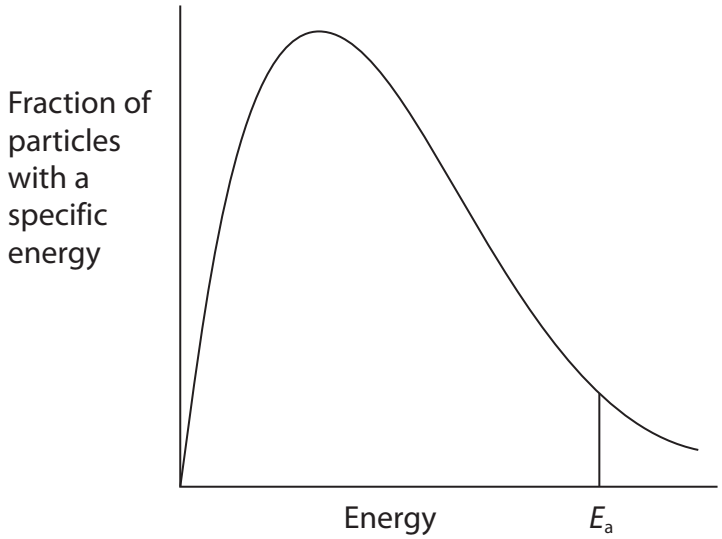
1 A Maxwell-Boltzmann curve shows the distribution of molecular energies in a reaction system. When the temperature in this system is **increased**, the peak is

- ☒ **A** higher and further to the right.
- ☒ **B** higher and further to the left.
- ☒ **C** lower and further to the right.
- ☒ **D** lower and further to the left.

(Total for Question = 1 mark)

2 These questions concern the Maxwell-Boltzmann energy distribution shown below.



(a) What is the best way to describe the activation energy, E_a, of a reaction?

(1)

☒ **A** The average energy of the particles that react.

☒ **B** The minimum energy required for a reaction to occur.

☒ **C** The energy difference between the reactants and products.

☒ **D** The energy produced by the particles that react.

(b) How does the curve above change when the temperature is **increased**?

(1)

☒ **A** The peak increases in height and moves to the left.

☒ **B** The peak increases in height and moves to the right.

☒ **C** The peak decreases in height and moves to the left.

☒ **D** The peak decreases in height and moves to the right.

(c) What would be the effect on the diagram if the reactant concentrations were **increased**?

(1)

☒ **A** There would be no change.

☒ **B** The E_a line would move to the right.

☒ **C** The E_a line would move to the left.

☒ **D** The peak decreases in height and moves to the right.

(d) What would be the effect on the diagram if a catalyst was added?
The activation energy would

(1)

☒ **A** be unchanged and the peak would move to the right.

☒ **B** move to the left and the peak would move to the right.

☒ **C** move to the left and the peak would move to the left.

☒ **D** move to the left and the peak would be unchanged.

(Total for Question = 4 marks)

3 A **heterogeneous** catalyst is often preferred to a **homogenous** catalyst for an industrial process because

☒ **A** it is easily separated from the products.

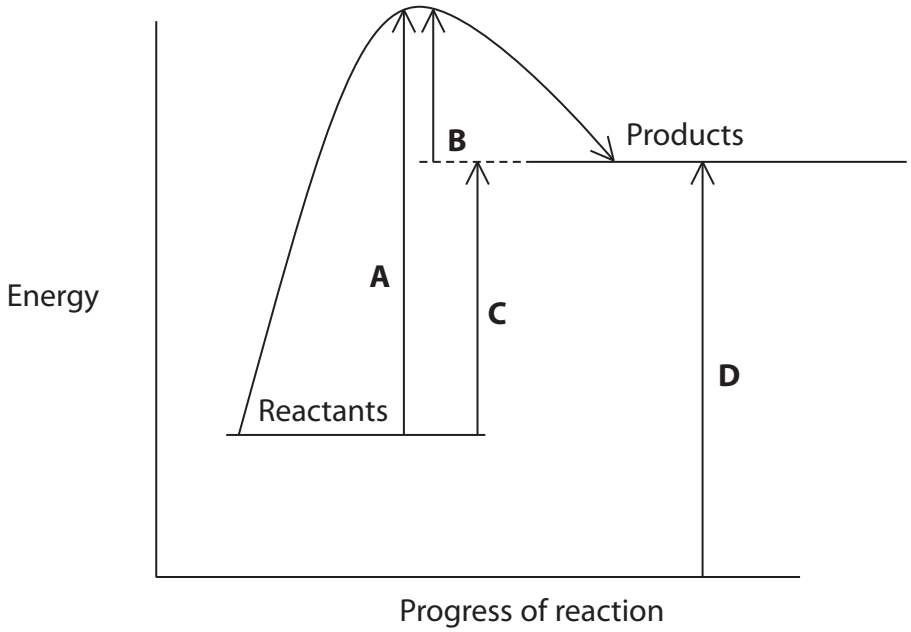
☒ **B** it has empty d-orbitals.

☒ **C** it has more than one oxidation state.

☒ **D** it cannot be poisoned.

(Total for Question = 1 mark)

4 The reaction profile for an endothermic reaction is shown below.



(a) Which arrow represents the activation energy for the **forward** reaction?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) Which arrow represents the activation energy for the **backward** reaction?

(1)

☒ **A**

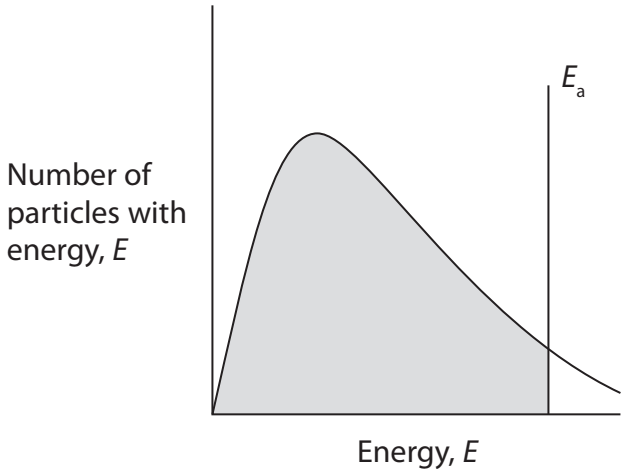
☒ **B**

☒ **C**

☒ **D**

(Total for Question = 2 marks)

5 Consider the Maxwell-Boltzmann distribution of energies for a gas shown below.
E_a represents the activation energy.



The shaded area of the diagram indicates the total number of particles that

☒ **A** do have enough energy to react.

☒ **B** do not have enough energy to react.

☒ **C** do have enough energy to react in the presence of a catalyst.

☒ **D** do not have enough energy to react in the presence of a catalyst.

(Total for Question = 1 mark)

6 Which of the following will **not** affect the rate of the reaction below?

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

☒ **A** Surface area

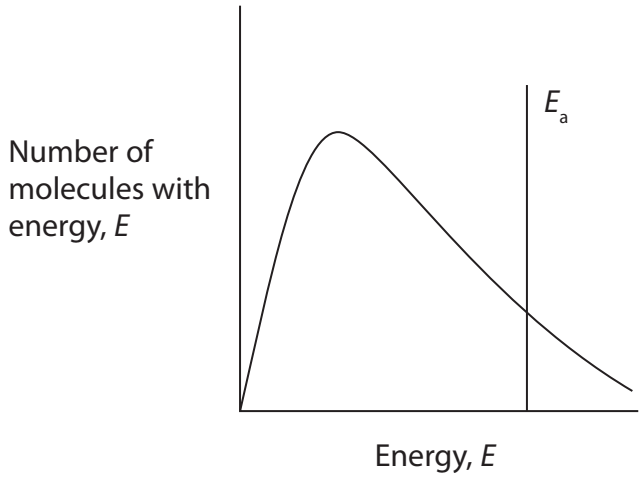
☒ **B** Concentration

☒ **C** Pressure

☒ **D** Temperature

(Total for Question = 1 mark)

7 The diagram below shows the Maxwell-Boltzmann distribution of molecular energies for a catalysed reaction.



(a) If the temperature were **lowered**, what would be the effect on the shape of the curve?

(1)

☒ **A** The peak would shift to the left and be higher.

☒ **B** The peak would shift to the left and be lower.

☒ **C** The peak would shift to the right and be higher.

☒ **D** The peak would shift to the right and be lower.

(b) Which of the following would shift the activation energy line to the right?

(1)

☒ **A** An increase in reactant concentration.

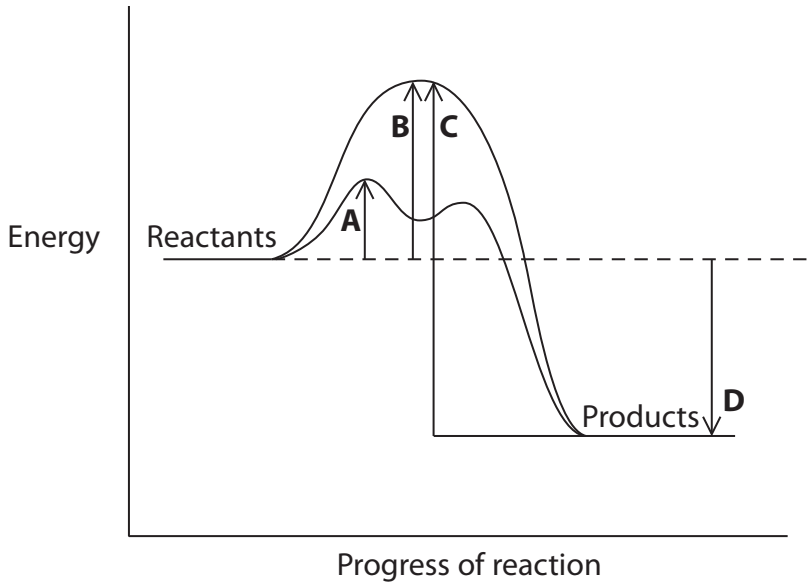
☒ **B** The removal of the product.

☒ **C** The removal of the catalyst.

☒ **D** The use of smaller particles with a larger surface area.

(Total for Question = 2 marks)

8 Which of the arrows, **A**, **B**, **C**, **D**, indicates the activation energy for a **catalysed** reaction on the reaction profile shown?



☒ **A**

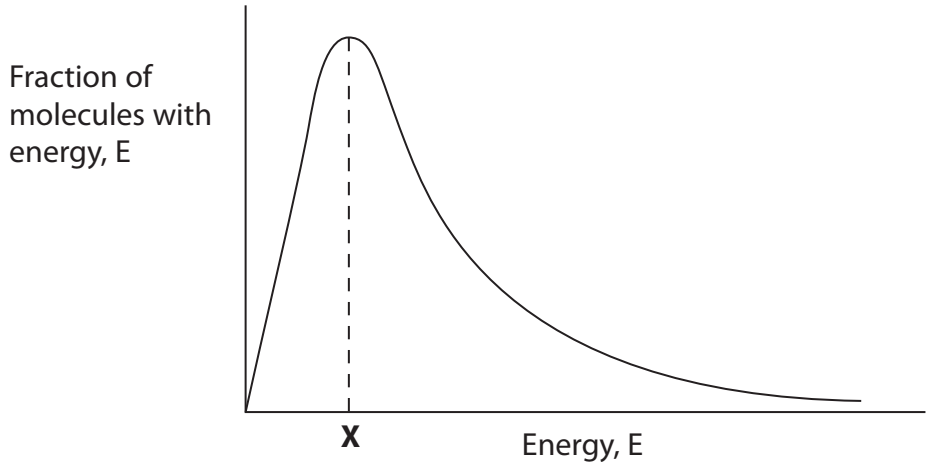
☒ **B**

☒ **C**

☒ **D**

(Total for Question = 1 mark)

9



The energy marked **X** in the Maxwell-Boltzmann distribution shows

☒ **A** the most common energy of the molecules.

☒ **B** the activation energy of the reaction.

☒ **C** the activation energy of a catalysed reaction.

☒ **D** the number of molecules with energy greater than the activation energy.

(Total for Question = 1 mark)

10 In the industrial process involving gas phase reactions to produce ammonia, many collisions between molecules are unsuccessful because

☒ **A** gas phase reactions are reversible.

☒ **B** the collisions are not energetic enough to break the bonds in the molecules.

☒ **C** gas phase reactions can only occur when a catalyst is present.

☒ **D** gas phase reactions can only occur when UV light is present.

(Total for Question = 1 mark)

11 In a chemical reaction, which of the following factors increases the proportion of particles that have sufficient energy to react?

☒ **A** A decrease in concentration

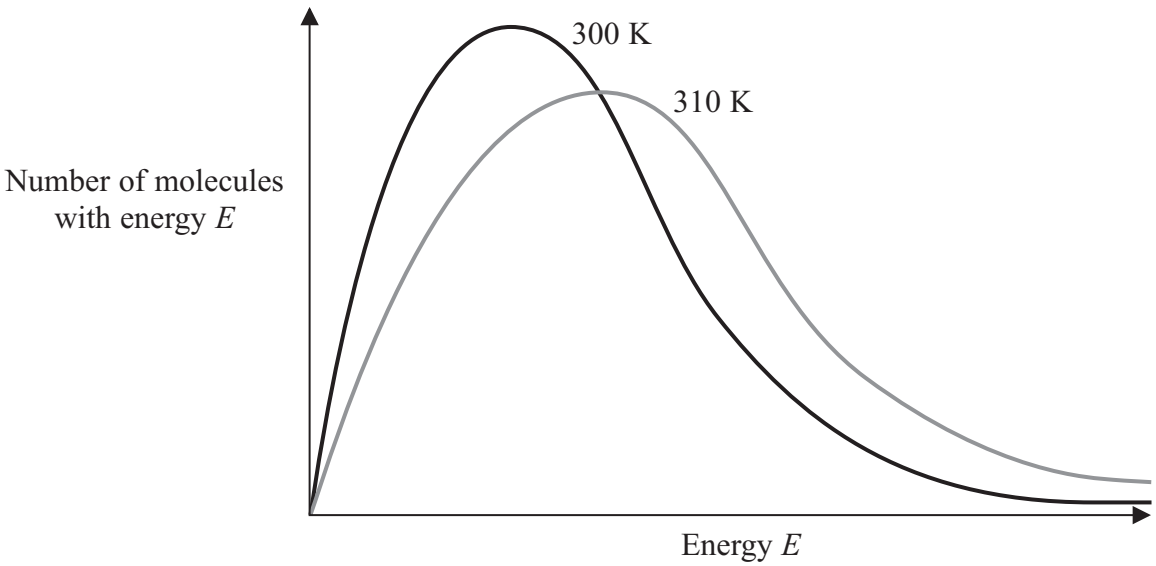
☒ **B** An increase in concentration

☒ **C** A decrease in temperature

☒ **D** An increase in temperature

(Total for Question = 1 mark)

12 The diagram below shows the Maxwell-Boltzmann distribution of molecular energies for a gaseous system at two temperatures.



(a) The energy plotted on the horizontal axis is **mainly**

(1)

☒ **A** activation.

☒ **B** kinetic.

☒ **C** rotation.

☒ **D** vibration.

(b) The rate of a chemical reaction increases with temperature **mainly** because

(1)

☒ **A** the activation energy increases.

☒ **B** the activation energy decreases.

☒ **C** more collisions occur with energy greater than the activation energy.

☒ **D** the molecules collide more frequently.

(c) The total area under each curve

(1)

☒ **A** decreases with increasing temperature.

☒ **B** increases with increasing temperature.

☒ **C** increases or decreases with increasing temperature, depending on the size of the molecules.

☒ **D** does not change with temperature.

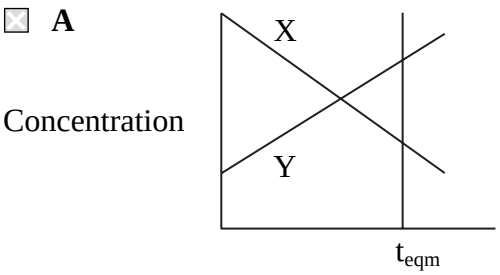
(Total for Question 3 marks)

13 For the reversible reaction

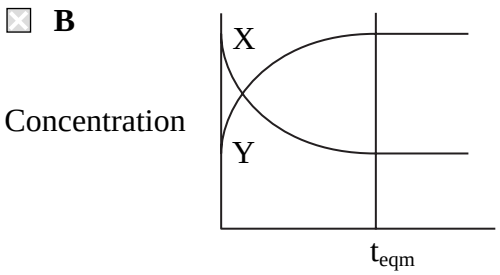
$$X \rightleftharpoons Y$$

which of the following could represent the change in the concentrations of X and Y with time, starting with a mixture of both X and Y? Equilibrium is reached at time t_{eqm}.

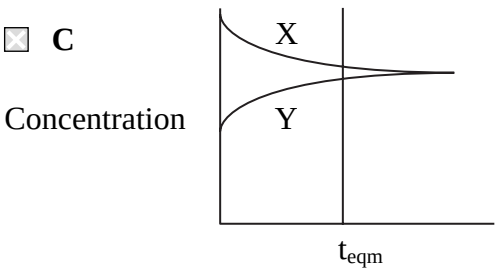
☒ **A**



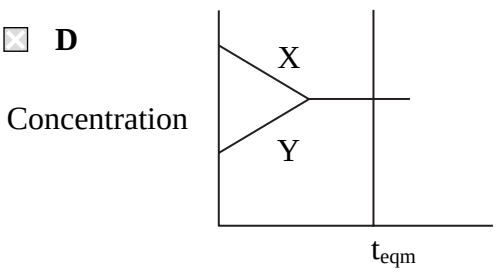
☒ **B**



☒ **C**

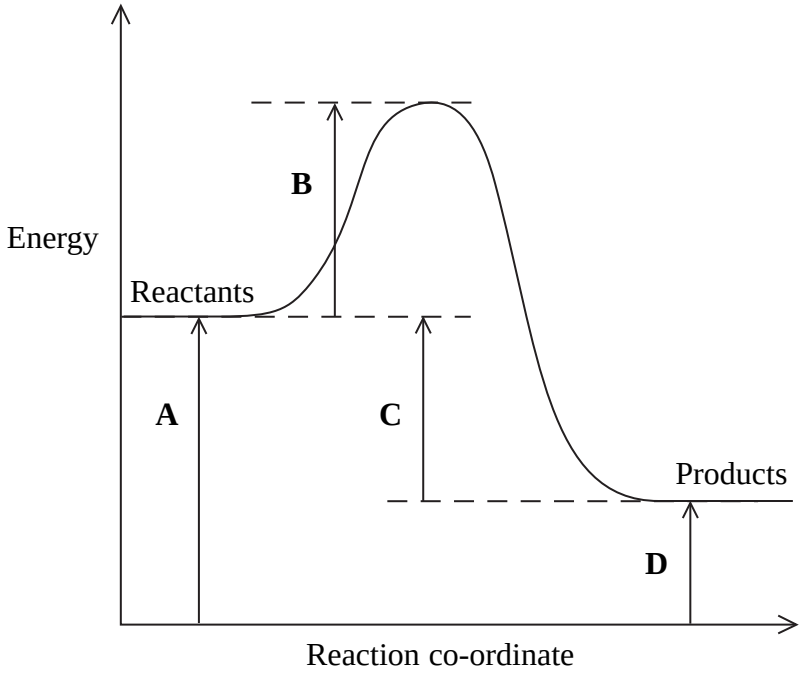


☒ **D**



(Total for Question = 1 mark)

14 In the reaction profile below, which energy change would alter if a catalyst was added to the reaction?



☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question = 1 mark)

15 The reaction of heated magnesium with steam is faster than the reaction of magnesium with cold water. This is mainly because

☒ **A** in cold water, the water molecules do not collide as frequently with magnesium.

☒ **B** the coating of oxide on magnesium decomposes when it is heated.

☒ **C** the fraction of particles with energy greater than the activation energy is higher in the reaction with steam.

☒ **D** the reaction with steam goes by an alternative route with lower activation energy.

(Total for Question = 1 mark)

16 The Maxwell-Boltzmann distribution of molecular energies is useful for explaining why increasing temperature affects the rate of a chemical reaction.

(a) Which of the following statements describes how the shape of the Maxwell-Boltzmann distribution curve changes as temperature increases?

(1)

☒ **A** The peak decreases in height and moves to the left.

☒ **B** The peak increases in height and moves to the left.

☒ **C** The peak decreases in height and moves to the right.

☒ **D** The peak increases in height and moves to the right.

(b) The **main** reason that reaction rates increase with temperature is that

(1)

☒ **A** all the molecules move faster.

☒ **B** all the molecules collide more frequently.

☒ **C** more molecules collide with the correct orientation.

☒ **D** a larger proportion of molecules have high energies.

(Total for Question 2 marks)

17 Methods for investigating reaction rates include

A colorimetry.

B measurement of change in volume.

C measurement of change of mass.

D quenching followed by titrating with acid.

Which method would be most suitable to investigate the rate of the following reactions?

(a) $HCOOCH_3(aq) + NaOH(aq) \rightarrow HCOONa(aq) + CH_3OH(aq)$

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) $(CH_3)_2C \quad CH_2(g) + HI(g) \rightarrow (CH_3)_3CI(g)$

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(c) $BrO_3\ (aq) + 5Br\ (aq) + 6H^+(aq) \rightarrow 3Br_2(aq) + 3H_2O(l)$

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 3 marks)

18 $2H_2(g) + 2NO(g) \rightarrow 2H_2O(g) + N_2(g)$

This reaction is first order with respect to hydrogen and second order with respect to nitrogen(II) oxide.

By what factor will the initial rate increase if the concentration of hydrogen and nitrogen(II) oxide are both tripled?

☒ **A** 3

☒ **B** 9

☒ **C** 12

☒ **D** 27

(Total for Question 1 mark)