Answers

# Practice-for-exam questions

*Mary Whitehouse*

## Viking navigation

**1**      At a position further north at a particular time of day, the Sun would be lower in the sky, casting a longer shadow on the horizontal disc.

**2**      A small portable radio can be used to demonstrate polarisation. When tuned to a MW or LW station the changing magnetic field of the electromagnetic wave is detected by a coil wound around a ferrite rod.

The quality of the sound produced can be shown to vary significantly if the orientation of the radio is rotated, so that the magnetic field is not aligned with the coil, and consequently not inducing the maximum changing pd across the coil. This demonstrates that the wave is polarised. You can download a Word file with more home experiments exploring broadcast radio signals here: http://tap.iop.org/vibration/em/313/file_46685.doc

## Isotopes of hydrogen

**1**      The $^{2}$H ions have twice the mass of the $^{1}$H ions, but the same charge.  The electric force Eq on the ions will be the same, so the acceleration ($a = F/m$) of the deuterium ions will be half that of the hydrogen ions, so they will travel more slowly when accelerated over the same distance.

**2**      Tritium is a source of beta radiation. The ionising beta particles have a short range in air so the external risk is low. However if ingested the radiation will be close to body cells and ionisation of chemicals in cells can damage cells or cause them to change their behaviour.
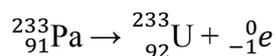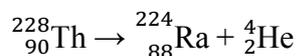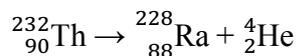
## *Skillset*: Measuring the Planck constant

**1**      Different people have different colour perception, so different people may detect the light emitted for different values of *V*. To improve the accuracy of the results, ask each student to repeat their observations. You could argue that the most accurate value for the threshold voltage is the lowest value recorded by any of the students.

**2**      It is possible that the LED emits light, or allows a current to pass before it can be observed, therefore the recorded value of *V* will be higher than the threshold pd. Using Equations 4 and 3a, it can be seen that a higher value of *V* would yield a higher value for *h* than the accepted value.

## Radiation: not so simple

**1**      Beta emission results in a change in the number of protons in the nucleus and therefore a change in the number of electrons in the atom. Chemical properties are determined by the number of electrons in the outermost shell of the atom.

**2**

$$^{232}_{90}\text{Th} \rightarrow {}^{228}_{88}\text{Ra} + {}^{4}_{2}\text{He}$$

$$^{228}_{90}\text{Th} \rightarrow {}^{224}_{88}\text{Ra} + {}^{4}_{2}\text{He}$$

$$^{233}_{91}\text{Pa} \rightarrow {}^{233}_{92}\text{U} + {}^{0}_{-1}e$$

# *Mathskit*: Forces and free-body diagrams

Both questions can be answered using Lami's theorem (Equation 9 in the article).

**1**

$$\frac{m_1 g}{\sin B} = \frac{m_2 g}{\sin C} = \frac{m_3 g}{\sin A}$$

$$\frac{0.60\ \text{kg} \times g}{\sin 149°} = \frac{m_3 g}{\sin 51°}$$

$$m_3 = \frac{0.60\ \text{kg} \times \sin 51°}{\sin 149°} = 0.91\ \text{kg}$$

Sense check — load is less than the sum of the masses $m_1$ and $m_2$ but in the same order of magnitude.

**2**

$$\frac{m_1 g}{\sin B} = \frac{m_2 g}{\sin C} = \frac{m_3 g}{\sin A}$$

$$\frac{0.8\ \text{kg} \times g}{\sin 127°} = \frac{0.99\text{kg} \times g}{\sin A}$$

$$\sin A = \frac{0.99\ \text{kg} \times \sin 127°}{0.8\ \text{kg}} = 0.99$$

$$A = 81°$$

(You may get a slightly different value depending on the number of significant figures you use in your calculations.)

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