Class | Adm No

Candidate Name: _____

H

millennia institute

2024 Preliminary Exams
Pre–University 2

H1 CHEMISTRY **8873/1**

Paper 1 Multiple Choice **19 September 2024**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Data Booklet

READ THESE INSTRUCTIONS FIRST

Do not turn over this question paper until you are told to do so.

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.

At the top of this page:
Write your name, class and admission number in the spaces provided.

On the Answer Sheet:
Write your name, class and subject.
Write your identification number and shade the corresponding bubbles.

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

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

Marks **30**

1 Which of the following substances contains 1 mol of the stated particles?

	particles	substance
A	molecules	14.0 g of nitrogen gas
B	ions	1.00 mol of sodium chloride
C	hydrogen ions	1 dm^3 of 1.00 mol dm^{-3} sulfuric acid
D	molecules	24.0 dm^3 of carbon dioxide gas at room temperature and pressure

2 10 cm^3 of hydrocarbon was completely combusted in 50 cm^3 of oxygen. 40 cm^3 of gas was present after cooling the mixture to room temperature.

After passing the gases through sodium hydroxide, 20 cm^3 of gas was remaining.

What is the molecular formula of the hydrocarbon?

A C_2H_4 **B** C_2H_6 **C** C_4H_8 **D** C_4H_{10}

3 In a reaction, iodine reacts with nitric acid in the mole ratio 1 : 10. The three products of this reaction are nitrogen dioxide, water and an iodine-containing product, X.

What is the oxidation number of iodine in the iodine-containing product, X?

A +1 **B** +3 **C** +5 **D** +7

4 Deuterium is an isotope of hydrogen. It has a relative mass of 2.

What would be the correct number of subatomic particles present in an ion of deuterium that has a charge of 1–?

	number of protons	number of neutrons	number of electrons
A	1	1	1
B	1	1	2
C	1	2	1
D	1	2	2

5 Which ion, when passed through an electric field, would be deflected the least?

A $^{4}He^{2+}$ **B** $^{6}Li^{+}$ **C** $^{10}B^{3+}$ **D** $^{14}N^{3-}$

6 Which ion has the highest number of unpaired electrons?

A Cr^{3+} **B** Fe^{3+} **C** Ni^{2+} **D** Cu^{2+}

7 *Use of the Data Booklet is relevant to this question.*

Which metal has the lowest melting point?

A Li **B** Na **C** Mg **D** A*l*

8 Phosphorus trichloride, PCl_3, reacts with chlorine to form phosphorus pentachloride, PCl_5.

Which statements correctly describe the changes from PCl_3 to PCl_5?

1 The molecule turned from polar to non-polar.

2 The molecule turned from planar to three-dimensional.

3 The additional chlorine atoms formed dative bonds to phosphorus atom, as phosphorus atom contains energetically-accessible vacant orbitals to accommodate additional lone pairs of electrons.

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

9 Which statements correctly explain the trend in boiling points for the hydrogen halides from HC*l* to HBr to HI?

	HC*l*	HBr	HI
boiling point / °C	–85	–66	–35

1 The instantaneous dipole-induced dipole forces of attraction become stronger.

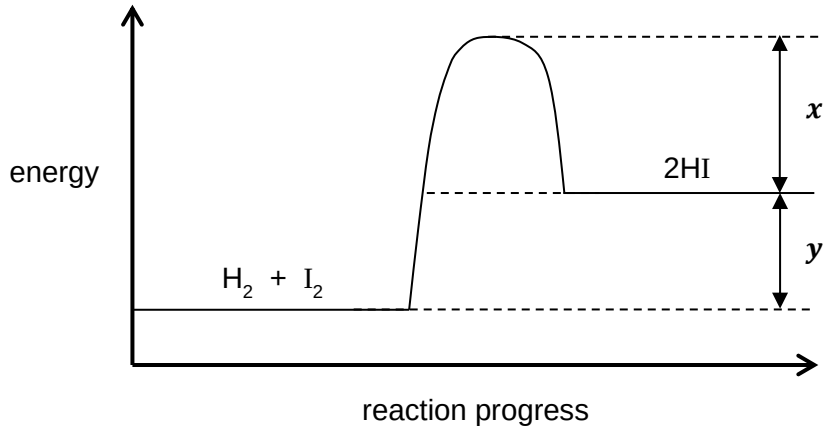
2 The permanent dipole-permanent dipole forces of attraction become stronger.

3 The bond energies become higher.

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

10 The progress of reaction for the formation of hydrogen iodide is shown.

$H_2 + I_2 \longrightarrow 2HI$



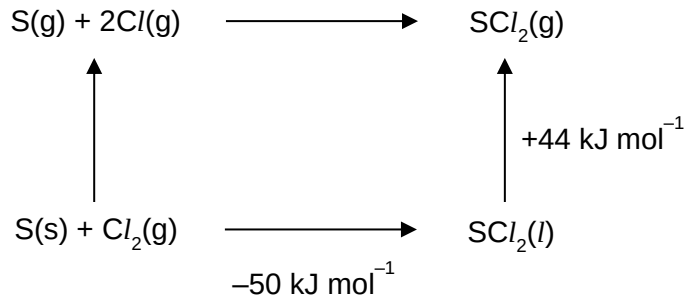
Which row about the magnitudes of energy changes is correct?

	energy required to break bonds	energy released when bonds are formed	enthalpy of the reaction
A	x	$x + y$	y
B	$x + y$	y	x
C	$x + y$	x	y
D	y	$x + y$	x

11 *Use of the Data Booklet is relevant to this question.*

The standard enthalpy change of sublimation of S(s) is +12 kJ mol^{-1}.

An energy cycle is shown.



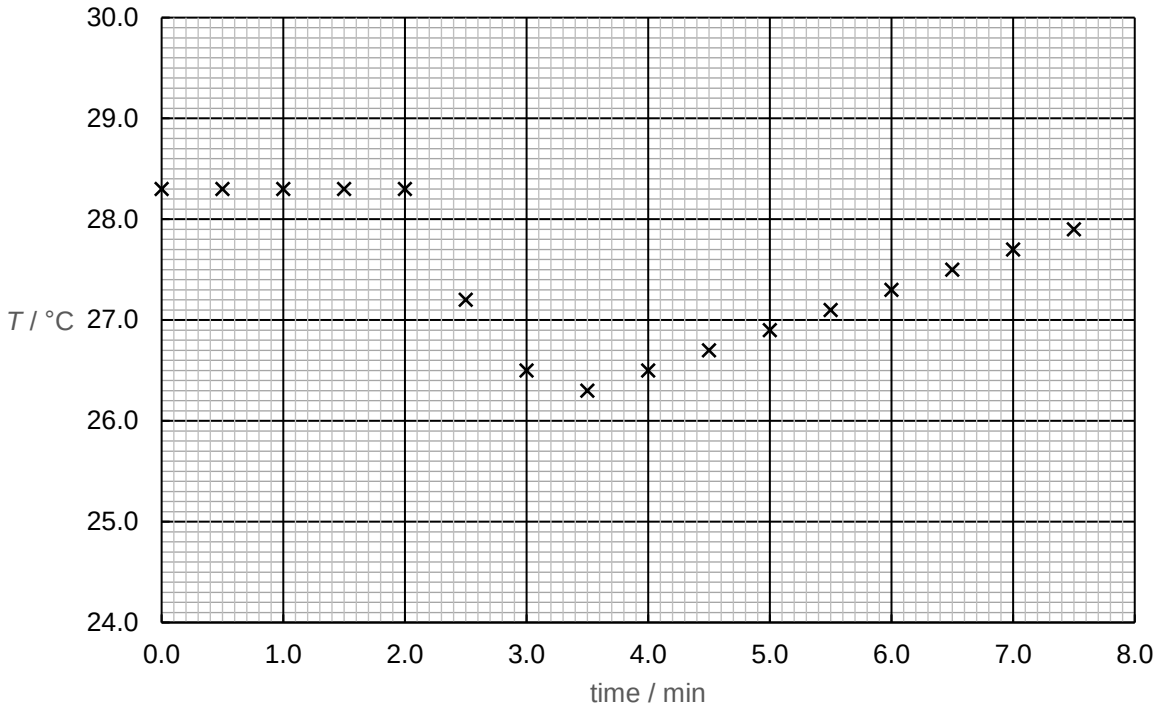
What is the average bond energy of the S–C*l* bond in S$C\mathit{l}_2$?

A 9 kJ mol^{-1} **B** 125 kJ mol^{-1} **C** 131 kJ mol^{-1} **D** 253 kJ mol^{-1}

12 *Use of the Data Booklet is relevant to this question.*

The temperature, *T*, of a beaker of 25.0 cm^3 water was measured at regular intervals.

At 2.0 minutes, 1.00 g of ammonium chloride was dissolved into the water.

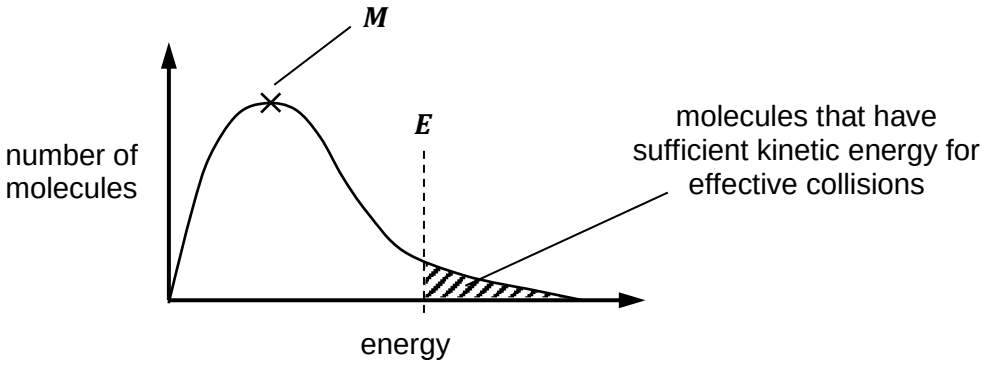


What is the enthalpy of dissolution of ammonium chloride?

You may assume that the specific heat capacity of the solution = 4.18 J cm^{-3} K^{-1}.

A +11.2 kJ mol^{-1} **B** +11.6 kJ mol^{-1} **C** +14.5 kJ mol^{-1} **D** +15.1 kJ mol^{-1}

13 The curve below shows the Boltzmann distribution for a reaction mixture.



Which statement is correct?

A At a higher temperature, energy ***E*** will shift to the right.

B At a higher temperature, point ***M*** will shift upwards.

C When a catalyst is used, energy ***E*** will shift to the left.

D When a catalyst is used, point ***M*** will shift to the right.

14 In the Haber process, finely-divided iron is used as a catalyst for the formation of ammonia from hydrogen and nitrogen.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H < 0$$

Which statement correctly describes the mode of action of iron for the formation of ammonia?

A Iron increases the reaction rate by desorbing H_2 and N_2 molecules.

B Ammonia molecules adsorb onto the iron surface, increasing the local concentration of ammonia.

C Iron forms weak forces with H_2 and N_2 molecules, allowing the bonds in H_2 and N_2 to be broken more easily.

D Iron absorbs heat energy from the H_2 and N_2, shifting the equilibrium position right to increase the yield of ammonia.

15 Which reactions are catalysed by a catalytic converter in car exhaust?

1 $2CO + O_2 \longrightarrow 2CO_2$

2 $N_2 + 2O_2 \longrightarrow 2NO_2$

3 $S + O_2 \longrightarrow SO_2$

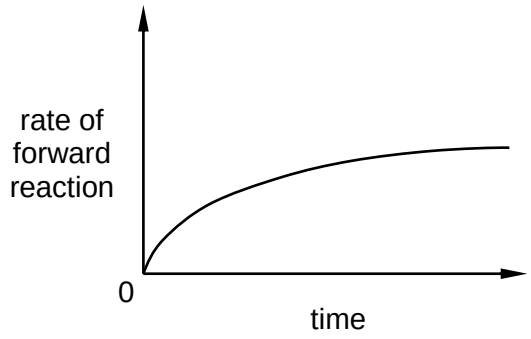
A 1 only **B** 1 and 2 only **C** 2 and 3 only **D** 1, 2 and 3

16 When dinitrogen tetroxide, N_2O_4, is warmed in a closed vessel it dissociates. The reaction eventually reaches equilibrium.

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

Which graph shows the rate of the forward reaction from the start of the reaction until the system reaches equilibrium?

A



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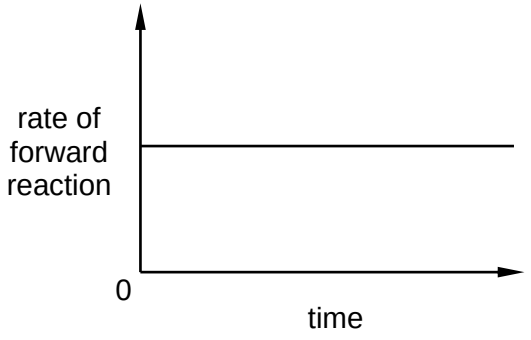

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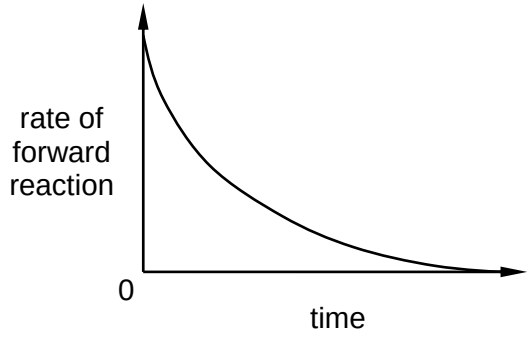

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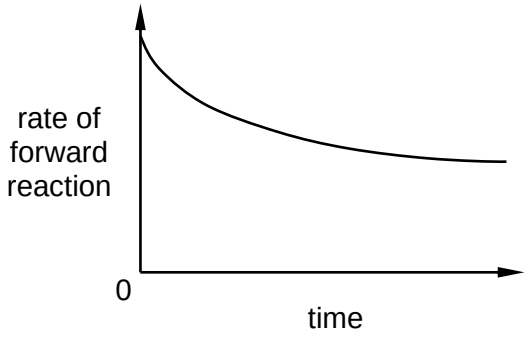


17 When a mixture of 1 mol of methane and 1 mol of steam is allowed to reach equilibrium at a given temperature, the mixture is found to contain *x* mol of methane.

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$$

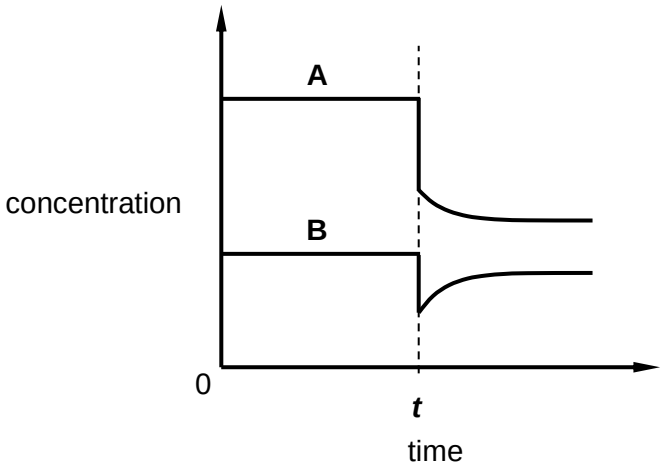
What is the amount of hydrogen (in mol) present at equilibrium?

A $3 - x$ **B** $3 - 3x$ **C** $3x$ **D** $3x - 3$

18 A mixture of gases **A** and **B** was kept in a closed vessel.

$$\mathbf{A}(g) \rightleftharpoons 2\mathbf{B}(g) \qquad \Delta H < 0$$

At time *t*, one condition in the vessel was changed.



What could be the change made to the vessel at time *t*?

A The vessel was cooled.

B The vessel was heated.

C The vessel was compressed.

D The vessel was expanded.

19 Which compound cannot behave as an Arrhenius base?

A CH_3OH **B** H_2O **C** LiOH **D** $Mg(OH)_2$

20 Four acid solutions are shown.

acid	concentration / mol dm^{-3}	pH
α	0.01	2
β	0.1	0.7
γ	1	0.3
δ	2	1

What can be deduced about the acid solutions?

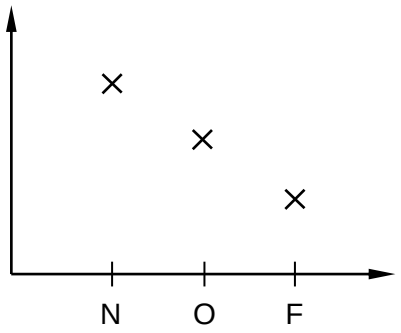
A α is a dibasic acid.

B β is a monobasic acid.

C γ is a strong acid.

D δ is a weak acid.

21 Nitrogen, oxygen, and fluorine are consecutive elements in the Periodic Table.



Which property of the three elements is being shown in the graph above?

A atomic radius

B boiling point

C electronegativity

D first ionisation energy

22 Aluminium chloride, $AlCl_3$, and silicon tetrachloride, $SiCl_4$, were each added into water.

Which statement correctly describes the reactions?

A Neither chloride is soluble in water.

B Both chlorides form acidic solutions.

C Both chlorides give off white fumes with water.

D Both chlorides dissolve in water to form colourless solutions.

23 Which statements about the reactions of Group 17 elements are correct?

1 Chlorine is a stronger oxidising agent than bromine.

2 Bromine does not react with potassium iodide.

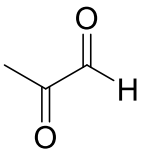
3 Iodine does not react with sodium chloride or sodium bromide.

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

24 How many constitutional isomers that are alcohols have the molecular formula $C_4H_{10}O$?

A 2 **B** 4 **C** 6 **D** 8

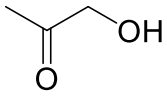
25 Methylglyoxal is a metabolic intermediate.



methylglyoxal

What would be the product after methylglyoxal reacts with sodium borohydride?

A



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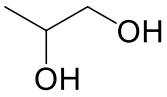

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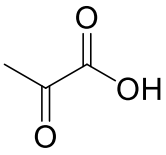

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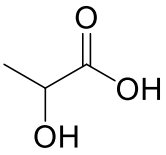
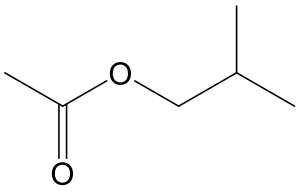


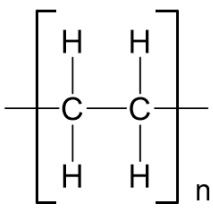
26 Which are the reactant molecules that would form the ester as shown?



	carboxylic acid	alcohol
A	2-methylpropanoic acid	ethanol
B	ethanoic acid	2-methylpropan-1-ol
C	methanoic acid	2-methylpropan-1-ol
D	methanoic acid	3-methylbutan-1-ol

27 Which polymer is the most suitable material to make the casing for laundry detergent pods?

A



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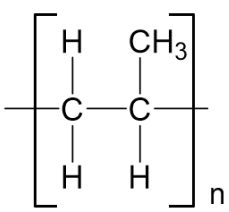

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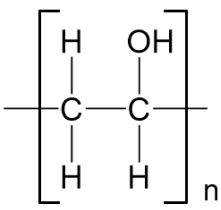

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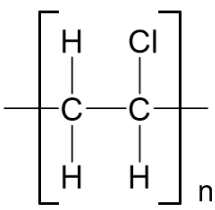
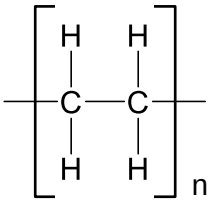


28 Which material can be used to make clothes that are wrinkle-free?

A



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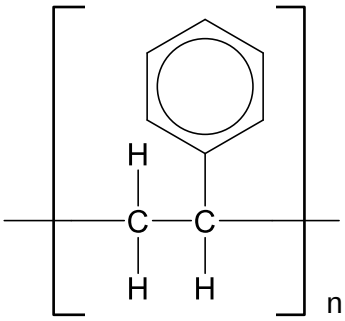

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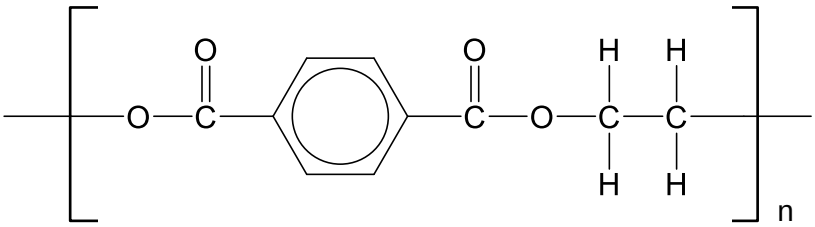

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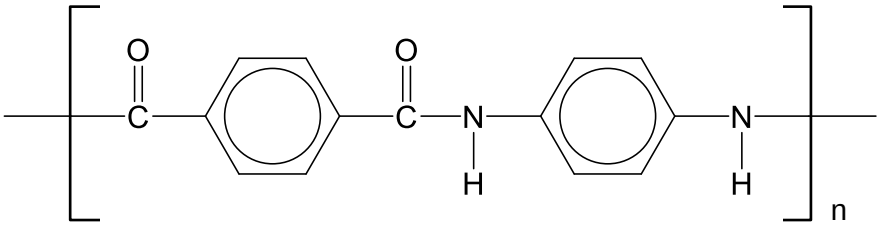

29 Which statement explains why geckos can attach to walls?

A The feet of geckos form hydrogen bonding with the wall.

B The wall has a large surface area to interact with the gecko's feet.

C The feet of geckos contain branching structures that has large surface area.

D The feet of geckos have surface tension which interacts strongly with the wall.

30 Which particles are considered nanoparticles?

You may assume that the particles are spherical.

	particle	diameter / nm
1	gold atom	0.3
2	fullerene, C_{70}	1.5
3	zinc sulfide quantum dot	2.5
4	liposome in cells	500

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

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