M1. (a) pV = nRT
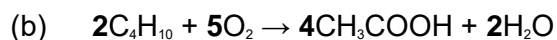
Do not penalise incorrect use of capitals / lower case letters.
Accept correct rearrangement of equation.

1

(b) $2C_4H_{10} + 5O_2 \rightarrow 4CH_3COOH + 2H_2O$

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) $\dfrac{34 \times 100}{212.1}$

> *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 = $\dfrac{PV}{RT}$

> *If rearranged incorrectly lose M1 and M3*

1

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

> *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*

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

Alternative method gives180 for water part = 2 marks

x = 10

X = 10 = 3 marks
10.02 = 2 marks

[13]

M3.   (a)   (i)   0.00301/ 3.01×10^{-3};

Penalise < 3sf in (a)(i);
Allow 3.01×10^{-3} – 3.05×10^{-3}.
(for candidates who have used Mg as 24)

(ii)   0.00602
Allow correct answer a(i) × 2.

(iii)   0.00965/ 9.65×10^{-3};
Allow 0.009646/ 0.0096-0.0097.

(iv)   0.00363 moles;
Allow range 0.0035 to 0.0037.
Allow (a)(iii) – 2 (a)(ii) (must be positive).

(b)   PV = nRT;
Allow all capitals/ lower case.

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

M2 Mark is for __all numbers correct__.
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 __Must have correct units__/
allow 13200 cm^3.
Allow min 2 sig figs in answer.

1

(c)   O = 69.6 (%);

1

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

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

$V = nRT/P = 3 \times 8.31 \times 298/100000$

1

$= 7.43 \times 10^{-2}$ m^3

1

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

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) $Moles\ O_2 = \dfrac{0.350}{32}$ $(= 1.09 \times 10^{-2}\ mol)$

1

$= 29\ (\times\ 1.09 \times 10^{-2})$
[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 $= 4 \times 1.09 \times 10^{-2}$ $(= 0.0438\ mol)$
[Mark conseq on their moles of O_2]

1

M_r of nitroglycerine = 227 or number string

1

Moles of nitroglycerine $= 227 \times 0.0438 = 9.90 – 9.93(\underline{g})$
[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** $pV = \dfrac{mRT}{V}$ **or** $p = \dfrac{nRT}{V}$

1

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

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]