Level 1 Physics, Earth and Space Science: practice paper 2026

AS 92047 Demonstrate understanding of a physical system using energy concepts · Vertex Academy practice paper, not an NZQA paper

Attempt ALL the questions. Show ALL working. Write your answers on lined paper, or in the space under each question.

QUESTION ONE

(a) A luge track runs down a hill in Rotorua. A rider sits in a luge cart at the top of the track. The cart starts from rest and rolls all the way down the track to the bottom, with no motor.
(i) Describe the energy changes as the cart rolls from the top of the track to the bottom.
(ii) State the law of conservation of energy.

(b) A luge track runs down a hill in Rotorua. The top of the track is 25 m higher than the bottom. A chairlift carries the rider and the luge cart from the bottom back up to the top. The rider and cart have a total mass of 90 kg, and the chairlift takes 75 s to lift them.
Use $g = 10$ N kg^{-1}, $E_p = mgh$ and $P = E \div t$ (from $E = Pt$).
(i) Calculate the gravitational potential energy gained by the rider and cart.
(ii) Calculate the power needed to give them this energy in 75 s.
(iii) The chairlift motor uses much more power than your answer to (ii) for each rider it carries. Explain why.

(c) A luge track runs down a hill in Rotorua. The top of the track is 25 m higher than the bottom and the track is 400 m long. The rider and cart have a total mass of 90 kg. The cart starts from rest at the top and rolls down with no braking. At the bottom its speed is measured as 12.0 m s^{-1}.

Use g = 10 N kg^{-1}, Ep = mgh, Ek = $(\frac{1}{2})mv^2$ and W = Fd.

Discuss the energy of the cart and rider as they roll down the track.

In your answer, you should:

- calculate the greatest speed the cart could have at the bottom, and state the assumption you made
- calculate the kinetic energy the cart actually has at the bottom
- calculate how much energy was transformed into other forms, and the average force resisting the motion over the 400 m track
- explain why the cart does not reach the greatest speed.

(d) At the bottom of a luge track in Rotorua there is a flat run-out where riders brake to a stop. A rider and cart with a total mass of 90 kg arrive at the run-out at 12.0 m s^{-1}. The rider pulls the brake and the cart stops in 8.0 m.

Use $E_k = (\frac{1}{2})mv^2$ and $W = Fd$.

Discuss the energy transfers as the cart brakes, and what this means for a faster rider.

In your answer, you should:

- calculate the average braking force on the cart
- describe where the cart's kinetic energy goes
- calculate the stopping distance for a 90 kg rider and cart arriving at 18.0 m s^{-1} with the same braking force
- explain why the stopping distance increases by more than the speed does, and what this means for the length of the run-out.

QUESTION TWO

(a) A family in Invercargill has two kinds of light bulb in their house: an old filament bulb rated 60 W and an LED bulb rated 8 W. Both give about the same amount of light.

(i) Describe the energy changes in each bulb when it is switched on.

(ii) State what the power rating of 60 W tells you about the filament bulb.

(b) A heater in a house in Invercargill is plugged into the 240 V mains supply. On its high setting it has a power of 2400 W.

Use $P = VI$ and $V = IR$.

Calculate the current in the heater and the resistance of its heating element on the high setting.

Include the correct units.

(c) A family in Invercargill is choosing between a 60 W filament bulb and an 8 W LED bulb for the lounge. Both give out about 5 W of light. The lounge light is on for 5 hours every evening for the 90 days of winter. Electricity costs $0.34 per kWh.

Use E = Pt (with P in kW and t in hours, E is in kWh).

Discuss which bulb the family should choose.

In your answer, you should:

• calculate the energy each bulb uses over the winter, in kWh

• calculate the cost of running each bulb over the winter, and the money saved by the LED

• calculate the efficiency of each bulb

• explain, using energy transformations, why the LED uses less energy for the same light.

(d) A heater in a house in Invercargill runs on the 240 V mains supply. On its high setting the heating element has a resistance of 24 Ω. When the heater is switched to its low setting, the resistance of the element changes to 48 Ω. The voltage stays at 240 V.

Use $V = IR$, $P = VI$ and $E = Pt$.

Discuss how switching from the high setting to the low setting changes the thermal energy released by the heater in 2 hours.

In your answer, you should:

- calculate the current and the power on each setting
- calculate the thermal energy released in 2 hours on each setting
- explain, using the formulae, why doubling the resistance changes the thermal energy in this way.

QUESTION THREE

(a) A student takes ice cubes from a freezer and leaves them in a bowl in a warm kitchen. The ice warms up to 0 °C and then melts. While the ice is melting, its temperature stays at 0 °C.

(i) State what is meant by the specific latent heat of fusion of a substance.

(ii) Describe what happens to the particles of ice as it melts, and why the temperature stays at 0 °C while it melts.

(b) Tama fills an electric jug with 1.5 kg of tap water at 15 °C. The jug has a power of 2200 W. It takes 4 minutes 30 seconds for the water to reach 100 °C.

The specific heat capacity of water is 4200 J kg^{-1} $°C^{-1}$.

Use $E = mc\Delta T$ and $E = Pt$.

(i) Calculate the thermal energy gained by the water.

(ii) Calculate the electrical energy used by the jug.

(iii) Explain why your two answers are different.

(c) A student measures the specific latent heat of fusion of ice. The student puts 0.200 kg of crushed ice at −10.0 °C into a thin plastic cup in a room at 20 °C, puts a 100 W immersion heater in it, switches the heater on and stirs. The table shows the temperature readings.

The accepted value for the specific latent heat of fusion of ice is 334 000 J kg^{-1}.

Use E = Pt and E = mL.

Discuss the student's result.

In your answer, you should:

• use the table to find how long the ice took to melt, and explain how you can tell

• calculate the student's value for the specific latent heat of fusion of ice, with its unit

• compare it with the accepted value, and explain the difference using heat transfer between the cup and the room.

Time (s)	**0**	**20**	**40**	**100**	**200**	**300**	**400**	**500**	**600**	**640**	**700**	**760**
Temperature (°C)	−10.0	−5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5	15.0

(d) A family takes a chilly bin to the beach at Mount Maunganui on a hot day. The chilly bin has thick polystyrene foam walls, a white outside and a lid that seals tightly. Heat leaks into the chilly bin at about 20 W.

They can cool the food with either 2.0 kg of ice packs at 0 °C or 2.0 kg of water at 0 °C. The food is safe while the inside of the chilly bin stays at or below 6 °C.

Specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$. Specific latent heat of fusion of ice = 334 000 J kg^{-1}.

Use $E = mc\Delta T$, $E = mL$ and $E = Pt$.

Discuss which choice keeps the food safe for longer, and how the chilly bin's design helps.

In your answer, you should:

- calculate the energy each choice can absorb before reaching 6 °C
- calculate how long each choice keeps the food at or below 6 °C
- explain why the ice packs last so much longer
- explain how the foam walls, the white outside and the tight lid reduce the heat flowing in.

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