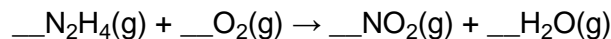# IB CHEMISTRY 1 – SUMMER ASSIGNMENT 2018

Topics 1, 11.1, 11.2, 2–6, 12–16,
[75 marks]

1. What is the sum of the coefficients for the equation when balanced using the smallest possible whole numbers?

$$\_\_N_2H_4(g) + \_\_O_2(g) \rightarrow \_\_NO_2(g) + \_\_H_2O(g)$$

A. 5

B. 6

C. 7

D. 8

(Total 1 mark)

2. Chloroethene, C_2H_3Cl, reacts with oxygen according to the equation below.

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

What is the amount, in mol, of H_2O produced when 10.0 mol of C_2H_3Cl and 10.0 mol of O_2 are mixed together, and the above reaction goes to completion?

A. 4.00

B. 8.00

C. 10.0

D. 20.0

(Total 1 mark)

3. What will be the concentration of sulfate ions in mol dm^{-3} when 0.20 mol of $KAl(SO_4)_2$ is dissolved in water to give 100 cm^3 of aqueous solution?

A. 0.2

B. 1.0

C. 2.0

D. 4.0

(Total 1 mark)

4. Smog is common in cities throughout the world. One component of smog is PAN (peroxyacylnitrate) which consists of 20.2 % C, 11.4 % N, 65.9 % O and 2.50 % H by mass. Determine the empirical formula of PAN, showing your working.

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(Total 3 marks)

5. The volume of an ideal gas at 27.0 °C is increased from 3.00 dm^3 to 6.00 dm^3. At what temperature, in °C, will the gas have the original pressure?

A. 13.5

B. 54.0

C. 327

D. 600

(Total 1 mark)

6. How many significant figures are there in 0.00370?

A. 2

B. 3

C. 5

D. 6

(Total 1 mark)

7. A piece of metallic aluminium with a mass of 10.044 g was found to have a volume of 3.70 cm^3.
A student carried out the following calculation to determine the density.

$$\text{Density (g cm}^{-3}) = \frac{10.044}{3.70}$$

What is the best value the student could report for the density of aluminium?

A. 2.715 g cm^{-3}

B. 2.7 g cm^{-3}

C. 2.71 g cm^{-3}

D. 2.7146 g cm^{-3}

(Total 1 mark)

8. Which describes the visible emission spectrum of hydrogen?

A. A series of lines converging at longer wavelength

B. A series of regularly spaced lines

C. A series of lines converging at lower energy

D. A series of lines converging at higher frequency

(Total 1 mark)

9. Which is correct for the following regions of the electromagnetic spectrum?

	Ultraviolet (UV)		Infrared (IR)	
A.	high energy	short wavelength	low energy	low frequency
B.	high energy	low frequency	low energy	long wavelength
C.	high frequency	short wavelength	high energy	long wavelength
D.	high frequency	long wavelength	low frequency	low energy

(Total 1 mark)

10. The relative atomic mass of naturally occurring copper is 63.55. Calculate the abundances of
^{63}Cu and ^{65}Cu in naturally occurring copper.

(Total 2 marks)

11. (a) Explain why the relative atomic mass of argon is greater than the relative atomic mass of potassium, even though the atomic number of potassium is greater than the atomic number of argon.

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(1)

(b) Deduce the numbers of protons and electrons in the K^+ ion.

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(1)

(c) Deduce the electron arrangement for the K^+ ion.

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(1)
(Total 3 marks)

12. What is the electron configuration for the copper(I) ion, ($Z = 29$)?

A. $[Ar]4s^23d^9$

B. $[Ar]4s^13d^{10}$

C. $[Ar]4s^13d^9$

D. $[Ar]3d^{10}$

(Total 1 mark)

13. (i) Define the term *first ionization energy*.

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(2)

(ii)   Explain why the first ionization energy of magnesium is higher than that of sodium.

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(2)
(Total 4 marks)

14.   Which ion has the largest radius?

A. Cl^-

B. K^+

C. Br^-

D. F^-

(Total 1 mark)

15.   Which statement describes the trends of electronegativity values in the periodic table?

A.   Values increase from left to right across a period and increase down a group.

B.   Values increase from left to right across a period and decrease down a group.

C.   Values decrease from left to right across a period and increase down a group.

D.   Values decrease from left to right across a period and decrease down a group.

(Total 1 mark)

16.   Which oxides produce an acidic solution when added to water?

I. P_4O_{10}

II. MgO

III. SO_3

A.   I and II only

B.   I and III only

C.   II and III only

D.   I, II and III

(Total 1 mark)

17. (a) (i) Draw the shape of the p_z orbital using the coordinates shown.
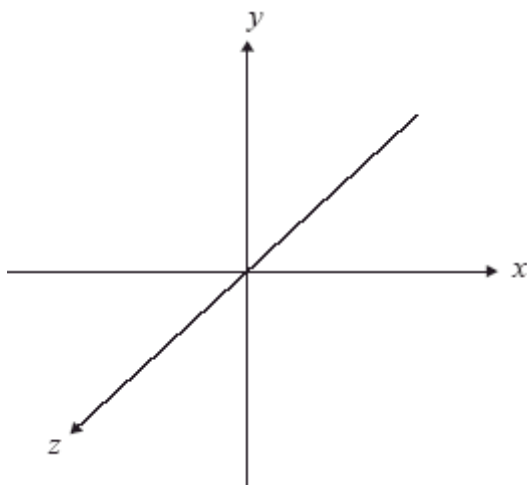
(1)

(ii) State the electron configuration of Fe^{3+}.

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(1)

(iii) Define the term *ligand.*

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(1)

(iv) Explain why the complex $[Fe(H_2O)_6]^{3+}$ is coloured.

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(3)

(v)   The element selenium ($Z = 34$) has electrons in the 4s, 3d and 4p orbitals. Draw an orbital box diagram (arrow-in-box notation) to represent these electrons.

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(1)
(Total 7 marks)

18. Explain the origin of colour in transition metal complexes and use your explanation to suggest why copper(II) sulfate, $CuSO_4(aq)$, is blue, but zinc sulfate, $ZnSO_4(aq)$, is colourless.

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(Total 4 marks)

19. The graph below shows the first four ionization energies of four elements A, B, C and D (the letters are not their chemical symbols). Which element is magnesium?
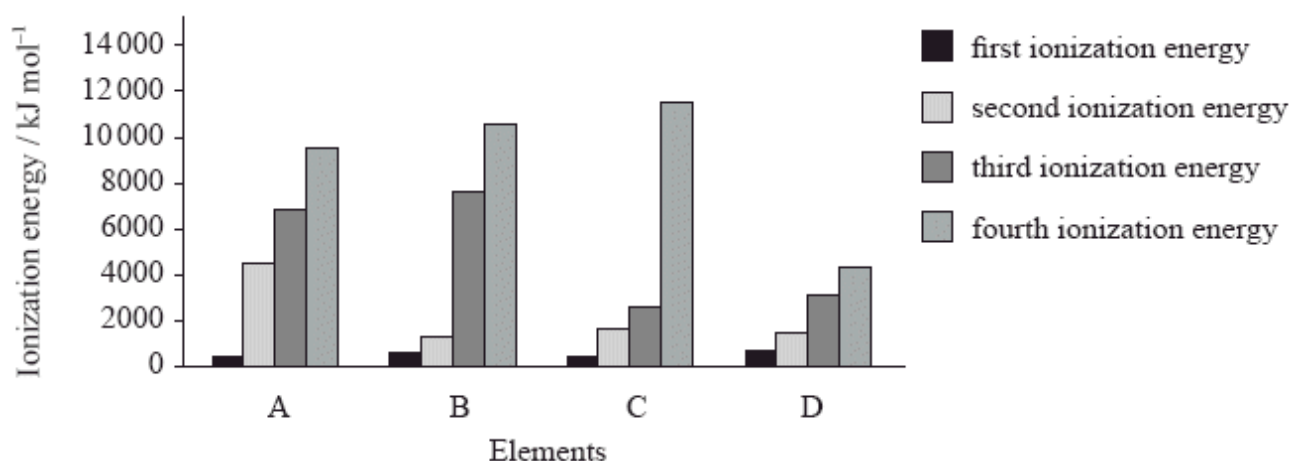
(Total 1 mark)

20. (i) Draw the Lewis structures for carbon monoxide, CO, carbon dioxide, CO_2 and methanol, CH_3OH.

(3)

(ii) List, with an explanation, the three compounds in order of increasing carbon to oxygen bond length (shortest first).

(2)

(Total 5 marks)

21. Which compound has a covalent macromolecular (giant covalent) structure?

A. MgO(s)

B. Al_2O_3(s)

C. P_4O_{10}(s)

D. SiO_2(s)

(Total 1 mark)

22. Which substance is made up of a lattice of positive ions and free moving electrons?

A. Graphite

B. Sodium chloride

C. Sulfur

D. Sodium

(Total 1 mark)

23. Which statements about σ and π bonds are correct?

      I.   σ bonds result from the axial overlap of orbitals.

      II.   σ bonds only form from s orbitals.

      III.   π bonds result from the sideways overlap of parallel p orbitals.

A.   I and II only

B.   I and III only

C.   II and III only

D.   I, II and III

(Total 1 mark)

24. Which pair of compounds is arranged in correct order of relative boiling points?

	Lower Boiling Point	Higher Boiling Point
A.	H_2S	H_2O
B.	NH_3	PH_3
C.	HF	HCl
D.	CH_3COOH	CH_3CH_2OH

(Total 1 mark)

25. Which statement is correct given the enthalpy level diagram below?

Course of the reaction
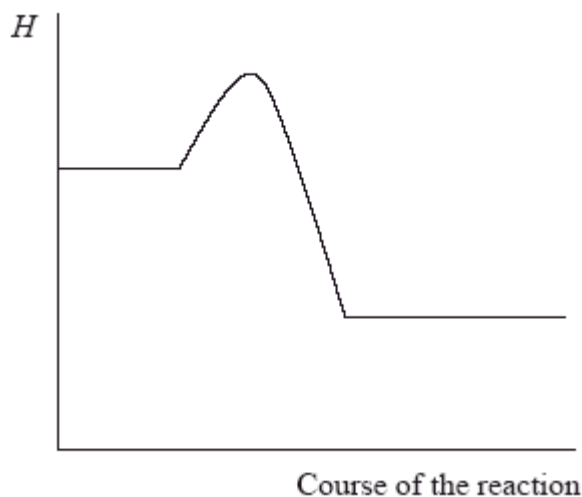
A.   The reaction is endothermic and the products are more thermodynamically stable than the reactants.

B.   The reaction is exothermic and the products are more thermodynamically stable than the reactants.

C.   The reaction is endothermic and the reactants are more thermodynamically stable than the products.

D.   The reaction is exothermic and the reactants are more thermodynamically stable than the products.

(Total 1 mark)

26. Which combination of ionic radius and ionic charge would result in the highest lattice enthalpy for an ionic compound?

	Ionic radius	Ionic charge
A.	small	high
B.	large	high
C.	small	low
D.	large	low

(Total 1 mark)

27. Which equation corresponds to the lattice enthalpy for silver iodide, AgI?

A. $AgI(s) \rightarrow Ag(s) + I(g)$

B. $AgI(s) \rightarrow Ag(s) + \dfrac{1}{2}I_2(g)$

C. $AgI(s) \rightarrow Ag^+(aq) + I^-(aq)$

D. $AgI(s) \rightarrow Ag^+(g) + I^-(g)$

(Total 1 mark)

28. Consider the following reactions.

$$Cu_2O(s) + \frac{1}{2}O_2(g) \rightarrow 2CuO(s) \qquad \Delta H^{\ominus} = -144 \text{ kJ}$$
$$Cu_2O(s) \rightarrow Cu(s) + CuO(s) \qquad \Delta H^{\ominus} = +11 \text{ kJ}$$
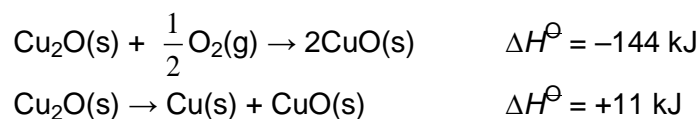
What is the value of $\Delta H^{\ominus}$, in kJ, for this reaction?

$$Cu(s) + \frac{1}{2}O_2(g) \rightarrow CuO(s)$$
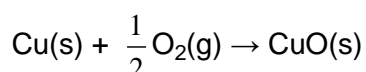
A. $-144 + 11$

B. $+144 - 11$

C. $-144 - 11$

D. $+144 + 11$

(Total 1 mark)

29. Which change leads to an increase in entropy?

A. $CO_2(g) \rightarrow CO_2(s)$

B. $SF_6(g) \rightarrow SF_6(l)$

C. $H_2O(l) \rightarrow H_2O(s)$

D. $NaCl(s) \rightarrow NaCl(aq)$

(Total 1 mark)

30. The Born-Haber cycle for MgO under standard conditions is shown below.
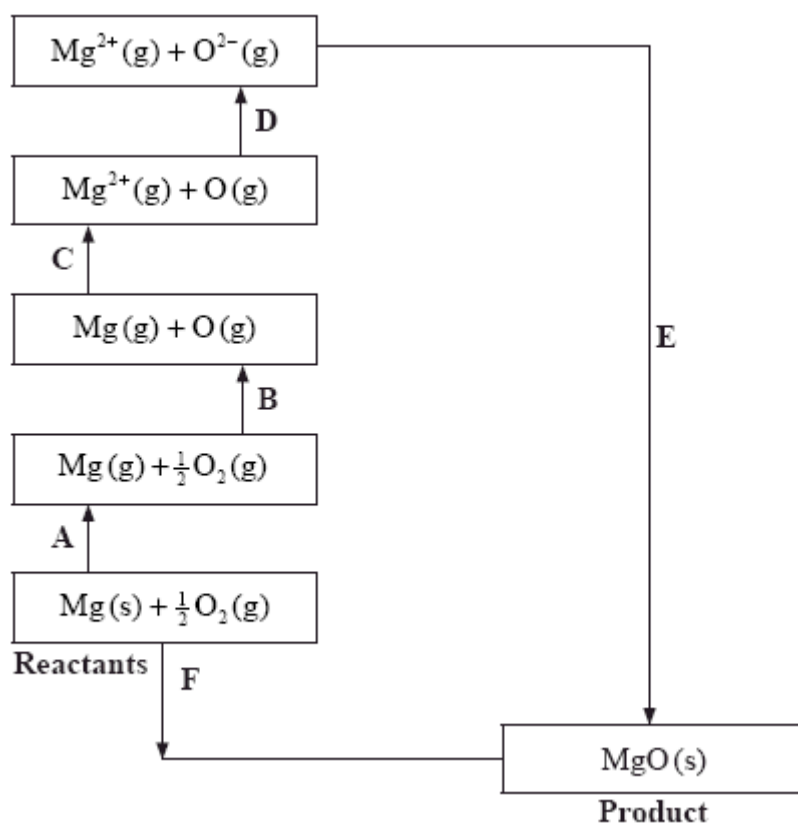
The values are shown in the table below.

Process	enthalpy change / kJ mol^{-1}
A	+150
B	+248
C	+736 + (+1450)
D	−142 + (+844)
E	
F	− 602

(i) Identify the processes represented by **A**, **B** and **D** in the cycle.

(3)

(ii) Define the enthalpy change, **F**.

(2)

(iii) Determine the value of the enthalpy change, **E**.

(2)

(iv) Define the enthalpy change **C** for the first value. Explain why the second value is significantly larger than the first.

(4)

(v) The inter-ionic distance between the ions in NaF is very similar to that between the ions in MgO. Suggest with a reason, which compound has the higher lattice enthalpy value.

(2)

(Total 13 marks)

31. What is the best definition of *rate of reaction*?

A. The time it takes to use up all the reactants

B. The rate at which all the reactants are used up

C. The time it takes for one of the reactants to be used up

D. The increase in concentration of a product per unit time

(Total 1 mark)

32. On the axes below sketch **two** Maxwell-Boltzmann energy distribution curves for the same sample of gas, one at a temperature T and another at a higher temperature T'. Label both axes. Explain why raising the temperature increases the rate of a chemical reaction.

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(Total 5 marks)

33. Which statements describe the action of a catalyst?

      I.   It does **not** alter the ΔH for a reaction.

      II.   It increases the E_a for the reaction.

      III.   It alters the mechanism (pathway) of a reaction.

A.   I and II only

B.   I and III only

C.   II and III only

D.   I, II and III

(Total 1 mark)

34. Excess magnesium, was added to a beaker of aqueous hydrochloric acid. A graph of the mass of the beaker and contents was plotted against time (line 1).
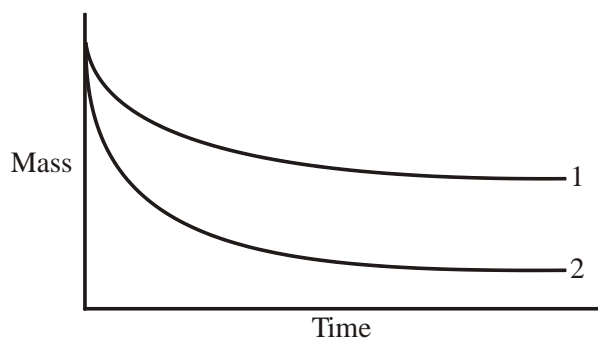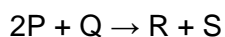


What change in the experiment could give line 2?

A.   The same mass of magnesium in smaller pieces

B.   The same volume of a more concentrated solution of hydrochloric acid

C.   A lower temperature

D.   A more accurate instrument to measure the time

(Total 1 mark)

35. Consider the following reaction.

$$2P + Q \rightarrow R + S$$

This reaction occurs according to the following mechanism.

$P + Q \rightarrow X$	*slow*
$P + X \rightarrow R + S$	*fast*
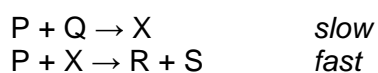
What is the rate expression?

A.   rate = k[P]

B.   rate = k[P][X]

C.   rate = k[P][Q]

D.   rate = k[P]^2[Q]

(Total 1 mark)

36. The rate information below was obtained for the following reaction at a constant temperature.
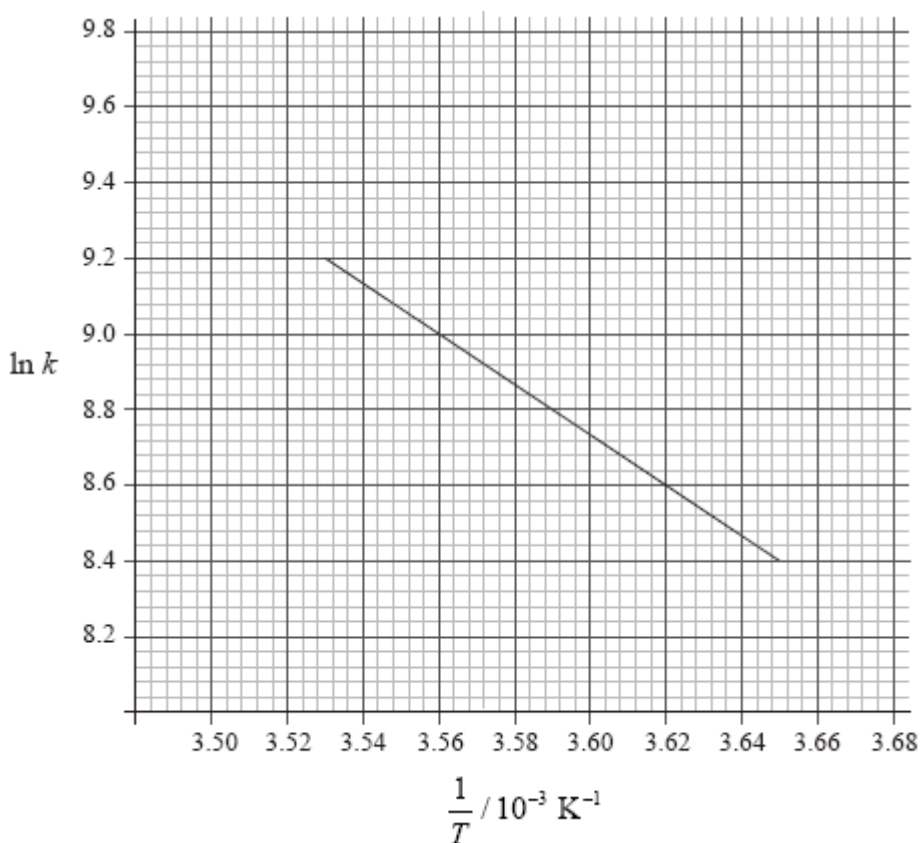
$$2NO_2(g) + F_2(g) \rightarrow 2NO_2F(g)$$
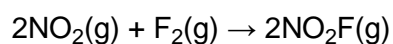
$[NO_2]$ / mol dm^{-3}	$[F_2]$ / mol dm^{-3}	Rate / mol dm^{-3} s^{-1}
2.0×10^{-3}	1.0×10^{-2}	4.0×10^{-4}
4.0×10^{-3}	1.0×10^{-2}	8.0×10^{-4}
4.0×10^{-3}	2.0×10^{-2}	1.6×10^{-3}

What are the orders of the reaction with respect to NO_2 and F_2?

A. NO_2 is first order and F_2 is second order

B. NO_2 is second order and F_2 is first order

C. NO_2 is first order and F_2 is first order

D. NO_2 is second order and F_2 is second order

(Total 1 mark)

37. Consider the following graph of ln k against $\frac{1}{T}$ for the first order decomposition of N_2O_4 into NO_2. Determine the activation energy in kJ mol^{-1} for this reaction.

(Total 2 marks)