1. B

[1]

2. B

[1]

3. D

[1]

4. C

[1]

5. Al $\frac{20.3}{26.98}$ Cl $\frac{79.70}{35.45}$ or similar working *(no penalty for use of 27 or 35.5)*;

empirical formula $AlCl_3$;

molecular formula: n = $\frac{267}{133.5}$ = 2;

Al_2Cl_6;

*Full credit can be obtained if the calculations are carried out by another valid method. Two correct formulas but no valid method scores **[2 max]**.*

[4]

6. moles of Na = $\frac{1.15}{23}$ = 0.05;

moles of NaOH = 0.05;

Accept "same as moles of Na"

concentration = $\left(\frac{0.05}{0.25}\right)$ = 0.20 (mol dm^{-3}) 3

Allow ECF from moles of NaOH

[3]

7. (i) bubbling / effervescence / dissolving of / gas given off $CaCO_3$ (*do not accept* CO_2 *produced*);
more vigorous reaction with HCl / *OWTTE*; 2

(ii) $2HCl(aq) + CaCO_3(s) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(1)$; 2

__[1]__ for correct formulas, __[1]__ for balanced, state symbols not essential.

(iii) amount of $CaCO_3$ = $\frac{1.25}{100.09}$ (*no penalty for use of 100*);
amount of HCl = 2 × 0.0125 = 0.0250 mol (*allow ECF*);
volume of HCl = 0.0167 dm^3 / 16.7 cm^3 (*allow ECF*); 3

(iv) 1:1 ratio of $CaCO_3$ to CO_2 to / use 0.0125 moles CO_2 (*allow ECF*);
(0.0125 × 22.4) = 0.28 dm^3 / 280 cm^3 / 2.8×10^{-4} m^3 (*allow ECF*); 1
Accept calculation using pV=nRT.

[9]

8. B

[1]

9. A

[1]

10. B

[1]

11. C

[1]

12. B

[1]

13. A

[1]

14. D

[1]

15. B

[1]

16. C

[1]

17. D

[1]

18. (a) $C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$; 2
*Award **[1]** for formulas and **[1]** for coefficients.*

(b) (CO_2 produced) = 200 (cm^3) ;
(O_2 remaining) = 100 (cm^3) ; 2
ECF from 2(a).

[4]

19. (a) $Zn + I_2 \rightarrow ZnI_2$; 1

Accept equilibrium sign.

(b) (moles of) zinc $\left(= \frac{100.0\text{ g}}{65.37\text{ g mol}^{-1}}\right)$ = 1.530;

(moles of) iodine $\left(= \frac{100.0\text{ g}}{253.8\text{ g mol}^{-1}}\right)$ = 0.3940; 3

ECF throughout.
–1 (SF) possible.

(reacting ratio is 1:1, therefore) zinc is in excess;
Must be consistent with calculation above.

(c) (amount of zinc iodide = amount of iodine used = $\frac{100.0}{253.8}$ moles)

(mass of zinc iodide = $\frac{100.0}{253.8}$ × (65.37 + 253.8) = 253.8) 125.8 (g); 1

Use ECF throughout.
-1 (*SF*) *possible.*

[5]

20. A

[1]

21. C

[1]

22. B

[1]

23. C

[1]

24. (a) to prevent (re)oxidation of the copper / *OWTTE*; 1

(b) number of moles of oxygen $\frac{1.60}{16.00}$ = 0.10;

number of moles of copper = $\frac{6.35}{63.55}$ =0.10;

empirical formula = Cu (0.10) : O (0.10) = CuO; 3

Allow ECF.

Award ***[1]*** *for CuO with no working.*

Alternate solution

$\frac{6.35}{7.95}$ = 79.8 % $\frac{1.60}{7.95}$ = 20.2 %

$\frac{70.8}{63.5}$ = 1.25 $\frac{20.2}{16}$ = 1.29

(c) $H_2 + CuO \rightarrow Cu + H_2O$; 1

Allow ECF.

(d) (black copper oxide) solid turns red / brown;
condensation / water vapour (on sides of test tube); 2

Accept change colour.
*Do **not** accept reduction of sample size.*

[7]

25. A

[1]

26. D

[1]

27. D

[1]

28. D

[1]

29. C

[1]

30. C

[1]

31. C

[1]

32. (a) mole ratio C : H = $\frac{85.6}{12.01} : \frac{14.4}{1.01} = 7.13 : 14.3$;

No penalty for using integer atomic masses.

empirical formula is $\underline{CH_2}$; 2

(b) (i) number of moles of gas n = $\frac{PV}{RT} = \frac{\text{mass}}{\text{molar mass}}$; $\frac{1.01 \times 10^2 \text{ kPa } (.399 \text{ dm}^3);}{8.314 \frac{\text{J}}{\text{mol K}} (273 \text{ K})}$;

$\frac{1.00 \text{ g}}{.017 \text{ mol}} = 56.3 \text{ (g mol}^{-1}\text{)}$ 2

OR

molar mass is the $\frac{\text{mass of the molar volume}}{22.4 \text{ dm}^3}$ at STP;

$\frac{1.00 \times 22.4}{0.399} = 56.1 \quad \text{(g mol}^{-1}\text{)}$

Accept answers in range 56.0 to 56.3.

Accept two, three or four significant figures.

(ii) C_4H_8; 1

No ECF.

[5]

33. B

[1]