1. (a) isothermal: takes place at constant temperature;
adiabatic: no energy exchange between gas and surroundings; 2

(b) (i) neither; 1

(ii) $\Delta W = P\Delta V = 1.2 \times 10^5 \times 0.05 = 6.0 \times 10^3$ J; 1

(iii) recognize to use $\Delta Q = \Delta U + \Delta W$;
to give $\Delta U = 2.0 \times 10^3$ J; 2

[6]

2. (a) ***[1]*** *for each appropriate and valid point e.g.*
thermal energy is the K.E. of the component particles of an object;
thus measured in joules;
the temperature of an object is a measure how hot something is (it can be used to work out the direction of the natural flow of thermal energy between two objects in thermal contact) / measure of the average K.E. of molecules;
it is measured on a defined scale (Celsius, Kelvin *etc.*); 4 max

(b) (i) correct substitution: energy = power time;
$= 1200 \text{ W} \times (30 \times 60) \text{ s}$;
$= 2.2 \times 10^6$ J 2 max

(ii) use of $E = m\, c\, \Delta\theta$;
to get $\Delta\theta = 2.2 \times 10^6 / (4200 \times 70)$ K;
$= 7.5$ K; 3 max

(c) ***[1]*** *naming each process up to* ***[3 max]***.
convection;
conduction;
radiation;

[1] *for an appropriate (matching) piece of information / outline for each process up to* ***[3 max]***.

e.g. convection is the transfer of thermal energy via bulk movement of a gas due to a change of density;
conduction is transfer of thermal energy via intermolecular collisions;
radiation is the transfer of thermal energy via electromagnetic waves (IR part of the electromagnetic spectrum in this situation) / *OWTTE*; 6 max

(d) (i) energy lost by evaporation = 50 % $\times 2.2 \times 10^6$ J;
$= 1.1 \times 10^6$ J;
correct substitution into $E = m\, l$
to give mass lost $= 1.1 \times 10^6 \text{ J} / 2.26 \times 10^6 \text{ J kg}^{-1}$
$= 0.487$ kg
$= 487$ g; 3 max

(ii) ***[1 max]*** *for any valid and relevant factor e.g.*
area of skin exposed;
presence or absence of wind;
temperature of air;
humidity of air *etc.*;

[1 max] *for an appropriate and matching explanation e.g.*
increased area means greater total evaporation rate;
presence of wind means greater total evaporation rate;
evaporation rate depends on temperature difference;
increased humidity decreases total evaporation rate *etc.*; 2 max

[20]

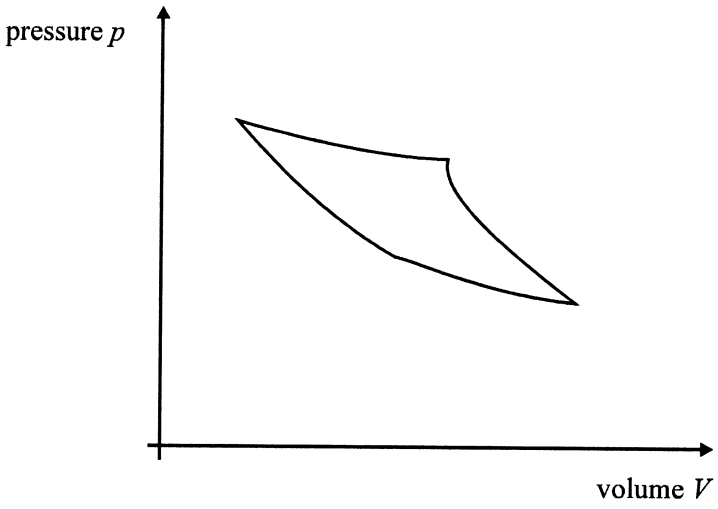
3. (a) statement (implication) that work done is associated with area within the rectangle;
Do not award mark for just "area" without reference.

calculation of $2 \times 10^5 \times 8 = 1.6 \times 10^6$ J; 2 max

(b) thermal energy from hot reservoir = $1.8 \times 10^6 + 1.6 \times 10^6$ J
$= 3.4 \times 10^6$ J;

efficiency = work done / thermal energy from hot reservoir
$= 1.6 \times 10^6 / 3.4 \times 10^6$
= 47 %; 2 max
[0] *for* $1.6 \times 10^6 / 1.8 \times 10^6 = 89$ %.

(c) closed cycle of rough approximate shape;
quality of diagram (adiabatic "steeper" than isothermal *etc.*); 2 max



(d) (i) adiabatic (expansion and contraction);
isothermal (expansion and contraction); 2 max

(ii) correct "sense" of adiabatic followed by and isothermal *etc.*;
e.g. adiabatic (expansion) then
isothermal (contraction) then
adiabatic (contraction) then
isothermal (expansion) then
correct identification of adiabatic as the steeper curve when compared with isothermal; 2 max

[10]