Nuclear physics – 2020 O Level 5054

1. Nov/2020/Paper_11/No.40

An isotope P is radioactive and has a half-life of 7.0 years. A sample initially contains 0.016 kg of P.

After how long will the sample contain 0.0020 kg of P?

A 7.0 years **B** 14 years **C** 21 years **D** 28 years

2. Nov/2020/Paper_12/No.39

What is the definition of the half-life of a radioactive element?

A half of the time it takes for one atom to decay

B half of the time taken for all the atoms in a sample to decay

C the time taken for half of the atoms in a sample to decay

D the time taken for the nucleon number (mass number) to halve

3. Nov/2020/Paper_12/No.40

Which row shows the atomic structure of a neutral atom with a nucleon number of 9?

	number of neutrons	number of protons	number of electrons
A	4	5	4
B	4	5	5
C	5	4	5
D	5	5	4

4. Nov/2020/Paper_21/No.7

Nuclear fusion is a reaction that occurs in the Sun and other stars.

(a) Explain what is meant by *nuclear fusion*.

.....

.....

..... [2]

(b) Describe the nuclear fusion reaction that takes place in the Sun.

.....

.....

..... [1]

(c) A star forms when the temperature of a large cloud of gas in space increases as the cloud collapses inwards.

(i) State the energy transfers that occur as the cloud collapses.

.....

.....

..... [2]

(ii) The temperature increase starts a nuclear fusion reaction.

Explain why the temperature of the star eventually reaches a steady value.

.....

.....

..... [2]

[Total: 7]

5. Nov/2020/Paper_22/No.6

Phosphorus-32 ($^{32}_{15}P$) is an isotope of phosphorus that undergoes radioactive decay.

(a) The most common isotope of phosphorus is phosphorus-31.

(i) Describe the structure and composition of a neutral atom of phosphorus-31.

.....

.....

..... [2]

(ii) State how an atom of phosphorus-32 differs from an atom of phosphorus-31.

.....

..... [1]

(b) Phosphorus-32 decays by beta-particle emission to a stable isotope of sulfur. The half-life for this decay is 2.0 weeks.

(i) State how a nucleus of this isotope of sulfur is different to a nucleus of phosphorus-32.

.....

..... [1]

(ii) At time $t = 0$, a radioactive sample contains 3.2×10^{11} atoms of phosphorus-32.

At the same moment, the sample contains no atoms of sulfur. This is shown by the cross on Fig. 6.1.

On Fig. 6.1, plot a graph to show how the total number of sulfur atoms in the sample changes with t and draw a suitable curve. [3]

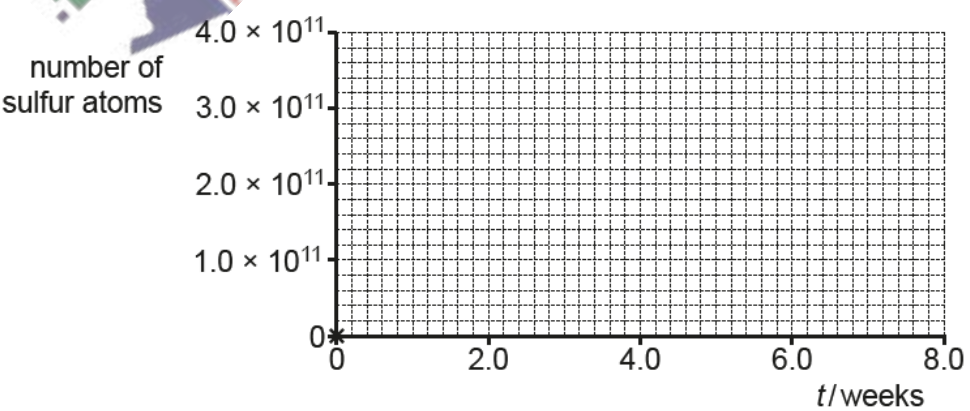

Fig. 6.1

(c) State **two** precautions taken when storing or moving radioactive materials.

1. .....

.....

2. .....

.....

[2]

[Total: 9]

6. June/2020/Paper_11/No.37

The nuclide notation for an isotope of X is ${}^{A}_{Z}X$.

How many neutrons are there in a nucleus?

A A **B** A – Z **C** Z – A **D** Z

7. June/2020/Paper_11/No.38

Radioactivity is used in several activities that take place in hospitals.

Which activity **never** uses radioactivity?

A cooking meals

B diagnosing illnesses

C sterilising equipment

D treating illnesses

8. June/2020/Paper_11/No.39

${}^{14}_{6}C$ is a natural radioactive isotope of carbon and is present in all living things. It has a half-life of 5700 years.

How old is a bone that is found to have only $\frac{1}{4}$ of the natural proportion of ${}^{14}_{6}C$?

A 5700 years

B 11 400 years

C 17 100 years

D 22 800 years

9. June/2020/Paper_11/No.40

A kettle is connected to the 240 V mains supply using a plug containing a 13 A fuse.

The kettle contains water.

When it is switched on, the fuse blows. This happens again after a new fuse is fitted.

Someone replaces the fuse with a nail, and the kettle works.

What else might happen as a result of replacing the fuse with a nail?

A A very large current overloads the wiring, causing a fire.

B The kettle boils the water less quickly.

C The kettle uses more energy to boil the water.

D The water boils at a higher temperature.

10. June/2020/Paper_21/No.7

Two isotopes of carbon are carbon-12 and carbon-14.

One of these isotopes, carbon-14, undergoes radioactive decay.

(a) Describe what is meant by *radioactive decay*.

.....

..... [2]

(b) Carbon-12 has a proton number (atomic number) of 6 and a nucleon number (mass number) of 12.

Complete Table 7.1 for a neutral atom of each of these two isotopes.

Table 7.1

	carbon-12	carbon-14
number of protons	6	
number of neutrons		
number of electrons		

[2]

(c) A sample of carbon-14 is contained in a thin aluminium container of thickness 0.2 mm.

Radiation from the sample is detected outside the container.

When the thickness of the aluminium is increased to 6 mm, no radiation from the sample is detected outside the container.

(i) State the type of radiation which is stopped by increasing the thickness of the aluminium.

..... [1]

(ii) Explain how you know that the sample does **not** emit one other type of radiation.

.....

.....

.....

..... [2]

[Total: 7]

11. June/2020/Paper_22/No.7

Radon-222 is an isotope of radon which undergoes a series of radioactive decays.

Fig. 7.1 is a diagram showing the proton number (atomic number) and nucleon number (mass number) of nuclei involved in the series of decays.

The point P represents a nucleus of radon-222.

Starting at P, a nucleus of radon-222 decays to Q; then from Q to R; then from R to S; then from S to T; and finally from T to U.

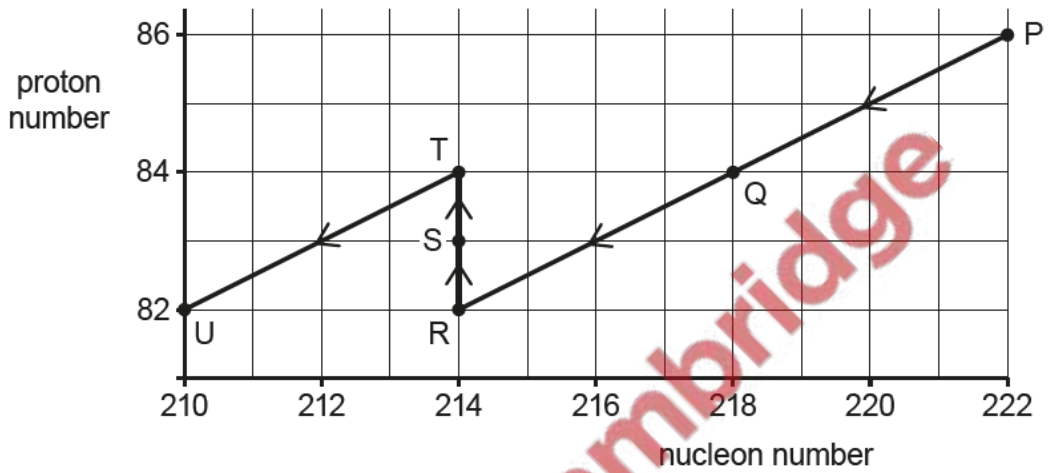

Fig. 7.1

(a) **(i)** State two points on Fig. 7.1 which represent isotopes of the same element.

..... [1]

(ii) Different isotopes of the same element have different atomic compositions.

State how the composition of their atoms is different.

.....

..... [1]

(b) A nucleus of radon-222 emits an alpha-particle as it decays.

(i) The radioactive decay of a single nucleus is random.

Explain what is meant by the *random* radioactive decay of a nucleus.

.....

.....

..... [1]

(ii) In nuclide notation, radon-222 is written as $^{222}_{86}Rn$.

When a nucleus of radon-222 emits an alpha-particle (α), it decays to an isotope of polonium (Po).

Complete the decay equation below for this decay.

$$^{222}_{86}Rn \rightarrow \begin{matrix}\cdots\cdots\\ \cdots\cdots\end{matrix} Po + \begin{matrix}\cdots\cdots\\ \cdots\cdots\end{matrix} \alpha$$

[2]

(c) **(i)** State the name of the particle emitted as a nucleus of R decays to a nucleus of S.

..... [1]

(ii) Describe the change in the composition of a nucleus of R as it decays to a nucleus of S.

.....

.....

..... [2]

[Total: 8]

12. June/2020/Paper_22/No.8

Fig. 8.1 shows the circuit diagram of a temperature gauge. It contains an ammeter, a thermistor, a fixed resistor R and a battery.

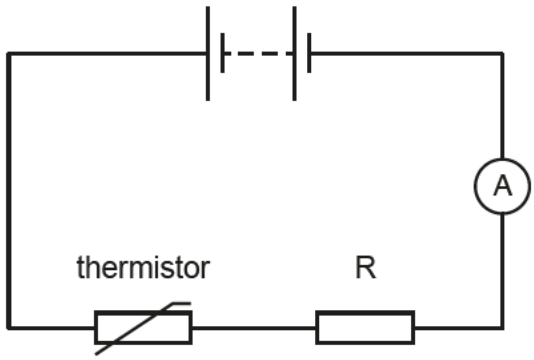

Fig. 8.1

The current is measured at different temperatures and a graph of the results is shown in Fig. 8.2.

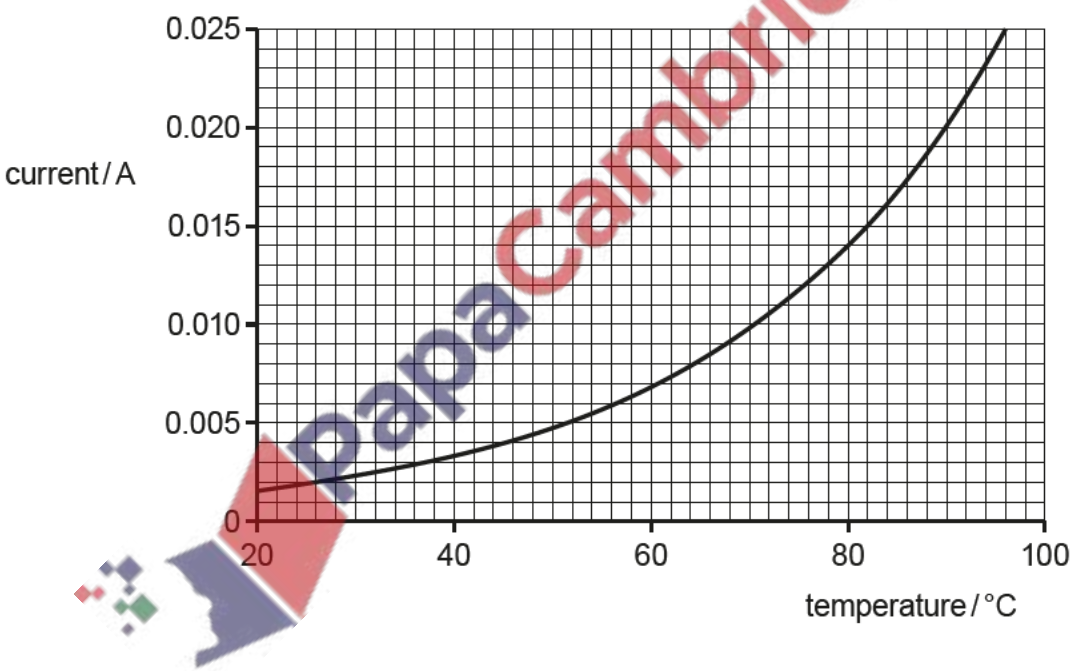

Fig. 8.2

(a) (i) State how the resistance of the thermistor changes with temperature and explain how Fig. 8.2 shows this change.

.....

.....

..... [2]

(ii) Resistance and current are used for the measurement of temperature.

State **one** other physical property that is used for the measurement of temperature.

.....

..... [1]

(b) A temperature scale involves the use of fixed points.

State what is meant by:

(i) *the ice point*

.....

..... [1]

(ii) *the steam point*.

.....

..... [1]

(c) At 80 °C, the potential difference (p.d.) across the thermistor is 3.6 V.

(i) State what is meant by *potential difference*.

.....

..... [1]

(ii) Calculate the resistance of the thermistor when the temperature is 80 °C.

resistance = ... [3]

(iii) The electromotive force (e.m.f.) of the battery is 25 V.

Calculate the resistance of the resistor R.

resistance = ... [2]

(d) The current scale on the ammeter is linear.

Using values from Fig. 8.2, a student marks the scale on the ammeter with temperature values that correspond to the values of the current.

The temperature is then read directly from the temperature scale on the ammeter.

(i) State what is meant by a *sensitive* thermometer.

.....

.....

..... [1]

(ii) State and explain at which temperatures this thermometer is most sensitive.

.....

.....

.....

..... [2]

(e) The temperature gauge is used to measure the temperature of a room.

Suggest why the temperature obtained using the gauge is slightly higher than the actual temperature of the room.

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..... [1]

[Total: 15]