Assess Quizzes from the o-book – Explanations for the answers.

Chapter 3 Review – Support

Q	Reason
1	Radiation is strongly *reflected* from a silver surface. For the temperature option: 30°C = (30 + 273)K = 303K. It is true that heat energy will flow from 350 K to 303 K. As a matter of interest, the reflectivity of silver is about 58% whereas the reflectivity of black is 2.6%. Pure white is even higher at 91%.
2	By definition. See page 114.
3	Must increase as 'energy in' is greater than 'energy out'. See page 121.
4	Radiation – by definition. See page 114.
5	Convection needs a fluid medium. A fluid is a substance a substance that has no fixed shape and yields easily to external pressure; a gas or (especially) a liquid. I try to trap students with this question by saying 'sand must be a fluid as it flows through a hole'.
6	See definition page 125. Needs a high temperature source and a low temperature sink.
7	$\eta = \frac{W_{out}}{Q_H} \times 100$ (H is for the hot reservoir) $40 = \frac{80}{Q_H} \times 100$ $Q_H = \frac{80}{40} \times 100 = 200\,J\ (input)$ *Note*: $W = W_{in} - W_{out}\ (W\ is\ used\ for\ W_{net})$ $= 0 - 80$ (for a heat engine there is no work input) $W = -80J$ (negative means output) $W = -Q_{net}$ (there is no temperature change ($\Delta U = 0$) for a heat engine) $Q_{net} = -W$ $= -(-80) = +80$ $Q_{net} = Q_H - Q_C$ $+80 = +200 - Q_C$ $Q_C = 200 - 80$ $= 120J\ (waste)$ Alternatively, if 200 J comes in and 80 J comes out as work, then 120 J must be wasted.

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8	The outputs of the system are 30 J of useful work (W_{out}) and 10 J of water heat (Q_{out}). Together they make up 40 J of thermal energy (but only 30 J is useful as the other 10 goes to waste).
9	$\Delta U = Q + W$ $0 = (Q_{in} - Q_{out}) + (W_{in} - W_{out})$ $0 = (Q_{in} - 10) + (6 - 30)$ $0 = Q_{in} - 34$ $Q_{in} = 34\,J$
10	It is stated that there is no change in internal energy, so there is no temperature change. Note also that for a heat engine, the change of internal energy at the end of a cycle is zero. That is $\Delta U = 0$.

Chapter 3 Review – Consolidate

Q	Reason
1	The better conductor will conduct heat faster if everything else is the same. It is tempting to say the specific heat capacity of Rod A must also be less as the same amount of heat to both metals makes Rod A rise in temperature faster. However, that may be true but the higher temperature at the hot end may not cause heat to pass along the rod very quickly. There is absolutely no relationship between specific heat capacity and thermal conductivity, not even an inverse one.
2	$Q_{in} = 200J$ $W_{out} = 125\,J$ $\eta = \frac{W_{out}}{Q_{in}} \times 100$ $= \frac{125}{200} \times 100$ $= 62.5\%$
3	$\Delta U = Q + W$ $U_f - U_i = Q + W$ $45 - 9 = Q + 6$ $Q = 30\,J$
4	When work is done ON the system, W is positive, so W = + 10 J (but this is irrelevant). $\Delta U = U_f - U_i$ $24 = 35 - U_i$ $U_i = 35 - 24 = 11J$

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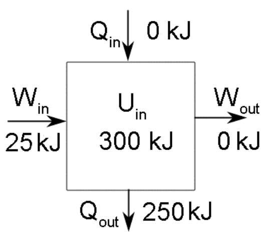
5	This should not have said 'heat engine' as that implies ΔU = 0 J. It is just an energy system such as the paddlewheel where there is work done and the temperature (and hence, internal energy) rises. $\Delta U = Q + W$ $25 = 14 + (W_{in} - W_{out})$ $25 = 14 + W_{in} - 30$ $W_{in} = 25 + 30 - 14 = 41 J$

Chapter 3 Review – Extend

Q	Reason
1	First law states that during an interaction between a system and its surroundings, the amount of energy gained by the system must be exactly equal to the amount of energy lost be the surroundings. First law states that during an interaction between a system and its surroundings, the amount of energy gained by the system: * this is the change in internal energy (ΔU); must be exactly equal to the amount of energy lost be the surroundings: * this is the sum of the: • thermal energy lost to the surroundings: $Q = Q_{in} - Q_{out} = 60 - 20 = +40$ J and • work done on the system: $W = W_{in} - W_{out} = 10 - 25 = -15$J That is: ΔU = Q + W . Note: the other options are incorrect for these reasons: * $U_f - U_i = \Delta U$ is correct in itself but is not a statement of the 1st Law * $Q_{net} = Q_{in} - Q_{out}$ is correct in itself but is not a statement of the 1st Law * $W_{net} = W_{in} - W_{out}$ is correct in itself but is not a statement of the 1st Law
2	 $U_i = 300 kJ$ $Q_{in} = 0 kJ$ (assume this for the purpose of the question) $Q_{out} = 250 kJ$ $W = +25 kJ$ (work done ON the system, thus positive) $\Delta U = Q + W$ $= (Q_{in} - Q_{out}) + W$ $= (0 - 250) + 25$ $= -225 kJ$

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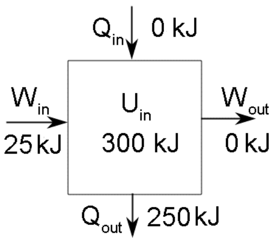

$$U_i = 300\,kJ$$
$$Q_{in} = 0\,kJ \text{(assume this for the purpose of the question)}$$
$$Q_{out} = 250\,kJ$$
$$Q = Q_{in} - Q_{out} = 0 - 250 = -250\,kJ$$
$$W = +25\,kJ \text{(work done ON the system, thus positive)}$$
$$\Delta U = Q + W$$
$$U_f - U_i = Q + W$$
$$U_f - 300 = -250 + 25$$
$$= -250 + 25 + 300\,kJ$$
$$= +75\,kJ$$
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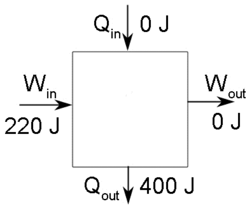

There is a net transfer of heat OUT of the system so by using $Q = Q_{in} – Q_{out}$, Q_{out} must be 400 kJ bigger than Q_{in} so Q is negative, and in fact Q = -400 kJ.

$$W = +220kJ \text{ (work done ON the system so W is positive)}$$
$$Q = -400J \text{(net heat loss)}$$
$$\Delta U = Q + W$$
$$= -400 + 220$$
$$= -180\,kJ$$
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<tr><td>5</td><td>
Energy input = Q_H = 175J

For a heat engine we assume the energy output W is given by:

$$W = -Q_{net}$$
$$= -(Q_{hot} - Q_{cold})$$
$$= -(175 - 100)$$
$$= -75J$$

Note that this value is negative, so work is done BY the system or, that is, heat is given out.
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	$\eta = \frac{\text{energy output}}{\text{energy input}} \times 100\%$ $= \frac{W_{out}}{Q_{in}} \times 100\%$ $= \frac{75}{175} \times 100\%$ [ignore the negative] $= 43\%$ See NCPQ U1&2 page 128.