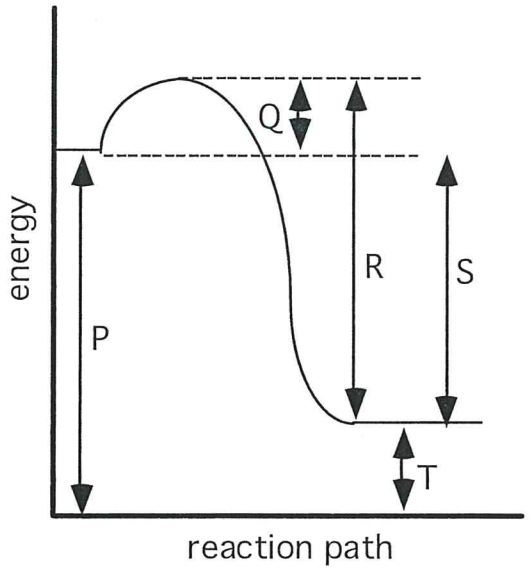
UNIT 2 **Rates and Energy SAMPLE TEST** **Mark:** **/35**

Name: _____ **Teacher:** _____

Section One: Multiple Choice (10 marks)

1. According to the following energy diagram, which of the following represents the activation energy and the heat of reaction for the **REVERSE** reaction?



	Activation Energy	Heat of Reaction
A.	R	S
B.	P + Q	T
C.	R	Q
D.	Q	S

The reaction below is exothermic

$$A + B \rightleftharpoons C + D$$

The total enthalpy (heat content) of the products is:

A. higher than the reactants

B. different for different elements

C. the same for all compounds

D. lower than that of the reactants

3. Reaction rate is **NOT** increased by

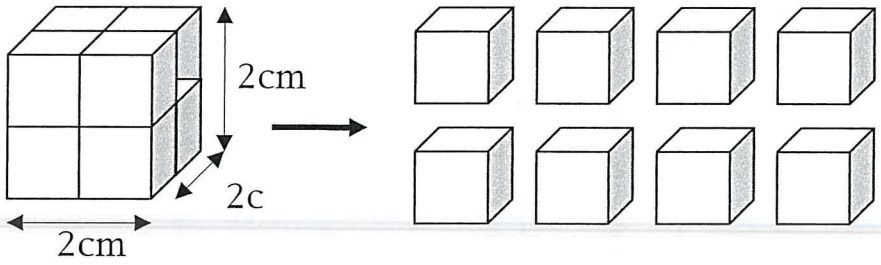
A. heating the reagents

B. adding a catalyst

C. adding larger lumps of reagent

D. stirring a reaction mixture

Q4. The rate at which a chemical dissolves is found to be proportional to the surface area in contact with the solvent.



A cubic shaped crystal of a chemical which measures 2cm x 2cm x 2cm takes 10 minutes to dissolve. A similar crystal of the same chemical was cut along the lines shown above. How long will it take all 8 pieces to dissolve?

A. about 5 minutes

B. about 7.5 minutes

C. about 10 minutes

D. about 20 minutes

Q5. The reaction between hydrazine and hydrogen peroxide, used to propel rockets, is represented by the following equation:

$$N_2H_4 + 2H_2O_2 \longrightarrow N_2 + 4H_2O \qquad \Delta H = -684 \text{ kJ}$$

1368 kJ of heat is released by this reaction if:

A. one mole of hydrazine is used

B. 64 g of hydrazine is used

C. 28 g of nitrogen is formed

D. 28 mole of nitrogen is formed.

Q6. Which of the following statements is **TRUE**?

A. Exothermic reactions slow down when the reactants are heated.

B. Only endothermic reactions go faster when the reactants are heated..

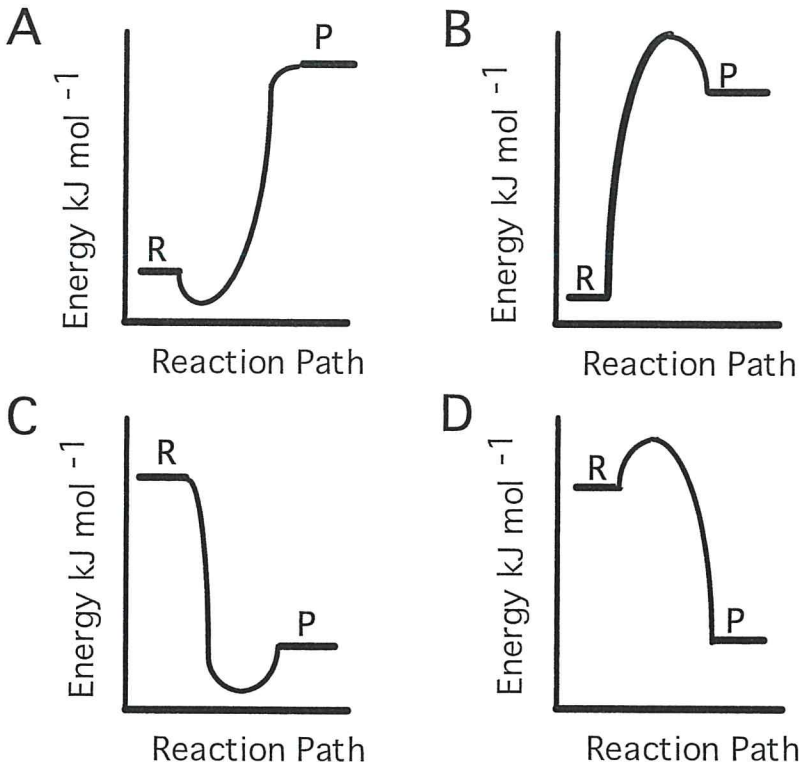
C. Only exothermic reactions proceed spontaneously at room temperature.

D. The rates of all chemical reactions increase with temperature.

Q7. Consider the following reaction

$$2NO_{2(g)} \longrightarrow N_{2(g)} + 2O_{2(g)} \quad \Delta H = +33.7 \text{ kJ mol}^{-1}$$

Which graph below could represent the changes of potential energy during the course of this reaction?



Q8. In which of the following changes at constant temperature does the entropy of the system **NOT** increase?

A. decomposition of one mole of hydrogen peroxide:

$$H_2O_{2(l)} \longrightarrow H_2O_{(l)} + \tfrac{1}{2}O_{2(g)}$$

B. decomposition of two moles of ammonia:

$$2NH_{3(g)} \longrightarrow N_{2(g)} + 3H_{2(g)}$$

C. formation of one mole of water from its elements:

$$H_{2(g)} + \tfrac{1}{2}O_{2(g)} \longrightarrow H_2O_{(l)}$$

D. reaction of one mole of zinc with hydrochloric acid:

$$Zn_{(s)} + 2HCl_{(aq)} \longrightarrow ZnCl_{2(aq)} + H_{2(g)}$$

Q9. When a liquid evaporates:

A. there is a decrease in entropy

B. the value for ΔH for the process is negative

C. the process can be described as homogenous

D. none of the above.

Q10. A mixture of oxygen and hydrogen gases do not react rapidly at room temperature because:

A. ΔH is small and negative

B. E_a is large

C. ΔH is small and positive

D. E_a is small.

End of Section One

Section Two: Short answer **(15 marks)**

11. Ethene can be produced from ethane by heating it in the presence of a catalyst. The reaction can be represented by the equation:

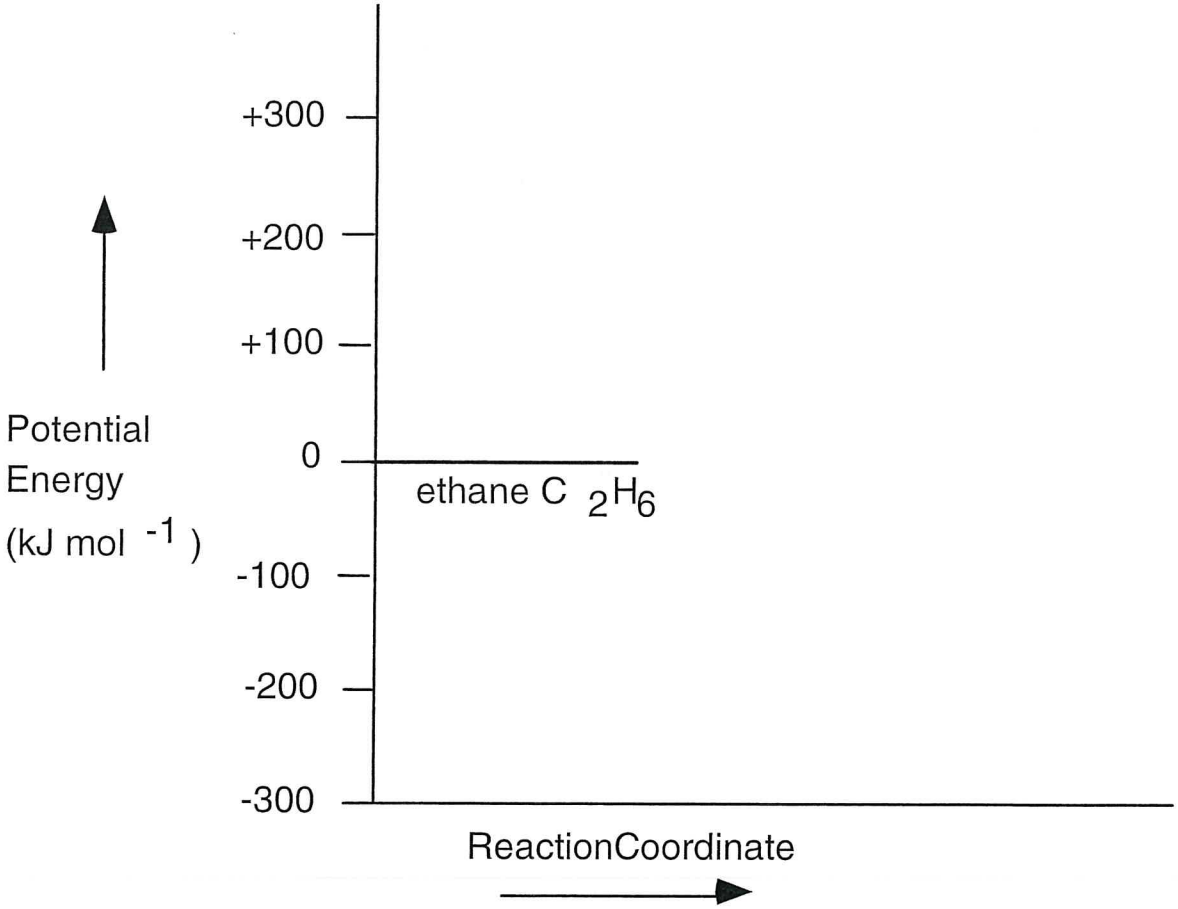
$$C_2H_{6\,(g)} = C_2H_{4\,(g)} + H_{2\,(g)};\ \Delta H = +120\ kJ\ mol^{-1}$$

On the axes below

A. draw a potential energy diagram for the uncatalysed reaction if the activation energy is 180 kJ mol^{-1}.

B. using a dotted line, draw a possible potential energy diagram for the same reaction in the presence of a catalyst.

(3 marks)



12. Carbon forms two oxides, carbon monoxide and carbon dioxide, according to the following equations:

(I) $2C_{(s)} + O_{2(g)} \longrightarrow 2CO_{(g)}$ $\Delta H = -222$ kJ

(II) $C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$ $\Delta H = -393$ kJ

Use the information given in equations (I) and (II) to calculate the enthalpy change (ΔH) for the reaction:

$$C_{(s)} + CO_{2(g)} \longrightarrow 2CO_{(g)}$$

(4 marks)

13. Propene (C_3H_6) has a Heat of Combustion or $\Delta H = -2056$ kJ mol^{-1} while butene (C_4H_8) has a Heat of Combustion or $\Delta H = -2715$ kJ mol^{-1}.

a) Write a balanced chemical equation for the complete combustion of propene.

(1 mark)

b) Why is there a difference in the values of the heats of combustion of the two fuels?

(2 marks)

14. The enzyme *polyphenoxidase* is involved in the oxidation reaction that causes sliced apple to turn brown in air. Explain the following observations.

A. When the apple is first cut open the apple is not brown.

_____

_____

_____ (1 mark)

B. Browning is much slower when the apple is placed in the fridge.

_____

_____

_____ (1 mark)

C. Apple that has been pulped in a food mixer turns brown much faster than sliced apple does.

_____

_____

_____

_____ (2 marks)

D. The browning reaction does not take place if the sliced apple is dipped in lemon juice straight away.

_____

_____

_____ (1 mark)

End of Section Two

Section Three: Extended answer

(10 marks)

15. Manganese may be prepared by the reduction of manganese (II, III) oxide Mn_3O_4 according to the following equation

$$3Mn_3O_4 + 8Al \longrightarrow 9Mn + 4Al_2O_3 \; ; \qquad \Delta H = -2510 \text{ kJ mol}^{-1}$$

The notation $\Delta H = -2510$ kJ mol^{-1} refers to the enthalpy change per mole of Mn_3O_4 reduced.

A. Explain what is meant by the notation ΔH or the term enthalpy change.

_____

_____

(1 mark)

B. State whether this reaction is endothermic or exothermic. Explain your answer

endothermic or *exothermic* _____ (1 mark)

Explanation: _____

(1 mark)

C. Calculate the mass of Al required to reduce (react with) 10.0 g of Mn_3O_4

_____

_____

_____

_____

_____

(3 marks)

D. Calculate the enthalpy change for the reduction of 1.00 g of Mn_3O_4

_____

_____

_____

(2 marks)

E. Calculate the number of moles of Al_2O_3 resulting from the reduction of 1.00 kg of Mn_3O_4.

_____

_____

_____

(2 marks)

End of Test

UNIT2 **SOLUTIONS**

RATES AND ENERGY : **Answer all questions**

Section One: MULTIPLE CHOICE QUESTIONS (10 marks)

1A	2D	3C	4A	5B	6D	7B	8C	9D	10B

Section Two: Short Answer (15 marks)

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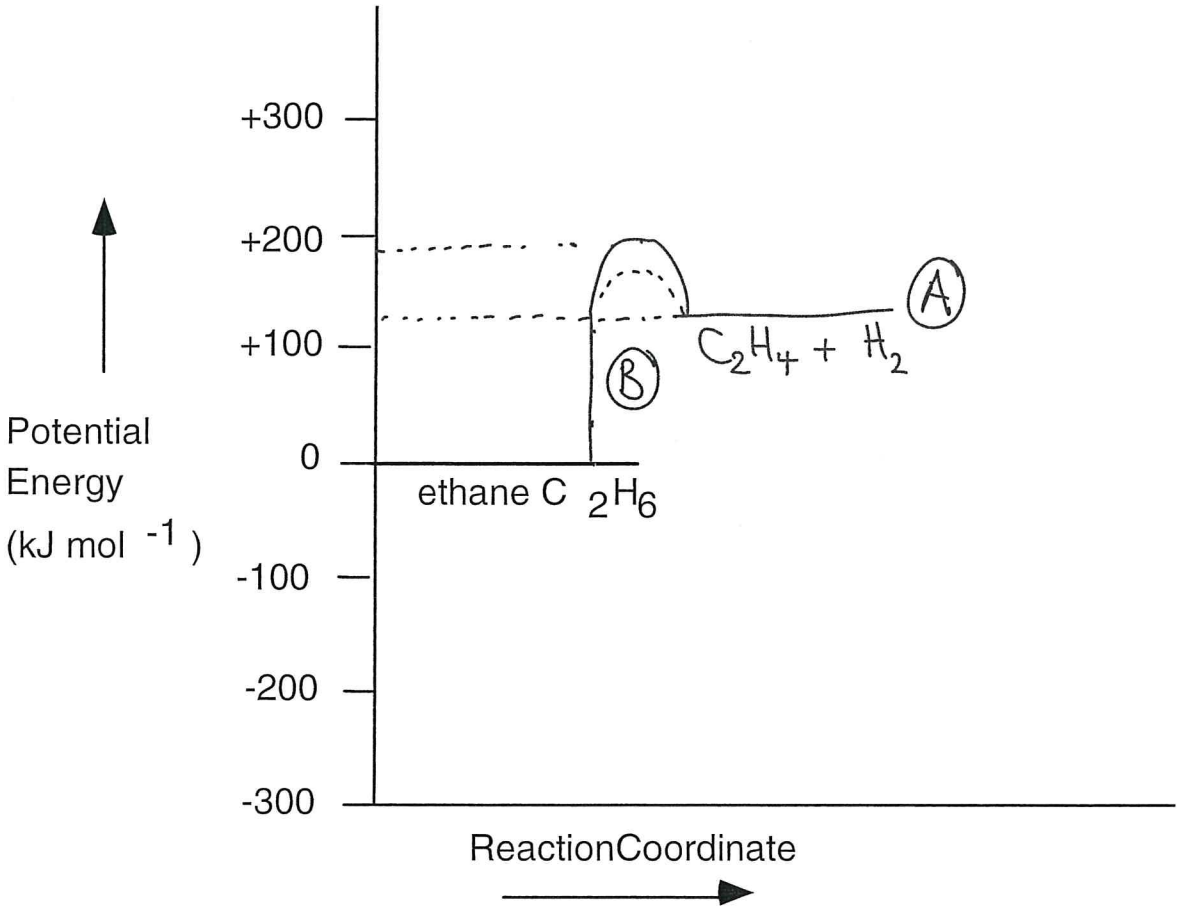
On the axes below

A. draw a potential energy diagram for the uncatalysed reaction if the activation energy is 180 kJ mol^{-1}.

B. using a dotted line, draw a possible potential energy diagram for the same reaction in the presence of a catalyst.



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(I) $2C_{(s)} + O_{2(g)} \longrightarrow 2CO_{(g)}$ $\Delta H = -222$ kJ

(II) $C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$ $\Delta H = -393$ kJ

Use the information given in equations (I) and (II) to calculate the enthalpy change (Δ**H**) for the reaction:

$$C_{(s)} + CO_{2(g)} \xrightarrow{\Delta H} 2CO_{(g)}$$

-393 ↑ ↑ -222

$2C + O_2$

$\Delta H - 393 = -222$ [1]

$\Delta H = +171$ kJ [1x3, number, sign units]

(4 marks)

13. Propene (C_3H_6) has a Heat of Combustion or $\Delta H = -2056$ kJ mol^{-1} while butene (C_4H_8) has a Heat of Combustion or $\Delta H = -2715$ kJ mol^{-1}.

a) Write a balanced chemical equation for the complete combustion of propene.

$2C_3H_6 + 9O_2 \rightarrow 6CO_2 + 6H_2O$

(1 mark)

b) Why is there a difference in the values of the heats of combustion of the two fuels?

More bonds that store more energy in butane [1]

So on combustion more energy is released into the environment [1]

(2 marks)

14. The enzyme *polyphenoxidase* is involved in the oxidation reaction that causes sliced apple to turn brown in air. Explain the following observations.

A. When the apple is first cut open the apple is not brown.

Oxygen has not had time to react with apple. Or any comment about DURATION

(1 mark)

B. Browning is much slower when the apple is placed in the fridge.

Temperature decreased making molecules move slowly less collisions per unit time

OR; Molecules have less than Activation energy required to react

(1 mark)

C. Apple that has been pulped in a food mixer turns brown much faster than sliced apple does.

Increased surface area in pulped apple [1]

Increase number of collisions per unit time [1]

(2 marks)

D. The browning reaction does not take place if the sliced apple is dipped in lemon juice straight away.

Lemon juice denatures the enzyme catalyst [1]

(1 mark)

End of Section Two

Section Three: Extended answer (10 marks)

14. Manganese may be prepared by the reduction of manganese (II, III) oxide Mn_3O_4 according to the following equation

$$3Mn_3O_4 + 8Al \longrightarrow 9Mn + 4Al_2O_3 \; ; \qquad \Delta H = -2510 \text{ kJ mol}^{-1}$$

The notation $\Delta H = -2510$ kJ mol^{-1} refers to the enthalpy change per mole of Mn_3O_4 reduced.

A. Explain what is meant by the notation ΔH or the term enthalpy change.

The net change in energy, from the start of the reaction until the end **[1]** stored within the molecules involved. **[1]**

(1 mark)

B. State whether this reaction is endothermic or exothermic. Explain your answer

endothermic or *exothermic* exothermic (1 mark)

Explanation: Because the molecules have lost stored bond energy overall

(1 mark)

C. Calculate the mass of Al required to reduce (react with) 10.0 g of Mn_3O_4

$n(Mn_3O_4) = m(Mn_3O_4)/ M(Mn_3O_4) = 10 / 228.82 = 0.0437024$ moles **[1]**

$n(Al) = 8/3\ n(Mn_3O_4) = 0.1165399$ moles **[1]**

$m(Al) = n(Al) \times M(Al) = 26.98 \times n(Al) = 3.14$ g **[1]**

(3 marks)

D. Calculate the enthalpy change for the reduction of 1.00 g of Mn_3O_4

$n(Mn_3O_4) = m(Mn_3O_4)/M(Mn_3O_4) = 1g / 228.82 = 0.0043702$ **[1]**

total $\Delta H/g = n\ (Mn_3O_4) \times \Delta H/mol = 0.0043702 \times -2510 = 10.969202$ kJ/g **[1]**

(2 marks)

E. Calculate the number of moles of Al_2O_3 resulting from the reduction of 1.00 kg of Mn_3O_4.

$n(Mn_3O_4) = m(Mn_3O_4)/M(Mn_3O_4) = 1000g / 228.82 = 4.3702$ moles **[1]**

$n(Al_2O_3) = 4/3\ n(Mn_3O_4) = 5.826996$ moles **[1]**

(2 marks)