M1. (a) because this lithium atom has

3 protons

and 4 neutrons

mass number is total of neutrons and protons

accept protons and neutrons have a mass of 1
accept number of neutrons = 7 - 3(protons)
ignore mass of electron is negligible

(b) grams

accept g

\(^{12}\text{C}\)

allow carbon-12 or C-12
ignore hydrogen or H

(c) any three from:

max 2 if no numbers given
numbers if given must be correct

• both have 8 protons
  accept same number of protons
• \(^{16}\text{O}\) has 10 neutrons
• \(^{18}\text{O}\) has 8 neutrons
  accept different number of neutrons or \(^{16}\text{O}\) has two more neutrons
  for 1 mark
• both have 8 electrons.
  accept same number of electrons

[8]
M2. (a) (i) lit splint or ignite the gas

(squeaky) pop / explosion

(ii) because it provides energy (for the reaction)

to break bonds (in the reactants) or so the particles collide successfully
ignore reference to frequency or rate of collisions
because it provides the activation energy gains 2 marks

(b) (i) 1.67(g)

allow 1.66-1.68
correct answer (to 3 significant figures) with or without working gains 3 marks
if answer incorrect allow up to 2 marks for the following steps:
24 \to 40
1.00 \to 40 / 24
or
moles magnesium = 1 / 24 or 0.04(17)
multiply by 40
allow ecf from incorrect ratio or incorrect number of moles

(ii) if correct answer from part (b)(i) used

allow ecf from part (b)(i)

89.8 or 90

if 1.82 g used

82.4 or 82
correct answer with or without working gains 2 marks
if answer incorrect, allow the following for 1 mark:
1.50 / 1.67 (or their answer from part (b)(i))
if 1.82 g used: 1.50 / 1.82

(iii) any one from:
  - ignore measurement errors
  - not all the magnesium reacted
    allow the reaction may be reversible
  - some of the magnesium oxide / product may have been left in the tube
    or may have been lost
    ignore magnesium lost
  - different / unexpected reaction
  - magnesium not pure

[10]
M3. (a) because they are gases
    ignore vapours / evaporate / (g)
    allow it is a gas

(b) (i) $80 / 79.5$
    correct answer with or without working = 2 marks
    ignore units
    if no answer or incorrect answer then evidence of $64 / 63.5 + 16$
    gains 1 mark

(ii) $80 / 79.87 / 79.9 / 79.375 / 79.38 / 79.4$
    correct answer with or without working = 2 marks
    if no answer or incorrect answer then
    evidence of $\frac{64}{80}$ or $\frac{63.5}{79.5}$ ($\times 100$) gains 1 mark
    accept (ecf)
    $\frac{64\text{ or }63.5}{\text{answer}(b)(i)}$ ($\times 100$) for 2 marks if correctly calculated
    if incorrectly calculated
    evidence of $\frac{64\text{ or }63.5}{\text{answer}(b)(i)}$ ($\times 100$)
    gains 1 mark

(iii) 3.2
    correct answer with or without working = 1 mark
    allow (ecf)
    $4 \times ((b)(ii)/100)$ for 1 mark if correctly calculated

(c) (i) 3.3
accept $3.33\ldots$ or $\frac{10}{3}$ or $3.3 \cdot 3.3$.

(ii) measure to more decimal places
or use a more sensitive balance / apparatus
allow use smaller scale (division)
or use a smaller unit
ignore accurate / repeat

(iii) any two from:

- ignore systematic / human / apparatus / zero / measurement / random / weighing / reading errors unless qualified
- different balances used or faulty balance
  ignore dirty apparatus
- reading / using the balance incorrectly or recording error
  accept incorrect weighing of copper / copper oxide
- spilling copper oxide / copper
  allow some copper left in tube
- copper oxide impure
  allow impure copper (produced)
- not all of the copper oxide was reduced / converted to copper
  or not enough / different amounts of methane used
  accept not all copper oxide (fully) reacted
- heated for different times
- heated at different temperatures
  accept Bunsen burner / flame at different temperatures
- some of the copper made is oxidised / forms copper oxide
- some of the copper oxide / copper blown out / escapes (from tube)
  ignore some copper oxide / copper lost
- some water still in the test tube

[10]
M4. (a) (i) straight line through the ‘points’ and extended to C$_{18}$H$_{18}$
do not accept multiple lines

(ii) 5500
range 5400 to 5600
accept ecf from their graph

(iii) it is a straight line graph
allow directly proportional
accept constant difference between (energy) values
accept C$_{12}$H$_{12}$, close to values on the graph
or C$_{12}$H$_{12}$ comes in middle of the graph
ignore ‘fits the pattern’ unqualified
ignore ‘line of best fit’
ignore ‘positive correlation’

(iv) expected ranges for working are:
accept correct numerical answer as evidence of working

(5400 to 5600) – (2800 to 2900) = (2500 to 2800)
or
their value from (a)(ii) – a value from 2800 to 2900
or
(5400 to 5600) / their (a)(ii) divided by 2
or
a value from 2800 to 2900 - 2
no / not quite / almost / yes
this mark is only awarded on evidence from their correct working

(b) (i) incorrect / no or partially correct
ignore references to hydrogen

bio-ethanol produces least energy
mark independently

or

bio-ethanol produces 29 kJ

(ii) ignore incorrect / correct
any two from:

• hydrogen produces only H₂O
  accept hydrogen does not produce harmful gases / CO₂ / SO₂

• coal produces SO₂
  allow coal causes acid rain / respiratory problems

• coal produces smoke
  allow coal causes global dimming

• both renewable and non-renewable fuels produce CO₂
  accept bio-ethanol and natural gas / coal produce CO₂ / global warming

• (both) the non-renewable fuels produce CO₂
  accept coal and natural gas produce CO₂ / global warming

• (both) renewable fuels produce no smoke
  accept hydrogen and bio-ethanol do not produce smoke / global dimming

• (both) renewable fuels produce no SO₂
  accept hydrogen and bio-ethanol do not produce SO₂ / acid rain

2

[9]