M1.(a) q = 500 × 4.18 × 40

Do not penalise precision.

1

= 83600 J

Accept this answer only.
Ignore conversion to 83.6 kJ if 83600 J shown.
Unit not required but penalise if wrong unit given.
Ignore the sign of the heat change.
An answer of 83.6 with no working scores one mark only.
An answer of 83600 with no working scores both marks.

1

(b) Moles (= 83.6 / 51.2) = 1.63

Using 77400 alternative gives 1.51 mol
Allow (a) in kJ / 51.2
Do not penalise precision.

1

Mass = 1.63 × 40(.0) = 65.2 (g)

Allow 65.3 (g)
Using 77400 alternative gives 60.4 to 60.5
Allow consequential answer on M1.
1 mark for M_r (shown, not implied) and 1 for calculation.
Do not penalise precision.

2

(c) Molarity = 1.63 / 0.500 = 3.26 mol dm–3

Allow (b) M1 × 2
Using 1.51 gives 3.02

1

(d) Container splitting <u>and</u> releasing irritant / corrosive chemicals

*Must have reference to both aspects; splitting or leaking (can be implied such as contact with body / hands) **and** hazardous chemicals.*

Allow 'burns skin / hands' as covering both points
Ignore any reference to 'harmful'.
Do not allow 'toxic'.

1

(e) (i) $4Fe + 3O_2 \rightarrow 2Fe_2O_3$

Allow fractions / multiples in equation.
Ignore state symbols.

1

(ii) Iron powder particle size could be increased / surface area lessened

Decrease in particle size, chemical error = 0 / 3
Change in oxygen, chemical error = 0 / 3

1

Not all the iron reacts / less reaction / not all energy released / slower release of energy / lower rate of reaction

Mark points M2 and M3 independently.

1

Correct consequence of M2

An appropriate consequence, for example

- *too slow to warm the pouch effectively*
- *lower temperature reached*
- *waste of materials*

1

(f) (i) Conserves resources / fewer disposal problems / less use of landfill / fewer waste products

Must give a specific point.
Do not allow 'does not need to be thrown away' without qualification.
Do not accept 'no waste'.

1

(ii) Heat to / or above 80 °C (to allow thiosulfate to redissolve)

Accept 'heat in boiling water'.
If steps are transposed, max 1 mark.

1

Allow to cool before using again

Reference to crystallisation here loses this mark.

1

[14]

M2.(a) Number / proportion / percentage / fraction of molecules

Ignore "particles"

1

(b) None ***OR*** no effect ***OR*** no change

1

(c) **X**

1

(d) **Answers in either order**

M1 collision ***OR*** collide

Mark independently

M2 collision / molecules / particles

Ignore "correct" amount of energy

with the activation energy

OR with $E \geq E_{act}$

OR with sufficient /enough energy

OR with the minimum energy

OR with the correct orientation

2

(e) A small increase in temperature results in many more / much higher proportion of / a lot more / significantly more molecules / particles / collisions with $E \geq E_{act}$ / energy greater than the activation energy / sufficient energy / enough energy / minimum energy to react

(compared with a small increase in concentration)

Not just "more molecules with $E \geq E_{act}$"

*The answer must convey that the increase is **significant***

Accept reference to "atoms", "molecules", "particles"

Ignore "species"

1

[6]

M3. (a) **M1** The activation energy is the <u>minimum</u> / <u>least</u> / <u>lowest energy</u>

Mark independently

Ignore ''heat'' and ignore ''enthalpy''

M2 (energy) <u>for a reaction</u> to occur / to go / to start

OR (energy) for a <u>successful / effective collision</u>

Ignore "breaking the bonds''

2

(b) **M1** Catalysts provide an alternative route OR an alternative mechanism OR alternative / different path(way)

M2 Lowers the activation energy

Mark independently

Ignore reference to ''surface''

2

(c) (i) Stay(s) the same

1

(ii) Increases

Credit ''increase" or ''increased''

1

(iii) Increases

Credit ''increase'' or ''increased''

1

(iv) Stay(s) the same

1

(d) (i) **M1** yeast or zymase

M2 ethanol

Ignore ''enzyme''

In M2, ignore ''alcohol'' and ignore any formula

2

(ii) **M1** (Concentrated) H_3PO_4 OR (Concentrated) H_2SO_4

M2 butan-2-ol

Credit correct names

Ignore ''hydrogenphosphate or hydrogensulfate''

Ignore ''dilute'' or ''aq''

Do not penalise absence of hyphens in name.

In M2, ignore any formula

2

[12]

M4. (a) Equation $1/2N_2 + 3/2H_2 \rightarrow NH_3$

1

$\Delta Hf = [(945 \times 0.5) + (426 \times 1.5)] – (391 \times 3)$

1

$= –46.5$ kJ mol^{-1}

1

Mark Range	The marking scheme for this part of the question includes an overall assessment for the Quality of Written Communication (QWC). There are no discrete marks for the assessment of QWC but the candidates' QWC in this answer will be one of the criteria used to assign a level and award the marks for this part of the question **Descriptor** an answer will be expected to meet most of the criteria in the level descriptor
4-5	– claims supported by an appropriate range of evidence – good use of information or ideas about chemistry, going beyond those given in the question – argument well structured with minimal repetition or irrelevant

	points – accurate and clear expression of ideas with only minor errors of grammar, punctuation and spelling
2-3	– claims partially supported by evidence – good use of information or ideas about chemistry given in the question but limited beyond this – the argument shows some attempt at structure – the ideas are expressed with reasonable clarity but with a few errors of grammar, punctuation and spelling
0-1	– valid points but not clearly linked to an argument structure – limited use of information or ideas about chemistry – unstructured – errors in spelling, punctuation and grammar or lack of fluency

(b) The higher the temperature the faster the reaction QWC **1**

but, since the reaction is exothermic **1**

the equilibrium yield is lower QWC **1**

The higher the pressure the greater the equilibrium yield QWC **1**

because there is a reduction in the number of moles of gas in the reaction **1**

but higher pressure is expensive to produce or plant is more expensive to build QWC **1**

A better catalyst would lessen the time to reach equilibrium **1**

and allow more ammonia to be produced in a given time QWC **1**

[11]

M5. (a) Sulfur OR S OR S_8

Sulphur

1

(b) **M1** The activation energy is the <u>minimum</u> / <u>least</u> / <u>lowest</u>

Mark these independently

1

M2 Energy for a reaction to occur / to go / to start

OR

Energy for a <u>successful / effective</u> collision

1

(c) Explanation:

M1 <u>Twice</u> as many / <u>double</u> number of <u>particles</u>

M1 NOT molecules

1

M2 <u>More / twice / double</u> (effective) <u>collisions</u> (in a given time)

OR

<u>Double / greater / increased collision frequency</u>

1

(d) (i) (Measured) <u>change</u> in <u>concentration</u> (of a substance) in unit <u>time</u> / given <u>time</u>

May be written mathematically

OR the gradient of the <u>concentration</u> (against) <u>time</u>

1

(ii) The measured change / amount (of precipitate) / cloudiness is <u>fixed</u> or <u>constant</u> or <u>unchanged</u>

1

[7]