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Activity**Practice-for-exam questions****Mary Whitehouse**

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.

Sustainable building

1 The Institute of Physics building includes concrete columns that absorb energy from sunlight during the day and release it slowly at night. Other building materials, which have been in use for hundreds of years, include granite rock and oak wood.

Material	Density $\rho / \text{kg m}^{-3}$	Specific heat capacity $c / \text{J kg}^{-1}\text{K}^{-1}$
Concrete (type used in IOP building)	2300	1000
Granite rock	2700	774
Oak wood	720	2380

Discuss, without detailed calculations, the difference it would make to the energy stored, and to the temperature inside the building, if either granite or oak had been used, instead of the concrete chosen by the architects, to make pillars of the same dimensions.

2 Consider the three materials described in Question 1. What factors other than thermal properties might be considered in choosing which of these materials to use in a sustainable building?

What use are theories?

1 The author states that 'For elements with higher atomic numbers these photons are in the X-ray region, and for lighter elements in the ultraviolet range'.

Use your ideas about energy to justify this statement.

2 The author states that 'outer electrons are screened from the charge of the nucleus by the electrons in the inner shells'.

Use your ideas about electric fields to justify this statement.

Rutherford's nuclear atom revisited

1 Bismuth-214 ($^{214}_{83}\text{Bi}$) is in the radioactive decay chain that begins with uranium-238. Bismuth-214 is the product of polonium-218 ($^{218}_{84}\text{Po}$), decaying by the emission of an alpha particle followed by a beta particle.

Write out the decay chain that describes this process. Use a periodic table to identify the nuclide in the middle of the chain.

2 The alpha particle emitted by polonium-218 has an energy 6.0 MeV.

Determine the speed of the alpha particle and discuss whether there would have been relativistic effects if Rutherford had used polonium-218 as a source of alpha particles.

Frisbee physics

1 In deriving an expression for the aerodynamic lift on a Frisbee, the author states that the kinetic energy per unit volume can be calculated from the expression $\frac{1}{2}v^2\rho$

Show that this is the case.

2 A typical Frisbee used in the sport of ultimate Frisbee has a mass of 175 g and a diameter of about 27 cm.

Calculate the pressure difference needed to create the lift for the Frisbee to remain aloft.

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