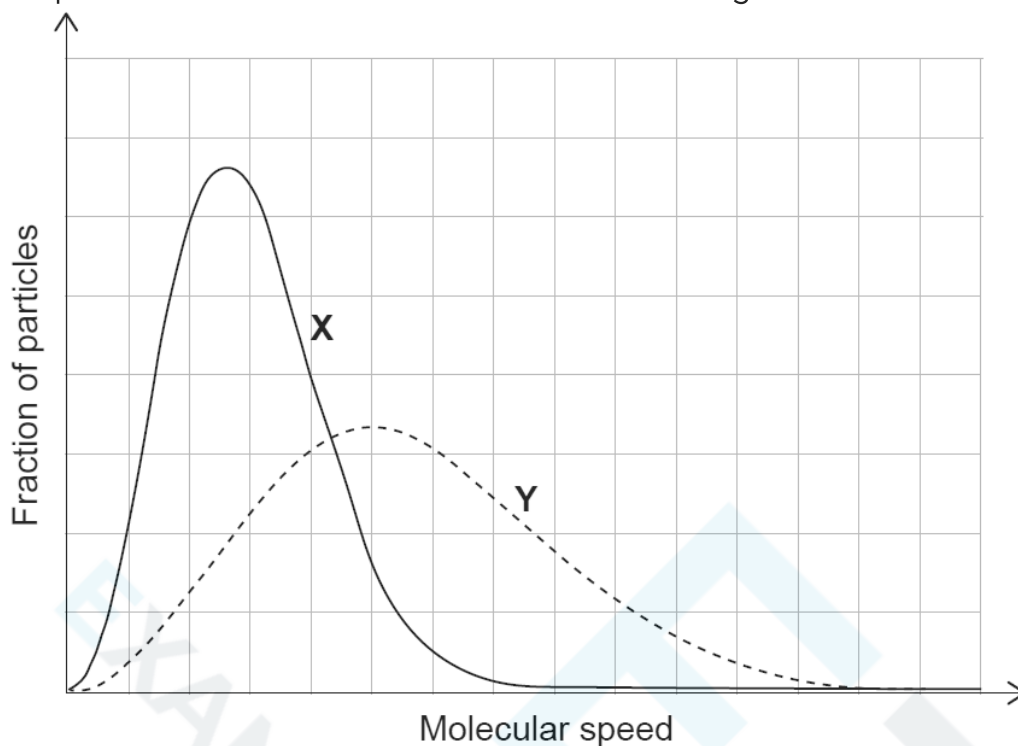
Which is a propagation step in the free-radical substitution mechanism of ethane with chlorine?

- A. $\text{Cl}_2 \rightarrow 2 \cdot\text{Cl}$
 B. $\cdot\text{C}_2\text{H}_5 + \text{Cl}_2 \rightarrow \text{C}_2\text{H}_5\text{Cl} + \cdot\text{Cl}$
 C. $\cdot\text{C}_2\text{H}_5 + \cdot\text{Cl} \rightarrow \text{C}_2\text{H}_5\text{Cl}$
 D. $\text{C}_2\text{H}_6 + \cdot\text{Cl} \rightarrow \text{C}_2\text{H}_5\text{Cl} + \cdot\text{H}$

[1]

19M.1A.SL.TZ2.16

The same amount of two gases, X and Y, are in two identical containers at the same temperature. What is the difference between the gases?



- A. X has the higher molar mass.
- B. Y has the higher molar mass.
- C. X has the higher average kinetic energy.
- D. Y has the higher average kinetic energy.

[1]

21M.1A.SL.TZ2.8

Which is a d-block element? [1]

- A. Ca
- B. Cf
- C. Cl
- D. Co

21N.1A.SL.TZ0.12

The following compounds have similar relative molecular masses. What is the order of increasing boiling point?

- A. $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH} < \text{CH}_3\text{CH}_2\text{CHO} < \text{CH}_3\text{COOH}$
- B. $\text{CH}_3\text{CH}_2\text{CHO} < \text{CH}_3\text{CH}_2\text{CH}_2\text{OH} < \text{CH}_3\text{COOH}$
- C. $\text{CH}_3\text{CH}_2\text{CHO} < \text{CH}_3\text{COOH} < \text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
- D. $\text{CH}_3\text{COOH} < \text{CH}_3\text{CH}_2\text{CHO} < \text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$

[1]

21M.1A.SL.TZ1.29



Burette readings for a titration are shown.

EXAM PAPERS PRACTICE

[1]

Burette readings / $\text{cm}^3 \pm 0.05 \text{ cm}^3$	Trial 1	Trial 2	Trial 3
Final	11.35	24.60	11.70
Initial	0.20	13.50	0.50

What is the mean titre?

- A. $11.1 \text{ cm}^3 \pm 0.1 \text{ cm}^3$
- B. $11.15 \text{ cm}^3 \pm 0.05 \text{ cm}^3$
- C. $11.2 \text{ cm}^3 \pm 0.05 \text{ cm}^3$
- D. $11.2 \text{ cm}^3 \pm 0.1 \text{ cm}^3$

21N.1A.SL.TZ0.1

What is the number of hydrogen atoms in 2.00 moles of $\text{Ca}(\text{HCO}_3)_2$? [1]

Avogadro's constant, L or N_A : $6.02 \times 10^{23} \text{ mol}^{-1}$

- A. 2.00
- B. 4.00
- C. 1.20×10^{24}
- D. 2.41×10^{24}

20N.1A.SL.TZ0.22

What is correct in an electrolytic cell?

[1]

	Electrode	Process at this electrode	Electrons lost or gained at this electrode
A.	Anode (positive)	Oxidation	Gained
B.	Anode (positive)	Reduction	Lost
C.	Cathode (negative)	Oxidation	Lost
D.	Cathode (negative)	Reduction	Gained

19N.1A.SL.TZ0.20

What is the difference between a conjugate Brønsted–Lowry acid–base pair? [1]

- A. Electron pair
- B. Positive charge
- C. Proton
- D. Hydrogen atom

19N.1A.SL.TZ0.13

What is the enthalpy of combustion, ΔH_c , of ethanol in kJ mol^{-1} ? [1]

Maximum temperature of water: 30.0°C

Initial temperature of water: 20.0°C

Mass of water in beaker: 100.0 g

Loss in mass of ethanol: 0.230 g

M_r (ethanol): 46.08

Specific heat capacity of water: $4.18 \text{ J g}^{-1} \text{ K}^{-1}$

$$q = mc \Delta T$$

A. $-\frac{100.0 \times 4.18 \times (10.0 \times 273)}{0.230}$

B. $-\frac{0.0230 \times 4.18 \times 10.0}{\frac{100.0}{46.08} \times 1000}$

C. $-\frac{100.0 \times 4.18 \times 10.0}{0.230}$

D. $-\frac{100.0 \times 4.18 \times 10.0}{\frac{0.230}{46.08}}$

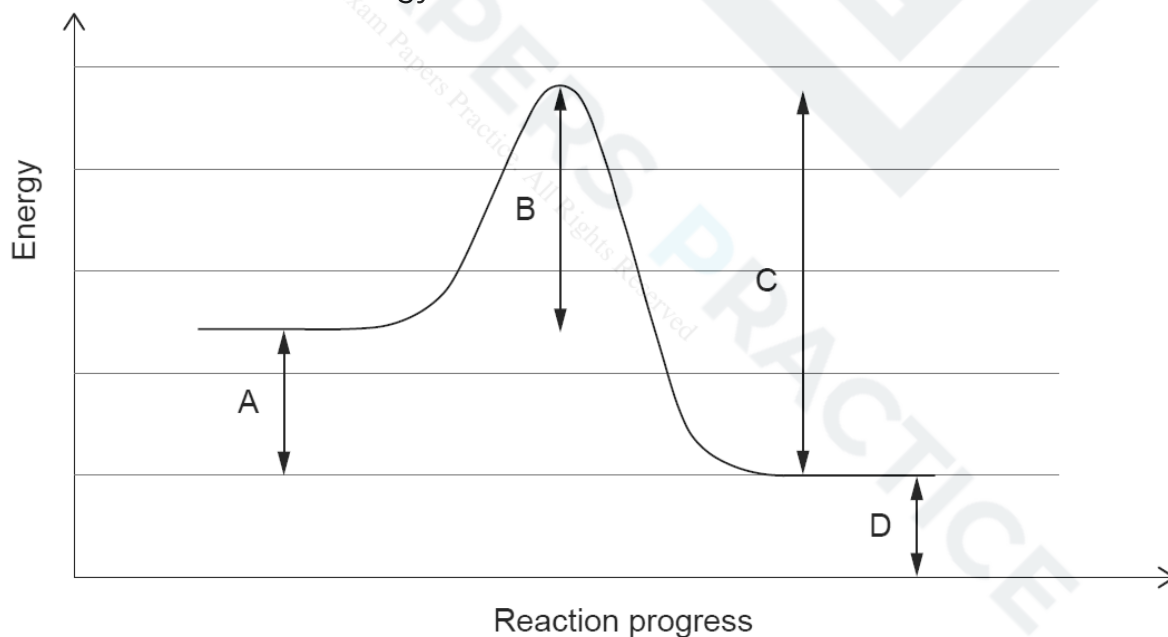
22M.1A.SL.TZ1.25

Which compounds are members of the same homologous series? [1]

- A. propanal, propanone, propanoic acid
- B. propane, propene, propyne
- C. hexan-1-ol, hexan-2-ol, hexan-3-ol
- D. ethanol, propan-1-ol, butan-1-ol

19M.1A.SL.TZ2.15

What is the activation energy of the reverse reaction? [1]



19N.1A.SL.TZ0.12

What is the structure and bonding in $\text{SiO}_2(\text{s})$? [1]



	Structure	Bonding
A.	giant	covalent
B.	giant	ionic
C.	bent molecule	covalent
D.	linear molecule	covalent

23M.1A.SL.TZ1.6

What can be deduced from the period number of an element? [1]

- . Highest occupied energy level
- . Number of sub-levels in the outer shell
- . Number of outer electrons

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

19N.1A.SL.TZ0.25

Which compound is **not** in the same homologous series as the others? [1]

- A. C_5H_{12}
- B. C_6H_{12}
- C. C_7H_{16}
- D. C_8H_{18}

20N.1A.SL.TZ0.28

A student obtained the following data to calculate q , using $q = mc\Delta T$. [1]

$$\begin{aligned}m &= 20.2 \text{ g} \pm 0.2 \text{ g} \\ \Delta T &= 10^\circ\text{C} \pm 1^\circ\text{C} \\ c &= 4.18 \text{ J g}^{-1} \text{ K}^{-1}\end{aligned}$$

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

- A. 0.2
- B. 1.2
- C. 11
- D. 14

19M.1A.SL.TZ2.19

What is the pH of $0.001 \text{ mol dm}^{-3} \text{ NaOH (aq)}$? [1]

- A. 1
- B. 3
- C. 11
- D. 13

23M.1A.SL.TZ1.28

Which change involves oxidation of N? [1]

- A. NH_3 to N_2
- B. NO_2 to NO
- C. N_2 to AlN
- D. NO_2 to N_2O_4

19M.1A.SL.TZ1.28

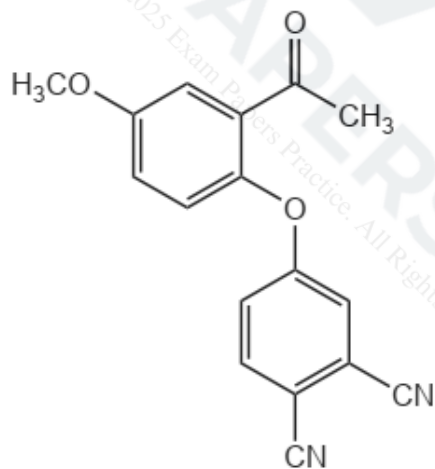
Which product will be obtained at the anode (positive electrode) when molten NaCl is electrolysed?

- A. Na (l)
- B. Cl (g)
- C. $\text{Cl}_2 \text{ (g)}$
- D. Na (s)

[1]

20N.1A.SL.TZ0.24

Which functional groups are present in this molecule? [1]



- A. carbonyl, ether, nitrile
- B. carbonyl, ester, nitrile
- C. carboxyl, ether, amine
- D. carboxyl, ester, amine

20N.1A.SL.TZ0.3

Which of these molecular formulae are also empirical formulae? [1]

- . $\text{C}_2\text{H}_6\text{O}$
- . $\text{C}_2\text{H}_4\text{O}_2$
- . C_5H_{12}
- A. I and II only
- B. I and III only
- C. II and III only

D. I, II and III

19M.1A.SL.TZ1.38

How should a measurement of 5.00 g from a balance be recorded? [1]

- A. $5.00 \pm 0.1 \text{ g}$
- B. $5.00 \pm 0.01 \text{ g}$
- C. $5.00 \pm 1 \text{ g}$
- D. $5.00 \pm 0.001 \text{ g}$

23M.1A.SL.TZ1.5

Which statement best explains the first ionization energy of sulfur being lower than that of phosphorus?

- A. Sulfur has more protons than phosphorus.
- B. Phosphorus does not have paired electrons in the outer p sub-level.
- C. Sulfur has an unpaired electron in the outer p sub-level.
- D. Phosphorus is more reactive than sulfur.

[1]

23M.1A.SL.TZ2.30

Which compound will have only one ^1H NMR signal and show a carbonyl group in the IR spectrum?

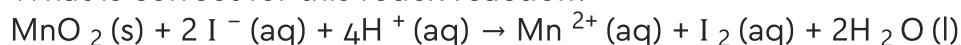
- A. CH_3CHO
- B. CH_3COOH
- C. CH_3OCH_3
- D. CH_3COCH_3

[1]

21M.1A.SL.TZ1.22

What is correct for this redox reaction?

[1]



	Reduced	Reducing agent
A.	$\text{MnO}_2(\text{s})$	$\text{I}^-(\text{aq})$
B.	$\text{I}^-(\text{aq})$	$\text{H}^+(\text{aq})$
C.	$\text{I}^-(\text{aq})$	$\text{MnO}_2(\text{s})$
D.	$\text{H}^+(\text{aq})$	$\text{I}^-(\text{aq})$

19M.1A.SL.TZ1.30

Which factors affect the amount of product formed at the cathode during electrolysis of molten salts?

- I. current
- II. time
- III. charge on the cation

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

[1]

21M.1A.SL.TZ2.22

What are the products of the electrolysis of molten potassium chloride, KCl(l) ? [1]

	Anode (positive electrode)	Cathode (negative electrode)
A.	K	Cl
B.	Cl_2	K
C.	Cl	K
D.	K	Cl_2

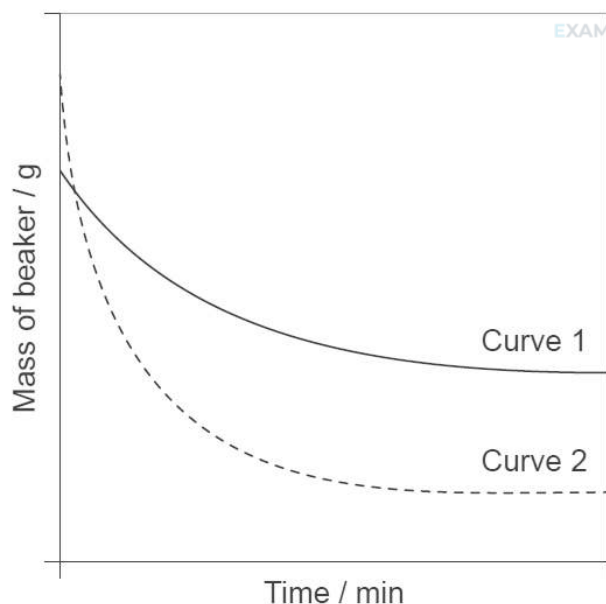
21M.1A.SL.TZ2.13

What is the electron domain geometry of Si in SiO_2 ? [1]

- A. bent
- B. linear
- C. square planar
- D. tetrahedral

21M.1A.SL.TZ1.16

Curve 1 shows the mass change when marble chips are added to excess hydrochloric acid in an open beaker.



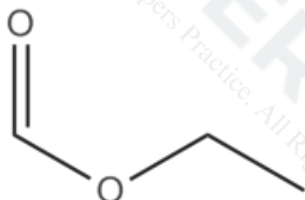
Which changes would produce curve 2?

- A. Powdering the marble chips and heating
- B. Powdering the marble chips and doubling their mass
- C. Doubling the volume of acid and heating
- D. Doubling the acid concentration and powdering the marble chips

[1]

EXM.1A.SL.TZ0.3

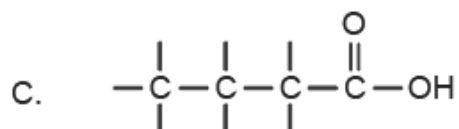
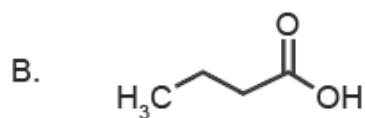
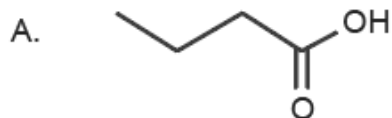
Which is the correct structural formula of this compound? [1]



- A. $\text{OCOCH}_2\text{CH}_3$
- B. HCOOC_2H_5
- C. $\text{HCOOCH}_2\text{CH}_3$
- D. $\text{OCOHC}_2\text{CH}_3$

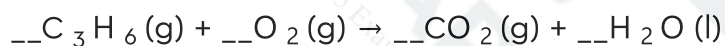
EXM.1A.SL.TZ0.2

Which of the following is the correct skeletal formula of butanoic acid? [1]



19M.1A.SL.TZ2.2

What is the sum of the integer coefficients when propene undergoes complete combustion?



- A. 11
- B. 17
- C. 21
- D. 23

[1]

19M.1A.SL.TZ1.11

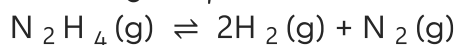
Which describes an ionic compound?

[1]

	Melting point	Electrical conductivity of solid
A.	high	high
B.	high	low
C.	low	high
D.	low	low

21N.1A.SL.TZ0.19

The equilibrium $2\text{H}_2(\text{g}) + \text{N}_2(\text{g}) \rightleftharpoons \text{N}_2\text{H}_4(\text{g})$ has an equilibrium constant, K , at 150°C . What is the equilibrium constant at 150°C , for the reverse reaction?

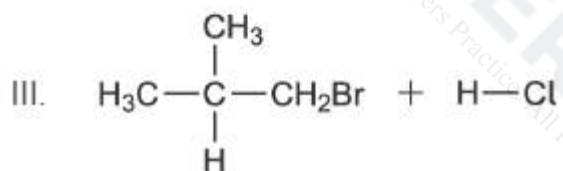
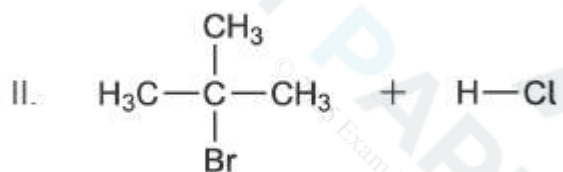
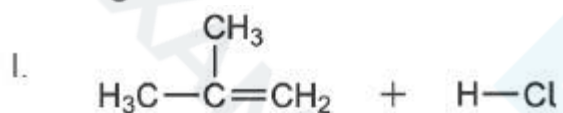
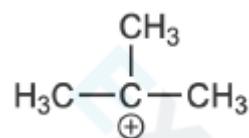


- A. K
- B. K^{-1}
- C. $-K$
- D. $2K$

[1]

23M.1A.SL.TZ1.36

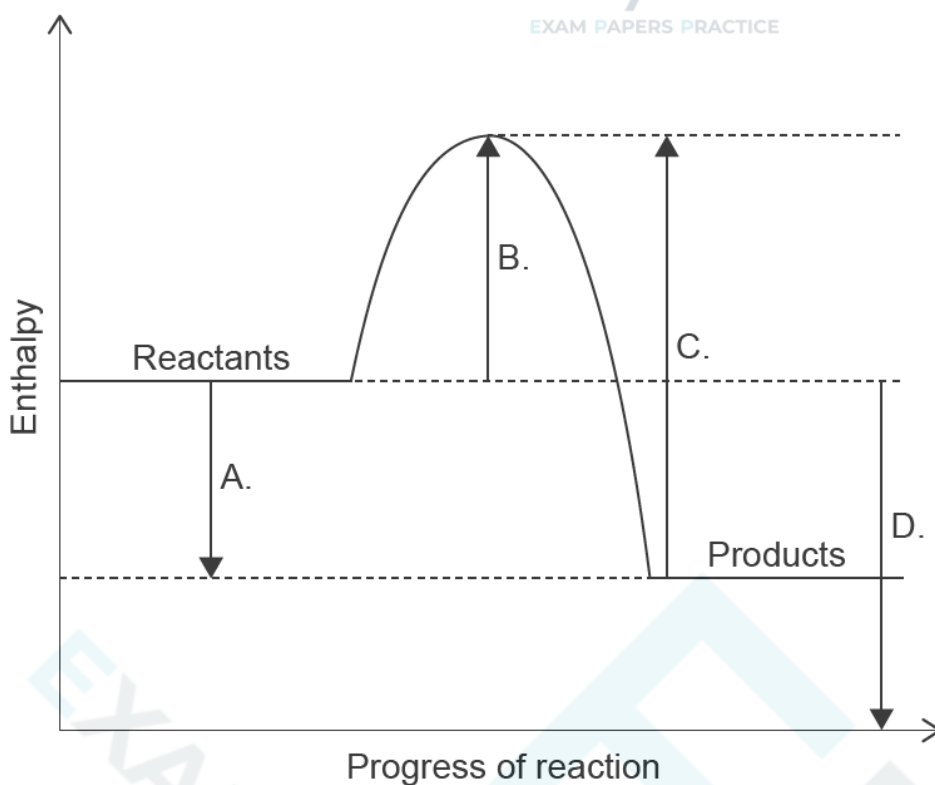
Which pairs of reactants could produce the following intermediate? [1]



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

21M.1A.SL.TZ2.15

Which is the enthalpy change of reaction, ΔH ? [1]



23M.1A.SL.TZ2.6

Which sequence has the oxides arranged in order of increasing acidity? [1]

- A. $\text{Na}_2\text{O} < \text{Al}_2\text{O}_3 < \text{SO}_3$
- B. $\text{Al}_2\text{O}_3 < \text{SO}_3 < \text{Na}_2\text{O}$
- C. $\text{SO}_3 < \text{Na}_2\text{O} < \text{Al}_2\text{O}_3$
- D. $\text{SO}_3 < \text{Al}_2\text{O}_3 < \text{Na}_2\text{O}$

23M.1A.SL.TZ2.36

The observed specific optical rotation, $[\alpha]$, of a compound is $+7.00^\circ$. What is the specific optical rotation of a racemate of this compound?

- A. -7.00°
- B. 0.00°
- C. $+7.00^\circ$
- D. $+14.00^\circ$

[1]

21N.1A.SL.TZ0.13

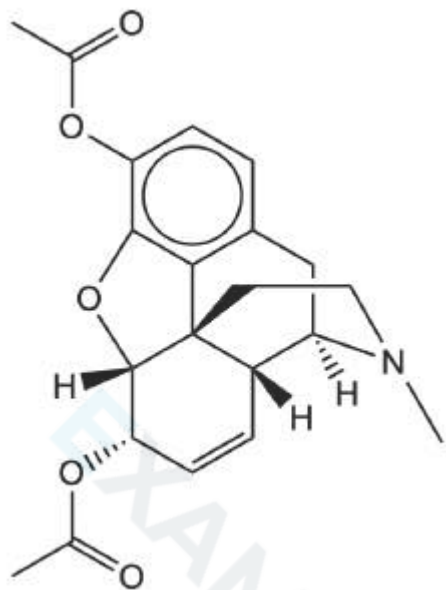
Which alcohol is **least** soluble in water? [1]

- A. CH_3OH
- B. $\text{CH}_3\text{CH}_2\text{OH}$
- C. $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$

D. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$

SPM.1A.SL.TZ0.12

Which functional groups are present in this molecule? [1]



- A. amino, alkoxy, ester
- B. ether, carboxyl, amino
- C. carboxyl, alkoxy, ester
- D. ester, amino, carboxyl

23M.1A.SL.TZ2.1

Which is the correct equation for the electrolysis of molten sodium chloride? [1]

- A. $2\text{NaCl (l)} \rightarrow 2\text{Na (l)} + \text{Cl}_2 \text{ (g)}$
- B. $2\text{NaCl (s)} \rightarrow 2\text{Na (s)} + \text{Cl}_2 \text{ (g)}$
- C. $2\text{NaCl (l)} \rightarrow 2\text{Na (s)} + \text{Cl}_2 \text{ (g)}$
- D. $2\text{NaCl (aq)} \rightarrow 2\text{Na (s)} + \text{Cl}_2 \text{ (g)}$

19M.1A.SL.TZ1.7

Which series represents atoms in order of decreasing atomic radius? [1]

- A. $\text{N} > \text{C} > \text{Be} > \text{Mg}$
- B. $\text{Mg} > \text{N} > \text{C} > \text{Be}$
- C. $\text{Be} > \text{C} > \text{N} > \text{Mg}$
- D. $\text{Mg} > \text{Be} > \text{C} > \text{N}$

EXM.1A.SL.TZ0.5

Which is the product when but-1-yne reacts with excess hydrogen gas? [1]

- A. But-1-ene
- B. Butane
- C. But-2-ene
- D. No reaction

20N.1A.SL.TZ0.10

Which molecule is most polar? [1]

- A. CHF_3
- B. CF_4
- C. CClF_3
- D. CCl_4

19M.1A.SL.TZ2.37

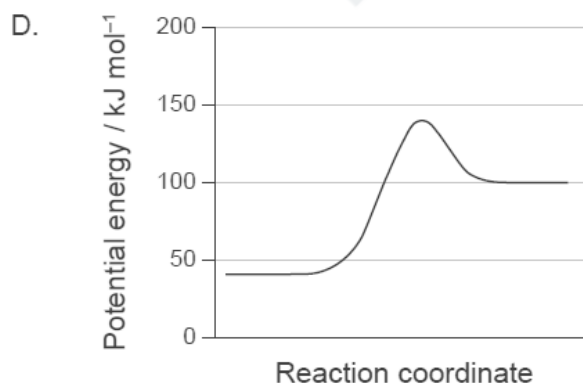
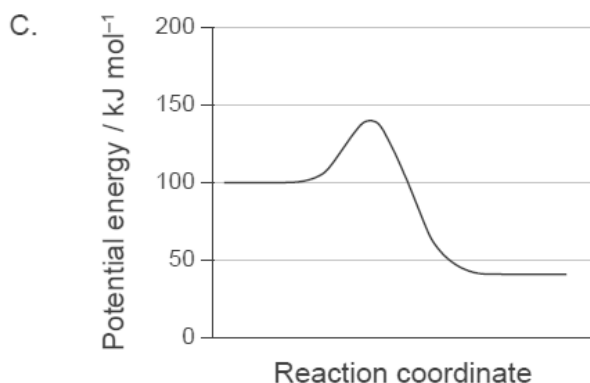
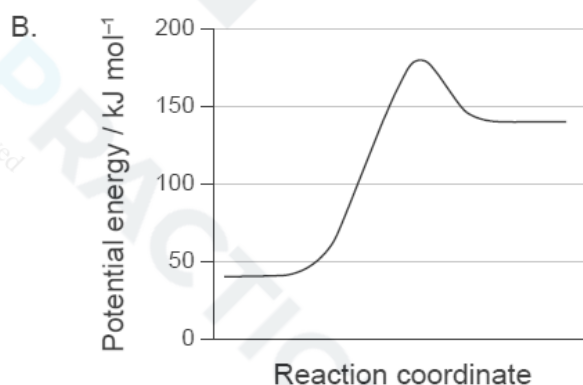
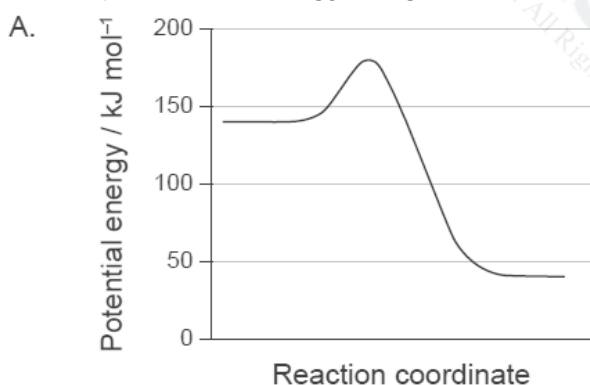
Which class of compound is formed when a ketone is reduced? [1]

- A. primary alcohol
- B. secondary alcohol
- C. ether
- D. carboxylic acid

22M.1A.SL.TZ2.17

A reaction has an activation energy of 40 kJ mol^{-1} and an enthalpy change of -60 kJ mol^{-1} .

Which potential energy diagram illustrates this reaction?



[1]

19M.1A.SL.TZ1.20

Which is **not** a source of oxides of sulfur and nitrogen? [1]

- A. burning coal
- B. internal combustion engines
- C. burning methane
- D. volcanic eruptions

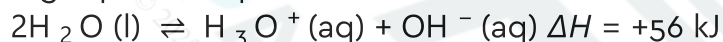
19M.1A.SL.TZ1.4

What is the ground state electron configuration of an atom of chromium, Cr ($Z = 24$)? [1]

- A. $[\text{Ar}]3d^6$
- B. $[\text{Ar}]4s^2 3d^4$
- C. $[\text{Ar}]4s^1 3d^5$
- D. $[\text{Ar}]4s^2 4p^4$

19M.1A.SL.TZ2.27

The following equation represents the dissociation of water at 25°C . [1]



Which changes occur as the temperature increases?

- A. $[\text{H}_3\text{O}^+]$ increases and pH will decrease.
- B. $[\text{H}_3\text{O}^+]$ decreases and pH will increase.
- C. $[\text{H}_3\text{O}^+]$ increases and pH will increase.
- D. $[\text{H}_3\text{O}^+]$ decreases and pH will decrease.

21N.1A.SL.TZ0.23

Which statement is correct about the electrolysis of molten lead(II) bromide, PbBr_2 ? [1]

- A. Br^- ions accept electrons at the cathode (negative electrode).
- B. Pb^{2+} ions accept electrons at the anode (positive electrode).
- C. Br^- ions lose electrons at the anode (positive electrode).
- D. Pb^{2+} ions lose electrons at the cathode (negative electrode).

19N.1A.SL.TZ0.3

Which is correct?

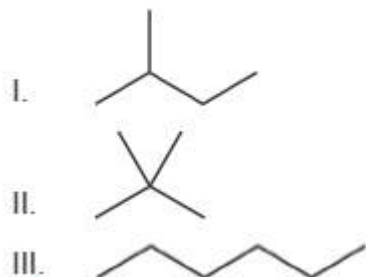
- A. Mixtures are either homogeneous or heterogeneous and their chemical properties are an average of the individual component properties.
- B. Mixtures are never heterogeneous and their chemical properties are an average of the individual component properties.
- C. Mixtures are either homogeneous or heterogeneous and the components retain their individual chemical properties.

D. Mixtures are never homogeneous and the components retain their individual chemical properties.

[1]

22N.1A.SL.TZ0.24

Which are isomers of C_5H_{12} ? [1]



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

21M.1A.SL.TZ1.11

Which substance is most likely to be ionic?

	Melting point	Solubility in hexane	Electrical conductivity of solid
A.	High	Low	High
B.	Low	Low	Low
C.	Low	High	Low
D.	High	Low	Low

[1]

21M.1A.SL.TZ1.7

Which species has the same electron configuration as argon? [1]

- A. Br^-
B. Ca^{2+}
C. Al^{3+}
D. Si^{4+}

EXM.1A.SL.TZ0.1

Which of the following is most likely to be a transition metal?

[1]



	Melting point	Electrical conductivity	Ductility
A.	High	Good	Low
B.	High	Poor	Low
C.	High	Good	High
D.	Low	Good	High

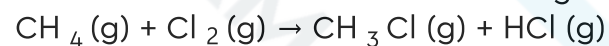
21M.1A.SL.TZ1.12

Along which series is the bond angle increasing? [1]

- A. NH_3 H_2O CH_4
- B. CH_4 NH_3 H_2O
- C. H_2O NH_3 CH_4
- D. H_2O CH_4 NH_3

19M.1A.SL.TZ2.33

Methane reacts with chlorine in sunlight. [1]



Which type of reaction occurs?

- A. free-radical substitution
- B. electrophilic substitution
- C. nucleophilic substitution
- D. electrophilic addition

22M.1A.SL.TZ1.1

2.67 g of lead (II) carbonate is decomposed by heating until constant mass. [1]



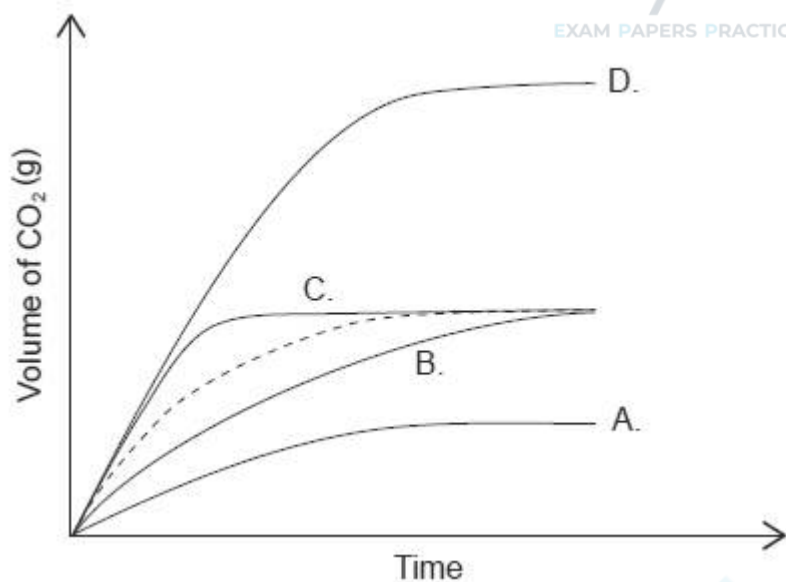
What is the final mass of solid?

- A. 0.44 g
- B. 2.23 g
- C. 2.67 g
- D. 3.11 g

19N.1A.SL.TZ0.17

The dotted line represents the volume of carbon dioxide evolved when excess calcium carbonate is added to hydrochloric acid.

Which graph represents the production of carbon dioxide when excess calcium carbonate is added to the same volume of hydrochloric acid of double concentration?



[1]

SPM.1A.SL.TZ0.23

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.

[1]

23M.1A.SL.TZ2.25

Which products could be obtained by heating isomers of C_3H_8O under reflux with acidified potassium dichromate (VI)?

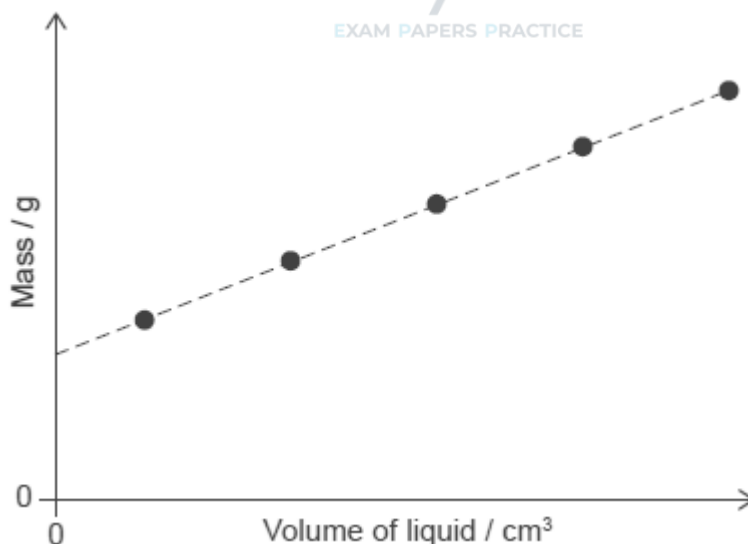
- . I. propanal
- . II. propanone
- . III. propanoic acid

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

[1]

21M.1A.SL.TZ2.30

A liquid was added to a graduated cylinder. What can be deduced from the graph? [1]



	Gradient	y-intercept
A.	density of liquid	amount of liquid
B.	density of liquid	mass of empty cylinder
C.	rate of adding liquid	amount of liquid
D.	rate of adding liquid	mass of empty cylinder

19M.1A.SL.TZ2.21

Which species contains nitrogen with the highest oxidation state? [1]

- A. NO_3^-
- B. NO_2^-
- C. NO_2
- D. N_2O

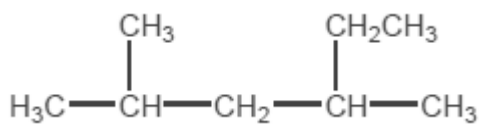
22N.1A.SL.TZ0.17

Which changes would increase the rate of an exothermic reaction? [1]

	Temperature	Particle size
A.	Increase	Decrease
B.	Increase	Increase
C.	Decrease	Increase
D.	Decrease	Decrease

21M.1A.SL.TZ2.25

What is the IUPAC name of the molecule shown? [1]



- A. 2,4-dimethylhexane
- B. 3,5-dimethylhexane
- C. 2-methyl-4-ethylpentane
- D. 2-ethyl-4-methylpentane

19N.1A.SL.TZ0.22

In which species does sulfur have the same oxidation state as in SO_3^{2-} ? [1]

- A. $\text{S}_2\text{O}_3^{2-}$
- B. SO_4^{2-}
- C. H_2S
- D. SOCl_2

19M.1A.SL.TZ1.27

Which has the strongest conjugate base? [1]

- A. HCOOH ($K_a = 1.8 \times 10^{-4}$)
- B. HNO_2 ($K_a = 7.2 \times 10^{-4}$)
- C. HCN ($K_a = 6.2 \times 10^{-10}$)
- D. HIO_3 ($K_a = 1.7 \times 10^{-1}$)

22M.1A.SL.TZ1.34

Which reagents and conditions are best for converting propan-1-ol into propanoic acid?

- A. Reflux with acidified potassium dichromate (VI)
- B. Reflux with LiAlH_4
- C. Distil with acidified potassium dichromate (VI)
- D. Distil with LiAlH_4

[1]

22M.1A.SL.TZ1.27

What is produced when chlorobutane is treated with aqueous sodium hydroxide solution?

- A. butane
- B. butanoic acid
- C. butanal
- D. butan-1-ol

[1]

19N.1A.SL.TZ0.14

Which quantity is likely to be the most inaccurate due to the sources of error in this experiment?

- A. Mass of ethanol burnt
- B. Molecular mass of ethanol
- C. Mass of water
- D. Temperature change

[1]

22M.1A.SL.TZ1.28

A student performed an experiment to find the melting point of sulfur, obtaining 118.0 °C. The literature value is 115.2 °C. What was the percentage error?

- A. $\frac{118.0 - 115.2}{115.2} \times 100 \%$
- B. $\frac{115.2}{118.0} \times 100 \%$
- C. $\frac{118.0}{118.0 - 115.2} \times 100 \%$
- D. $\frac{118.0}{115.2} \times 100 \%$

[1]

20N.1A.SL.TZ0.19

Which substance will **not** produce copper(II) chloride when added to dilute hydrochloric acid?

- A. Cu s
- B. Cu (OH)₂ (s)
- C. CuCO₃ (s)
- D. CuO (s)

[1]

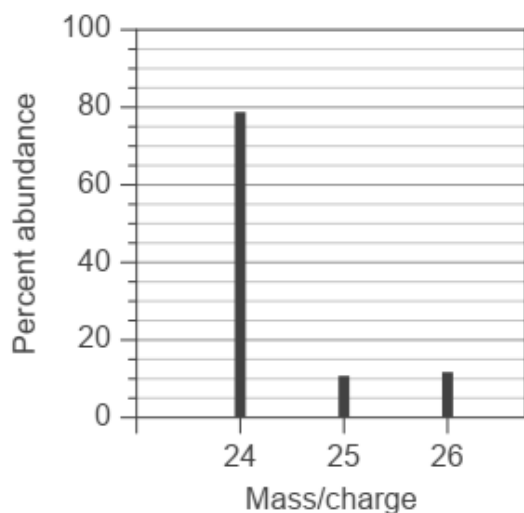
22M.1A.SL.TZ2.21

Which species could be reduced to form NO₂? [1]

- A. N₂
- B. NO₃⁻
- C. HNO₂
- D. NO

20N.1A.SL.TZ0.5

What is the relative atomic mass, A_r, of an element with this mass spectrum? [1]



- A. 24 . 0
- B. 24 . 3
- C. 24 . 9
- D. 25 . 0

23M.1A.SL.TZ1.17

What happens to the average kinetic energy, KE, of the particles in a gas when the absolute temperature is doubled?

$$KE = \frac{1}{2} mv^2$$

- A. Increases by a factor of 2
- B. Decreases by a factor of 2
- C. Increases by a factor of 4
- D. Decreases by a factor of 4

[1]

21N.1A.SL.TZ0.11

Which compound contains both ionic and covalent bonds? [1]

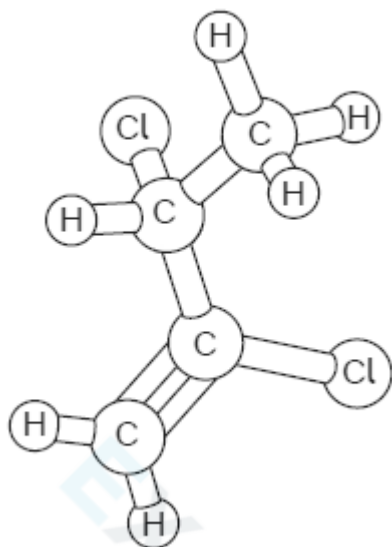
- A. CH_3COONa
- B. CH_3COOH
- C. K_2O
- D. CaCl_2

23M.1A.SL.TZ2.21

Which value increases when the temperature of a reaction increases? [1]

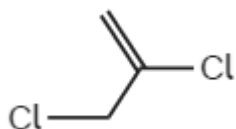
- A. Activation energy
- B. Rate constant
- C. Enthalpy of reaction
- D. Equilibrium constant for exothermic reaction

Which is a correct alternative representation of this molecule? [1]



A. $C_3H_6Cl_2$

B.



C. 2,2-dichlorobut-1-ene

D. $CH_3CHClC(Cl)=CH_2$

21N.1A.SL.TZ0.10

Which combination would create the strongest ionic bond? [1]

	Ionic radius	Charges on ions
A.	large	high
B.	large	low
C.	small	high
D.	small	low

22N.1A.SL.TZ0.18

The exothermic reaction $I_2(g) + 3Cl_2(g) \rightleftharpoons 2ICl_3(g)$ is at equilibrium in a fixed volume. What is correct about the reaction quotient, Q , and shift in position of equilibrium the instant temperature is raised?

A. $Q > K$, equilibrium shifts right towards products.

B. $Q > K$, equilibrium shifts left towards reactants.

C. $Q < K$, equilibrium shifts right towards products.

D. $Q < K$, equilibrium shifts left towards reactants.

[1]

19M.1A.SL.TZ2.10

Which combination causes the strength of metallic bonding to increase? [1]

	Charge on cations	Ionic radius
A.	smaller	smaller
B.	larger	larger
C.	smaller	larger
D.	larger	smaller

23M.1A.SL.TZ2.15

When 100 cm^3 of 1.0 mol dm^{-3} HCl is mixed with 100 cm^3 of 1.0 mol dm^{-3} NaOH, the temperature of the resulting solution increases by 5.0°C . What will be the temperature change, in $^\circ\text{C}$, when 50 cm^3 of 2.0 mol dm^{-3} HCl is mixed with 50 cm^3 of 2.0 mol dm^{-3} NaOH?

- A. 2.5
- B. 5.0
- C. 10
- D. 20

[1]

19N.1A.SL.TZ0.8

Which is an f-block element? [1]

- A. Sc
- B. Sm
- C. Sn
- D. Sr

19M.1A.SL.TZ1.31

Which is **not** a requirement of the standard hydrogen electrode (SHE)? [1]

- A. $V = 1 \text{ dm}^3$
- B. $p(\text{H}_2) = 100 \text{ kPa}$
- C. use of platinum as the electrode material
- D. $[\text{H}_3\text{O}^+] = 1 \text{ mol dm}^{-3}$

23M.1A.SL.TZ1.35

Which molecule is optically active? [1]

- A. 2,2-dichloropropane
- B. 1,2-dichloropropane
- C. 1,3-dichloropropane
- D. 1,2,3-trichloropropane

21N.1A.SL.TZ0.26

Which pair of compounds are structural isomers? [1]

- A. Propane and propene
- B. Propanal and propanone
- C. Propan-1-ol and propanal
- D. Propyl propanoate and propanoic acid

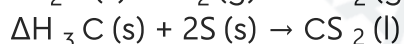
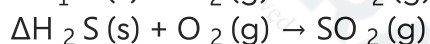
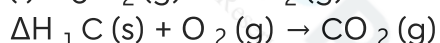
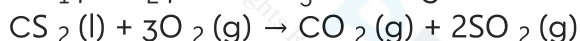
22M.1A.SL.TZ1.10

What is the explanation for the high melting point of sodium chloride? [1]

- A. The covalent bond between sodium and chlorine atoms is strong.
- B. Electrostatic attraction between sodium and chloride ions is strong.
- C. Intermolecular forces in sodium chloride are strong.
- D. Delocalized electrons cause strong bonding in sodium chloride.

22M.1A.SL.TZ2.14

Which combination of ΔH_1 , ΔH_2 , and ΔH_3 would give the enthalpy of the reaction? [1]



- A. $\Delta H = \Delta H_1 + \Delta H_2 + \Delta H_3$
- B. $\Delta H = \Delta H_1 + \Delta H_2 - \Delta H_3$
- C. $\Delta H = \Delta H_1 + 2(\Delta H_2) + \Delta H_3$
- D. $\Delta H = \Delta H_1 + 2(\Delta H_2) - \Delta H_3$

22M.1A.SL.TZ2.16

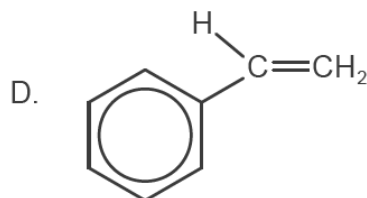
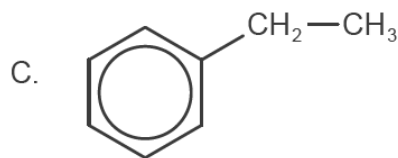
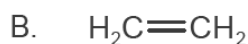
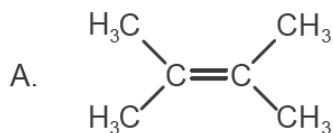
Why does a reaction for a sample of gases, at constant temperature, occur faster at higher pressure?

- A. Collisions are more frequent.
- B. Collisions are more energetic.
- C. High pressure lowers activation energy.
- D. The reaction is more exothermic at high pressure.

[1]

19N.1A.SL.TZ0.28

Which compound **cannot** undergo addition polymerization? [1]



22M.1A.SL.TZ2.2

30 g of an organic compound produces 44 g CO_2 and 18 g H_2O as the only combustion products. Which of the following is the empirical formula for this compound?

$$M_r \text{CO}_2 = 44 \quad M_r \text{H}_2\text{O} = 18$$

- A. CH_2
- B. CH_3
- C. CHO
- D. CH_2O

[1]

SPM.1A.SL.TZ0.25

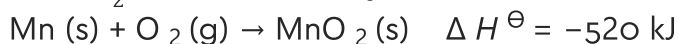
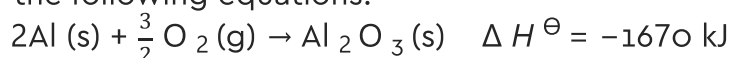
Which reactions involve the transfer of a proton? [1]

- I. $2\text{HCl}(\text{aq}) + \text{Mg}(\text{s}) \rightarrow \text{MgCl}_2(\text{aq}) + \text{H}_2(\text{g})$
- II. $2\text{HCl}(\text{aq}) + \text{MgO}(\text{s}) \rightarrow \text{MgCl}_2(\text{aq}) + \text{H}_2\text{O}(\text{l})$
- III. $2\text{HCl}(\text{aq}) + \text{MgCO}_3(\text{s}) \rightarrow \text{MgCl}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$

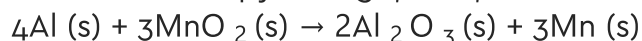
- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

19M.1A.SL.TZ2.13

Consider the following equations. [1]



What is the standard enthalpy change, in kJ, of the reaction below?



- A. $-1670 + 520$
- B. $\frac{3}{2}(-1670) + 3(520)$
- C. $2(-1670) + 3(-520)$

D. $2(-1670) + 3(520)$

21M.1A.SL.TZ2.19

Which explains increasing rate of reaction with increasing temperature? [1]

	Particles with $E > E_a$	Frequency of collisions
A.	same	same
B.	more	greater
C.	same	greater
D.	more	same

19M.1A.SL.TZ2.3

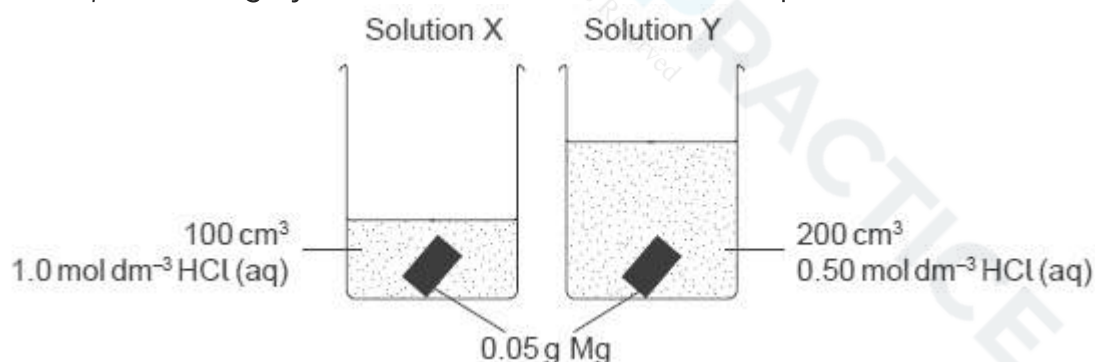
What is the volume of gas when the pressure on 100 cm^3 of gas is changed from 400 kPa to 200 kPa at constant temperature?

- A. 50.0 cm^3
- B. 100 cm^3
- C. 200 cm^3
- D. 800 cm^3

[1]

22M.1A.SL.TZ2.15

Which statement is correct about identical pieces of magnesium added to two solutions, X and Y, containing hydrochloric acid at the same temperature?

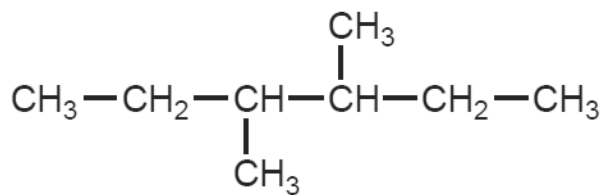


- A. Solution X will reach a higher maximum temperature.
- B. Solution Y will reach a higher maximum temperature.
- C. Solutions X and Y will have the same temperature rise.
- D. It is not possible to predict whether X or Y will have the higher maximum temperature because we cannot identify the limiting reactant.

[1]

19M.1A.SL.TZ2.34

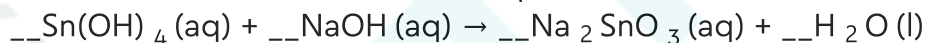
What is the name of this compound using IUPAC rules? [1]



- A. 2,3-diethylbutane
- B. 2-ethyl-3-methylpentane
- C. 3-methyl-4-ethylpentane
- D. 3,4-dimethylhexane

21M.1A.SL.TZ2.4

What is the sum of the coefficients when the equation is balanced with whole numbers?



- A. 4
- B. 5
- C. 6
- D. 7

[1]

23M.1A.SL.TZ2.17

Which is correct when $\Delta H - T\Delta S = 0$? [1]

- A. Forward reaction is favoured.
- B. Reverse reaction is favoured.
- C. Reaction is in a state of equilibrium.
- D. No chemical changes can occur.

22M.1A.SL.TZ1.26

Which reagents and conditions are best for converting propan-1-ol into propanoic acid?

- A. Reflux with acidified potassium dichromate (VI)
- B. Reflux with aqueous sodium hydroxide
- C. Distil with acidified potassium dichromate (VI)
- D. Distil with aqueous sodium hydroxide

[1]

21N.1A.SL.TZ0.21

What is the conjugate acid of HS^- ? [1]

- A. H_2S

- B. S^{2-}
- C. H_2SO_3
- D. H_2SO_4

23M.1A.SL.TZ1.4

What is the maximum number of electrons in energy level $n = 4$? [1]

- A. 8
- B. 18
- C. 32
- D. 50

21N.1A.SL.TZ0.27

What is the general formula of alkynes? [1]

- A. C_nH_{2n+2}
- B. C_nH_{2n}
- C. C_nH_{2n-2}
- D. C_nH_n

23M.1A.SL.TZ2.28

Which species is the oxidizing agent? [1]
 $14H^+(aq) + 2Mn^{2+}(aq) + 5BiO_3^-(aq) \rightarrow 2MnO_4^-(aq) + 5Bi^{3+}(aq) + 7H_2O(l)$

- A. $H^+(aq)$
- B. $Mn^{2+}(aq)$
- C. $BiO_3^-(aq)$
- D. $MnO_4^-(aq)$

SPM.1A.SL.TZ0.11

What is the explanation for the malleability of metals? [1]

- 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.

22N.1A.SL.TZ0.7

Which elements are considered to be metalloids? [1]

- I. Gallium
- II. Germanium
- III. Arsenic

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

23M.1A.SL.TZ2.4

What is the correct ground state electron orbital configuration for $2s^2 2p^2$? [1]

- | | 2s | | 2p | | |
|----|-----------|--|-----------|---|--|
| A. | ↑↓ | | ↑ | ↑ | |
| B. | ↑↓ | | ↑ | ↓ | |
| C. | ↑↑ | | ↑ | ↑ | |
| D. | ↑↑ | | ↑ | ↓ | |

19M.1A.SL.TZ2.7

How do the following properties change down Group 17 of the periodic table? [1]

	Ionization energy	Ionic radius
A.	increases	decreases
B.	increases	increases
C.	decreases	increases
D.	decreases	decreases

19M.1A.SL.TZ2.20

- Which statement is correct about a catalyst? [1]
- A. It decreases the activation energy of the forward reaction but not the reverse.
 - B. It increases the proportion of products to reactants in an equilibrium.
 - C. It decreases the enthalpy change of the reaction.
 - D. It changes the mechanism of the reaction.

21N.1A.SL.TZ0.14



Which combustion reaction releases the **least** energy per mole of C_3H_8 ?

Approximate bond enthalpy / kJ mol^{-1}

$\text{O}=\text{O}$ 500

$\text{C}=\text{O}$ 800

$\text{C}\equiv\text{O}$ 1000

- A. $\text{C}_3\text{H}_8(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 3\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\text{g})$
 B. $\text{C}_3\text{H}_8(\text{g}) + \frac{9}{2}\text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) + \text{CO}(\text{g}) + 4\text{H}_2\text{O}(\text{g})$
 C. $\text{C}_3\text{H}_8(\text{g}) + 4\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{CO}(\text{g}) + 4\text{H}_2\text{O}(\text{g})$
 D. $\text{C}_3\text{H}_8(\text{g}) + \frac{7}{2}\text{O}_2(\text{g}) \rightarrow 3\text{CO}(\text{g}) + 4\text{H}_2\text{O}(\text{g})$

*Chemistry: Atoms First 2e, <https://openstax.org/books/chemistry-atoms-first-2e/pages/9-4-strengths-of-ionic-and-covalent-bonds> © 1999–2021, Rice University. Except where otherwise noted, textbooks on this site are licensed under a Creative Commons Attribution 4.0 International License.
 (CC BY 4.0) <https://creativecommons.org/licenses/by/4.0/>.*

[1]

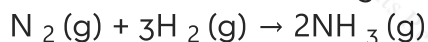
22M.1A.SL.TZ2.26

Which is a homologous series? [1]

- A. C_2H_4 , C_3H_5 , C_4H_6
 B. C_2H_2 , C_3H_4 , C_4H_6
 C. C_2H_2 , C_2H_4 , C_2H_6
 D. C_2H_2 , C_4H_4 , C_6H_6

23M.1A.SL.TZ2.13

The enthalpy of formation of ammonia gas is -46 kJ mol^{-1} . [1]



What is the energy released, in kJ, in the reaction?

- A. 23
 B. 46
 C. 69
 D. 92

23M.1A.SL.TZ2.10

Which are the correct sequences of **increasing** bond strengths and bond lengths between two carbon atoms?

Bond strength

Bond length

- | | | |
|----|--|--|
| A. | $\text{C}\equiv\text{C} < \text{C}=\text{C} < \text{C}-\text{C}$ | $\text{C}\equiv\text{C} < \text{C}=\text{C} < \text{C}-\text{C}$ |
| B. | $\text{C}\equiv\text{C} < \text{C}=\text{C} < \text{C}-\text{C}$ | $\text{C}-\text{C} < \text{C}=\text{C} < \text{C}\equiv\text{C}$ |
| C. | $\text{C}-\text{C} < \text{C}=\text{C} < \text{C}\equiv\text{C}$ | $\text{C}\equiv\text{C} < \text{C}=\text{C} < \text{C}-\text{C}$ |
| D. | $\text{C}-\text{C} < \text{C}=\text{C} < \text{C}\equiv\text{C}$ | $\text{C}-\text{C} < \text{C}=\text{C} < \text{C}\equiv\text{C}$ |

[1]

19M.1A.SL.TZ2.6

Which transition in the hydrogen atom emits visible light? [1]

- A. $n = 1$ to $n = 2$
- B. $n = 2$ to $n = 3$
- C. $n = 2$ to $n = 1$
- D. $n = 3$ to $n = 2$

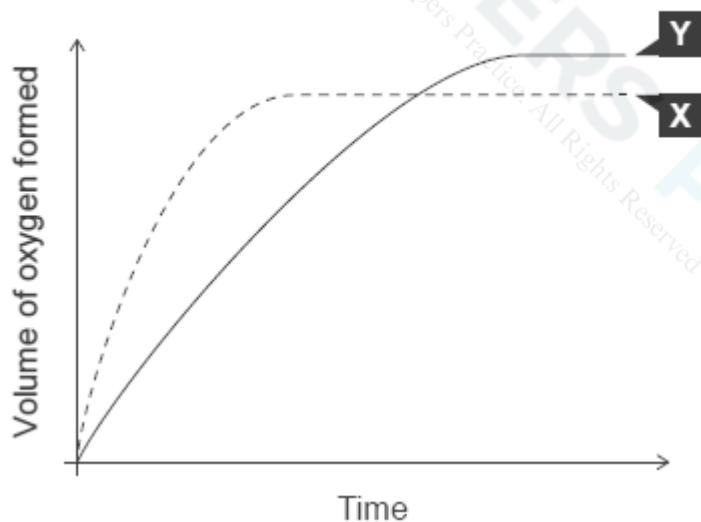
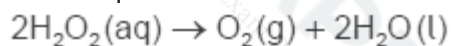
20N.1A.SL.TZ0.36

What will be the major product in the reaction between but-1-ene and HBr? [1]

- A. 2-bromobut-1-ene
- B. 1-bromobut-1-ene
- C. 2-bromobutane
- D. 1-bromobutane

23M.1A.SL.TZ2.18

Curve **X** on the following graph shows the volume of oxygen formed during the catalytic decomposition of a 1.0 mol dm^{-3} solution of hydrogen peroxide.



Which change would produce the curve **Y**?

- A. Adding water.
- B. Adding some 0.1 mol dm^{-3} hydrogen peroxide solution.
- C. Adding some 2.0 mol dm^{-3} hydrogen peroxide solution.
- D. Repeating the experiment without a catalyst.

[1]

21M.1A.SL.TZ1.14

What is the enthalpy change, **in J**, when 5 g of water is heated from 10°C to 18°C? [1]
Specific heat capacity of water: 4.18 kJ kg⁻¹ K⁻¹

- A. $5 \times 4.18 \times 8$
- B. $5 \times 10^{-3} \times 4.18 \times 8$
- C. $5 \times 4.18 \times (273 + 8)$
- D. $5 \times 10^{-3} \times 4.18 \times (273 + 8)$

19M.1A.SL.TZ1.22

Which is the species oxidized and the oxidizing agent in the reaction? [1]



	Species oxidized	Oxidizing agent
A.	Cl^-	HCl
B.	MnO_2	MnO_2
C.	MnO_2	HCl
D.	Cl^-	MnO_2

22M.1A.SL.TZ2.24

What happens to the amount of hydroxide ions and hydroxide ion concentration when water is added to a solution of $\text{NH}_3(\text{aq})$?

	$n(\text{OH}^-)$	$[\text{OH}^-]$
A.	Increases	Increases
B.	Decreases	Decreases
C.	Increases	Decreases
D.	Decreases	Increases

[1]

23M.1A.SL.TZ2.29

Which chemical process would produce a voltaic cell? [1]

- A. spontaneous redox reaction
- B. spontaneous non-redox reaction
- C. non-spontaneous redox reaction
- D. non-spontaneous non-redox reaction

21M.1A.SL.TZ2.10

Which compound has the shortest C to N bond? [1]

- A. HCN
- B. $\text{CH}_3\text{CH}_2\text{NH}_2$
- C. CH_3CHNH
- D. $(\text{CH}_3)_2\text{NH}$

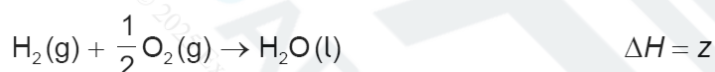
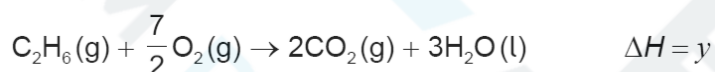
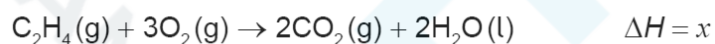
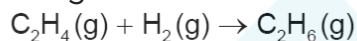
22M.1A.SL.TZ1.8

Which of the following is the electron configuration of a metallic element? [1]

- A. $[\text{Ne}] 3s^2 3p^2$
- B. $[\text{Ne}] 3s^2 3p^4$
- C. $[\text{Ne}] 3s^2 3p^6 3d^3 4s^2$
- D. $[\text{Ne}] 3s^2 3p^6 3d^{10} 4s^2 4p^5$

19M.1A.SL.TZ1.14

What is the enthalpy change of reaction for the following equation? [1]



- A. $x + y + z$
- B. $-x - y + z$
- C. $x - y - z$
- D. $x - y + z$

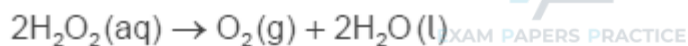
22M.1A.SL.TZ1.6

What is the maximum number of electrons that can occupy a p-orbital? [1]

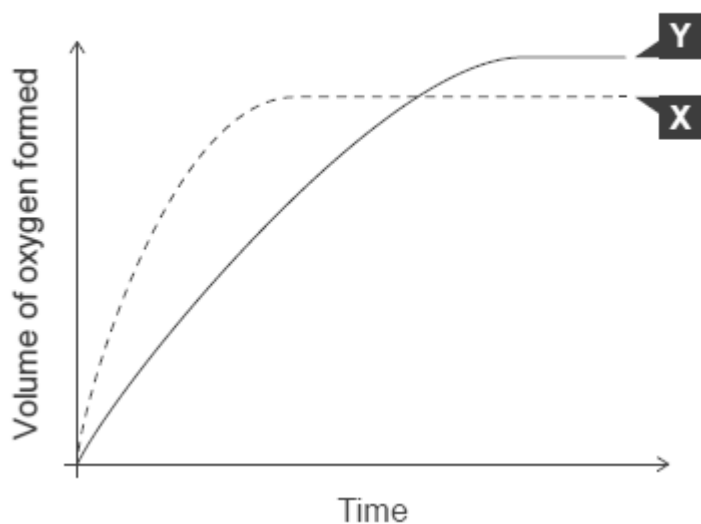
- A. 2
- B. 3
- C. 6
- D. 8

23M.1A.SL.TZ2.16

Curve **X** on the following graph shows the volume of oxygen formed during the catalytic decomposition of a 1.0 mol dm^{-3} solution of hydrogen peroxide.



XAM PAPERS PRACTICE



Which change would produce the curve ?

- A. Adding water.
- B. Adding some 0.1 mol dm^{-3} hydrogen peroxide solution.
- C. Adding some 2.0 mol dm^{-3} hydrogen peroxide solution.
- D. Repeating the experiment without a catalyst.

[1]

19M.1A.SL.TZ1.19

Which conditions are required for the reaction between two molecules? [1]

- I. a collision
 - II. $E \geq E_a$
 - III. proper orientation
- A. I and II only
 - B. I and III only
 - C. II and III only
 - D. I, II and III

23M.1A.SL.TZ1.9

Which substance is likely to have an ionic lattice structure at 298 K and 100 kPa? [1]

	Melting point	Conducts electricity in a liquid state?
A.	low	yes
B.	low	no
C.	high	no
D.	high	yes

23M.1A.SL.TZ2.38

Which observation would explain a systematic error for an experiment involving the combustion of magnesium to find the empirical formula of its oxide?

- A. The crucible lid was slightly ajar during heating.
- B. The product was a white powdery substance.
- C. The crucible had black soot on the bottom after heating.
- D. The flame colour during heating was yellow.

[1]

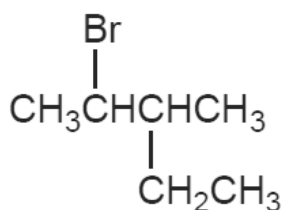
19M.1A.SL.TZ2.8

How do the following properties change down Group 17 of the periodic table? [1]

	Ionization energy	Ionic radius
A.	increases	decreases
B.	increases	increases
C.	decreases	increases
D.	decreases	decreases

19M.1A.SL.TZ1.25

What is the IUPAC name of the following molecule? [1]



- A. 2-bromo-3-ethylbutane
- B. 3-methyl-4-bromopentane
- C. 2-ethyl-3-bromobutane
- D. 2-bromo-3-methylpentane

20N.1A.SL.TZ0.1

What is the molar mass, in g mol^{-1} , of a compound if 0.200 mol of the compound has a mass of 13.2 g ?

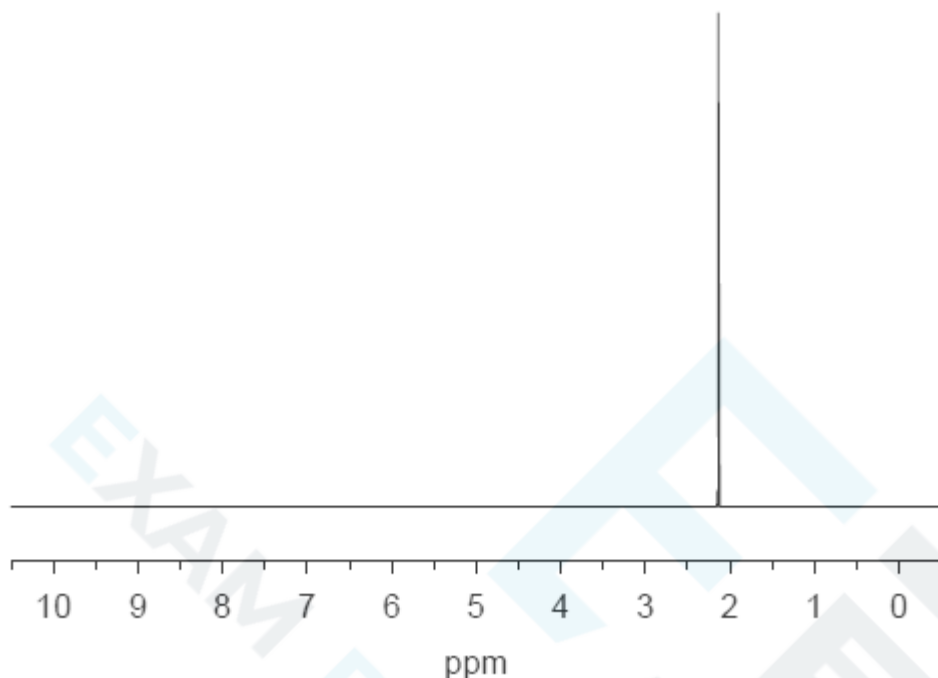
- A. 66.0
- B. 66
- C. 26.4
- D. 26

[1]

23M.1A.SL.TZ1.39

Which molecule produces this ^1H -NMR spectrum?

[1]



[Source: SDBS, National Institute of Advanced Industrial Science and Technology.]

- A. $\text{CH}_3\text{COOCH}_3$
- B. CH_3COCH_3
- C. CH_3CHO
- D. $\text{CH}_3\text{CH}_2\text{CH}_3$

23M.1A.SL.TZ2.19

Which two colliding species have the highest probability of having the proper orientation for a reaction to occur?

- A. $\text{Cl}\cdot + \text{Cl}\cdot$
- B. $\text{Cl}\cdot + \text{CH}_3\cdot$
- C. $\text{HCl} + \text{CH}_2 = \text{CH}_2$
- D. $\text{CF}_3\text{Cl} + \text{O}_3$

[1]

SPM.1A.SL.TZ0.20

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

- B. C_2H_2
 C. C_2H_4
 D. C_3H_6

[1]

21N.1A.SL.TZ0.7

Which element has the highest metallic character in Group 14? [1]

- A. C
 B. Si
 C. Ge
 D. Sn

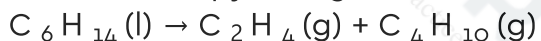
22M.1A.SL.TZ2.25

Which structure represents a repeating unit of a polymer formed from propene? [1]

- A. $-CH_2-CH(CH_3)-$
 B. $-CH_2-CH_2-CH_2-$
 C. $-CH(CH_3)-CH(CH_3)-$
 D. $-CH_2-CH_2-$

19N.1A.SL.TZ0.15

What is the enthalpy change of the reaction? [1]



	Enthalpy of combustion / kJ mol^{-1}
$C_6H_{14}(l)$	-4163
$C_2H_4(g)$	-1411
$C_4H_{10}(g)$	-2878

- A. $+1411 + 2878 + 4163$
 B. $+1411 - 2878 - 4163$
 C. $+1411 + 2878 - 4163$
 D. $-1411 - 2878 + 4163$

23M.1A.SL.TZ2.9

Which compound is both volatile and soluble in water? [1]

- A. NaCl
 B. $CH_3CH_2CH_3$
 C. CH_3OH
 D. $C_{12}H_{22}O_{11}$

22N.1A.SL.TZ0.26

Which conditions best favour oxidation of primary alcohols directly to carboxylic acids?

- A. Excess acidified potassium dichromate (VI) and distillation
- B. Excess acidified potassium dichromate (VI) and reflux
- C. Few drops of acidified potassium dichromate (VI) and distillation
- D. Few drops of acidified potassium dichromate (VI) and reflux

[1]

23M.1A.SL.TZ1.2

A student heated a known mass of zinc powder in an open crucible until there was no further mass change and recorded the final mass.

What would the student be able to derive from this data?

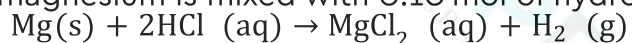
- . Percentage composition of zinc oxide
- . Empirical formula of zinc oxide
- . Molecular formula of zinc oxide

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

[1]

21M.1A.SL.TZ2.1

0.20 mol of magnesium is mixed with 0.10 mol of hydrochloric acid. [1]



Which is correct?

	Limiting reagent	Maximum yield of H_2 / mol
A.	HCl	0.10
B.	Mg	0.20
C.	HCl	0.05
D.	Mg	0.10

23M.1A.SL.TZ2.27

What are the most likely reactions ethene and benzene will undergo? [1]

Ethene

Benzene



- | | |
|-----------------|--------------|
| A. Addition | Substitution |
| B. Addition | Addition |
| C. Substitution | Substitution |
| D. Substitution | Addition |

SPM.1A.SL.TZ0.17

Which enthalpy changes can be calculated using only bond enthalpy data? [1]

- I. $\text{N}_2(\text{g}) + 2\text{H}_2(\text{g}) \rightarrow \text{N}_2\text{H}_4(\text{g})$
II. $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$
III. $\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{HCl}(\text{g})$

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

19M.1A.SL.TZ1.33

Which is a major product of the electrophilic addition of hydrogen chloride to propene?

- A. $\text{ClCH}_2\text{CH}=\text{CH}_2$
B. $\text{CH}_3\text{CH}(\text{Cl})\text{CH}_3$
C. $\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$
D. $\text{CH}_3\text{CH}=\text{CHCl}$

[1]

19N.1A.SL.TZ0.37

Which can be reduced to an aldehyde? [1]

- A. Butanone
B. Butan-1-ol
C. Butanoic acid
D. Butan-2-ol

22M.1A.SL.TZ1.22

Which statement is correct for both voltaic and electrolytic cells? [1]

- A. The oxidation reaction releases electrons.
B. The oxidation reaction occurs at the positive electrode.
C. The cathode is negative.
D. Electrons flow through the electrolyte.

19M.1A.SL.TZ2.29



Data collected from a larger number of silicon samples could also be plotted to determine the density using the following axes.



Which statements are correct?

- I. The density is the slope of the graph.
 - II. The data will show that mass is proportional to volume.
 - III. The best-fit line should pass through the origin.
- A. I and II only
B. I and III only
C. II and III only
D. I, II and III

[1]

19M.1A.SL.TZ2.38

The following data were recorded for determining the density of three samples of silicon, Si.

Mass / g ± 0.01 g	Volume / cm ³ ± 0.1 cm ³
5.61	2.8
4.32	1.7
6.37	2.8

Which average density value, in g cm⁻³, has been calculated to the correct number of significant figures?

- A. 2
B. 2.3
C. 2.27
D. 2.273

[1]

21M.1A.SL.TZ2.20



Which causes acid deposition? [1]

- A. SO_2
- B. SiO_2
- C. SrO
- D. CO_2

19M.1A.SL.TZ1.34

Which alcohol would produce a carboxylic acid when heated with acidified potassium dichromate(VI)?

- A. propan-2-ol
- B. butan-1-ol
- C. 2-methylpropan-2-ol
- D. pentan-3-ol

[1]

19N.1A.SL.TZ0.30

Which technique is used to detect the isotopes of an element? [1]

- A. Mass spectrometry
- B. Infrared spectroscopy
- C. Titration
- D. Recrystallization

20N.1A.SL.TZ0.7

Which of the following shows a general increase across period 3 from Na to Cl? [1]

- A. Ionic radius
- B. Atomic radius
- C. Ionization energy
- D. Melting point

23M.1A.SL.TZ2.11

What is the correct comparison of H–N–H bond angles in NH_2^- , NH_3 , and NH_4^+ ? [1]

- A. $\text{NH}_2^- < \text{NH}_3 < \text{NH}_4^+$
- B. $\text{NH}_4^+ < \text{NH}_3 < \text{NH}_2^-$
- C. $\text{NH}_3 < \text{NH}_2^- < \text{NH}_4^+$
- D. $\text{NH}_3 < \text{NH}_4^+ < \text{NH}_2^-$

23M.1A.SL.TZ2.3

20 cm³ of gas A reacts with 20 cm³ of gas B to produce 10 cm³ of gas A_xB_y and 10 cm³ of excess gas A. What are the correct values for subscripts **x** and **y** in the empirical formula of the product A_xB_y (g)?

	x	y
A.	2	1
B.	2	2
C.	1	1
D.	1	2

[1]

22M.1A.SL.TZ1.4

8.8 g of an oxide of nitrogen contains 3.2 g of oxygen. What is the empirical formula of the compound?

- A. N_2O_5
- B. N_2O
- C. NO_2
- D. NO

[1]

19N.1A.SL.TZ0.4

Which contains the greatest number of moles of oxygen atoms? [1]

- A. 0.05 mol $\text{Mg}(\text{NO}_3)_2$
- B. 0.05 mol $\text{C}_6\text{H}_4(\text{NO}_2)_2$
- C. 0.1 mol H_2O
- D. 0.1 mol NO_2

19N.1A.SL.TZ0.9

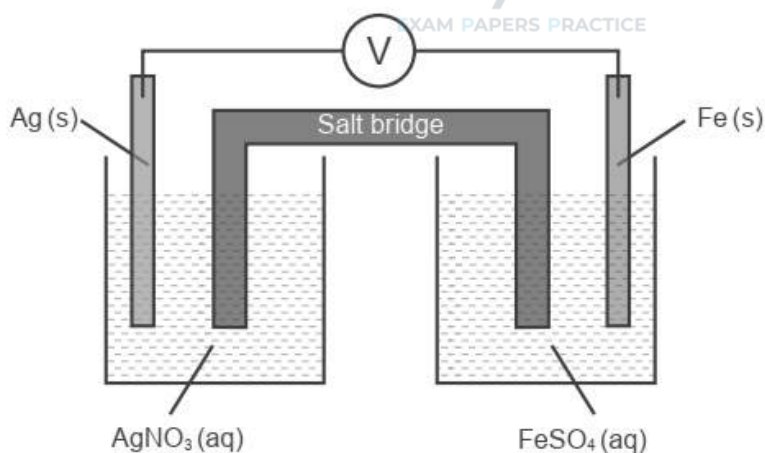
Which is correct for all solid ionic compounds? [1]

- A. High volatility
- B. Poor electrical conductivity
- C. Low melting point
- D. Good solubility in water

20N.1A.SL.TZ0.21

Iron is a stronger reducing agent than silver.
What is correct when this voltaic cell is in operation?

[1]



	Anode (negative electrode)	Cathode (positive electrode)	Direction of electron flow in wire
A.	Ag	Fe	right to left
B.	Ag	Fe	left to right
C.	Fe	Ag	left to right
D.	Fe	Ag	right to left

23M.1A.SL.TZ1.31

Which statement is correct about the ions in a cell assembled from these half-cells? [1]

Reaction	$E^\ominus$
$\text{Ni}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Ni}(\text{s})$	-0.26 V
$\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Zn}(\text{s})$	-0.76 V

- A. Negative ions flow into the zinc half-cell from the salt bridge.
- B. Negative ions flow into the nickel half-cell from the salt bridge.
- C. Zn^{2+} ions are reduced to Zn.
- D. The concentration of Ni^{2+} ions increases.

23M.1A.SL.TZ1.3

A student heated a known mass of zinc powder in an open crucible until there was no further mass change and recorded the final mass.

What would the student be able to derive from this data?

- . Percentage composition of zinc oxide
- . Empirical formula of zinc oxide
- . Molecular formula of zinc oxide

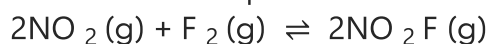
- A. I and II only
- B. I and III only

- C. II and III only
 D. I, II and III

[1]

19M.1A.SL.TZ2.18

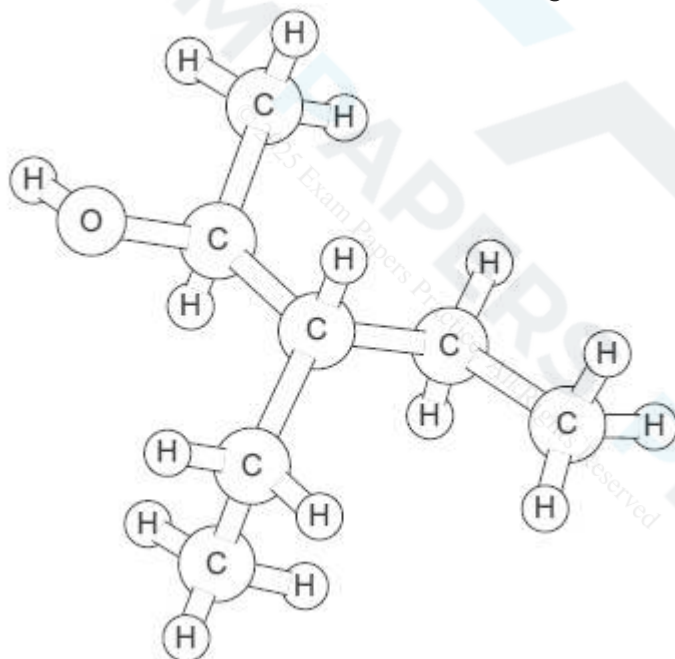
What is the equilibrium constant expression for the following equation? [1]



- A. $\frac{2[\text{NO}_2\text{F}]}{2[\text{NO}_2] + [\text{F}_2]}$
 B. $\frac{2[\text{NO}_2][\text{F}_2]}{2[\text{NO}_2\text{F}]}$
 C. $\frac{[\text{NO}_2]^2[\text{F}_2]}{[\text{NO}_2\text{F}]^2}$
 D. $\frac{[\text{NO}_2\text{F}]^2}{[\text{NO}_2]^2[\text{F}_2]}$

21N.1A.SL.TZ0.25

What is the name of this substance using IUPAC rules? [1]



- A. 2-ethyl-1-methylbutan-1-ol
 B. 1-methyl-2-ethylbutan-1-ol
 C. 3-ethylpentan-2-ol
 D. 3-ethylpentan-4-ol

21M.1A.SL.TZ2.7

Which property increases down group 1? [1]

- A. atomic radius
 B. electronegativity
 C. first ionization energy
 D. melting point

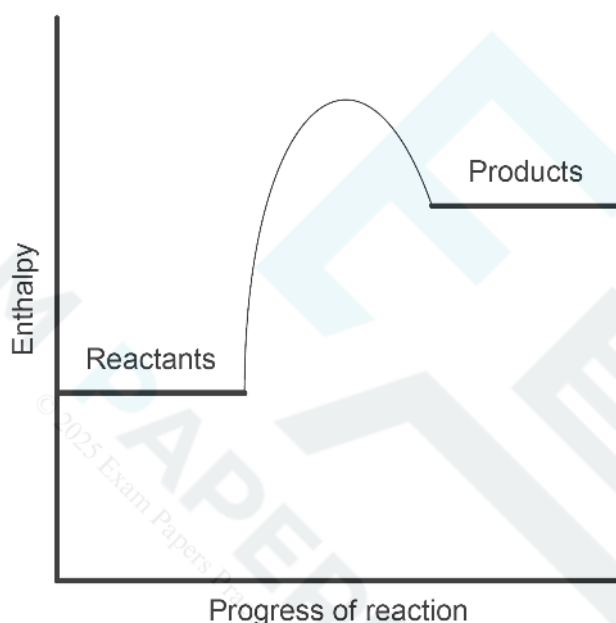
22N.1A.SL.TZ0.2

What is the change of state for a gas to a solid? [1]

- A. Condensation
- B. Deposition
- C. Freezing
- D. Sublimation

22M.1A.SL.TZ1.15

What is the correct interpretation of the following potential energy profile? [1]



- A. Endothermic reaction; products more stable than reactants.
- B. Exothermic reaction; products more stable than reactants.
- C. Endothermic reaction; products less stable than reactants.
- D. Exothermic reaction; products less stable than reactants.

22M.1A.SL.TZ2.7

Three elements, X, Y, and Z are in the same period of the periodic table. The relative sizes of their atoms are represented by the diagram.



Which general trends are correct?

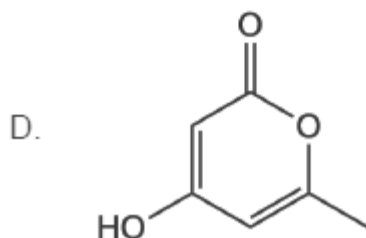
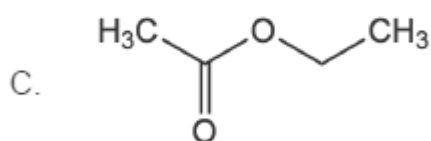
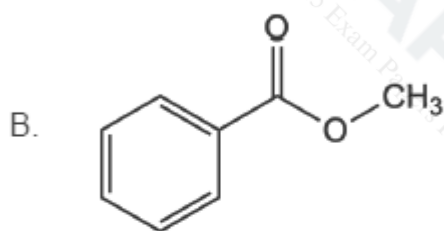
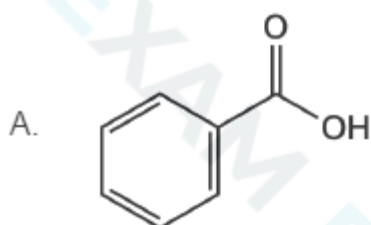


	Ionization energy	Effective nuclear charge	Least to most acidic oxide
A.	$X < Y < Z$	$X < Y < Z$	$Z < Y < X$
B.	$X < Y < Z$	$Z < Y < X$	$X < Y < Z$
C.	$X < Y < Z$	$X < Y < Z$	$X < Y < Z$
D.	$Z < Y < X$	$Z < Y < X$	$Z < Y < X$

[1]

23M.1A.SL.TZ2.32

Which compound is an aromatic ester? [1]



19M.1A.SL.TZ1.12

Which combination corresponds to a strong metallic bond? [1]



	Charge on the metal ion	Radius of ion
A.	large	large
B.	large	small
C.	small	small
D.	small	large

23M.1A.SL.TZ1.26

Why does benzene undergo substitution more readily than addition? [1]

- A. Benzene is unsaturated.
- B. Addition could produce an alkane.
- C. Resonance makes carbon-carbon bonds too strong to break.
- D. A benzene molecule is planar.

21M.1A.SL.TZ2.6

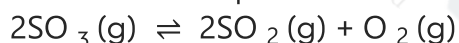
How are emission spectra formed?

[1]

- A. Photons are absorbed when promoted electrons return to a lower energy level.
- B. Photons are absorbed when electrons are promoted to a higher energy level.
- C. Photons are emitted when electrons are promoted to a higher energy level.
- D. Photons are emitted when promoted electrons return to a lower energy level.

SPM.1A.SL.TZ0.24

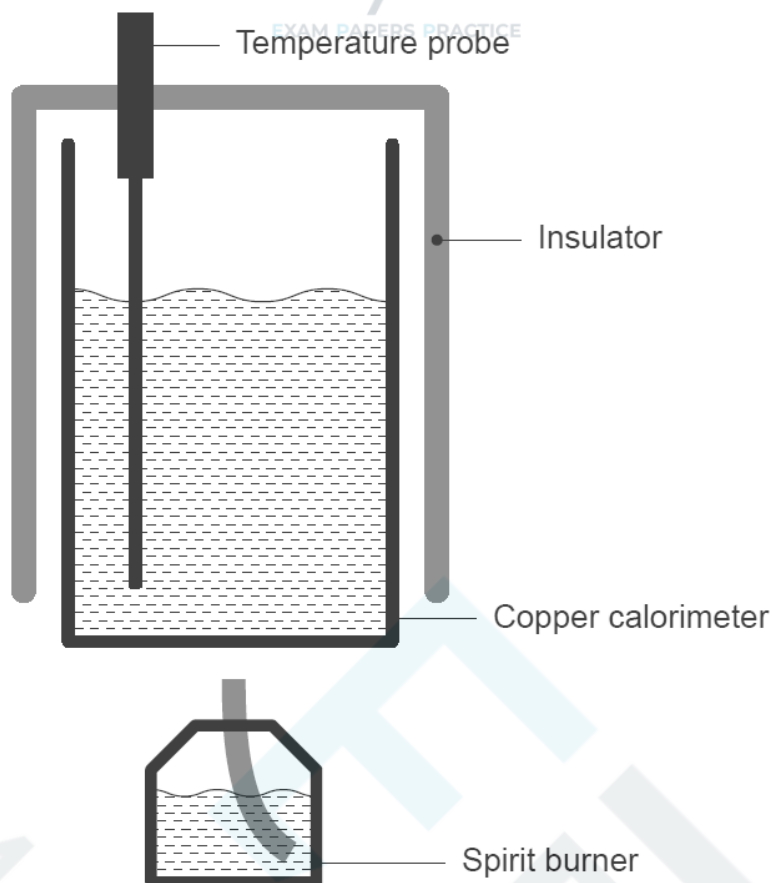
What is the equilibrium constant expression for the following reaction? [1]



- A. $\frac{2[\text{SO}_2]^2[\text{O}_2]}{[\text{SO}_3]^2}$
- B. $\frac{[\text{SO}_2]^2 + [\text{O}_2]}{[\text{SO}_3]^2}$
- C. $\frac{[\text{SO}_2]^2[\text{O}_2]}{2[\text{SO}_3]^2}$
- D. $\frac{2[\text{SO}_2]^2[\text{O}_2]}{2[\text{SO}_3]}$

21M.1A.SL.TZ1.28

The enthalpy of combustion of a fuel was determined using the calorimeter shown. The final result was lower than the literature value.



Which factors could have contributed to this error?

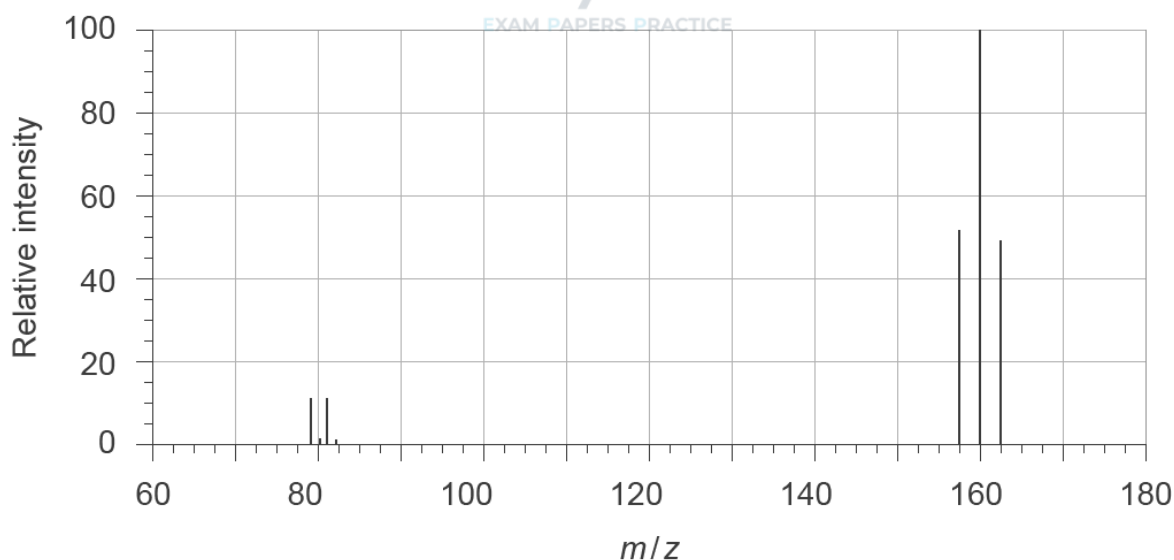
- I. Not all heat from the combustion was transferred to the calorimeter.
- II. Incomplete combustion occurred.
- III. The temperature probe touched the bottom of the calorimeter.

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

[1]

21M.1A.SL.TZ1.5

What is the relative molecular mass of bromine, according to the following mass spectrum?



NIST Mass Spectrometry Data Center Collection © 2014 copyright by the U.S. Secretary of Commerce on behalf of the United States of America. All rights reserved.

- A. $\frac{158 \times 52 + 160 \times 100 + 162 \times 48}{158 \times 52 + 160 \times 100 + 162 \times 48}$
 B. $\frac{52 + 100 + 48}{158 \times 52 + 160 \times 100 + 162 \times 48}$
 C. $\frac{79 \times 11 + 81 \times 11 + 158 \times 52 + 160 \times 100 + 162 \times 48}{79 \times 11 + 81 \times 11 + 158 \times 52 + 160 \times 100 + 162 \times 48}$
 D. $\frac{11 + 11 + 52 + 100 + 48}{11 + 11}$

[1]

23M.1A.SL.TZ2.35

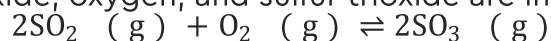
What is the correct order of reaction types in the following sequence? [1]



- | I | II | III |
|-----------------|--------------|--------------|
| A. substitution | oxidation | reduction |
| B. addition | substitution | reduction |
| C. oxidation | substitution | reduction |
| D. substitution | oxidation | substitution |

21M.1A.SL.TZ1.23

1.0 mol each of sulfur dioxide, oxygen, and sulfur trioxide are in equilibrium.



Which change in the molar ratio of reactants will cause the greatest increase in the amount of sulfur trioxide?

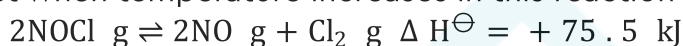
Assume volume and temperature of the reaction mixture remain constant.

	Moles of SO ₂ (g) changed from 1.0 to...	Moles of O ₂ (g) changed from 1.0 to...
A.	0.8	1.2
B.	0.9	1.1
C.	1.1	0.9
D.	1.2	0.8

[1]

20N.1A.SL.TZ0.18

What is correct when temperature increases in this reaction at equilibrium? [1]



	Position of equilibrium	Equilibrium constant, K_c
A.	Shifts left	Unchanged
B.	Shifts left	Decreases
C.	Shifts right	Unchanged
D.	Shifts right	Increases

19N.1A.SL.TZ0.16

Which equation represents the N–H bond enthalpy in NH₃? [1]

- A. $\text{NH}_3 \text{ (g)} \rightarrow \text{N (g)} + 3\text{H (g)}$
 B. $\frac{1}{3} \text{NH}_3 \text{ (g)} \rightarrow \frac{1}{3} \text{N (g)} + \text{H (g)}$
 C. $\text{NH}_3 \text{ (g)} \rightarrow \frac{1}{2} \text{N}_2 \text{ (g)} + \frac{3}{2} \text{H}_2 \text{ (g)}$
 D. $\text{NH}_3 \text{ (g)} \rightarrow \bullet\text{NH}_2 \text{ (g)} + \bullet\text{H (g)}$

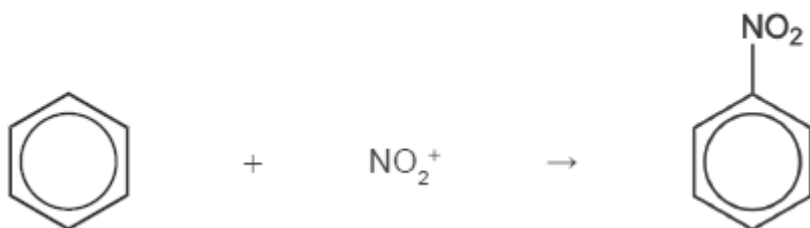
23M.1A.SL.TZ1.37

Which terms describe the nitronium ion in the nitration of benzene? [1]

Benzene

Nitronium ion

Nitrobenzene



Type of reactant

Acid-base nature

- A. nucleophile Lewis base
 B. nucleophile Lewis acid



- C. electrophile Lewis base
D. electrophile Lewis acid

21M.1A.SL.TZ1.15

What is the enthalpy change of the reaction, in kJ? [1]



Substance	$\Delta H^\ominus_{\text{combustion}} / \text{kJ mol}^{-1}$
C (graphite)	-394
CO (g)	-283

- A. $-394 - 283$
B. $2(-394) + 2(-283)$
C. $-394 + 283$
D. $2(-394) + 2(283)$

19M.1A.SL.TZ1.21

Where does oxidation occur in a voltaic cell? [1]

- A. positive electrode and anode
B. negative electrode and anode
C. positive electrode and cathode
D. negative electrode and cathode

21M.1A.SL.TZ1.2

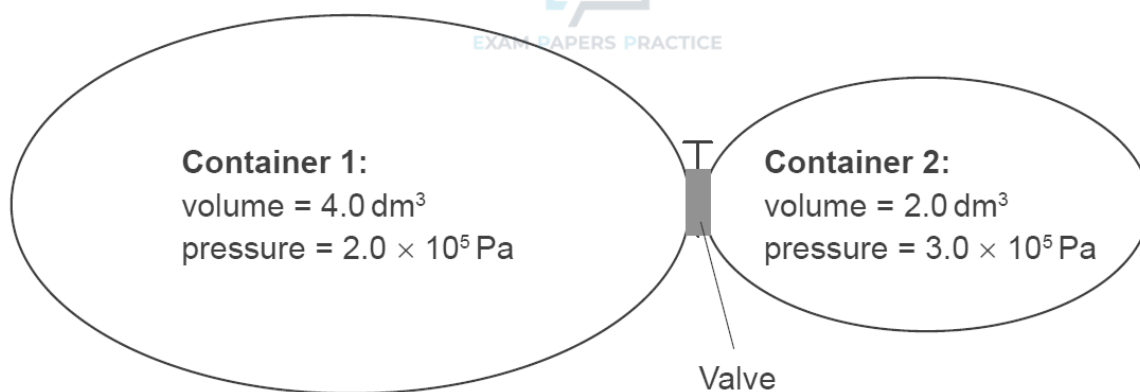
A sample of a compound contains approximately 24.0 g C, 3.0 g H, and 1.6 g O. What is the empirical formula of the compound?

- A. $\text{C}_{20}\text{H}_{30}\text{O}$
B. $\text{C}_{84}\text{H}_{10}\text{O}_6$
C. $\text{C}_2\text{H}_3\text{O}$
D. $\text{C}_{24}\text{H}_{30}\text{O}_2$

[1]

21N.1A.SL.TZ0.4

The two containers shown are connected by a valve. What is the total pressure after the valve is opened and the two gas samples are allowed to mix at constant temperature?

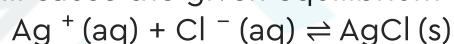


- A. $1.5 \times 10^5 \text{ Pa}$
- B. $2.3 \times 10^5 \text{ Pa}$
- C. $2.5 \times 10^5 \text{ Pa}$
- D. $5.0 \times 10^5 \text{ Pa}$

[1]

23M.1A.SL.TZ2.22

Which condition will cause the given equilibrium to shift to the right? [1]



- A. One half of solid AgCl is removed.
- B. Water is added.
- C. Solid NaCl is added.
- D. The system is subjected to increased pressure.

22N.1A.SL.TZ0.3

How many moles of carbon dioxide are produced by the complete combustion of 7.0 g of ethene, $\text{C}_2\text{H}_4 (\text{g})$?

$$M_r = 28$$

- A. 0.25
- B. 0.5
- C. 0.75
- D. 1.0

[1]

19M.1A.SL.TZ1.23

Which product will be obtained at the anode (positive electrode) when molten NaCl is electrolysed?

- A. Na (l)
- B. Cl (g)
- C. $\text{Cl}_2 (\text{g})$
- D. Na (s)

[1]

23M.1A.SL.TZ2.12

What is the correct comparison of H–N–H bond angles in NH_2^- , NH_3 , and NH_4^+ ? [1]

- A. $\text{NH}_2^- < \text{NH}_3 < \text{NH}_4^+$
- B. $\text{NH}_4^+ < \text{NH}_3 < \text{NH}_2^-$
- C. $\text{NH}_3 < \text{NH}_2^- < \text{NH}_4^+$
- D. $\text{NH}_3 < \text{NH}_4^+ < \text{NH}_2^-$

22N.1A.SL.TZ0.19

Equal volumes of 0.10 mol dm^{-3} weak acid and strong acid are titrated with 0.10 mol dm^{-3} NaOH solution. Which of these is the same for the two acids?

- A. Initial pH
- B. Heat evolved in the neutralization
- C. Volume of NaOH for complete neutralization
- D. Initial electrical conductivity

[1]

19M.1A.SL.TZ1.8

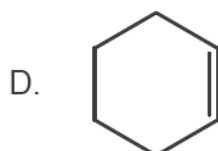
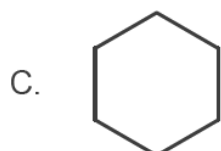
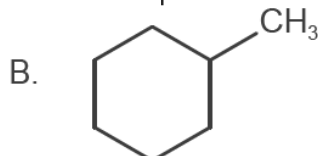
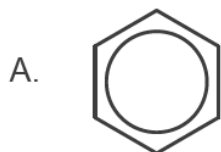
What are typical characteristics of metals?

[1]

	Ionization energy	Electron affinity
A.	low	low
B.	high	high
C.	high	low
D.	low	high

19N.1A.SL.TZ0.27

Which will react with a halogen by an electrophilic substitution mechanism? [1]



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

	Average electronegativity $\frac{E_X + E_Y}{2}$	Electronegativity difference $E_X - E_Y$
A.	2.5	2.5
B.	2.5	1.0
C.	3.5	0.2
D.	1.2	0.2

[1]

22M.1A.SL.TZ2.5

What is the correct order for **increasing** first ionization energy? [1]

- A. Na < Mg < Al
- B. Na < Al < Mg
- C. Al < Mg < Na
- D. Al < Na < Mg

21M.1A.SL.TZ1.26

What is formed in a propagation step of the substitution reaction between bromine and ethane?

- A. $\text{CH}_3\text{CH}_2\cdot$
- B. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$
- C. $\text{H}\cdot$
- D. Br^-

[1]

22M.1A.SL.TZ1.9

A compound consists of the ions Ca^{2+} and PO_4^{3-} . What are the name and formula of the compound?



	Name	Formula
A.	calcium phosphorus oxide	CaPO_4
B.	calcium phosphorus oxide	$\text{Ca}_3(\text{PO}_4)_2$
C.	calcium phosphate	CaPO_4
D.	calcium phosphate	$\text{Ca}_3(\text{PO}_4)_2$

[1]

23M.1A.SL.TZ1.11

In which molecule does the central atom have an incomplete octet of electrons? [1]

- A. H_2Se
- B. PH_3
- C. OF_2
- D. BF_3

21M.1A.SL.TZ2.14

What is the heat change, in kJ, when 100.0 g of aluminium is heated from 19.0 °C to 32.0 °C?

Specific heat capacity of aluminium: $0.90 \text{ J g}^{-1} \text{ K}^{-1}$

- A. $0.90 \times 100.0 \times 13.0$
- B. $0.90 \times 100.0 \times 286$
- C. $\frac{0.90 \times 100.0 \times 13.0}{1000}$
- D. $\frac{0.90 \times 100.0 \times 286}{1000}$

[1]

22N.1A.SL.TZ0.12

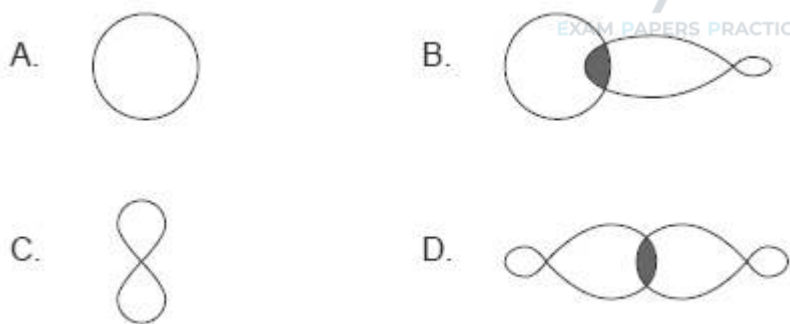
Alloying a metal with a metal of smaller atomic radius can disrupt the lattice and make it more difficult for atoms to slide over each other. Which property will increase as a result?

- A. Electrical conductivity
- B. Ductility
- C. Malleability
- D. Strength

[1]

19N.1A.SL.TZ0.6

Which represents the shape of an s atomic orbital? [1]



22M.1A.SL.TZ1.11

Which molecule is most polar? [1]

- A. CF_4
- B. CCl_4
- C. CHF_3
- D. CClF_3

23M.1A.SL.TZ1.23

Which equilibrium constant corresponds to the spontaneous reaction with the most negative value of $\Delta G^\ominus$?

- A. 4.9×10^{-3}
- B. 8.2×10^{-3}
- C. 4.9×10^2
- D. 8.2×10^2

[1]

21M.1A.SL.TZ1.3

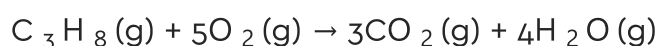
What volume of oxygen, in dm^3 at STP, is needed when 5.8 g of butane undergoes complete combustion?

- $2\text{C}_4\text{H}_{10}(\text{g}) + 13\text{O}_2(\text{g}) \rightarrow 8\text{CO}_2(\text{g}) + 10\text{H}_2\text{O}(\text{l})$
- A. $2 \times \frac{5.8}{12.01 \times 4 + 1.01 \times 10} \times 13 \times 22.7$
 - B. $\frac{5.8}{12.01 \times 4 + 1.01 \times 10} \times \frac{13}{2} \times 22.7$
 - C. $\frac{5.8}{12.01 \times 4 + 1.01 \times 10} \times \frac{13}{2} \times 22.7$
 - D. $\frac{5.8}{12.01 \times 4 + 1.01 \times 10} \times \frac{13}{2} \times \frac{22.7}{1000}$

[1]

21N.1A.SL.TZ0.2

3.00 mol of C_3H_8 is mixed with 20.00 mol of O_2 . Which quantity is present at the end of the reaction?



- A. 1.00 mol of C_3H_8
- B. 5.00 mol of O_2
- C. 12.00 mol of CO_2
- D. 16.00 mol of H_2O

[1]

21M.1A.SL.TZ2.9

Which compound has the greatest volatility under the same conditions? [1]

- A. SO_2
- B. SiO_2
- C. SnO_2
- D. SrO

19M.1A.SL.TZ1.18

Which properties can be monitored to determine the rate of the reaction? [1]



- I. change in volume
- II. change in temperature
- III. change in colour
- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

23M.1A.SL.TZ1.25

Which combination describes a strong Brønsted–Lowry acid? [1]

Proton donor Conjugate base

- | | | |
|----|------|--------|
| A. | good | strong |
| B. | good | weak |
| C. | poor | strong |
| D. | poor | weak |

21M.1A.SL.TZ1.24

Which series is in order of increasing boiling point? [1]

- A. $CH_3CH_2CH_2OH$ CH_3COCH_3 $CH_3CH_2CH_3$
- B. $CH_3CH_2CH_2CH_3$ CH_3COCH_3 $CH_3CH_2CH_2OH$
- C. CH_3COCH_3 $CH_3CH_2CH_2OH$ $CH_3CH_2CH_3$
- D. $CH_3CH_2CH_2CH_3$ $CH_3CH_2CH_2OH$ CH_3COCH_3

23M.1A.SL.TZ1.20

Which combination describes a strong Brønsted–Lowry acid? [1]

	Proton donor	Conjugate base
A.	good	strong
B.	good	weak
C.	poor	strong
D.	poor	weak

19N.1A.SL.TZ0.10

Which compound has the shortest C to O bond? [1]

- A. CH_3CHO
- B. CO
- C. CO_2
- D. $\text{C}_2\text{H}_5\text{OC}_2\text{H}_5$

23M.1A.SL.TZ1.33

Why does benzene undergo substitution more readily than addition? [1]

- A. Benzene is unsaturated.
- B. Addition could produce an alkane.
- C. Resonance makes carbon–carbon bonds too strong to break.
- D. A benzene molecule is planar.

22M.1A.SL.TZ2.35

Which reaction involves homolytic fission? [1]

- A. $\text{CH}_4 + \text{Cl}_2$
- B. $\text{CH}_3\text{Br} + \text{NaOH}$
- C. $(\text{CH}_3)_3\text{CBr} + \text{NaOH}$
- D. $\text{C}_6\text{H}_6 + \text{HNO}_3 + \text{H}_2\text{SO}_4$

22M.1A.SL.TZ2.1

What is the concentration of chloride ions, in mol dm^{-3} , in a solution formed by mixing 200 cm^3 of $1\text{ mol dm}^{-3}\text{ HCl}$ with 200 cm^3 of $5\text{ mol dm}^{-3}\text{ NaCl}$?

- A. 1
- B. 2
- C. 3
- D. 6

[1]

EXM.1A.SL.TZ0.4



Which of the following elements yields a basic oxide when combusted? [1]

- A. Au
- B. P
- C. Ca
- D. N

23M.1A.SL.TZ2.2

What is the mass of one molecule of C_{60} ? [1]

$$N_A = 6.0 \times 10^{23}$$

- A. 1.0×10^{-22} g
- B. 2.0×10^{-23} g
- C. 8.3×10^{-24} g
- D. 1.2×10^{-21} g

23M.1A.SL.TZ1.13

Which allotrope, oxygen or ozone, has the stronger bond between O atoms, and which absorbs higher frequency UV radiation in the atmosphere?

Stronger bond between O atoms

Absorbs higher frequency UV

- | | | |
|----|--------|--------|
| A. | ozone | ozone |
| B. | ozone | oxygen |
| C. | oxygen | oxygen |
| D. | oxygen | ozone |

[1]

19N.1A.SL.TZ0.26

What type of reaction occurs when $C_6H_{13}Br$ becomes $C_6H_{13}OH$? [1]

- A. Nucleophilic substitution
- B. Electrophilic substitution
- C. Radical substitution
- D. Addition

22M.1A.SL.TZ2.13

What is correct about energy changes during bond breaking and bond formation? [1]



	Bond breaking	Bond formation
A.	exothermic and ΔH positive	endothermic and ΔH negative
B.	exothermic and ΔH negative	endothermic and ΔH positive
C.	endothermic and ΔH positive	exothermic and ΔH negative
D.	endothermic and ΔH negative	exothermic and ΔH positive

19N.1A.SL.TZ0.24

What is formed at the electrodes during the electrolysis of molten sodium bromide? [1]

	Positive electrode	Negative electrode
A.	Na^+	Br^-
B.	Na	Br_2
C.	Br^-	Na^+
D.	Br_2	Na

19M.1A.SL.TZ2.9

How does a lithium atom form the most stable ion? [1]

- A. The atom gains a proton to form a positive ion.
- B. The atom loses a proton to form a negative ion.
- C. The atom loses an electron to form a positive ion.
- D. The atom gains an electron to form a negative ion.

19N.1A.SL.TZ0.2

What is the sum of the coefficients when the equation is balanced with whole numbers?



- A. 6
- B. 7
- C. 8
- D. 9

[1]

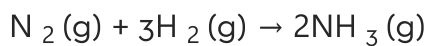
23M.1A.SL.TZ2.14

What is ΔH , in kJ, for the reaction $\text{N}_2\text{H}_4(\text{l}) + \text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$? [1]

Reaction

ΔH





-46 kJ



-65 kJ

- A. -18
- B. 18
- C. -83
- D. -148

22M.1A.SL.TZ2.8

Which element is found in the 4th group, 6th period of the periodic table? [1]

- A. Selenium
- B. Lead
- C. Chromium
- D. Hafnium

22M.1A.SL.TZ2.4

Which equation represents the deposition of iodine? [1]

- A. $\text{I}_2(\text{g}) \rightarrow \text{I}_2(\text{l})$
- B. $\text{I}_2(\text{g}) \rightarrow \text{I}_2(\text{s})$
- C. $\text{I}_2(\text{l}) \rightarrow \text{I}_2(\text{g})$
- D. $\text{I}_2(\text{s}) \rightarrow \text{I}_2(\text{g})$

20N.1A.SL.TZ0.2

What is the number of carbon atoms in 12 g of ethanoic acid CH_3COOH , $M_r = 60$? [1]

- A. 0.20
- B. 2.0
- C. 1.2×10^{23}
- D. 2.4×10^{23}

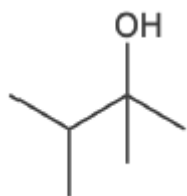
19M.1A.SL.TZ2.25

What is the major reason why the pH of unpolluted rain is less than 7? [1]

- A. methane
- B. carbon dioxide
- C. nitrogen oxides
- D. sulfur dioxide

23M.1A.SL.TZ2.26

What is the preferred IUPAC name of the structure shown? [1]



- A. 2-ethyl-3-methylbutan-1-ol
- B. 2,3-dimethylbutan-2-ol
- C. 1-ethyl-2-methylpropan-1-ol
- D. 1,1,2-trimethylpropan-1-ol

EXM.1B.SL.TZ0.1AIII

(iii)

The results calculated for the subsequent days are shown.

Day	Fe ²⁺ /%
2	0.33 ± 6.2%
3	0.22 ± 8.8%
4	0.11 ± 14.5%
5	0.09 ± 18.7%

Comment on the significance of the difference in Fe²⁺ content measured for day 4 and 5.

[1]

23M.1A.SL.TZ2.24

What is the order of increasing conductivity for aqueous solutions of these acids and bases at equal concentrations?

	p K _b
Methylamine	3.34
Ethanol	15.5
Phenylamine	9.13

- A. methylamine < ethanol < phenylamine
- B. ethanol < phenylamine < methylamine
- C. methylamine < phenylamine < ethanol
- D. ethanol < methylamine < phenylamine

[1]

22M.1A.SL.TZ1.7

Which gases are acidic? [1]

- I. nitrogen dioxide
 - II. carbon dioxide
 - III. sulfur dioxide
- A. I and II only
 B. I and III only
 C. II and III only
 D. I, II and III

22M.1A.SL.TZ1.3

What is the molecular formula of a compound with an empirical formula of CHO_2 and a relative molecular mass of 90?

- A. CHO_2
 B. $\text{C}_2\text{H}_2\text{O}_4$
 C. $\text{C}_3\text{H}_6\text{O}_3$
 D. $\text{C}_4\text{H}_{10}\text{O}_2$

[1]

19N.1A.SL.TZ0.1

0.10 mol of hydrochloric acid is mixed with 0.10 mol of calcium carbonate. [1]

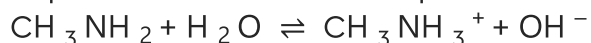


Which is correct?

	Limiting reagent	Maximum yield of CO_2 / mol
A.	$\text{HCl}(\text{aq})$	0.10
B.	$\text{CaCO}_3(\text{s})$	0.05
C.	$\text{HCl}(\text{aq})$	0.05
D.	$\text{CaCO}_3(\text{s})$	0.10

22M.1A.SL.TZ1.19

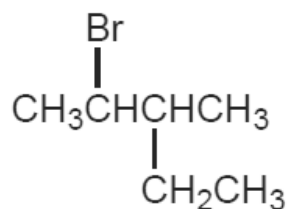
Which species are acids in the equilibrium below? [1]



- A. CH_3NH_2 and H_2O
 B. H_2O and CH_3NH_3^+
 C. H_2O and OH^-
 D. CH_3NH_2 and CH_3NH_3^+

19M.1A.SL.TZ1.32

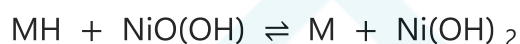
What is the IUPAC name of the following molecule? [1]



- A. 2-bromo-3-ethylbutane
- B. 3-methyl-4-bromopentane
- C. 2-ethyl-3-bromobutane
- D. 2-bromo-3-methylpentane

SPM.1A.SL.TZ0.26

The overall reaction occurring at the electrodes of a rechargeable metal hydride battery can be summarized as:



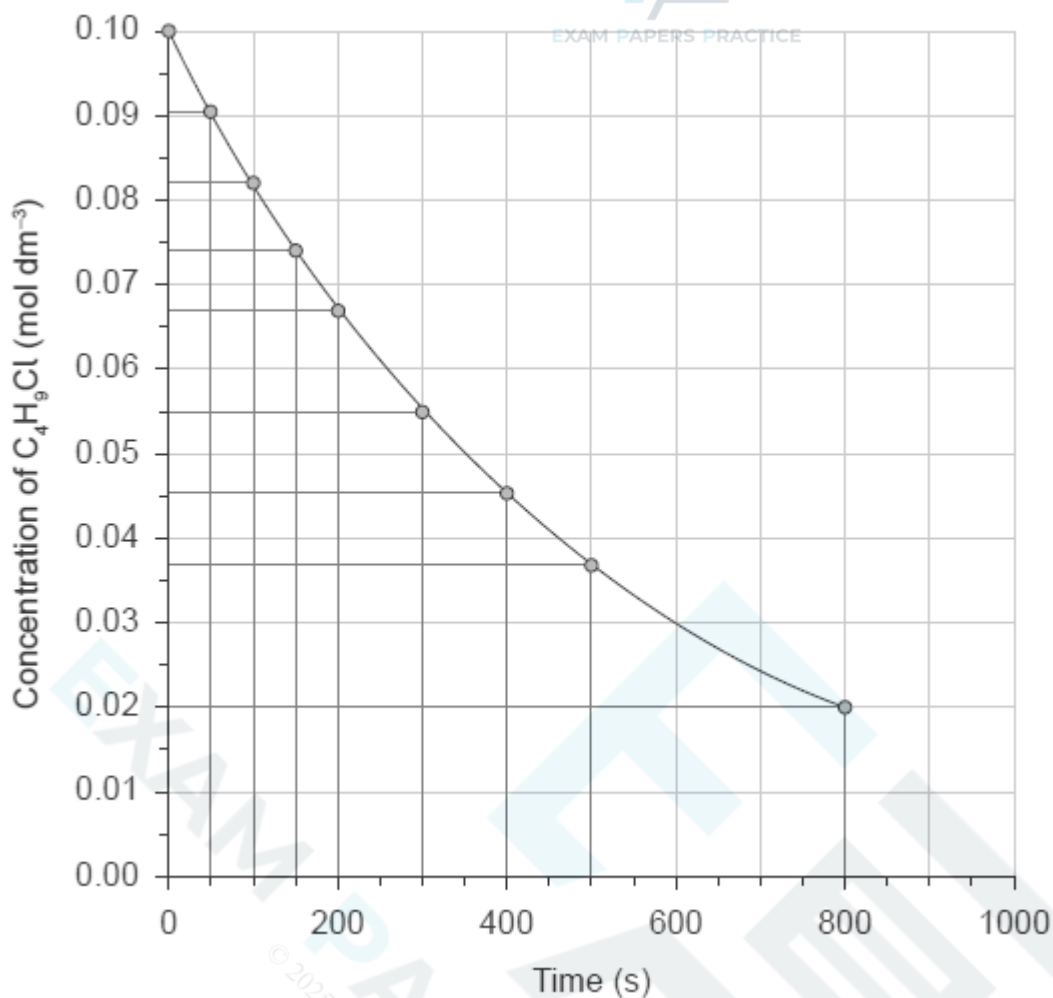
Which statement is correct?

- A. The oxidation state of Ni does not change.
- B. M is oxidized by loss of hydrogen.
- C. The oxidation state of one H atom changes from - 1 to + 1.
- D. The oxidation state of one O atom changes from - 1 to - 2.

[1]

23M.1A.SL.TZ2.40

The following graph shows the concentration of $\text{C}_4\text{H}_9\text{Cl}$ versus time. [1]

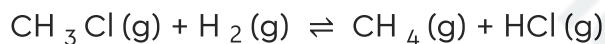


What is the average rate of reaction over the first 800 seconds?

- A. $1 \times 10^{-3} \text{ mol dm}^{-3} \text{ s}^{-1}$
- B. $1 \times 10^{-4} \text{ mol dm}^{-3} \text{ s}^{-1}$
- C. $2 \times 10^{-3} \text{ mol dm}^{-3} \text{ s}^{-1}$
- D. $2 \times 10^{-4} \text{ mol dm}^{-3} \text{ s}^{-1}$

22M.1A.SL.TZ2.22

Which combination best describes what is happening to chloromethane, CH_3Cl , in the equation below?



- A. Oxidation and addition
- B. Oxidation and substitution
- C. Reduction and addition
- D. Reduction and substitution

[1]

23M.1A.SL.TZ1.10

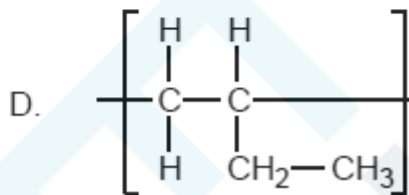
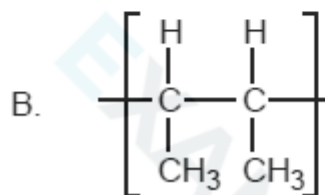
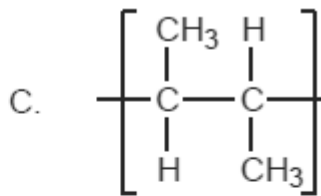
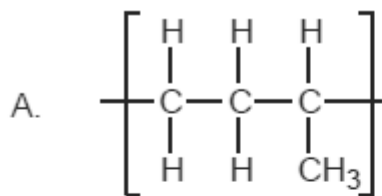
Why does the melting point of the elements decrease down group 1? [1]

- A. Atomic mass increases

- B. Number of electrons increases
- C. Radius of metal ion increases
- D. First ionization energy decreases

SPM.1A.SL.TZ0.10

Which structure shows the repeating unit of the polymer formed by but-1-ene? [1]



22M.1A.SL.TZ1.13

The energy from burning 0.250 g of ethanol causes the temperature of 150 cm³ of water to rise by 10.5 °C. What is the enthalpy of combustion of ethanol, in kJ mol⁻¹?
Specific heat capacity of water: 4.18 J g⁻¹ K⁻¹.

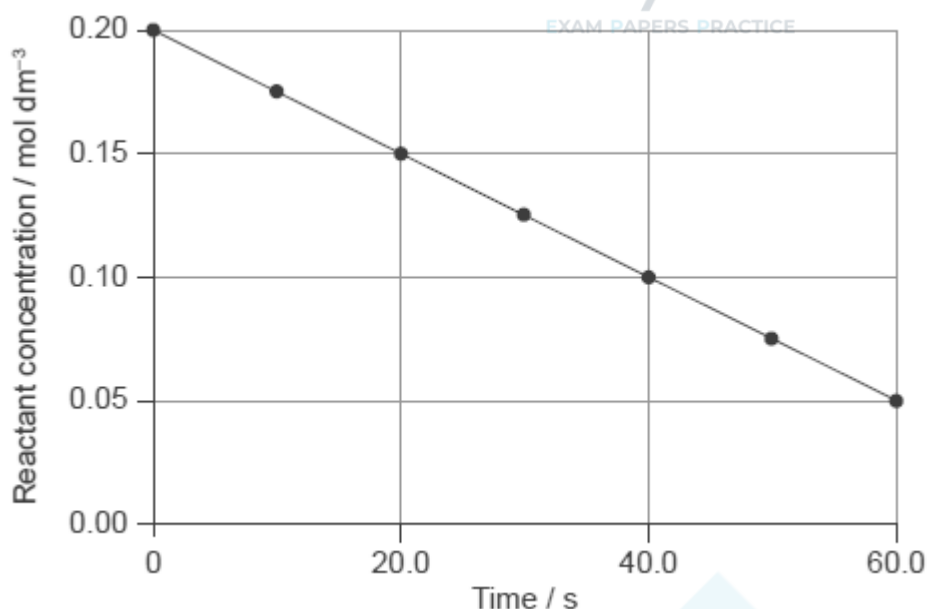
- A. $\frac{150 \times 4.18 \times 10.5}{0.250}$
- B. $\frac{150 \times 4.18 \times 10.5}{0.250} \times 1000$
- C. $\frac{150 \times 4.18 \times 273 + 10.5}{0.250}$
- D. $\frac{150 \times 4.18 \times 273 + 10.5}{0.250} \times 1000$

[1]

21N.1A.SL.TZ0.28

What is the slope of the graph?

[1]



- A. $-0.0025 \text{ mol dm}^{-3} \text{ s}^{-1}$
- B. $-0.0025 \text{ mol dm}^{-3} \text{ s}$
- C. $-0.0033 \text{ mol dm}^{-3} \text{ s}^{-1}$
- D. $-0.0033 \text{ mol dm}^{-3} \text{ s}$

23M.1A.SL.TZ2.33

Which reaction mechanisms involve heterolytic fission of chlorine? [1]

- . electrophilic addition
- . electrophilic substitution
- . nucleophilic substitution

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

23M.1A.SL.TZ1.29

In which case would repetition produce an improvement in accuracy? [1]

- A. A thermometer always gives low readings.
- B. An electronic balance has not been zeroed.
- C. A student always reads the burette from a seated position.
- D. Judgement of the end-point of a titration.

23M.1A.SL.TZ1.38

What is the percentage error if the enthalpy of combustion of a substance is determined experimentally to be $-2100 \text{ kJ mol}^{-1}$, but the literature value is $-3500 \text{ kJ mol}^{-1}$?

- A. 80 %

- B. 60 %
- C. 40 %
- D. 20 %

[1]

23M.1A.SL.TZ2.8

Which of these factors explains why NiCl_4^{2-} and CoCl_4^{2-} have different colours? [1]

- A. Identity of the metal ion
- B. Charge on the metal ion
- C. Identity of the ligand in the complex
- D. Spectrochemical series

23M.1A.SL.TZ1.19

Which products are formed from the neutralization of nitric acid by calcium hydroxide?

- A. Calcium oxide and ammonia
- B. Calcium nitrate and water
- C. Calcium nitrate and ammonia
- D. Calcium nitrate and hydrogen

[1]

19M.1A.SL.TZ1.5

Bromine consists of two stable isotopes that exist in approximately a 1 : 1 ratio. The relative atomic mass, A_r , of bromine is 79.90. Which are the stable isotopes of bromine?

- A. ^{79}Br and ^{81}Br
- B. ^{80}Br and ^{81}Br
- C. ^{78}Br and ^{80}Br
- D. ^{79}Br and ^{80}Br

[1]

22N.1A.SL.TZ0.6

What is the relative atomic mass of a sample of chlorine containing 70 % of the ^{35}Cl isotope and 30 % of the ^{37}Cl isotope?

- A. 35.4
- B. 35.5
- C. 35.6
- D. 35.7

[1]

22N.1A.SL.TZ0.25

Which homologous series has the general formula $C_n H_{2n} O$ ($n > 2$)? [1]

- A. Alcohols
- B. Carboxylic acids
- C. Ethers
- D. Ketones

22N.1A.SL.TZ0.23

Which combination is correct regarding the anode and electron flow in an electrolytic cell?

	Polarity of anode	Movement of electrons in external circuit
A.	Positive electrode	Anode to cathode
B.	Positive electrode	Cathode to anode
C.	Negative electrode	Anode to cathode
D.	Negative electrode	Cathode to anode

[1]

21M.1A.SL.TZ1.8

Which trend is correct, going down group 1? [1]

- A. Melting point increases
- B. Reactivity decreases
- C. First ionisation energy increases
- D. Electronegativity decreases

SPM.1A.SL.TZ0.15

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

- A. atomic number
- B. atomic mass
- C. electron configuration
- D. reactivity

[1]

19N.1A.SL.TZ0.29

What is the value of the temperature change? [1]



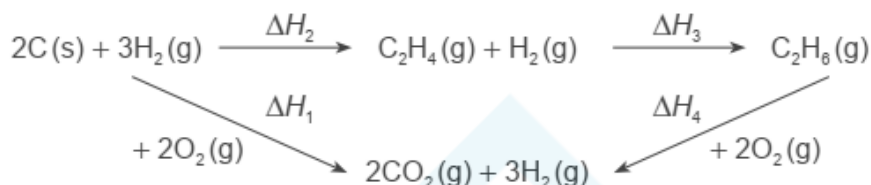
Initial temperature: $2.0 \pm 0.1^\circ\text{C}$

Final temperature: $15.0 \pm 1.0^\circ\text{C}$

- A. $13.0 \pm 0.1^\circ\text{C}$
- B. $13.0 \pm 0.9^\circ\text{C}$
- C. $13.0 \pm 1.0^\circ\text{C}$
- D. $13.0 \pm 1.1^\circ\text{C}$

20N.1A.SL.TZ0.14

Which combination will give you the enthalpy change for the hydrogenation of ethene to ethane, ΔH_3 ?



- A. $-\Delta H_2 + \Delta H_1 - \Delta H_4$
- B. $\Delta H_2 - \Delta H_1 + \Delta H_4$
- C. $\Delta H_2 + \Delta H_1 - \Delta H_4$
- D. $-\Delta H_2 - \Delta H_1 + \Delta H_4$

[1]

22N.1A.SL.TZ0.13

Chlorofluorocarbons (CFCs) contain bonds of the following lengths: [1]

$\text{C}-\text{C} = 1.54 \times 10^{-10} \text{ m}$

$\text{C}-\text{F} = 1.38 \times 10^{-10} \text{ m}$

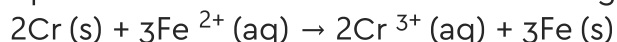
$\text{C}-\text{Cl} = 1.77 \times 10^{-10} \text{ m}$

What is the order of **increasing** bond strength in the CFC molecule?

- A. $\text{C}-\text{C} < \text{C}-\text{F} < \text{C}-\text{Cl}$
- B. $\text{C}-\text{C} < \text{C}-\text{Cl} < \text{C}-\text{F}$
- C. $\text{C}-\text{Cl} < \text{C}-\text{C} < \text{C}-\text{F}$
- D. $\text{C}-\text{F} < \text{C}-\text{C} < \text{C}-\text{Cl}$

22N.1A.SL.TZ0.21

What occurs during the operation of a voltaic cell based on the given reaction?



	External circuit	Ion movement in solution
A.	Electrons move from Cr to Fe	$\text{Fe}^{2+}(\text{aq})$ move away from Fe(s)
B.	Electrons move from Cr to Fe	$\text{Fe}^{2+}(\text{aq})$ move toward Fe(s)
C.	Electrons move from Fe to Cr	$\text{Cr}^{3+}(\text{aq})$ move away from Cr(s)
D.	Electrons move from Fe to Cr	$\text{Cr}^{3+}(\text{aq})$ move toward Cr(s)

[1]

21N.1A.SL.TZ0.20

Which ions are present in an aqueous solution of Na_2CO_3 ? [1]

- I. HCO_3^-
- II. OH^-
- III. CO_3^{2-}

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

19M.1A.SL.TZ1.29

Where does oxidation occur in a voltaic cell? [1]

- A. positive electrode and anode
- B. negative electrode and anode
- C. positive electrode and cathode
- D. negative electrode and cathode

19N.1A.SL.TZ0.7

Which property shows a general increase from left to right across period 2, Li to F? [1]

- A. Melting point
- B. Electronegativity
- C. Ionic radius
- D. Electrical conductivity

22N.1A.SL.TZ0.1

How many oxygen atoms are present in 0.0500 mol $\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$? [1]

$$N_A = 6.02 \times 10^{23}$$

- A. 3.01×10^{23}
- B. 6.02×10^{23}
- C. 3.01×10^{24}
- D. 6.02×10^{24}

SPM.1A.SL.TZ0.16

Which set of conditions describe a reaction in which the reactants are more stable than the products?

- A. endothermic and ΔH negative
- B. endothermic and ΔH positive
- C. exothermic and ΔH negative

D. exothermic and ΔH positive

[1]

SPM.1A.SL.TZ0.3

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

- A. $n = 1$ to $n = 2$
- B. $n = 2$ to $n = 3$
- C. $n = 2$ to $n = 1$
- D. $n = 3$ to $n = 2$

[1]

22M.1A.SL.TZ2.6

Which are the most reactive elements of the alkali metals and halogens? [1]

- A. Lithium and fluorine
- B. Lithium and iodine
- C. Caesium and fluorine
- D. Caesium and iodine

23M.1A.SL.TZ1.12

In which molecule does the central atom have an incomplete octet of electrons? [1]

- A. H_2Se
- B. PH_3
- C. OF_2
- D. BF_3

22N.1A.SL.TZ0.20

Which species has the weakest conjugate base? [1]

- A. HCl
- B. NH_4^+
- C. HCO_3^-
- D. H_2O

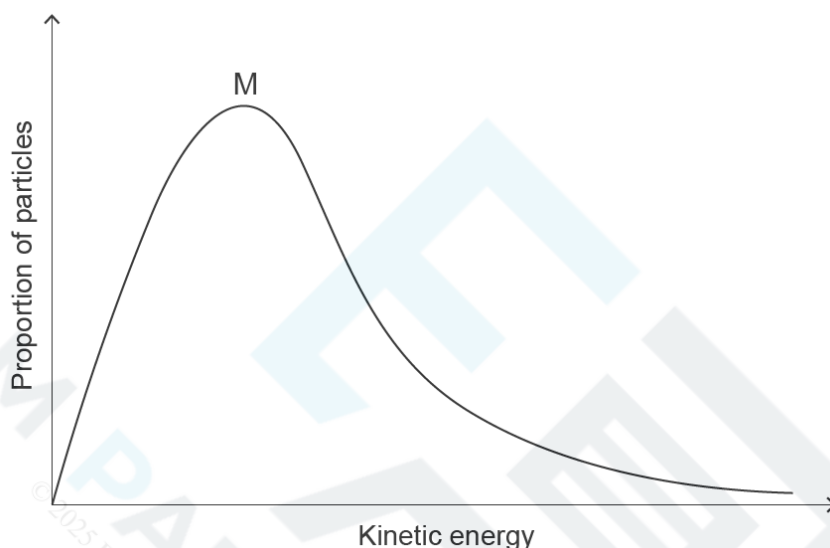
20N.1A.SL.TZ0.13

Which equation shows the enthalpy of formation, ΔH_f , of ethanol? [1]

- A. $2\text{C (s)} + 3\text{H}_2\text{ (g)} + \frac{1}{2}\text{O}_2\text{ (g)} \rightarrow \text{C}_2\text{H}_5\text{OH (g)}$
- B. $4\text{C (s)} + 6\text{H}_2\text{ (g)} + \text{O}_2\text{ (g)} \rightarrow 2\text{C}_2\text{H}_5\text{OH (g)}$
- C. $2\text{C (s)} + 3\text{H}_2\text{ (g)} + \frac{1}{2}\text{O}_2\text{ (g)} \rightarrow \text{C}_2\text{H}_5\text{OH (l)}$
- D. $4\text{C (s)} + 6\text{H}_2\text{ (g)} + \text{O}_2\text{ (g)} \rightarrow 2\text{C}_2\text{H}_5\text{OH (l)}$

21M.1A.SL.TZ2.17

The graph shows the Maxwell–Boltzmann energy distribution curve for a given gas at a certain temperature.



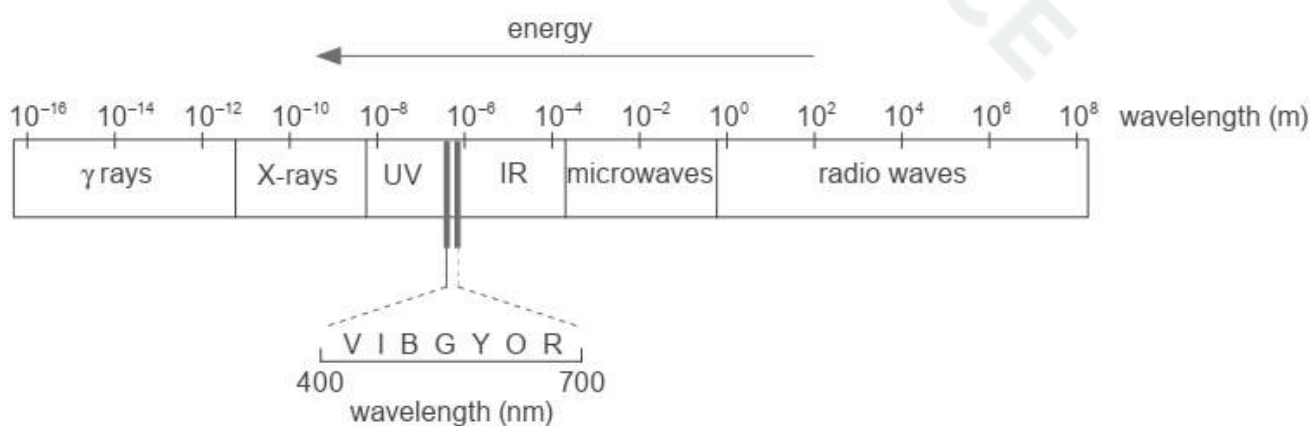
How would the curve change if the temperature of the gas decreases while the other conditions remain constant?

- A. The maximum would be lower and to the left of M.
- B. The maximum would be lower and to the right of M.
- C. The maximum would be higher and to the left of M.
- D. The maximum would be higher and to the right of M.

[1]

20N.1A.SL.TZ0.30

Which region of the electromagnetic spectrum is used to identify hydrogen environments in a molecule?



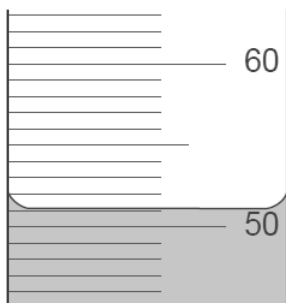
- A. X-ray

- B. UV
- C. IR
- D. radio waves

[1]

22M.1A.SL.TZ2.29

What is the uncertainty, in cm^3 , of this measurement? [1]



- A. ± 0.01
- B. ± 0.1
- C. ± 0.15
- D. ± 1

23M.1A.SL.TZ1.34

What is the product of the reaction of but-2-ene with bromine? [1]

- A. 1,2-dibromobutane
- B. 2,2-dibromobutane
- C. 2,3-dibromobutane
- D. 3,3-dibromobutane

SPM.1A.SL.TZ0.28

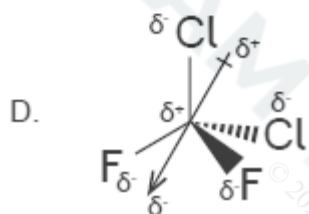
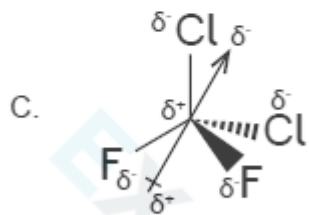
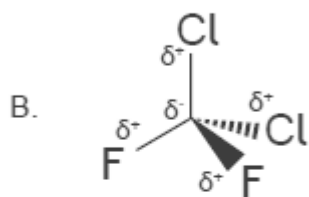
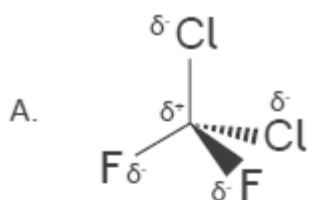
What is the organic product of the reaction of 1-chloropentane with aqueous sodium hydroxide?

- A. pentan-1-ol
- B. 1-chloropentan-1-ol
- C. 1-chloropent-1-ene
- D. 1-chloropent-2-ene

[1]

22N.1A.SL.TZ0.11

Which structure of CF_2Cl_2 is shown with correct bond and molecular dipoles? [1]



20N.1A.SL.TZ0.12

Which series shows the correct order of metallic bond strength from strongest to weakest?

- A. $\text{Na} > \text{K} > \text{Rb} > \text{Mg}$
- B. $\text{Mg} > \text{Rb} > \text{K} > \text{Na}$
- C. $\text{Rb} > \text{K} > \text{Na} > \text{Mg}$
- D. $\text{Mg} > \text{Na} > \text{K} > \text{Rb}$

[1]

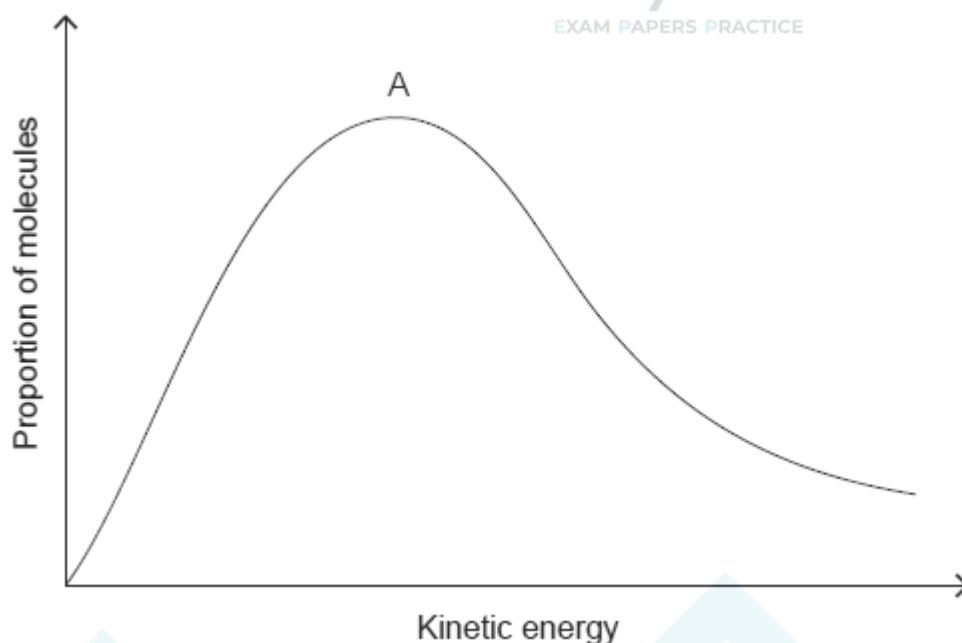
19N.1A.SL.TZ0.5

What is represented by A in ${}^A_Z\text{X}^{2-}$? [1]

- A. Number of electrons
- B. Number of neutrons
- C. Number of nucleons
- D. Number of protons

19N.1A.SL.TZ0.18

The graph shows the Maxwell–Boltzmann energy distribution curve for a given gas at a certain temperature.



How will the curve change if the temperature of the gas is increased, while other conditions remain constant?

- A. The maximum is higher and to the left of A.
- B. The maximum is higher and to the right of A.
- C. The maximum is lower and to the right of A.
- D. The maximum is lower and to the left of A.

[1]

22N.1A.SL.TZ0.8

Which property of elements increases down a group but decreases across a period? [1]

- A. Atomic radius
- B. Electronegativity
- C. Ionic radius
- D. Ionization energy

19M.1A.SL.TZ1.17

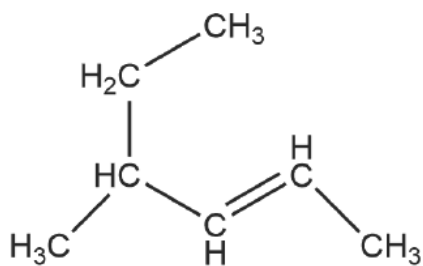
Which will increase the rate of reaction between calcium carbonate and hydrochloric acid?

- I. an increase in temperature
 - II. an increase in concentration of hydrochloric acid
 - III. an increase in particle size of calcium carbonate
- A. I and II only
 - B. I and III only
 - C. II and III only
 - D. I, II and III

[1]

21M.1A.SL.TZ1.25

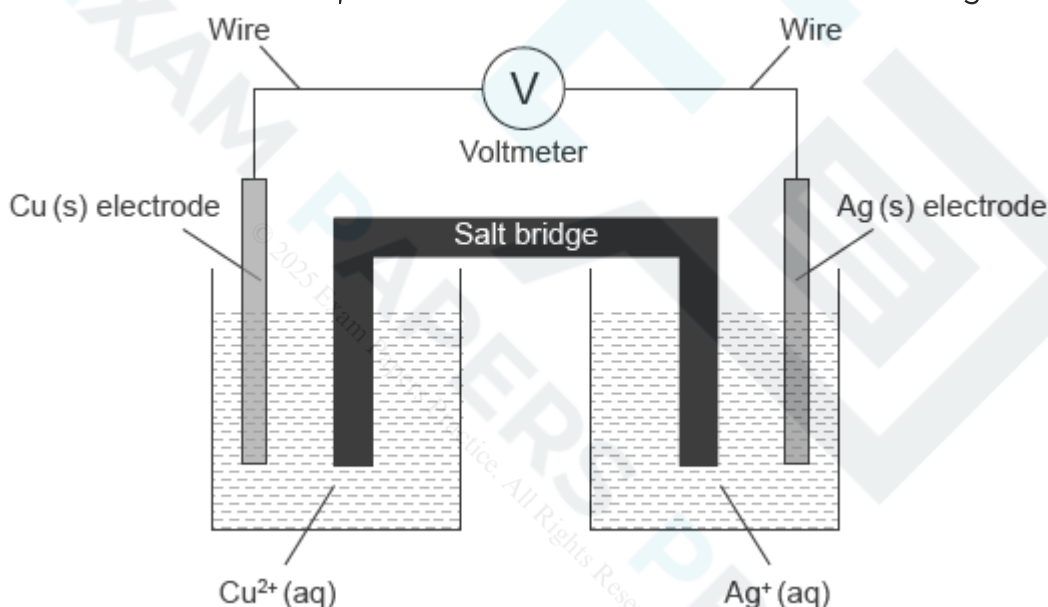
What is the name of this compound, applying IUPAC rules? [1]



- A. 4-methylhex-2-ene
- B. 4-ethylpent-2-ene
- C. 2-ethylpent-3-ene
- D. 3-methylhex-4-ene

21N.1A.SL.TZ0.24

Consider this voltaic cell, where Cu is a more reactive metal than Ag: [1]



Which combination describes the movement of charge in this cell?

	Flow of electrons in wire	Flow of negative ions in salt bridge
A.	Ag(s) to Cu(s)	Toward Ag ⁺ (aq)
B.	Cu(s) to Ag(s)	Toward Ag ⁺ (aq)
C.	Ag(s) to Cu(s)	Toward Cu ²⁺ (aq)
D.	Cu(s) to Ag(s)	Toward Cu ²⁺ (aq)

21M.1A.SL.TZ2.2

Which amount, in mol, of sodium chloride is needed to make 250 cm³ of 0.10 mol dm⁻³ solution?

- A. 4.0 × 10⁻⁴
- B. 0.025
- C. 0.40

D. 25

[1]

23M.1A.SL.TZ1.22

What is the formula of copper (I) sulfide? [1]

- A. CuS
- B. Cu₂S
- C. CuSO₃
- D. Cu₂SO₃

22M.1A.SL.TZ1.23

How many electrons are needed when the following half-equation is balanced using the lowest possible whole numbers?



- A. 1
- B. 2
- C. 3
- D. 5

[1]

SPM.1A.SL.TZ0.4

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

[1]

SPM.1A.SL.TZ0.6

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

- A. MgHCO₃
- B. Mg(HCO₃)₂
- C. Mg(HCO₃)₃
- D. Mg₃(HCO₃)₂

[1]

SPM.1A.SL.TZ0.2

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. $^2\text{H}_2\text{O}$ (s) has a higher melting point than normal ice.
- C. $^2\text{H}_2\text{O}$ (s) has a lower density than normal ice-cold water.
- D. $^2\text{H}_2\text{O}$ has different chemical properties from normal water.

[1]

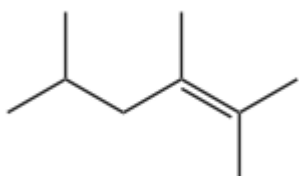
20N.1A.SL.TZ0.25

Which molecule will decolorize bromine water in the dark? [1]

- A. cyclohexane
- B. hexane
- C. hex-1-ene
- D. hexan-1-ol

20N.1A.SL.TZ0.26

What is the IUPAC name of this molecule? [1]



- A. 1,1,2,4-tetramethylpent-1-ene
- B. 2,4,5-trimethylhex-4-ene
- C. 2,4,5,5-tetramethylpent-4-ene
- D. 2,3,5-trimethylhex-2-ene

21M.1A.SL.TZ2.24

Which is in the same homologous series as CH_3OCH_3 ? [1]

- A. CH_3COCH_3
- B. $\text{CH}_3\text{COOCH}_3$
- C. $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
- D. $\text{CH}_3\text{CH}_2\text{CH}_2\text{OCH}_3$

21N.1A.SL.TZ0.8

Which combination describes the acid–base nature of aluminium and phosphorus oxides?

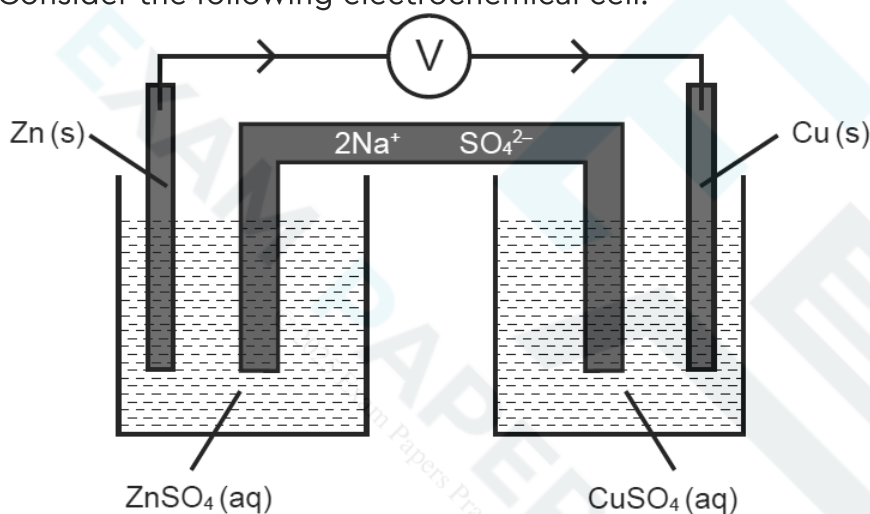
	Aluminium	Phosphorus
A.	Amphoteric oxide	Acidic oxide
B.	Basic oxide	Amphoteric oxide
C.	Acidic oxide	Amphoteric oxide
D.	Amphoteric oxide	Basic oxide

[1]

19M.1A.SL.TZ2.22

Consider the following electrochemical cell.

[1]



What happens to the ions in the salt bridge when a current flows?

- A. Na^+ ions flow to the zinc half-cell and SO_4^{2-} ions flow to the copper half-cell.
- B. Na^+ ions flow to the copper half-cell and SO_4^{2-} ions flow to the zinc half-cell.
- C. Na^+ and SO_4^{2-} ions flow to the copper half-cell.
- D. Na^+ and SO_4^{2-} ions flow to the zinc half-cell.

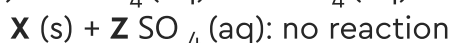
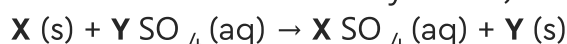
19M.1A.SL.TZ2.24

Which compound has the lowest boiling point? [1]

- A. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$
- B. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$
- C. $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_3$
- D. $\text{CH}_3\text{C}(\text{CH}_3)_2\text{CH}_3$

19N.1A.SL.TZ0.23

The following occurs when metal **X** is added to **Y** sulfate solution and **Z** sulfate solution. (**X**, **Y** and **Z** represent metal elements but not their symbols.)



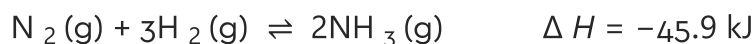
What is the order of increasing reactivity?

- A. $X < Y < Z$
- B. $Y < X < Z$
- C. $Z < Y < X$
- D. $Z < X < Y$

[1]

19N.1A.SL.TZ0.19

What effect does increasing both pressure and temperature have on the equilibrium constant, K_c ?



- A. Decreases
- B. Increases
- C. Remains constant
- D. Cannot be predicted as effects are opposite

[1]

19M.1A.SL.TZ2.17

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



Which reaction has the greatest rate?

	Concentration of $\text{HCl}(\text{aq})$	Surface area of same mass of $\text{CaCO}_3(\text{s})$
A.	higher	larger
B.	lower	smaller
C.	lower	larger
D.	higher	smaller

[1]

23M.1A.SL.TZ2.7

What is the electron configuration for an element in group 4 period 5? [1]

- A. $[\text{Kr}] 5s^2 4d^2$
- B. $[\text{Ar}] 4s^2 3d^3$
- C. $[\text{Ar}] 4s^2 3d^{10} 4p^3$
- D. $[\text{Kr}] 5s^2 4d^{10} 5p^2$

SPM.1A.SL.TZ0.13

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

[1]

SPM.1A.SL.TZ0.5

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

[1]

20N.1A.SL.TZ0.8

Which oxide will dissolve in water to give the solution with the lowest pH? [1]

- A. P_4O_{10}
- B. SiO_2
- C. Al_2O_3
- D. MgO

21M.1A.SL.TZ1.21

A student performed displacement reactions using metals W and X and solutions of salts of metals W, X, Y and Z. The results are summarized in the table.

		Salt solution			
		W^{2+}	X^{2+}	Y^{2+}	Z^{2+}
Metal	W		No reaction	No reaction	No reaction
	X	Reaction		Reaction	No reaction

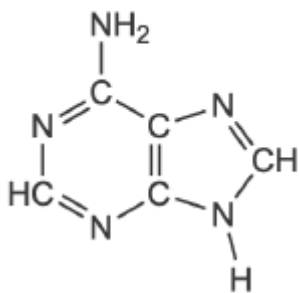
Which of the four metals is most reactive?

- A. W
- B. X
- C. Y
- D. Z

[1]

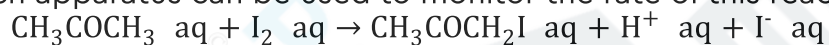
What is the index of hydrogen deficiency of adenine? [1]

Adenine (C₅H₅N₅)



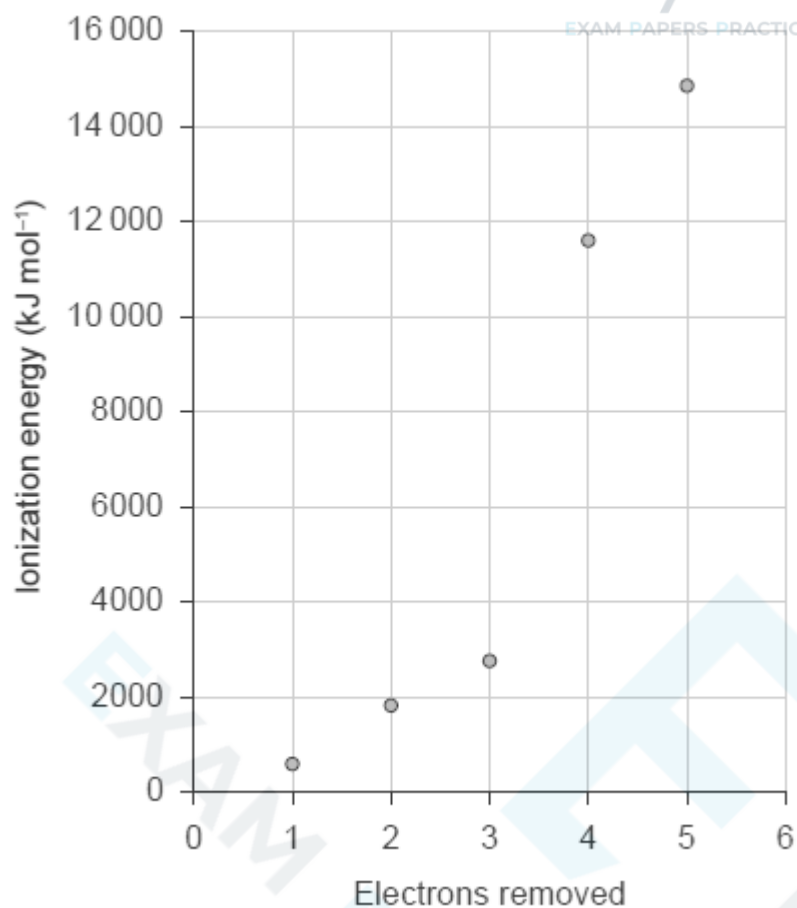
- A. 3
- B. 4
- C. 5
- D. 6

Which apparatus can be used to monitor the rate of this reaction? [1]



- . A pH meter
 - . A gas syringe
 - . A colorimeter
- A. I and II only
B. I and III only
C. II and III only
D. I, II and III

The successive ionization energies for an element in period three are shown. [1]



Which element in period 3 has these successive ionization energies?

- A. Na
- B. Mg
- C. Al
- D. Si

22M.1A.SL.TZ1.20

Which 0.01 mol dm^{-3} aqueous solution has the highest pH? [1]

- A. HCl
- B. H_2SO_4
- C. NaOH
- D. NH_3

21M.1A.SL.TZ1.6

Which represents a p orbital?

[1]

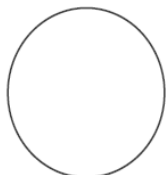
A.



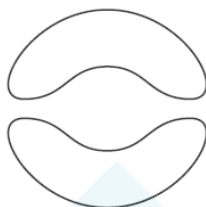
C.



B.

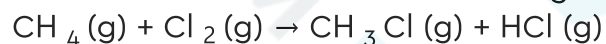


D.



19M.1A.SL.TZ2.26

Methane reacts with chlorine in sunlight. [1]



Which type of reaction occurs?

- A. free-radical substitution
- B. electrophilic substitution
- C. nucleophilic substitution
- D. electrophilic addition

23M.1A.SL.TZ2.23

Which species could be reduced to form SO_2 ? [1]

- A. S
- B. H_2SO_3
- C. H_2SO_4
- D. $(\text{CH}_3)_2\text{S}$

21N.1A.SL.TZ0.16

Which statement describes an endothermic reaction?

[1]

- A. The bonds broken are stronger than the bonds formed.
- B. The enthalpy of the reactants is higher than the enthalpy of the products.
- C. The temperature of the surroundings increases.
- D. The products are more stable than the reactants.

SPM.1A.SL.TZ0.21

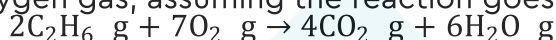
Large deposits of methane hydrate, $\text{CH}_4 \cdot 6\text{H}_2\text{O}$ ($M_r = 124$), have been discovered under the ocean floor. What mass of carbon dioxide would be produced by the complete combustion of 12.4 g of the methane hydrate?

- A. 4.40 g
- B. 26.4 g
- C. 34.1 g
- D. 44.0 g

[1]

20N.1A.SL.TZ0.4

Which volume of ethane gas, in cm^3 , will produce 40 cm^3 of carbon dioxide gas when mixed with 140 cm^3 of oxygen gas, assuming the reaction goes to completion?



- A. 10
- B. 20
- C. 40
- D. 80

[1]

22N.1A.SL.TZ0.27

What are nucleophiles most likely to react with? [1]

- A. Alkenes
- B. Alcohol
- C. Alkanes
- D. Halogenoalkanes

22M.1A.SL.TZ2.10

What is the type of bonding in a compound that has high boiling and melting points, poor electrical conductivity, and low solubility in water?

- A. Ionic
- B. Molecular covalent
- C. Metallic
- D. Giant covalent

[1]

19N.1A.SL.TZ0.31

What are the products of electrolysis of concentrated aqueous sodium bromide? [1]



	Positive electrode	Negative electrode
A.	Br ₂	Na
B.	O ₂	H ₂
C.	O ₂	Na
D.	Br ₂	H ₂

SPM.1A.SL.TZ0.27

In a redox titration, manganate(VII) ions are reduced to manganese(II) ions and iron(II) ions are oxidized to iron(III) ions.

MnO_4^- (aq) reduced to Mn^{2+} (aq)

Fe^{2+} (aq) oxidized to Fe^{3+} (aq)

What volume, in cm^3 , of $0.1 \text{ mol dm}^{-3} \text{MnO}_4^-$ (aq) is required to reach the equivalence point in the titration of 20.00 cm^3 of $0.1 \text{ mol dm}^{-3} \text{Fe}^{2+}$ (aq)?

- A. 2.00
- B. 4.00
- C. 20.00
- D. 100.00

[1]

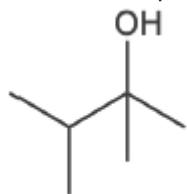
22M.1A.SL.TZ1.21

In which of the following species would sulfur be reduced if converted to SCl_2 ? [1]

- A. $\text{S}_2\text{O}_3^{2-}$
- B. H_2S
- C. S
- D. SO_2

23M.1A.SL.TZ2.34

What is the preferred IUPAC name of the structure shown? [1]



- A. 2-ethyl-3-methylbutan-1-ol
- B. 2,3-dimethylbutan-2-ol
- C. 1-ethyl-2-methylpropan-1-ol
- D. 1,1,2-trimethylpropan-1-ol

23M.1A.SL.TZ2.37

Which mechanism does the nitration of benzene proceed by? [1]

- A. electrophilic addition
- B. electrophilic substitution
- C. nucleophilic addition
- D. nucleophilic substitution

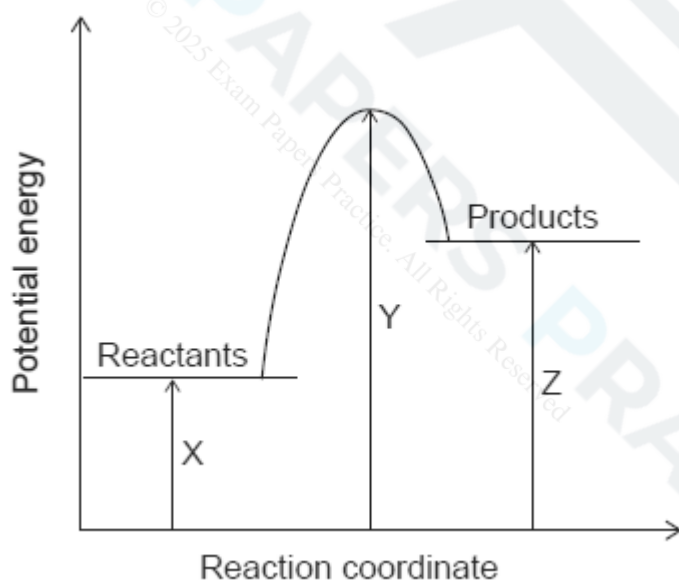
22N.1A.SL.TZ0.4

Which is a possible empirical formula for a substance with $M_r = 42$? [1]

- A. CH
- B. CH₂
- C. C₃H₆
- D. C₃H₈

SPM.1A.SL.TZ0.22

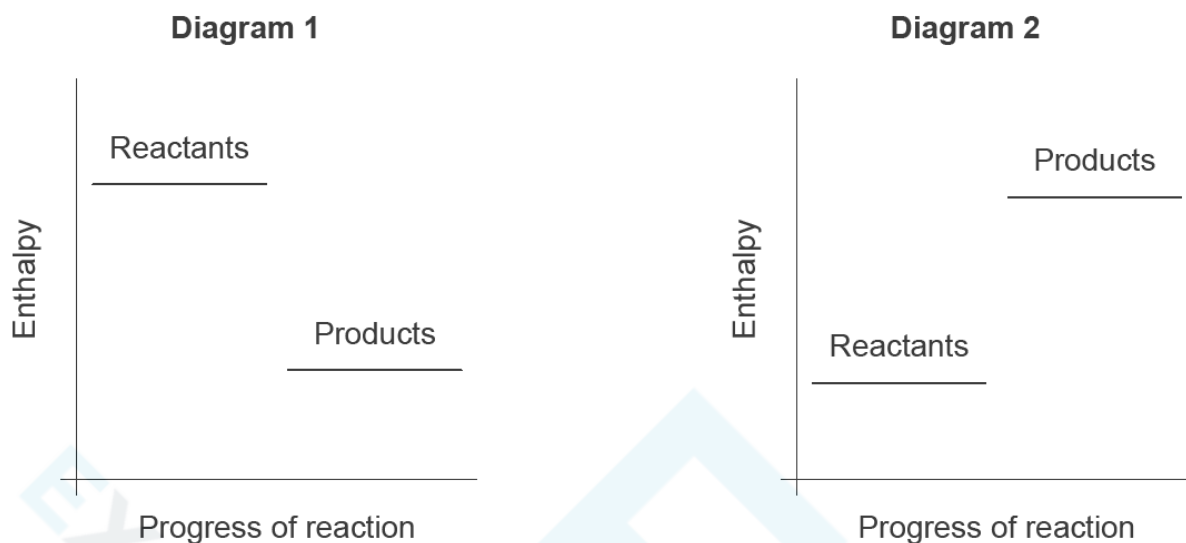
The diagram shows the energy profile of a reaction. [1]



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.	$Y - X$	$Z - X$

When sodium carbonate powder is added to ethanoic acid, the beaker becomes cooler. Possible enthalpy diagrams are shown.



Which correctly describes the reaction?

	Enthalpy diagram	Reaction
A.	1	Endothermic
B.	1	Exothermic
C.	2	Endothermic
D.	2	Exothermic

[1]

SPM.1A.SL.TZ0.19

What is the amount, in mol, of H_2O produced for a reaction between 10.0 mol of $\text{C}_2\text{H}_3\text{Cl}$ and 10.0 mol of O_2 if the yield is 90 %?



- A. 3.60
- B. 4.00
- C. 9.00
- D. 10.00

[1]

22M.1A.SL.TZ2.11

What is the name of the compound with formula $\text{Ti}_3(\text{PO}_4)_2$? [1]

- A. Titanium phosphate
- B. Titanium(II) phosphate
- C. Titanium(III) phosphate

23M.1A.SL.TZ2.31

Which will eventually yield the greatest mass of deposited copper in the electrolysis of a fixed volume of $1 \text{ mol dm}^{-3} \text{ CuSO}_4 (\text{aq})$?

- A. copper anode and inert cathode
- B. inert anode and copper cathode
- C. inert anode and inert cathode
- D. zinc anode and zinc cathode

[1]

SPM.1A.SL.TZ0.29

Which statements explain the following reactions occurring in the upper atmosphere?

	Chlorofluorocarbon (CFC) compounds break down to produce chlorine radicals but usually not fluorine radicals.	A single chlorine radical breaks down many ozone, O_3, molecules.
A.	C–Cl bond is stronger than C–F bond	chain propagation steps produce more radicals
B.	C–F bond is stronger than C–Cl bond	chain termination steps cause chlorine radicals to reform chlorine molecules
C.	C–Cl bond is stronger than C–F bond	chain termination steps cause chlorine radicals to reform chlorine molecules
D.	C–F bond is stronger than C–Cl bond	chain propagation steps produce more radicals

[1]