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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. Some of the questions require additional data, students should either make reasonable estimates of quantities, or look up values using a data book or websites. Suggested outline answers to questions are provided in a separate document.

## Electric vehicles

**1** The author states that the top speed of a Nissan Leaf is  $156 \text{ km h}^{-1}$ . Use the data on page 4 to show that this is correct.

**2** The author uses the term 'energy density' and states that lead-acid batteries have an energy density that is too low for modern electric vehicles. Lead-acid batteries are still used in slow moving vehicles such as golf buggies and mobility scooters. Explain why high 'energy density' is more important when choosing the battery for a car, but less so for a vehicle such as a mobility scooter.

## Building the pyramids

London has its own 'pyramid': the Shard, a tall multi-use building that houses shops, offices, a hotel and apartments. The building has an approximately square base, with sides about 50 m and a height of 310 m. The structure is mostly concrete, steel and glass.

### Data

concrete  $\rho \approx 2300 \text{ kg m}^{-3}$

steel  $\rho \approx 7700 \text{ kg m}^{-3}$

glass  $\rho \approx 2500 \text{ kg m}^{-3}$

**1 a** Estimate the loading stress on the ground below the Shard, in pascals, due to the weight of the building, assuming it were a solid pyramid made from the same limestone as the Great Pyramid.

**b** Explain, with reasoning, whether you would expect the actual stress on the ground of the Shard constructed from concrete, steel and glass, would be greater, the same, or less than that estimated in part (a).

**2** The Shard replaced a 24-storey office building made of concrete. Considering your answer to Question (1), suggest a concern engineers might have when demolishing a tall concrete building and replacing it with an even taller building.

## Brownian motion revisited

**1** The author uses Equation 1 to estimate that pollen particles would have a typical speed of  $0.1 \text{ mm s}^{-1}$  on a warm summer's day.

Use ideas about ratios to estimate the temperature at which the particles would move at  $1 \text{ mm s}^{-1}$ .

**2** The article explains some criteria for Brownian motion to be observable — the magnification of the microscope and the speed of the 'jiggling motion'. Suggest why larger particles do not jiggle around when subjected to molecular impacts.

## Metallic glasses

**1** The author states that metallic glasses have low *temperature coefficient of resistivity*, and are therefore useful in circuits that undergo large temperature changes.

**a** Use this example to explain what is meant by a low temperature coefficient of resistivity.

**b** Name an electrical component that has a high temperature coefficient of resistivity. Justify your suggestion.

**2** Box 2 on p. 31 of the magazine shows a typical stress–strain graph. What is represented by the shaded area below the straight-line part of the graph? Justify your answer.

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