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.

[4]

1

M2. (a) (i) $M_r = 132.1$

1

0.0238

132

Allow 0.024 Allow 0.0237

Penalise less than 2 sig fig once in (a)

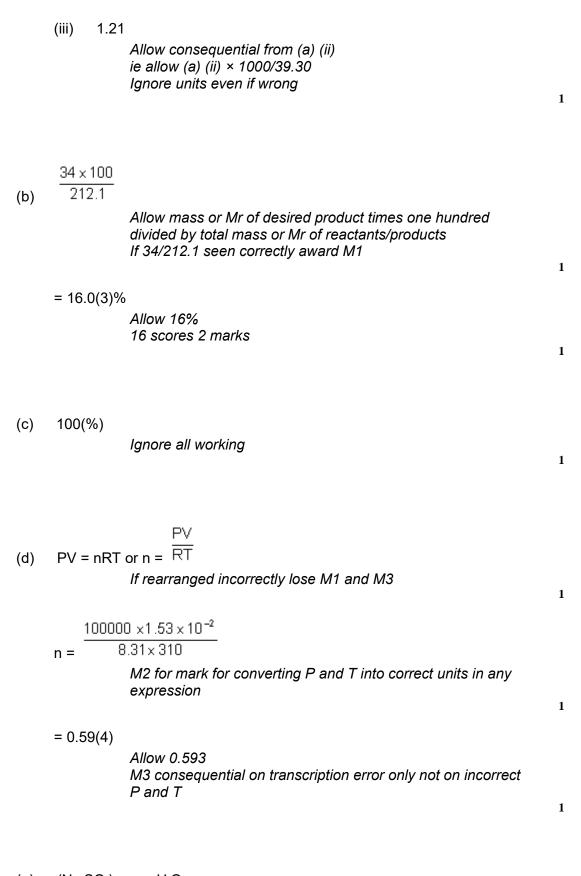
1

1

(ii) 0.0476

0.0474-0.0476

Allow (a) (i) \times 2



(e) (Na₂SO₄) H₂O (44.1%) 55.9% *M1 is for 55.9* 44.1/142.1 55.9/18 0.310 3.11 = 1 = 10 Alternative method gives 180 for water part = 2 marks 1 x = 10X = 10 = 3 marks

10.02 = 2 marks1

M3. $0.00301/3.01 \times 10^{-3}$; (a) (i) Penalise < 3sf in (a)(i);Allow $3.01 \times 10^{-3} - 3.05 \times 10^{-3}$. (for candidates who have used Mg as 24)

> (ii) 0.00602 Allow correct answer $a(i) \times 2$.

 $0.00965/9.65 \times 10^{-3}$; (iii) 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).

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

1

1

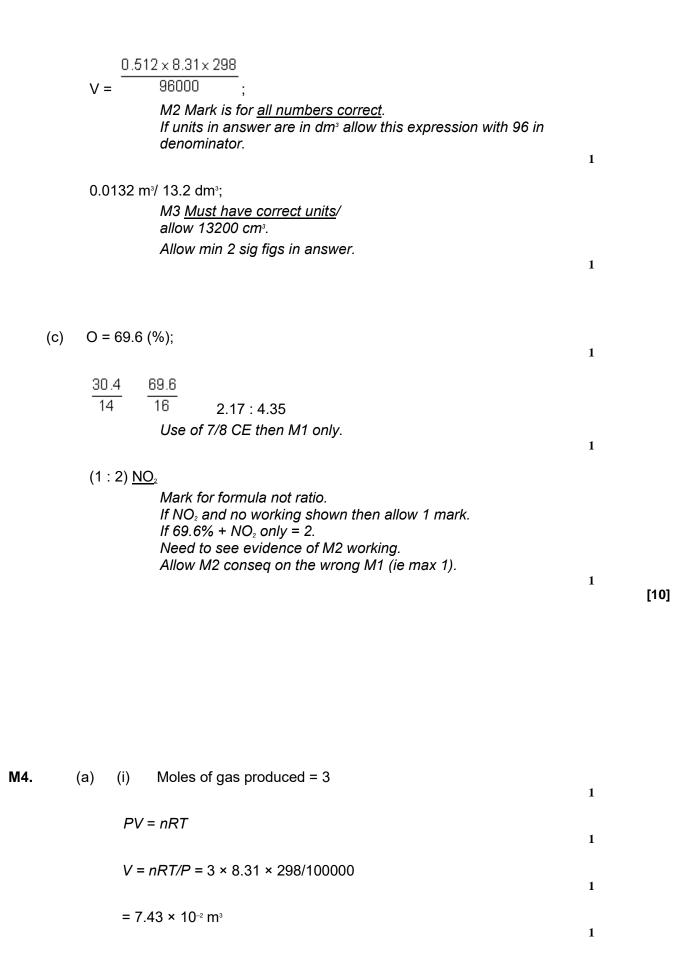
1

1

1

1

[13]



(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 CO₂ (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

1

(e) Proportion of O₂ increased leading to higher T (or more complete combustion)

[14]

M5. (a) (i) Avogadro's number/constant of molecules/particles/species /
$$6 \times 10^{23}$$
 [Not 'atoms']

Or same number of particles as (there are atoms) [Not molecules]

(ii) Moles
$$O_2 = \frac{0.350}{32}$$
 (= 1.09 × 10⁻² mol)
$$= 29 (× 1.09 × 10-2)$$

[Accept answers via 4 separate mole calculations]

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

[Mark conseq on their moles of O_2]

1

M, of nitroglycerine = 227 or number string

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

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

1

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]

[11]

1