Pilot Assessment Schedule – 2023

Physics, Earth and Space Science: Demonstrate understanding of energy in a physical system (92047)

Assessment criteria

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of energy in a physical system involves: • describing energy concepts involved in a physical system, using supporting evidence • describing change to a physical system and energy concepts involved, using supporting evidence.	Explain energy in a physical system involves: • linking energy concepts involved in the change to the physical system, using supporting evidence.	Analyse energy in a physical system involves: • discussing the implications for energy concepts of the change to the physical system, using supporting evidence.

Evidence

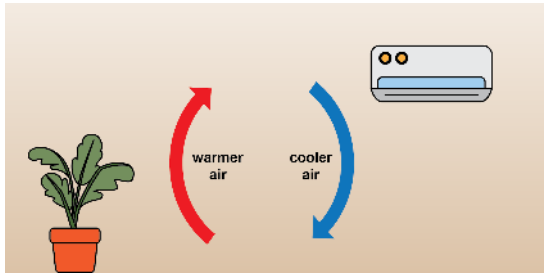
Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
ONE (a)	GPE → KE + heat.	Correct types of energy stated. Accept 'thermal energy' instead of 'heat'.		
(b)	Loss of GPE from highest point to ground level = $\Delta E_p = mg\Delta h = 0.150 \times 10 \times 3.4 = 5.1$ J Kinetic energy at ground level $= E_k = ½mv^2 = 0.5 \times 0.150 \times 7.8^2 = 4.563$ J Therefore, mechanical energy lost to environment $= 5.1 - 4.563 = 0.537$ J, which is equal to the work done by friction. Hence $F = \frac{W}{d} = \frac{0.537}{3.4} = 0.158$ N	Either $\Delta E_p = 5.1$ J or $E_k = 4.563$ J calculated correctly.	Size of friction between ball and air calculated with one major error in calculation. OR $\Delta E_p = 5.1$ J and $E_k = 4.563$ J calculated correctly AND difference shown to be 0.537 J.	Size of friction between ball and air calculated as $F = 0.158$ N with working shown.
(c)	Energy converted into thermal energy of the ball = 80% of 0.537 J = $0.80 \times 0.537 = 0.4296$ J. Hence the temperature increase of the ball $= \Delta T = \frac{E\,(\text{thermal})}{mc} = \frac{0.4296}{0.150 \times 8200} = 3.50 \times 10^{-4}$ °C	E(thermal) = 0.4296 J calculated correctly. OR Temperature increase of the ball calculated with one major error in calculation.	Temperature increase of the ball calculated as: $\Delta T = 3.50 \times 10^{-4}$ °C	

(d)(i)	No horizontal displacement, or change of speed, or vertical displacement of the backpack occur, so **no changes of KE and GPE** occur. With no change in energy, no work is done on the backpack.	Analysed one scenario correctly: EITHER changes in KE and/or GPE identified. OR Force and / or displacement linked to work done: (i) $F_{net} = d = 0$ (ii) $F_{net} = 0$ (iii) Down force on backpack vs. vertical displacement.	Analysed two scenarios.	Analysed all three scenarios.
(ii)	No change of speed and height of the backpack occur, so no **changes of KE and GPE** occur. With no change in energy, no work is done on the backpack.			
(iii)	The height of the backpack above the ground changes as Jamie climbs the stairs, so an increase of GPE occurs since a force is applied along the vertical distance covered: $W = Fd$. Therefore, work is done on the backpack.			

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

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
TWO (a)	$R = \frac{V}{I} = \frac{4.5}{0.5} = 9.0\ \Omega$	R = 9.0 Ω calculated correctly.		
(b)	The lamps are **connected in parallel**. Therefore, each branch receives the full 4.5 V. Each lamp is rated 4.5 V, so **each lamp receives its nominal voltage** and glows with full brightness.	Parallel connection identified. OR Stated / implied that both lamps receive the same (nominal) voltage.	Parallel connection. AND Explained that both lamps glow with full brightness because both receive the same (nominal) voltage.	
(c)	The power rating of a single lamp = $P = VI = 4.5 \times 0.5 = 2.25$ W. Total power output by two lamps = $2 \times 2.25 = 4.5$ W. Therefore, the amount of electric energy used by both lamps in two hours = $\Delta E = P\Delta t = 4.5 \times (2 \times 60 \times 60) = 32\ 400$ J.	P = 2.25 W calculated correctly.	P = 4.5 W for both lamps calculated correctly. OR Amount of electrical energy used by two lamps in two hours calculated with one major error in calculation. OR 16 200 J calculated as amount of electrical energy used by two lamps in two hours.	Amount of electrical energy used by two lamps in two hours calculated as ΔE = 32 400 J with working shown. OR 16 200 J calculated as amount of electrical energy used by each lamp in two hours.
(d)	When a current passes through the wire, **electrical potential energy changes into heat and light**. The high melting point of tungsten prevents the filament from melting, **keeping the circuit closed**. The filament's large resistance means that **a large amount of electric energy is changed into heat and light** per unit charge passing through it. The filament's small heat capacity means **a large temperature increase** for a given amount of electric potential energy changed into heat, and hence a larger brightness.	Described energy change correctly. OR Stated and reasoned either one point correctly.	Described energy change correctly AND stated and reasoned either one point with clear links. OR Stated and reasoned at least two points with clear links.	Described energy change correctly AND Stated and reasoned at least two points with clear links. OR Stated and reasoned three points with clear links.

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

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
THREE (a)		Arrow in down direction drawn and labelled ‘cooler air’. AND Arrow in up direction drawn and labelled ‘warmer air’.		
(b)	In cooler air, particles **move slower and with lesser energy**. Therefore, particles move at slightly **lesser average distances from each other**, implying that they occupy a slightly lesser volume of space.	Either one point stated / implied: slower speed or lesser energy, or lesser average distances from each other.	Both points clearly stated and linked.	
(c)	From the graph, $\Delta T = 4$ °C and $\Delta t = 2$ min = 120 s. Thermal energy removed from air in the room $= \Delta E(\text{thermal}) = mc\Delta T = 41.4 \times 718 \times 4$ = 118 901 J ≈ 119 kJ. Therefore, power $= P = \frac{\Delta E}{\Delta t} = \frac{118\,901}{120} = 990.84 \text{ W} \approx 991 \text{ W}$	E(thermal) calculated with minor computational errors, e.g. using an incorrect temperature drop, ΔT.	E(thermal) ≈ 119 kJ calculated correctly. OR Power calculated correctly from incorrect thermal energy. OR Power calculated with incorrect unit conversions and/or minor computational errors from otherwise correct thermal energy.	$P \approx 991$ W calculated correctly.

(d)	Particles in a warmer material **move or vibrate faster, with higher energies**. Particles that move or vibrate at higher energies **increase thermal motion of neighbouring particles** by means of collisions, effectively transporting thermal energy (as thermal motion of particles) through a material or from one in contact with another. Because **particles in air are much more spaced out than in glass, conduction through air is much less effective than through glass**. This makes the layer of air between the curtains and the window a thermal insulator, reducing heat transfer by conduction through the window.	Either one point stated / implied: Conduction described in terms of particles bouncing into each other. OR Air (gas) particles described as much more spaced out than glass (solid) particles. OR Layer of air explicitly described as thermal insulator.	Two points stated / implied.	All three points stated / implied and linked.

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

Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 7	8 – 13	14 – 19	20 – 24