Assessment Schedule – 2021

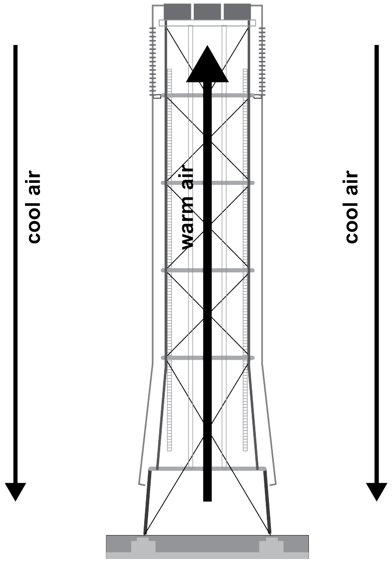
Physics: Demonstrate understanding of aspects of heat (90939)

Evidence

Q	Evidence	Achievement	Merit	Excellence
ONE (a)	Conduction, convection, radiation.	• States all three correctly.		
(b)	The reflective surfaces will bounce back some of the incoming (solar) radiation. That means that less energy is absorbed by the roof and less energy passes through the windows, resulting in a lesser warming up of the inside of the building.	• Identifies relevant heat transfer mechanism as 'radiation'. OR States / implies that the reflective surfaces bounce back incoming solar radiation.	• Links the reflective surfaces bouncing back incoming solar radiation to less energy transferred into the building and / or a lesser warming up of the inside of it.	
(c)	The energy required to increase the air temperature in the office room by $\Delta T = 25 - 20.5 = 4.5$ °C is: $Q = mc\Delta T = 85.8 \times 1006 \times 4.5 = 388\,417$ J. The time this takes is $t = \frac{Q}{P} = \frac{388417}{422} = 920.4$ s	• Calculates 388,417 J correctly. OR Calculates the time correctly from t = Q / P, but with incorrect value for Q.	Calculates 920 s correctly.	

(d)	The mechanism of heat transfer through the terracotta tiles is conduction. In terms of kinetic theory, the particles of the warmer outside of a tile vibrate and / or move about randomly at a faster average speed compared with those of the cooler inside of the tile. The energy associated with that motion is transferred through the tile when faster-moving particles bounce into their slower-moving neighbours, causing them to vibrate and / or move faster too. That way, their temperature increases. This is called conduction. The particles in air-filled space are trapped and hence convection currents cannot be set up easily. This trapped air reduces heat gained via conduction and convection. That way, the air-filled porous structure prevents heat from entering the building, helping to keep the inside cool.	• Identifies relevant heat-transfer mechanism as 'conduction'. OR Describes the particles of warmer materials as vibrating / moving at a faster average speed (and / or the particles of cooler materials as vibrating / moving at a slower average speed). OR States / implies that the underlying mechanism of conduction. OR Describes the trapped air particles stops convection currents from forming. OR Describes the trapped air particles reduce heat transfer due to conduction.	• Links warmer, faster-vibrating / -moving particles bouncing into cooler, slower-vibrating / -moving particles to transfer of energy through the tile. OR Links that air is an insulator to the reduction of convection currents that reduces heat transfer / reduces conduction that reduces heat transfer.	• Complete answer. • Links warmer, faster-vibrating / -moving particles bouncing into cooler, slower-vibrating / -moving particles to transfer of energy through the tile. AND Links that air is an insulator to the reduction of convection currents that reduces heat transfer / reduces conduction that reduces heat transfer.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No evidence.	1A	2A OR 1M/E	3A OR 1A + 1M	4A OR 2A + 1M OR 2M OR 1A + 1E	1A + 2M OR 1M + 1E	2A + 2M OR 3M	1A + 1M + 1E	2M + 1E

Q	Evidence	Achievement	Merit	Excellence
TWO (a)		• Draws arrow down, and arrow up labelled 'warm air' (or similar). Accept warm air rising up inside or outside of the tower, and cold air sinking down correspondingly (outside or inside).		
(b)	The higher temperature of warm air means that the particles move faster and at a larger average distance from each other. As there are, therefore, less particles per unit volume than compared to cool air, the density of warm air is lower. Hence, warm air will rise in cool air.	• The (average) distance between particles in warm air is greater. OR States / implies that the density of warm air is lower. OR States / implies that fluids of lower density rise in fluids of higher density. DO NOT ACCEPT 'HEAT RISES'.	• Links the larger average distance between particles in warm air to its lower density. AND Links the lower density of warm air to its rising up.	

(c)	The specific heat capacity of humid air is much greater than that of dry air: 1884 vs. 1006 J kg^{-1} $°C^{-1}$. This means that a much larger amount of energy (1884 J) is needed to heat up 1 kg of humid air by 1 °C, compared to only 1006 J for dry air. For the cooling jets, more energy is transferred to the humid air per degree change, so the temperature of the warm air decreases more, helping to keep the temperature at ground level cooler. Therefore, for a given amount of heat energy, humid air will warm up by much less than dry air, helping to keep the temperature at ground level down.	• Defines specific heat capacity as the amount of energy (per unit mass) needed to increase the temperature by 1 °C. OR States / implies that a larger amount of energy is required to warm up humid air compared with dry air. OR States / implies that the moist air takes more energy out of the air cooling down the air at ground level.	• Complete answer. States / implies that a larger amount of energy is required to warm up humid air compared with dry air. AND States / implies that the moist air takes more energy out of the air cooling down the air at ground level.	
(d)	'Thermal expansion' means the increase in length or size of objects that are being heated. The object's particles are constantly vibrating about their average position. When the object is heated, the supplied energy makes the particles vibrate more, implying that individual particles push their neighbours away by a bit more. Therefore, the space or distance between the object's particles grows larger as more energy is supplied, and the whole object increases in size accordingly. Expansion joints, as shown in the picture, allow warm parts of the structure to push into the empty space of the joints as they expand, as opposed to having to push into each other. DO NOT ACCEPT PARTICLES EXPAND.	• Defines / describes 'thermal expansion' as increasing of length or size when heated. OR Describes an object's particles as vibrating more strongly when it is heated. OR States / implies that the space or distance between the object's particles grows larger when it is heated. OR Describes the function of the empty spaces in the expansion joints as allowing the structural parts to expand.	• Links increase of length or size of a heated object to the object's particles vibrating more strongly. OR Links increase of length or size of a heated object to the space or distance between the object's particles increasing. OR Describes the function of the empty spaces in the expansion joints as preventing the structural parts from having to push into each other when they expand when heated.	• Links increase of length or size of a heated object to the object's particles vibrating more strongly AND to the space or distance between the object's particles increasing. AND Describes the function of the empty spaces in the expansion joints as preventing the structural parts from having to push into each other when they expand when heated.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No evidence.	1A	2A OR 1M/E	3A OR 1A + 1M	4A OR 2A + 1M OR 2M OR 1A + 1E	1A + 2M OR 1M + 1E	2A + 2M OR 3M	1A + 1M + 1E	2M + 1E

Q	Evidence	Achievement	Merit	Excellence
THREE (a)	‘Melting’ at B and ‘Evaporating’ at D.	• States BOTH changes of phase in the correct places. Accept ‘Freezing’ and ‘Condensing’ etc.		
(b)	At the boiling point of 100 °C, the energy supplied to the liquid water is used to break up the attractive forces between the particles and is therefore not available to increase their average speed. Since the average speed of the particles determines the temperature, the temperature of the boiling water does not increase above 100 °C.	• States / implies that the energy supplied is used to break up attractive forces between particles. OR States / implies that the particles’ average speed determines the temperature of the water.	• States / implies that the energy supplied is not available to increase the particles’ average speed because it is used to break up attractive forces between particles. AND Explains that not increasing the particles’ average speed means that the temperature does not increase further / above 100 °C.	
(c)	The energy supplied to salt water = Q = 0.65 × 3 800 × 2 400 = 5 928 000 J. Therefore, the amount of salt water evaporated = $m = \frac{Q}{L} = \frac{5928000}{2300000} = 2.577 \text{ kg}$	• Calculates 5 928 000 J of energy correctly with work clearly shown. OR Calculates 2.577 kg of water correctly with no relevant evidence of calculation of energy supplied. OR Calculates amount of water with incorrect efficiency (e.g. 3.965 kg for 100% efficiency, 1.388 kg for 35% …).	• Calculates 5 928 000 J of energy correctly with work clearly shown. AND Calculates 2.577 kg of water correctly.	

(d)	When steam is cooled to the condensation temperature (of 100 °C), the forces between the H_2O particles take effect and attract them closer together. The energy of the particles is thereby decreased and lost to the environment as heat. This is the latent heat of condensation. If some of the latent heat of condensation can be used to heat up the incoming water, a lesser ΔT (= 100 °C – initial T.) is required to evaporate it. From $Q = mc\Delta T$, for a given *m* and with *c* being constant, a lesser amount of solar energy, *Q*, is required to achieve a lesser ΔT up to the boiling point of 100 °C.	• Describes cooling and / or condensation in terms of particles coming much closer together. OR Describes the forces between particles in the liquid as attractive. OR Defines latent heat of condensation as heat energy lost to the environment upon condensation of steam to water. OR States / implies that less energy is required to bring (a given amount of) warmer water up to 100 °C.	• Links the decrease of the energy of the particles to the forces between them taking effect. OR Links the decrease of the energy of the particles to energy lost to the environment as heat and / or to latent heat of condensation. OR Explains that the heat capacity of water is constant so that less solar energy, *Q*, is required to achieve a lesser temperature increase, ΔT, up to the boiling point.	• Complete answer.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No evidence.	1A	2A OR 1M/E	3A OR 1A + 1M	4A OR 2A + 1M OR 2M OR 1A + 1E	1A + 2M OR 1M + 1E	2A + 2M OR 3M	1A + 1M + 1E	2M + 1E

Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 6	7 – 12	13 – 18	19 – 24