

# GCSE Physics

22<sup>nd</sup> Mar 2021 – Nuclear Radiation

Suitable for ALL exam boards



This session looks at radiation.

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Question taken from:

**OCR A – 2018 - Paper 4 H - J249/04 – Question 19**

**OCR B – 2018 - Depth H - J259/04 – Question 3**

19 Nuclear radiation, such as gamma, is used to irradiate some fresh food to increase its 'shelf-life' and make it last longer.

Fresh herbs and spices are dried and irradiated with gamma rays.

(a) Explain the difference between nuclear **irradiation** and nuclear **contamination**.

.....  
.....  
..... [2]

(b) Explain how the gamma rays can increase the 'shelf-life' of herbs and spices to make them last longer.

.....  
.....  
..... [2]

(c) Some people are worried about eating irradiated food.

Write down two **concerns** they may have about irradiated food.

1. ....  
.....  
2. ....  
..... [2]

(d) Carbon is a common element. Carbon has two different isotopes called carbon-12 and carbon-14. Both of these isotopes have six protons in the nucleus.

(i) Carbon-14 is radioactive and carbon-12 is **not** radioactive.

Explain why some isotopes are radioactive.

.....  
..... [1]

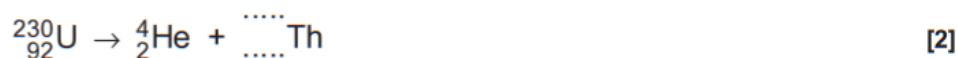
(ii) Describe how the nucleus of carbon-12 is different to the nucleus of carbon-14.

.....  
..... [1]



(e) Decay equations are used to show the type of emission from different radioactive elements.

(i) Complete the decay equation for **alpha** emission.



(ii) Complete the decay equation for **beta** emission.



(iii) Complete the decay equation for **gamma** emission.



3 There is a film about an astronaut named Mark Watney. He is left alone on the planet Mars. He has to use science to stay alive until he can be rescued.

(a) Mars is a cold planet, and Watney has a radioactive thermal generator. This contains radioactive plutonium-238 which emits alpha-particles, giving an isotope of uranium.

(i) Complete the radioactive decay equation for plutonium-238.



(ii) The plutonium emits  $1.6 \times 10^{15}$  alpha particles every second, each with an energy of  $9.0 \times 10^{-13}$  J.

The energy released is all transferred to the internal energy of the generator.

Show that the input power of the generator is about 1500 W.

[3]

(iii) Watney uses the generator to heat up water for a bath. He heats 100 kg of water from  $20^\circ\text{C}$  to  $37^\circ\text{C}$ .

Show that it takes more than an hour (3600s) for his bath to warm up using his 1500W generator.

You can assume that all the input energy to the generator is transferred to the internal energy of the water.

specific heat capacity of water =  $4200 \text{ J/kg}^\circ\text{C}$



- (b) To be rescued, Watney needs to drive a vehicle to a site 3200km away. The vehicle is powered by batteries of capacity 18 kWh.

Watney knows that the vehicle can travel at 25km/hour using 5kW of power from the batteries to do this. When the batteries are discharged Watney has to wait until the next day to continue. He has solar panels to recharge the batteries after a day's travel.

- (i) Use these data to calculate the smallest number of days it would take to drive to his destination.

Number of days = ..... days [4]

- (ii) Give **one** reason why it would actually take longer than the time calculated in (b)(i).

.....  
..... [1]

