Assessment Schedule – 2020

Physics: Demonstrate understanding of aspects of heat (90939)

Evidence

Q	Evidence	Achievement	Merit	Excellence
ONE (a)	Radiation.	• Stated correctly.		
(b)	In sections B and D of the graph, the water is undergoing a phase change. During this phase change, heat is being added and being used up to break bonds instead of increasing the temperature of the water.	States that, at B and D, the water is undergoing a phase change/change of state. OR Indicates heat / energy is being used to break bonds.	• Complete answer.	
(c)	$E = Pt = 750 \times 60 = 45\,000 \text{ J}$ for every square metre of paddock in one minute. This amount of energy is sufficient to melt up to 0.14 (2 s.f.) of ice: $E = Q = mL \rightarrow m = \frac{45\,000}{330\,000} = 0.136 \text{ kg}$	• Amount of energy calculated correctly. OR Amount of ice melted calculated correctly from incorrect energy (1 min vs. 60 s, etc.). OR Amount of ice melted calculated with correct reasoning, but minor computational errors.	• Amount of ice melted calculated correctly.	

(d)	• 'Latent heat' is the energy required to fully change one phase into another without changing the temperature of either. • In ice and liquid water, particles are densely packed between each other. These are somewhat less densely packed in the liquid, allowing particles to slide past each other. In contrast, with steam, particles are extremely far apart and move independently from each other. • To achieve a phase change, particles have to be re-arranged. Overcoming the forces between them requires energy. • The latent heat of vaporisation of water is large because the particles in the liquid phase have to be fully separated from each other, requiring large amounts of energy. The latent heat of melting of ice is smaller because both phases (ice and water) are densely packed requiring a lesser amount of energy.	• Arrangement (densely packed vs. fully separated) of particles. OR • Definition of 'latent heat' as energy required to achieve phase change given. OR • Stated or implied that phase changes involve overcoming forces/ breaking bonds between particles. OR • Stated or implied that overcoming forces between particles requires energy.	TWO correct ideas, linked, • Latent heat defined. • Arrangement of all 3 states (densely packed vs. fully separated). • Latent heat linked to energy required to re-arrange particles, to overcome attractive forces/break bonds between particles when phase changes occur.	Full linked answer: THREE correct ideas, linked, • Latent heat defined. • Arrangement of all 3 states (densely packed vs. fully separated). • Latent heat linked to energy required to re-arrange particles, to overcome attractive forces between particles when phase changes occur. • Latent heat of evaporation linked to fully separating particles in liquid water, and latent heat of melting to only partly separating particles in solid ice (or equivalent: fully overcoming and partly overcoming forces).

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No evidence.	1A	2A OR 1M	3A OR 1A + 1M OR 1E	4 A 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)	Average kinetic energy **decreases**. Average speed of water particles **decreases**.	• Both changes stated correctly.		
(b)	Double glazing would minimise heat loss due to conduction. The particles of the inner, warmer side of the windowpane vibrate about their average positions more strongly and set neighbouring particles farther out in motion. This way, their temperature increases and heat energy moves through the windowpane, out of Martha's house. The vacuum between the two sheets is an empty space, hence no heat energy can be transferred across it by vibrating particles setting other particles in motion.	• Double glazing would minimise heat loss due to **conduction**. OR • Increase of temperature and / or thermal energy described in terms of vibrating particles – vibrate more / vibrate faster OR Transfer of temperature and / or heat through the solid described in terms of vibrating particles. OR Absence of vibrating particles stated or implied as reason for the inability of the vacuum to conduct heat.	• Increase of temperature and / or thermal energy described in terms of vibrating particles - vibrate more / vibrate faster LINKED TO Transfer of temperature and / or heat through the solid described in terms of vibrating particles. OR • Double glazing would minimise heat loss due to **conduction**. LINKED TO Absence of vibrating particles stated or implied as reason for the inability of the vacuum to conduct heat.	• Increase of temperature and / or thermal energy described in terms of vibrating particles. LINKED TO Transfer of temperature and / or heat through the solid described in terms of vibrating particles. AND Absence of vibrating particles stated or implied as reason for the inability of the vacuum to conduct heat.
(c)	The heat energy provided by the two heaters over 45 minutes is: $(2\times1000)\times(45\times60)=5\,400\,000\text{ J}$ The temperature rise achieved by this heat energy is: $\Delta T=\frac{Q}{mc}=\frac{5\,400\,000}{172\times1800}=17.4\ ^\circ\text{C}$	• Amount of energy calculated correctly. OR Temperature rise calculated correctly from incorrect energy (one vs. two heaters, 45 min vs. 2700 s, etc.).	• Temperature rise calculated correctly.	

(d)(i) (ii)	Calculate energy lost = total energy – energy used $Q = mc\Delta T$ $Q = 172 \times 1800 \times 12$ $Q = 3\,715\,200$ J $\rightarrow$ Energy used to raise temperature Total energy $E = P \times t$ $= 2 \times 1000 \times 45 \times 60$ $= 5\,400\,000$ J $Q_{LOSS} = Q_{TOTAL} - Q_{USED}$ $= 5\,400\,000 - 3\,715\,200$ J $= 1684800$ J Possible reasons for heat loss (only needs one): • Conduction through walls, ceiling, floor, windows, Al frames. • Convection through gaps in door and windows. • Radiation through walls and surfaces including windows.	• Correctly calculates energy used to raise temperature. OR Attempts to calculate Q_{LOSS}. OR States possible reason for energy loss.	• Correctly calculates energy loss. OR Correctly explains possible reasons for heat loss.	• Both (i) and (ii). Complete answer.

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Q	Evidence	Achievement	Merit	Excellence
THREE (a)	When the liquid warms up, its particles begin to move faster and the average distance between them increases accordingly. Therefore, the space taken up by the liquid increases; this is called 'thermal expansion'. The liquid can only expand up the tube, hence it rises up in the thermometer. *DO NOT ACCEPT 'heat rises', 'particles expand' etc.*	• 'Thermal expansion' stated. OR Distance between particles increasing with temperature stated or implied. OR Volume of liquid increasing with temperature stated or implied. *DO NOT ACCEPT 'heat rises' etc.*	• Distance between particles increasing with temperature linked to increase in volume of liquid, linked to liquid rising up the tube.	
(b)	'Convection' is the transfer of heat energy by a moving warm fluids or gases and liquids.	• Idea that heat energy is carried from one place to another by a moving warm liquid or gas stated or implied.		
(c)	Compared to warm air, in cold air the particles have lesser energy and are on average closer to each other. Therefore, a given number of particles taking up a smaller volume have a greater mass per volume and thus sinks.	• Particles in cold air stated or implied to be closer together. OR Cold air stated or implied to occupy a smaller volume, more dense. OR Cold air sinks.	• Particles in cold air stated or implied to be **closer together**. AND Cold air stated or implied to occupy a smaller volume / more dense. Linked to cold air sinks / stays near the ground.	

(d)	Warm air has a lesser density than cold air. Therefore, when there is no wind, warm air rises up while the denser cold air sinks to the ground. These convection currents draw heat energy away from the ground, thereby cooling it. The SIS effectively reverses the convection currents by pushing air from ground level vertically up into the atmosphere: cold air is drawn away from the ground and continually replaced by warm air from higher up. By drawing warm air down to the ground, heat energy is transferred to the ground, helping to prevent frost and to protect the crops. *Accept diagrammatic evidence for either convection current (SIS not running or running).*	• Cold air described as sinking down OR warm air as rising up, cooling the ground when SIS is not running. OR Either one convection current (SIS not running or running) described. OR Convection identified as relevant mechanism of heat transfer. OR Warm air stated or implied to replace cold air at ground level.	• When SIS is not running convection currents of cold, denser air sinking to the ground and warm, less dense air rising up described. AND Convection currents linked to ground level cooling down when SIS is not running. OR When SIS is running, cold air described as being pushed up and replaced by warm air drawn down. OR Movement of warm air drawn down linked to heat energy transferred down to ground level, warming the vineyard at ground level.	• When SIS is not running convection currents of cold, denser air sinking to the ground and warm, less dense air rising up described. AND Convection currents linked to ground level cooling down when SIS is not running. AND Cold air described as being pushed up and replaced by warm air drawn down when SIS is running. AND Movement of warm air drawn down linked to heat energy transferred down to ground level, warming the vineyard at ground level.

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Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 6	7 – 13	14 – 18	19 – 24