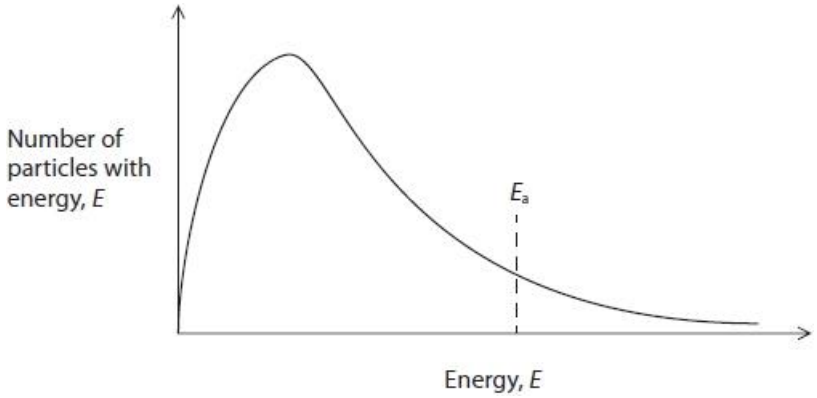
Questions

Q1.

This question is about the oxidation of ammonia.

The diagram shows a Maxwell-Boltzmann distribution of particle energies, including the activation energy, E_a , for a reaction.

(1)



An increase in temperature will

(1)

- ☒ **A** increase the area under the curve.
- ☒ **B** move the peak of the curve to the right.
- ☒ **C** raise the height of the peak.
- ☒ **D** move the position of the activation energy, E_a , to the left.

(Total for question = 2 marks)

Q2.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

This question is about reaction kinetics.

The best way to describe the activation energy of a reaction is

(1)

☐ **A** the average energy of the particles when they react

☐ **B** the difference in energy between the reactants and the products

☐ **C** the minimum energy required to make the particles collide

☐ **D** the minimum energy required for a reaction to occur

(Total for question = 1 mark)

Q3.

Answer the questions with a cross in the boxes you think are correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

This question is about reaction kinetics.

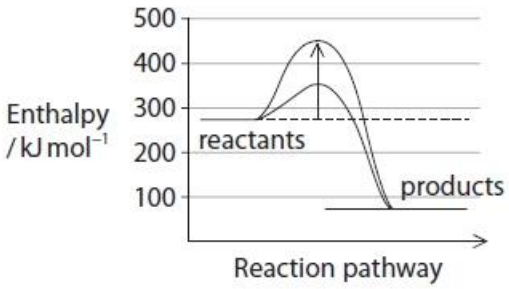
The diagrams show two reaction profiles for the same reversible reaction involving gaseous reactants.

Shown on each diagram are the reaction profiles for the pathway without a catalyst and the pathway catalysed by a heterogeneous catalyst.

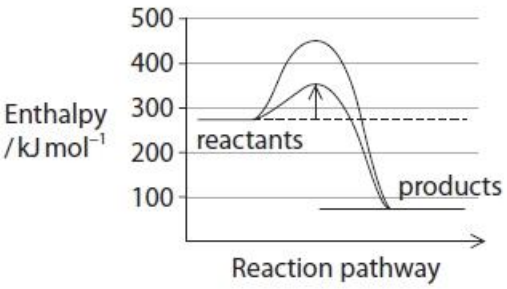
(i) In which diagram does the arrow represent the activation energy for the backward reaction when a catalyst is present?

(1)

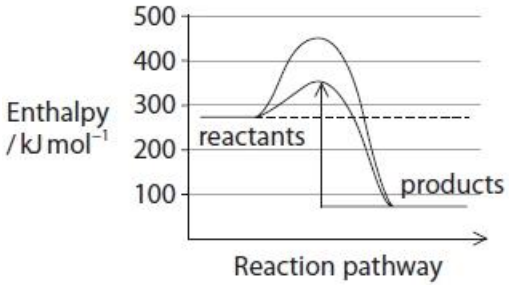
☐ **A**



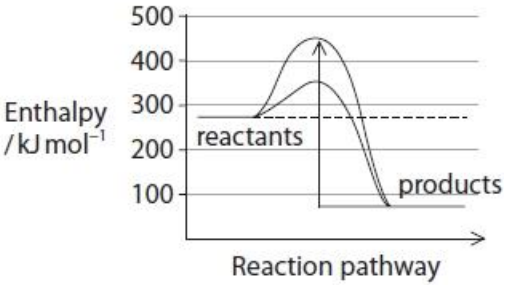
☐ **B**



☐ **C**

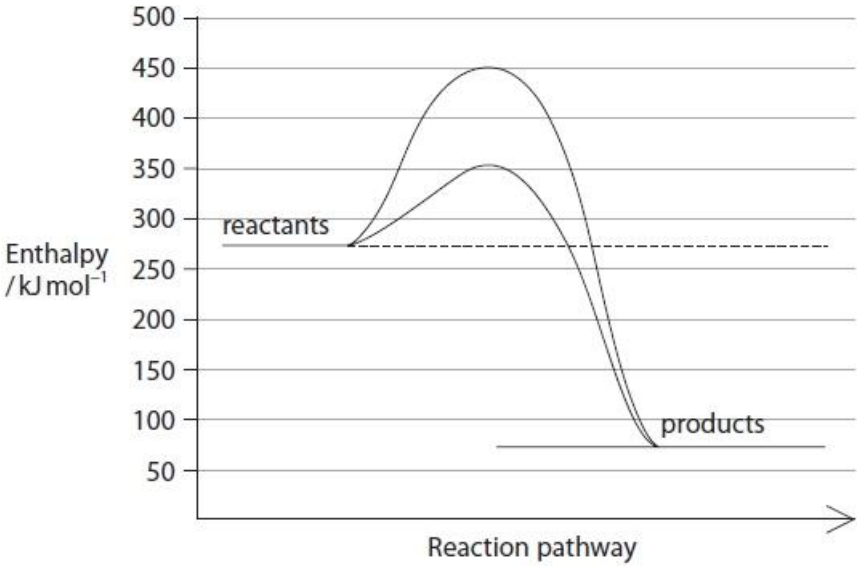


☐ **D**



(ii) Estimate, using the diagram, the **decrease** in the activation energy for the forward reaction when a catalyst is added.

(1)



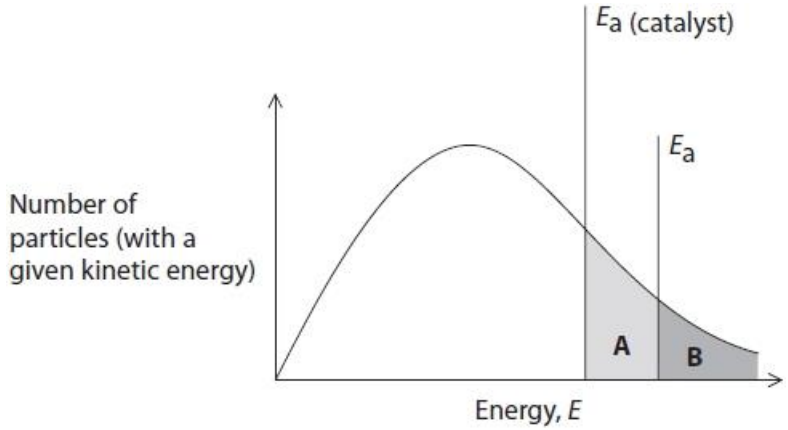
- ☒ **A** 75 kJ mol^{-1}
- ☒ **B** 100 kJ mol^{-1}
- ☒ **C** 175 kJ mol^{-1}
- ☒ **D** 200 kJ mol^{-1}

(Total for question = 2 marks)

Q4.

This is a question about catalytic converters in car exhaust systems.

Which area in the Maxwell-Boltzmann distribution diagram represents the **increase** in the number of particles with sufficient energy to react in the presence of a catalyst?



(1)

- ☒ **A** area A
- ☒ **B** area B
- ☒ **C** area A − area B
- ☒ **D** area A + area B

(Total for question = 1 mark)

Q5.

This question is about reaction kinetics.

A heterogeneous catalyst is often added to a reaction between gases.

A heterogeneous catalyst

(1)

- ☒ **A** increases the rate without taking part in the reaction
- ☒ **B** increases the yield of the reaction at equilibrium
- ☒ **C** is in the same phase as the reaction mixture
- ☒ **D** is often a porous material, so increasing the surface area

(Total for question = 1 mark)

Q6.

This question is about how catalysts work.

Gaseous reactants attach to the catalytic surface by the process of

(1)

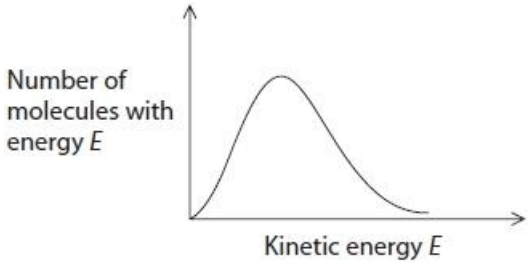
- ☒ **A** absorption
- ☒ **B** activation
- ☒ **C** adsorption
- ☒ **D** desorption

(Total for question = 1 mark)

Q7.

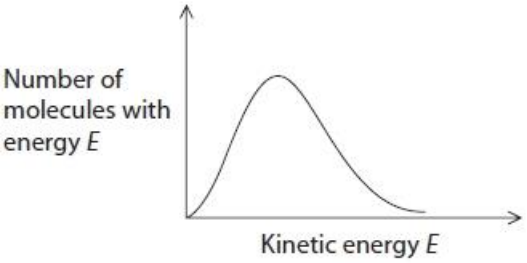
Answer the question with a cross in the box you think is correct ☒ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒ .

The Maxwell-Boltzmann distribution of molecular energies for the reactant molecules in an uncatalysed reaction is shown.

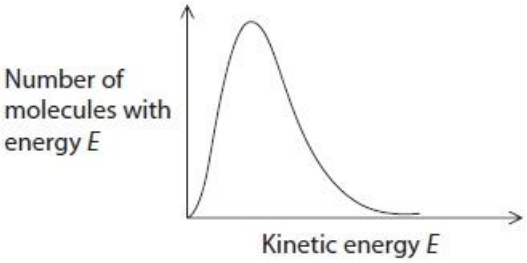


Which of these Maxwell-Boltzmann distributions would you expect for the same molecules in the presence of a catalyst at the same temperature and pressure?
All diagrams are drawn to the same scale.

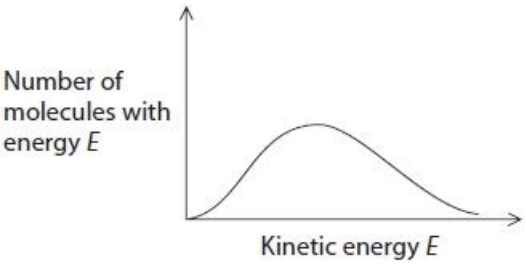
☐ **A**



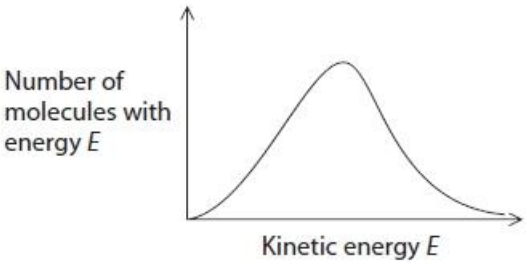
☐ **B**



☐ **C**



☐ **D**



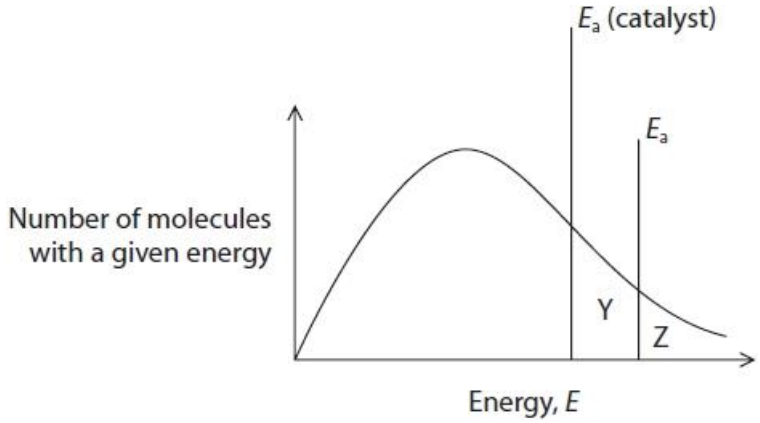
(Total for question = 1 mark)

Q8.

Answer the questions with a cross in the boxes you think are correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

This question is about reaction kinetics.

The diagram shows a Maxwell-Boltzmann distribution of molecular energies for gaseous molecules.



(i) Which is the area of the graph corresponding to the number of molecules with sufficient energy to react when a catalyst is present?

(1)

☒ **A** Y

☒ **B** Y − Z

☒ **C** Y + Z

☒ **D** Z

(ii) Which would always result in a **decrease** in the number of molecules contained within area Y?

(1)

☒ **A** decreasing the temperature of the gas

☒ **B** increasing the pressure of the gas

☒ **C** putting the gas in a smaller container

☒ **D** removing a quarter of the catalyst

(Total for question = 2 marks)

Mark Scheme

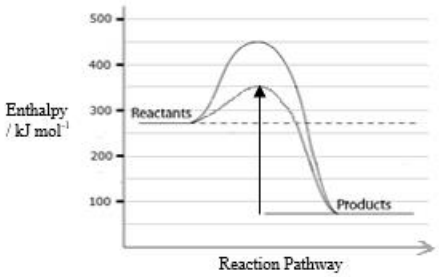
Q1.

Question Number	Acceptable Answer	Mark
	The only correct answer is B ***A*** *is not correct because there is no increase in number of particles* ***C*** *is not correct because distribution broadens as temperature rises, so peak is lower* ***D*** *is not correct because* E_a *is an intrinsic property of the reaction, not the applied temperature*	**(1)**

Q2.

Question Number	Answer	Mark
	The only correct answer is **D** (the minimum energy required for a reaction to occur) ***A*** *is not correct because it is the minimum energy of particles not the average* ***B*** *is not correct because that is the energy change for the reaction* ***C*** *is not correct because that will not necessarily result in a reaction if the energy is too small*	**(1)**

Q3.

Question Number	Answer	Mark
(i)	The only correct answer is **C**  ***A** is not correct because this is the activation energy for the uncatalysed forward reaction* ***B** is not correct because this is the activation energy for the catalysed forward reaction* ***D** is not correct because this is the activation energy for the uncatalysed backward reaction*	(1)

Question Number	Answer	Mark
(ii)	The only correct answer is **B** (100 kJ mol^{-1}) ***A** is not correct because this is the activation energy in the forward direction for the catalysed reaction* ***C** is not correct because this is the activation energy in the forward direction for the uncatalysed reaction* ***D** is not correct because this is the value of ΔH*	(1)

Q4.

Question Number	Answer	Mark
	The only correct answer is A (area A) ***B** is not correct because this is the area representing the number of particles with sufficient energy to react in the absence of a catalyst* ***C** is not correct because this area subtraction does not represent the increase in the number of particles with sufficient energy to react* ***D** is not correct because this sum of areas represents the total number of particles with sufficient energy to react in the presence of a catalyst*	(1)

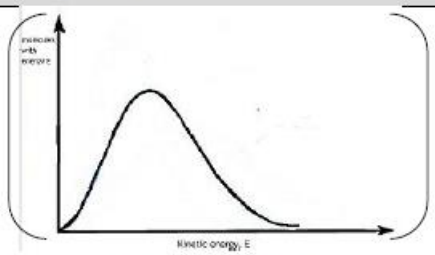
Q5.

Question Number	Answer	Mark
	The only correct answer is **D** (is often a porous material, so increasing the surface area) ***A*** *is not correct because though it increases the rate it does take part in, but is not used up by, the reaction* ***B*** *is not correct because the yield at equilibrium is not affected by the catalyst* ***C*** *is not correct because a heterogenous catalyst is in a different phase, while a homogeneous catalyst is in the same phase*	**(1)**

Q6.

Question Number	Acceptable Answer	Mark
	The only correct answer is **C** ***A*** *is incorrect because gaseous reactants attach only to the surface* ***B*** *is incorrect because this happens after adsorption* ***D*** *is incorrect because this is detachment of the products from the surface*	**(1)**

Q7.

Question Number	Answer	Mark
	The only correct answer is A  **B** *is not correct because a catalyst does not affect the Maxwell-Boltzmann distribution of molecular energies at the same T and P. This curve would be expected from a decrease in temperature.* **C** *is not correct because a catalyst does not affect the Maxwell-Boltzmann distribution of molecular energies at the same T and P. This curve would be expected from an increase in temperature.* **D** *is not correct because the area under the curve has increased, so the number of molecules has increased.*	**(1)**

Q8.

Question Number	Answer	Mark
(i)	The only correct answer is **C** (Y + Z) ***A*** *is not correct because this is the number of extra molecules which react when the catalyst is added* ***B*** *is not correct because Z should be added to Y, not subtracted from it* ***D*** *is not correct because this is the number of molecules which react without the catalyst added*	**(1)**

Question Number	Answer	Mark
(ii)	The only correct answer is **A** (Decreasing the temperature of the gas) ***B*** *is not correct because this will not change the number of molecules in area Y* ***C*** *is not correct because this will increase the number of molecules in area Y* ***D*** *is not correct because this will leave the number of molecules in area Y unchanged*	**(1)**