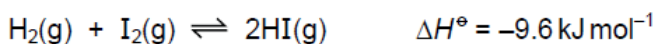
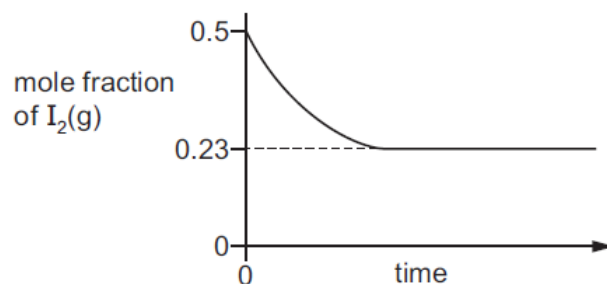


1. Nov/2021/Paper_11/No.10

The equation shows that $\text{H}_2(\text{g})$ and $\text{I}_2(\text{g})$ react to form an equilibrium mixture.

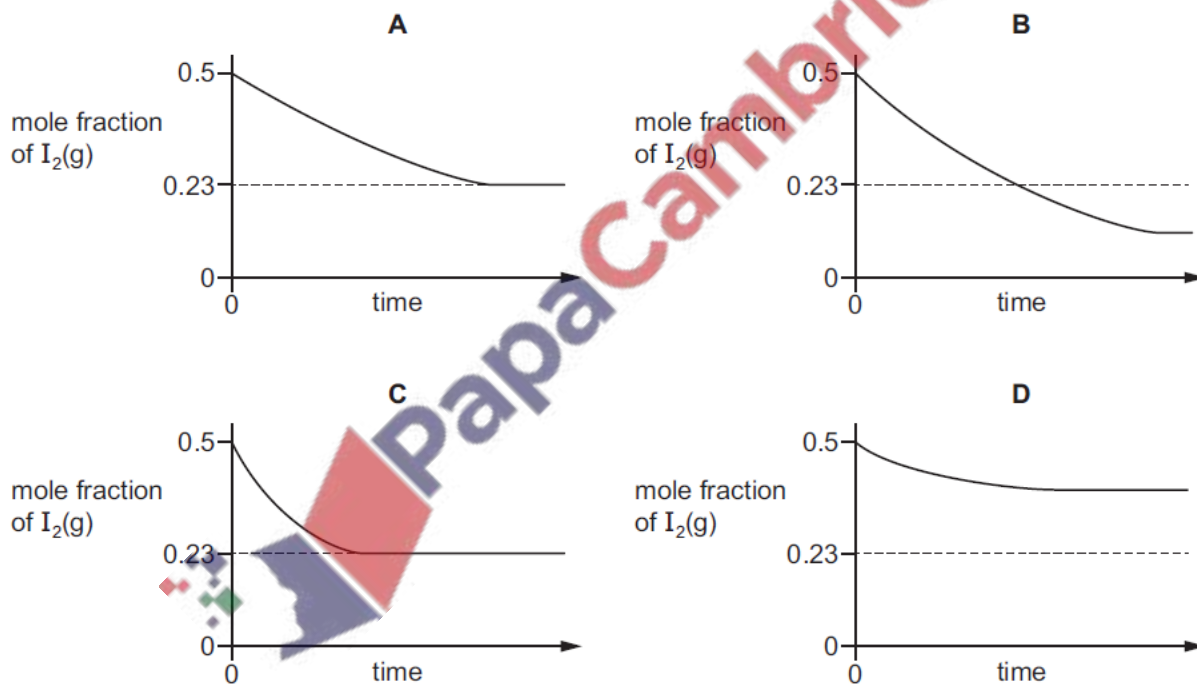


A mixture containing equal amounts of $\text{H}_2(\text{g})$ and $\text{I}_2(\text{g})$ is made at temperature T_1 and the composition of the mixture is monitored. A graph of the results is shown.



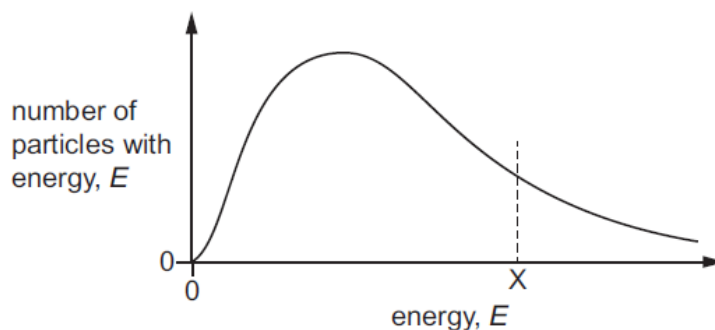
The experiment is repeated at a lower temperature, T_2 .

Which new graph would be obtained?



2. Nov/2021/Paper_11/No.11

The diagram shows the Boltzmann distribution of energies for a reactant gas. For a particular reaction, the activation energy is X.

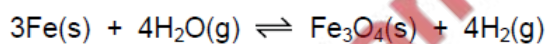


Which change to the diagram occurs if an effective catalyst is added at the same temperature?

- A More particles will possess higher values of E .
- B The peak will move to the left.
- C The peak will move to the right.
- D The value of the activation energy decreases.

3. Nov/2021/Paper_11/No.32

Iron reacts with steam to produce hydrogen and an oxide of iron.



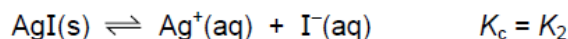
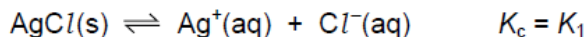
A system containing all four substances is at equilibrium.

Which changes will decrease the mass of Fe present at equilibrium?

- 1 addition of steam at constant pressure
- 2 increase in overall pressure
- 3 addition of an effective catalyst

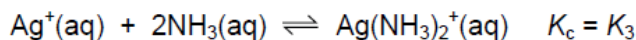
4. Nov/2021/Paper_12/No.16

Silver chloride and silver iodide form equilibria when added to water.



Each equilibrium position lies well to the left.

Silver iodide will not dissolve in aqueous ammonia. Silver chloride will dissolve in aqueous ammonia. Another equilibrium is formed.



The position of this equilibrium lies to the right.

What is the order of magnitude for these three equilibrium constants?

	smallest	→	largest
A	K_3	K_2	K_1
B	K_3	K_1	K_2
C	K_2	K_1	K_3
D	K_1	K_2	K_3

5. Nov/2021/Paper_12/No.31

Four solutions, each of concentration 0.1 mol dm^{-3} , were tested with a pH meter. The results are shown.

solution	formula of acid or base	pH
acid 1	$\text{CH}_3\text{CO}_2\text{H}$	4
acid 2	HNO_3	1
base 1	CH_3NH_2	11
base 2	NaOH	14

Which statements explain these results?

- Acid 2 has a lower pH than acid 1 because it is more soluble.
- Base 2 has a higher concentration of hydroxide ions in solution than base 1.
- Acid 1 dissociates less than acid 2.

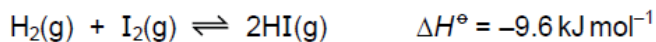
6. Nov/2021/Paper_12/No.36

Which statements about ammonium chloride are correct?

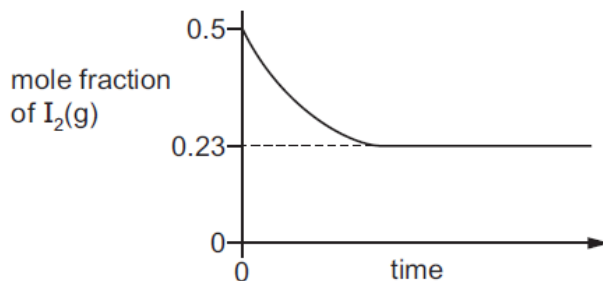
- It reacts with hot aqueous sodium hydroxide to produce an alkaline gas.
- In solution, it reacts with aqueous silver nitrate to produce a white precipitate.
- When solid, it reacts with concentrated sulfuric acid to produce chlorine.

7. Nov/2021/Paper_13/No.10

The equation shows that $\text{H}_2(\text{g})$ and $\text{I}_2(\text{g})$ react to form an equilibrium mixture.

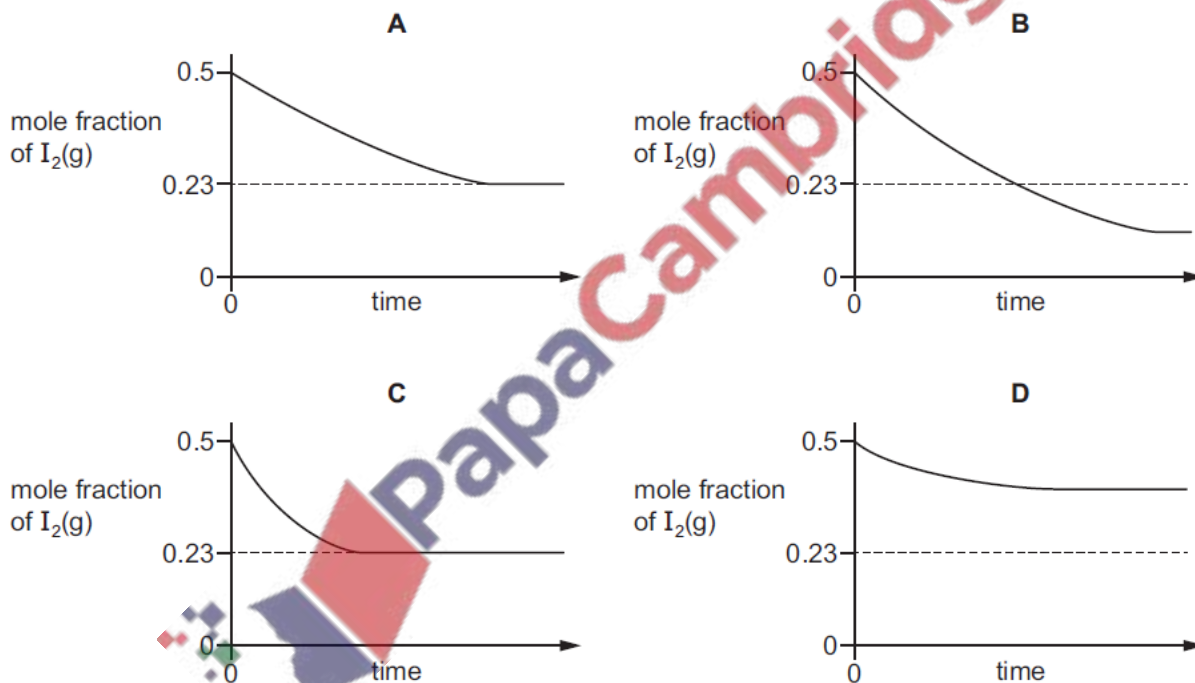


A mixture containing equal amounts of $\text{H}_2(\text{g})$ and $\text{I}_2(\text{g})$ is made at temperature T_1 and the composition of the mixture is monitored. A graph of the results is shown.



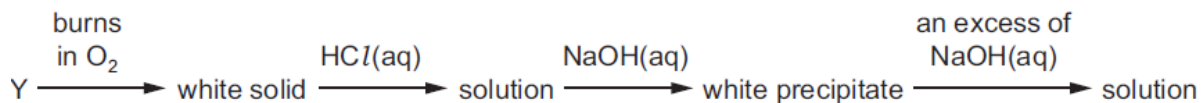
The experiment is repeated at a lower temperature, T_2 .

Which new graph would be obtained?



8. Nov/2021/Paper_13/No.11

An element, Y, reacts according to the following sequence.



What could be element Y?

- A** Na **B** Mg **C** Al **D** P

9. March/2021/Paper_12/No.9

In which reaction is water behaving as a Brønsted–Lowry base?

- A $\text{H}_2\text{O} + \text{Na} \rightarrow \text{NaOH} + \frac{1}{2}\text{H}_2$
- B $\text{H}_2\text{O} + \text{H}_3\text{PO}_4 \rightarrow \text{H}_3\text{O}^+ + \text{H}_2\text{PO}_4^-$
- C $\text{H}_2\text{O} + \text{CaO} \rightarrow \text{Ca(OH)}_2$
- D $\text{NH}_3 + [\text{Cu(H}_2\text{O)}_6]^{2+} \rightarrow \text{NH}_4^+ + [\text{Cu(H}_2\text{O)}_5(\text{OH})]^+$

10. March/2021/Paper_12/No.10

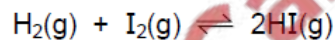
A large excess of marble chips is reacted with 25 cm^3 of 1.0 mol dm^{-3} hydrochloric acid at 40°C .

How is the result different when the reaction is repeated with 60 cm^3 of 0.5 mol dm^{-3} hydrochloric acid at 40°C ?

- A The reaction is faster and more of the products are made when the reaction is complete.
- B The reaction is faster and less of the products are made when the reaction is complete.
- C The reaction is slower and more of the products are made when the reaction is complete.
- D The reaction is slower and less of the products are made when the reaction is complete.

11. March/2021/Paper_12/No.31

A sample of 17.15 mol HI(g) is in dynamic equilibrium with $2.27 \text{ mol H}_2(\text{g})$ and $2.84 \text{ mol I}_2(\text{g})$ in a volume of 1 m^3 at 764 K and 141 kPa .



Two equilibrium constants, K_c and K_p , can be calculated for this mixture.

Which statements about the equilibrium constants for this mixture are correct?

- 1 neither K_c nor K_p has any units
- 2 $K_c = 45.6$
- 3 $K_c > K_p$

The rate of chemical reactions is affected by changes in temperature and pressure.

- (a) (i) Draw a curve on the axes to show the Boltzmann distribution of energy of particles in a sample of gaseous krypton atoms at a given temperature.

Label the curve T1 and label the axes.



[2]

- (ii) On the diagram in (a)(i), draw a second curve to show the distribution of energies of the krypton atoms at a higher temperature.

Label the second curve T2.

[1]

- (b) The Boltzmann distribution assumes that the particles behave as an ideal gas.

- (i) State **two** assumptions of the kinetic theory as applied to an ideal gas.

1

2

[2]

- (ii) 2.00g of krypton gas, Kr(g), is placed in a sealed 5.00 dm³ container at 120 °C.

Calculate the pressure, in Pa, of Kr(g) in the container.
Assume Kr(g) behaves as an ideal gas.

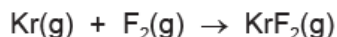
Show your working.

pressure = Pa [3]

(iii) State and explain the conditions at which krypton behaves most like an ideal gas.

.....
.....
.....
..... [2]

(c) Krypton reacts with fluorine in the presence of ultraviolet light to make krypton difluoride, KrF₂(g).

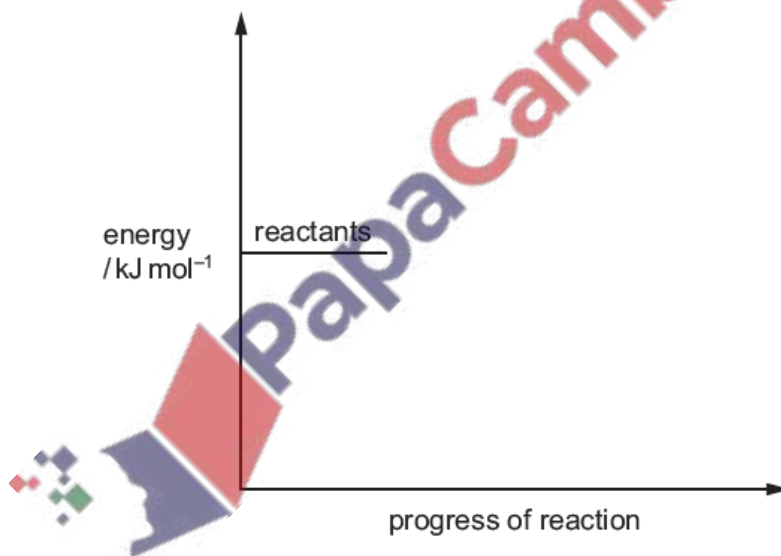


activation energy for the reaction, $E_a = +385 \text{ kJ mol}^{-1}$

enthalpy change of formation of KrF₂, $\Delta H_f = +60.2 \text{ kJ mol}^{-1}$

(i) Use this information to complete the reaction profile diagram for the formation of KrF₂. Label E_a and ΔH_f on the diagram.

Assume the reaction proceeds in one step.



[2]

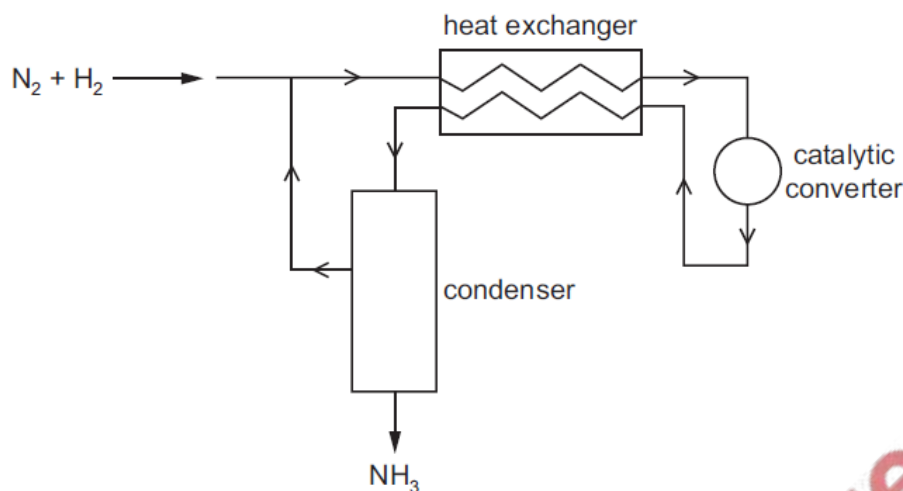
(ii) Explain, in terms of activation energy, E_a , and the collision of particles, how an increase in temperature affects the rate of a chemical reaction.

.....
.....
.....
..... [2]

[Total: 14]

13. June/2021/Paper_11/No.10

The diagram represents the Haber process for the manufacture of ammonia from nitrogen and hydrogen.



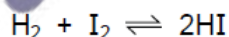
What is the purpose of the heat exchanger?

- A to cool the incoming gas mixture to avoid overheating the catalyst
- B to cool the reaction products and separate the NH_3 from unused N_2 and H_2
- C to warm the incoming gas mixture and shift the equilibrium to give more NH_3
- D to warm the incoming gas mixture and speed up the reaction

14. June/2021/Paper_12/No.10

3.60 moles of hydrogen gas and 2.00 moles of iodine vapour are placed in a reaction vessel which is then sealed and maintained at a constant temperature.

The equation for the reaction is shown.



At equilibrium, 3.20 moles of hydrogen remain. All reactants and products are gaseous.

What is the value of K_p under these conditions?

- A 0.0313 B 0.125 C 0.156 D 8.00

15. June/2021/Paper_12/No.14

A farmer requires a solid compound to raise the pH of the soil in a field from 5.5 to above 6.0.

Which compound could the farmer use?

- A $(NH_4)_2SO_4$ B NH_4NO_3 C $Ca(OH)_2$ D $Ca(NO_3)_2$

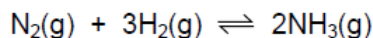
16. June/2021/Paper_12/No.35

Which oxides will cause a change in pH when added to water?

- 1 CaO
- 2 Al₂O₃
- 3 SiO₂

17. June/2021/Paper_13/No.10

Nitrogen reacts with hydrogen to produce ammonia.



A mixture of 2.00 mol of nitrogen, 6.00 mol of hydrogen and 2.40 mol of ammonia is allowed to reach equilibrium in a sealed vessel of volume 1 dm³. It is found that 2.32 mol of nitrogen were present in the equilibrium mixture.

Which expression will give the value of K_c ?

- A $\frac{(1.76)^2}{(2.32)(6.96)^3}$
- B $\frac{(1.76)^2}{(2.32)(6.32)^3}$
- C $\frac{(2.08)^2}{(2.32)(6.32)^3}$
- D $\frac{(2.40)^2}{(2.32)(6.00)^3}$

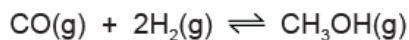
18. June/2021/Paper_13/No.1

Compound X is an organic compound that contains 30.6% carbon, 3.8% hydrogen, 20.4% oxygen and 45.2% chlorine by mass.

What is the empirical formula of X?

- A C₂H₃OCl B C₂H₄OCl C C₃H₄OCl D C₄H₃O₂Cl₂

(c) Methanol is made by reacting carbon monoxide with hydrogen.



Carbon monoxide and hydrogen react at $1.0 \times 10^7 \text{ Pa}$ and 200°C . Eventually the reaction mixture reaches dynamic equilibrium.

The table shows the amounts of each species present in the mixture.

	CO(g)	H ₂ (g)	CH ₃ OH(g)
initial amount/mol	1.0	2.0	0
equilibrium amount/mol	0.030	0.060	0.97

(i) Explain what is meant by *dynamic equilibrium*.

.....

 [2]

(ii) Calculate the partial pressure of methanol vapour at equilibrium under these conditions. Show your working.

..... Pa [2]

(iii) Write an expression for the equilibrium constant, K_p , for this reaction. State the units in your answer.

$K_p =$

units = [2]