1  (a) (i) water molecules hit copper/tank/atoms or copper atoms hit air molecules or radiation from water/tank/copper or describe/mention evaporation
   vibrating (copper) atoms/molecules/particles hit neighbours pass on energy/vibration or vibrating (copper) atoms/molecules/particles hit electrons (through copper)
   electrons strike copper atoms

   (ii) smaller temperature difference/thermal gradient (between tank and air) or reduced vibrations of copper atoms or water molecules slower/less kinetic energy or reduced radiation (emitted) or less evaporation

(b) diagram of suitable vessel(s) (one shiny; one dark)
   action – e.g. fill with hot water and same mass/volume
   starting temperatures are the same
   measure final temperature and compare drop or equivalent
   allow detailed description of Lesley’s cube method and measure emission rate (for a maximum of 4 marks) [8]

2  (a) matt black

(b) (i) L down and R up, equal amounts (by eye)

   (ii) on black side or on left (more) energy / heat absorbed OR greater temp rise OR heats up quicker

   on black side or on left greater expansion of air / greater pressure of air
3 (a) (i) good conductor (of heat) (ignore electricity) B1
(ii) black is good absorber/bad reflector (ignore emitter) B1
(iii) reduce heat lost/conducted away (from pipes/sheet) NOT prevents heat loss o.w.t.t.e. B1
(iv) air heated OR glass reduces/prevents convection OR greenhouse effect OR reference to far and near I.R. OR glass prevents warm air being blown away OR traps air Ignore traps heat B1

(b) 38 – 16 OR 22 C1
   mcθ OR 250 × 4200 × his 22 C1
   2.31 × 10^7 (J) e.c.f from previous line C1
   9.24 × 10^7 J OR e.c.f from previous line × 4 correctly evaluated A1
   No unit penalty if J seen anywhere in (b) clearly applied to an energy

[Total: 8]

4 (a) (i) heat for the same time B1
   take temps on both thermometers B1 [2]
(ii) dull black box temp > white box temp OR black is hotter etc. B1 [1]

(b) (i) large expansion/change in reading for small change in temp NOT detect/respond to small temp changes B1 [1]
(ii) temperature rise small and/or small difference between them B1 [1]
(iii) distance between each degree on scale is the same B1 [1]

[Total: 6]
5  (a) take readings of the detectors
    fill box with water
    take readings (again)

    (b) dull black best AND shiny white worst

    (c) two different metals
        two junctions (could be at meter) hot and cold need not be indicated
        any cell, max B1,B0

    [Total: 6]

6  (a) (i) conduction
    (ii) particles/atoms/ions vibrate or electrons move and carry energy
        pass on energy from one particle to the next

    (b) four surfaces facing one heat source
        suitable detector e.g. thermometer behind surface-read all 4
        precaution e.g. equal distance/time
        (Can not score last two marks if experiment is totally wrong)

    [Total: 6]

7  (a) (i) Thermopile / thermocouple / (blackened) thermometer / infra red detector or use ammeter / voltmeter in supply circuit
    (ii) One of: same distance of plate to detector or use two identical detectors or same time (after switching on)
    (iii) Dull black better radiator / radiates more than silver / or emits more heat / radiation
    (iv) Infra red (i.r.)

    (b) any correct example e.g. heating water or chimney
        current clear and complete
        direction shown correctly by arrows

    [Total: 7]