GCSE
PHYSICS

Physics Test 3: Particle model of matter and Atom Structure (Higher)

Total number of marks: 37

1 1 A teacher used a Geiger-Muller tube and counter to measure the number of counts in 60 seconds for a radioactive rock.

1 1 . 1 The counter recorded 819 counts in 60 seconds. The background radiation count rate was 0.30 counts per second.

Calculate the count rate for the rock.

Count rate of rock = Total − background
13.65 − 0.30

[3 marks]

Total count rate = $\frac{819}{60}$ = 13.65

Count rate = 13.35 per second

1 1 . 2 A householder is worried about the radiation emitted by the granite worktop in his kitchen.

1 kg of granite has an activity of 1250 Bq. The kitchen worktop has a mass of 180 kg.

Calculate the activity of the kitchen worktop in Bq.

[2 marks]

= 1250 × 180

Activity = 225000 Bq

1 1 . 3 The average total radiation dose per year in the UK is 2.0 millisieverts.

Table 2 shows the effects of radiation dose on the human body.

Table 2

Radiation dose in millisieverts	**Effects**
10 000	Immediate illness; death within a few weeks
1000	Radiation sickness; unlikely to cause death
100	Lowest dose with evidence of causing cancer

The average radiation dose from the granite worktop is 0.003 millisieverts per day.

Explain why the householder should **not** be concerned about his yearly radiation dose from the granite worktop.

One year is 365 days.

[2 marks]

Radiation dose for a year = 0.003 × 365

= 1.095 < UK average (2)

1 1 . 4 Bananas are a source of background radiation. Some people think that the unit of radiation dose should be changed from sieverts to Banana Equivalent Dose.

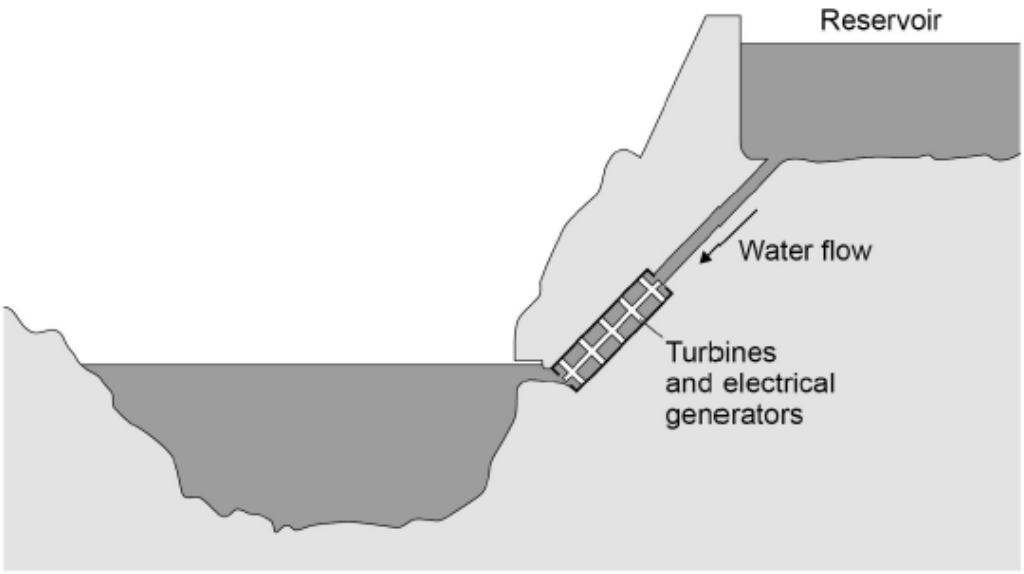
Suggest **one** reason why the Banana Equivalent Dose may help the public be more aware of radiation risks.

[1 mark]

Since Bananas are used frequently in day-to-day life, ordinary people will understand the concept better.

1 0 **Figure 14** shows a hydroelectric power station.

Figure 14



Electricity is generated when water from the reservoir flows through the turbines.

1 0 . 1 Write down the equation which links density (ρ), mass (m) and volume (V).

[1 mark]

$\rho = \frac{m}{V}$

1 0 . 2 The reservoir stores 6 500 000 m^3 of water.

The density of the water is 998 kg/m^3.

Calculate the mass of water in the reservoir.

Give your answer in standard form.

$\rho = \frac{m}{V}$

$998 = \frac{m}{6.5 \times 10^6}$

$m = 6487 \times 10^6$

[4 marks]

Mass (in standard form) = 6.487×10^9 kg

0 5 Radioactive waste from nuclear power stations is a man-made source of background radiation.

0 5 . 1 Give **one** other man-made source of background radiation.

[1 mark]

Medical X-rays

Nuclear power stations use the energy released by nuclear fission to generate electricity.

0 5 . 2 Give the name of **one** nuclear fuel.

[1 mark]

Uranium-235

0 5 . 3 Nuclear fission releases energy.

Describe the process of nuclear fission inside a nuclear reactor.

[4 marks]

Neutrons are bombarded into uranium nucleus which causes the uranium to be highly unstable. The nuclei split into fragments causing a series of further reactions (chain reaction). This process releases energy that is used to heat water to drive turbines.

0 5 . 4 A new type of power station is being developed that will generate electricity using nuclear fusion.

Explain how the process of nuclear fusion leads to the release of energy.

[2 marks]

As two nuclei combine to form a larger nuclei, some amount of mass is converted to energy and radiated.

0 5 . 5 Nuclear fusion power stations will produce radioactive waste. This waste will have a much shorter half-life than the radioactive waste from a nuclear fission power station.

Explain the advantage of the radioactive waste having a shorter half-life.

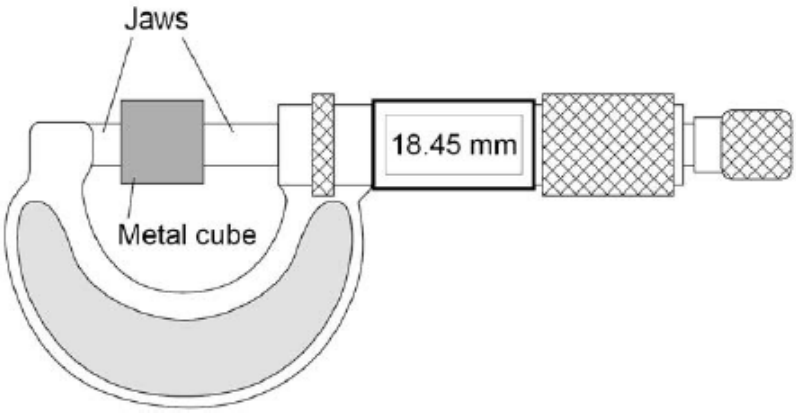
[2 marks]

It has a cheaper disposal cost as the duration of storage in nuclear waste facilities is less.

0 9 A student measured the width of a solid metal cube using a digital micrometer.

Figure 11 shows the micrometer.

Figure 11



0 9 . 1 The resolution of the micrometer is 0.01 mm

The student could have used a metre rule to measure the width of the cube.

Explain how using a metre rule would have affected the accuracy of the student's measurement of width.

[2 marks]

The smallest accuracy (least count) that can be measured with a meter ruler is 0.1cm. Hence, the value of 0.45 would not be measured.

0 9 . 2 The mass of the metal cube was measured using a top pan balance.

The balance had a zero error.

Explain how the zero error may be corrected after readings had been taken from the balance.

[2 marks]

Find the zero error by taking the reading without any mass on the balance and subtract that value from the reading taken for the metal cube.

0 9 . 3 The width of the cube was 18.45 mm. The density of the cube was 8.0×10^3 kg/m^3

Calculate the mass of the cube.

[5 marks]

$\text{Volume of cube} = \left(\frac{18.45}{1000}\right)^3 m^3$

$d = \frac{m}{v}$

$8 \times 10^3 = \frac{m}{\left(\frac{18.45}{1000}\right)^3}$

$m = 0.0502$

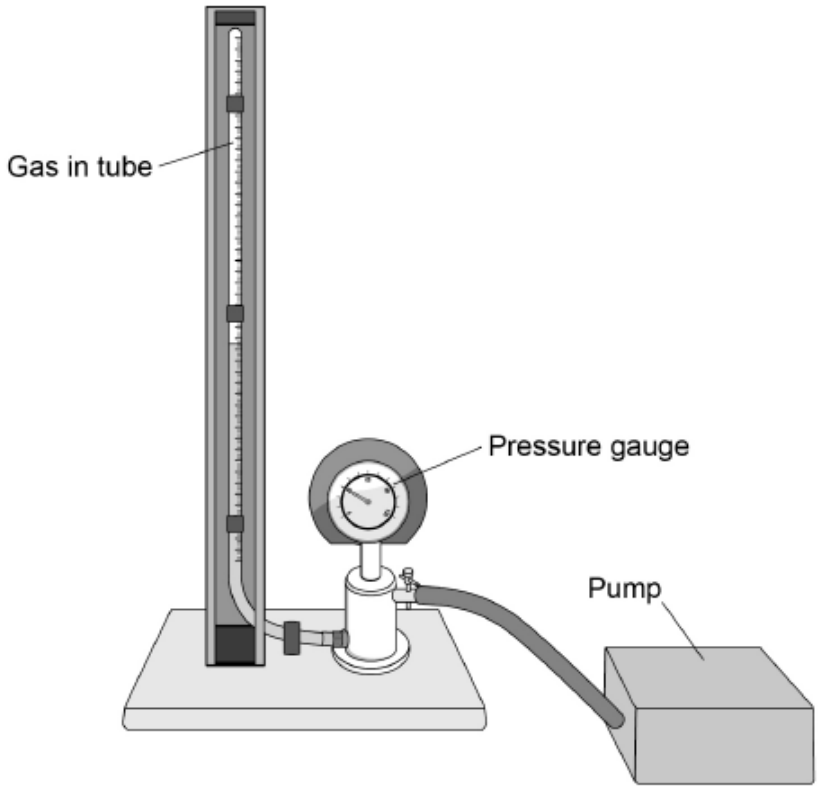
≈ 0.050

Mass = 0.05 kg

0 7 A student investigated how the pressure exerted by a gas varied with the volume of the gas.

Figure 12 shows the equipment the student used.

Figure 12



A pump was used to compress the gas in a tube. As the volume of the gas decreases, the pressure of the gas increases.

0 7 . 4 One of the student's results is given below.

pressure = 1.6×10^5 Pa
volume = 9.0 cm^3

Calculate the volume of the gas when the pressure was 1.8×10^5 Pa.

The temperature of the gas was constant.

[3 marks]

$P_1V_1 = P_2V_2$

$1.6 \times 10^5 \times \frac{9}{10^6} = 1.8 \times 10^5 \times \frac{V_2}{10^6}$

Volume = 8 cm^3

0 7 . 5 **Figure 14** shows a person using a bicycle pump to inflate a tyre.

Figure 14

The internal energy of the air increases as the tyre is inflated.

Explain why.

[2 marks]

As the man presses the piston, work is done on the gas since it is compressed. Hence, the internal energy of the gas increases.