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Activity

Practice-for-exam questions

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Use the questions below either in class or for individual work after students have read the articles in the magazine. Although the questions state the values of constants required, some of the questions require additional data – students should either make reasonable estimates of quantities or look up values using a data book or website. Students should clearly communicate any assumptions made. Suggested outline answers to questions are provided in a separate document.

Making the perfect cup of tea

1 A cup of 150 g of tea has cooled down to 85˚C. A person wants to drink the tea immediately, but needs it to cool to 65˚C. If they add milk from the fridge that is at 5˚C, how much do they need to add?

Specific heat capacity of milk = 4.0 kJ kg^{-1} $˚C^{-1}$

Specific heat capacity of water = 4.2 kJ kg^{-1} $˚C^{-1}$

2 The thermal conductivity of Pyrex is 1.50 $Wm^{-1}K^{-1}$.

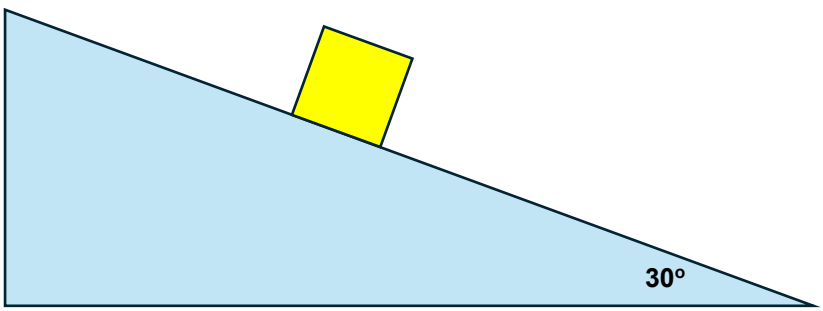
Porcelain has a thermal conductivity of 2.00 $Wm^{-1}K^{-1}$.

The 300 ml of tea, at the same initial temperature, is poured into two beakers. One is made of Pyrex and has a diameter of 6.00 cm. The other is made of porcelain, with a diameter of 8.00 cm. Assume both beakers are cylindrical. Both beakers are of equal thickness.

Which of the two beakers of tea will cool most quickly initially due to conduction through the beaker? Use calculations to support your answer where necessary.

Trigonometry

1 A box of mass 5.00 kg is at rest on a slope, as shown.



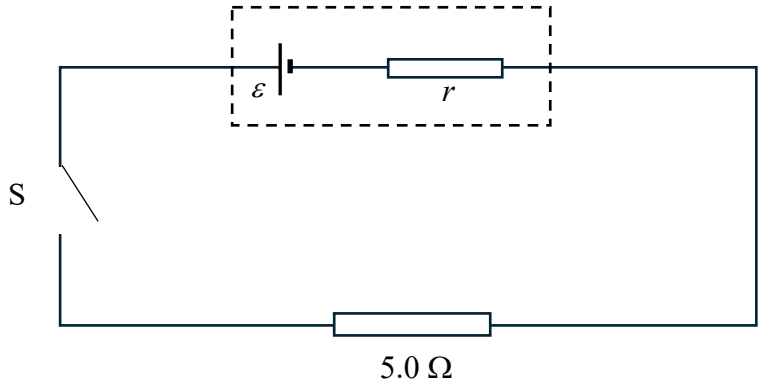
Copy the diagram and add arrows to show the forces acting on the box.

Find a value for the frictional force acting up the slope that prevents the box from sliding.

If the box were sliding down the slope at a steady speed, how would the frictional force acting up the slope compare with your first answer?

Internal resistance and emf in a battery

1 The diagram shows a simple circuit. The cell has an emf ε and internal resistance r.



Make a copy of the diagram and add an ammeter and a voltmeter to measure the current through the circuit and the potential difference across the terminals of the cell.

With the switch S open, the voltmeter reads 2.0 V. When the switch is closed, the reading on the voltmeter falls to 1.5 V.

Find a value for the internal resistance of the cell.

Explain why the cell gets warm when it is in use and find the power dissipated in the cell. If the energy transferred to the external resistance is useful work (for example, the external resistance might represent a simple heating element), calculate the efficiency of this circuit.

Orbital motion

1 The table shows the average orbital radii and periods for the planets of the Solar System.

Name	Orbital period / days	Average orbital radius / 106 km
Mercury	88.0	57.90
Venus	224.7	108.2
Earth	365.2	149.6
Mars	687.0	228.0
Jupiter	4331	778.5
Saturn	10747	1432.0
Uranus	30589	2867.0
Neptune	59800	4515.0

Use these data to verify Kepler's third law by drawing an appropriate graph. Use the graph to calculate a value for the mass of the Sun.

2 An object resting on the surface of the Earth feels a gravitational force, its weight, acting towards the centre of the Earth.

Using Newton's law for the gravitational force acting on the object, and the accepted value for the acceleration due to gravity, find a value for the mass of the Earth.

The radius of the Earth is 6378 km.

3 The International Space Station (ISS) orbits the Earth at a distance of 4.15×10^2 km above the Earth's surface.

Find the orbital speed of the ISS.

Suppose that the ISS moves into a lower orbit. Assuming that the total energy of the ISS is conserved, use an energy argument to find the orbital speed of the ISS if its altitude fell to 350 km above the Earth's surface.