A. Energy Changes part 1 – Exothermic and Endothermic Reactions

1. How do we describe energy conservation in reactions? (2)

   Amount of energy in the Universe at the end of a reaction [1]
   Is the same as before the reaction takes place [1]

2. What is an exothermic reaction? (2)

   One that transfers energy to the surroundings [1]
   The temperature of the surroundings increases [1]

3. Give two examples of exothermic reactions (2)

   Any two from combustion/oxidation/neutralisation (accept examples e.g. hydrochloric acid and sodium hydroxide) [2]

4. What is an endothermic reaction? (2)

   One that takes in energy from the surroundings [1]
   The temperature of the surroundings decreases [1]

5. Give one example of an endothermic reaction. (1)

   Any one from thermal decompositions/sports injury packs (accept examples e.g. citric acid and sodium hydrogen carbonate) [1]

6. **Extended response question:**
   A student wishes to investigate which of three metals will give the largest exothermic reaction when they react with hydrochloric acid. Describe how she would carry out the experiment making sure it was a fair test. (6)

- ***Level 3 (5-6 marks)***
  Complete description of experiment and fair test
- ***Level 2 (3-4 marks)***
  Partial description of experiment and fair test
- ***Level 1 (1-2 marks)***
  Limited description of experiment and fair test

The reaction will be exothermic therefore the rise in temperature will be measured [1] the greatest rise in temperature signifies the most exothermic [1]

Mass of metal/surface area must be the same [1]
Temperature of acid must be the same [1]
Concentration of acid must be the same [1]
Mention of agitation or stirring [1]

B. Energy Changes part 2 – Reaction profiles

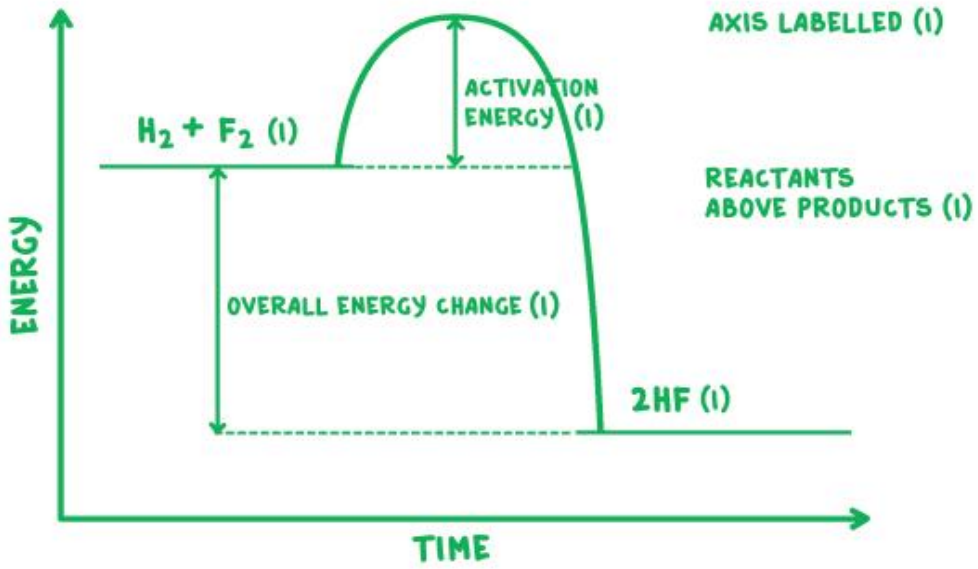
7. What is activation energy? (1)

   The energy needed for a reaction to occur [1]

8. **Extended response question:**
   The following reaction is exothermic:

   H_2 (g) + F_2 (g) → 2HF (g)

   Draw a reaction profile to show this reaction, including the relative energies of the reactants and products, the activation energy and the overall energy change (6)



9. (HT only) Below is a balanced chemical reaction between nitrogen gas and oxygen gas to produce nitrogen monoxide. The bond energy between two nitrogen atoms is 942kJ/mol, between two oxygen atoms is 494 Kj/mol and between a nitrogen atom and an oxygen atom is 607kJ/mol. Calculate the overall energy change for this reaction. (4)

   N_2 + O_2 → 2NO

   Bond energies for the reactants 1,436 kJ/mol [1]
   Bond energies for the products 1,214 kJ/mol [1]
   Answer = + [1] 222kJ/mol [1]

10. (HT only) Draw a reaction profile for the above reaction. (4)

    Correctly labelled axes [1] energy of products above reactants [1] both reactants and products labelled on correct lines [1] curved line showing activation energy [1]

11. Describe the energy release in an exothermic reaction in terms of bond energies. (2)

    Energy released from forming bonds is greater [1] than energy needed to break bonds [1]

C. Energy Changes part 3 – Cells, Batteries and Fuel Cells

12. A student has a number of cells all with a potential difference of 1.5V. Explain how they could construct a battery with a potential difference of 12V (2)

8 cells [1] All cells in series [1]

13. Below is a table of standard electrode potentials

Metal electrode	Standard electrode potential E^O in volts
Calcium	-2.76
Magnesium	-2.38
Aluminium	-1.66
Zinc	-0.76
Iron	-0.41
Lead	-0.13

When a cell contains an aluminium electrode and a zinc electrode the potential difference of the cell is 0.90 Volts.

Calculate the potential difference of a cell with magnesium and iron electrodes. (2)

Idea of 2.38V – 0.41V [1]
1.97 V [2]

14. How would you increase the potential difference of this cell? (1)

Change the magnesium electrode for a calcium electrode/change the iron electrode for a lead electrode [1]

15. (HT) Write the half equations for the electrode reactions in a hydrogen fuel cell

Cathode (2)

$2H_2\ (g) \rightarrow 4H^+\ (aq) + 4e^-$ correct chemicals including electrons [1] balanced [1]

Anode (2)

$4H^+\ (aq) + O_2\ (g) + 4e^- \rightarrow 2H_2O\ (g)$ correct chemicals including electrons [1]balanced [1]

16. Hydrogen fuel cells are used on space craft to produce electricity. Give an advantage and a disadvantage of using hydrogen fuel cells on a space craft. (2)

One advantage – no pollution/ water can be drunk by astronauts [1]
One disadvantage – hydrogen fuel takes a lot of space/explosive [1]