M1.(a) pV = nRT

Do not penalise incorrect use of capitals / lower case letters.
Accept correct rearrangement of equation.

1

(b) **2**C_4H_{10} + **5**O_2 → **4**CH_3COOH + **2**H_2O

Accept any correct combination of multiples, including fractions.

1

(c) 23.0 g ethanol produces 30.0 g ethanoic acid

1

15.1% (4.54 ×100 / 30)

Do not penalise precision.
15.1% scores 2 marks.
Accept consequential answer on wrong mass of ethanoic acid for second mark only.

1

[4]

M2. (a) (i) M_r = 132.1

1

132

0.0238

Allow 0.024
Allow 0.0237
Penalise less than 2 sig fig once in (a)

1

(ii) 0.0476

1

0.0474-0.0476
Allow (a) (i) × 2

(iii) 1.21

Allow consequential from (a) (ii)
ie allow (a) (ii) × 1000/39.30
Ignore units even if wrong

1

(b) $\frac{34 \times 100}{212.1}$

Allow mass or Mr of desired product times one hundred divided by total mass or Mr of reactants/products
If 34/212.1 seen correctly award M1

1

= 16.0(3)%

Allow 16%
16 scores 2 marks

1

(c) 100(%)

Ignore all working

1

(d) PV = nRT or n = $\frac{PV}{RT}$

If rearranged incorrectly lose M1 and M3

1

n = $\frac{100000 \times 1.53 \times 10^{-2}}{8.31 \times 310}$

M2 for mark for converting P and T into correct units in any expression

1

= 0.59(4)

Allow 0.593
M3 consequential on transcription error only not on incorrect P and T

1

(e) (Na_2SO_4) H_2O
(44.1%) 55.9%

M1 is for 55.9

1

44.1/142.1	55.9/18
0.310	3.11
= 1	= 10

Alternative method gives180 for water part = 2 marks

1

$x = 10$

X = 10 = 3 marks
10.02 = 2 marks

1

[13]

M3. (a) (i) 0.00301/ 3.01×10^{-3};

Penalise < 3sf in (a)(i);

Allow $3.01 \times 10^{-3} – 3.05 \times 10^{-3}$.
(for candidates who have used Mg as 24)

1

(ii) 0.00602

Allow correct answer a(i) × 2.

1

(iii) 0.00965/ 9.65×10^{-3};

Allow 0.009646/ 0.0096-0.0097.

1

(iv) 0.00363 moles;

Allow range 0.0035 to 0.0037.
Allow (a)(iii) – 2 (a)(ii) (must be positive).

1

(b) PV = nRT;

Allow all capitals/ lower case.

1

$V = \frac{0.512 \times 8.31 \times 298}{96000}$;

M2 Mark is for <u>all numbers correct</u>.
If units in answer are in dm^3 allow this expression with 96 in denominator.

1

0.0132 m^3/ 13.2 dm^3;

M3 <u>Must have correct units</u>/
allow 13200 cm^3.
Allow min 2 sig figs in answer.

1

(c) O = 69.6 (%);

1

$\frac{30.4}{14}$ $\frac{69.6}{16}$ 2.17 : 4.35

Use of 7/8 CE then M1 only.

1

(1 : 2) <u>NO_2</u>

Mark for formula not ratio.
If NO_2 and no working shown then allow 1 mark.
If 69.6% + NO_2 only = 2.
Need to see evidence of M2 working.
Allow M2 conseq on the wrong M1 (ie max 1).

1

[10]

M4. (a) (i) Moles of gas produced = 3

1

PV = nRT

1

V = nRT/P = 3 × 8.31 × 298/100000

1

= 7.43×10^{-2} m^3

1

(ii) $7.43 \times 10^{-2} \times 1000/298 = 0.249\ m^3$

1

(b) (i) any two from:

exhaust gases hot so would boil the solution away
solution would splash
reaction might be too slow
would need continuous supply of solution and/or replacement of products

2

(ii) *Commercial advantage* could sell chlorine and/or hydrogen

1

environmental disadvantage generation of electricity likely to lead to release of CO_2 (or chlorine toxic)

1

(c) % O = 74%

1

N:O = 26/14:74/16

1

= 1.86: 4.63 = 1:2.5 therefore formula is N_2O_5

1

(d) $2N_2O \rightarrow 2N_2 + O_2$

1

(e) Proportion of O_2 increased leading to higher T (or more complete combustion)

1

[14]

M5. (a) (i) Avogadro's number/constant of molecules/particles/species / 6×10^{23}

[Not 'atoms']

1

Or same number of particles as (there are atoms)

[Not molecules]

in 12.(00)g of ^{12}C

1

(ii) *Moles* O_2 = $\frac{0.350}{32}$ *(= 1.09 × 10⁻² mol)*

1

= 29 (× 1.09 × 10^{-2})

[Accept answers via 4 separate mole calculations]

1

= 0.316 – 0.317 mol [answer to 3 + sf]

[Mark conseq on errors in M1/M2] (1)

1

(iii) Moles of nitroglycerine = 4 × 1.09 × 10^{-2} (= 0.0438 mol)

[Mark conseq on their moles of O_2]

1

M_r of nitroglycerine = 227 or number string

1

Moles of nitroglycerine = 227 × 0.0438 = 9.90 – 9.93(g)

[answer to 3+ sf]

[If string OK but final answer wrong then allow M6 but AE for M7]

[Mark conseq on error in M_r] [Penalise wrong units]

[Penalise sig. fig. errors once only in whole question]

(b) pV = nRT **or** pV = $\frac{mRT}{V}$ **or** p = $\frac{nRT}{V}$

1

p = $\frac{nRT}{V}$ = $\frac{0.873 \times 8.31 \times 1100}{1.00 \times 10^{-3}}$

1

= 7980093 **or** 7980 **or** 7.98

[ignore s.f.]

1

units = Pa **or** kPa **or** MPa (as appropriate)

[If error in conversion from Pa, treat as a contradiction of the units mark]

[If transfer error, mark conseq but penalise M2]

[If data from outside of above used, penalise M2 and M3]

[If pV expression incorrectly rearranged, penalise M2 and M3]

[if T = 1373 K used, penalise M2]

1

[11]