

Solutions

2.1 On each bounce some kinetic energy is transferred to thermal stores of the ball, the floor and the air (work done against friction/air resistance deforms and heats them); the energy is still there, dissipated in less useful stores, so the gravitational potential store refills less each bounce and the ball rises less high.

2.2 A system from which (and into which) no energy is transferred – no energy enters or leaves it; the total energy of its stores is constant.

2.3 Any two of: use a thicker wall (reduces the rate – thickness is the changed property); use a material with lower thermal conductivity; add cavity insulation (a second, trapped-air layer – air has very low thermal conductivity).

3.1 As the car runs along the track, work is done against friction between the wheels and the track and against air resistance. Some of the car's kinetic store is transferred to thermal stores of the track, wheels and surrounding air. So to arrive at the top of the loop with the required 0.20 J of gravitational potential energy, the car must start with more than 0.20 J – the extra covers the dissipated share.

3.2 (a) Independent: the type of insulating material. Dependent: the time for the temperature to fall by 20 °C. (b) Any two: volume of water; starting temperature; same can/lid; same thickness of material; same room temperature. (c) B has a smaller scale division (higher resolution), so readings can be taken to nearer 0.5 °C and uncertainty is smaller. (d) X's water fell by the same amount in less time, so energy crossed X at a higher rate; with thickness and temperature difference equal, a higher rate of transfer means X has the higher thermal conductivity.

3.3 (a) Temperature falls: no wrap $85 - 57 = 28$ °C; thin $85 - 63 = 22$ °C; thick $85 - 71 = 14$ °C in the same 15 minutes. The thick fill leaves the highest final temperature (71 °C) / the smallest fall, so it is the best insulator – the lowest rate of energy transfer to the surroundings. (b) From thin to thick the fall drops from 22 °C to 14 °C – not a halving (a halving of 22 would be 11 °C). Thickness is not the only factor: energy is also lost through the flask's neck and lid, by radiation from the surface, and to the air above the fill. The rate of transfer falls as thickness grows but tends to a floor set by the other routes, so “halves the energy lost” overstates the data – the claim is not supported by these three readings.