**Physics Year 11 Nuclear Physics, Investigation 2 : Nuclear Reactors and Applications**

**Validation test**

|  |  |  |
| --- | --- | --- |
| **1.** | In a nuclear reaction, neutrons are produced. Which statements are correct in a nuclear reactor.  (i)The moderator reduces the number of neutrons.  (ii) The control rods act as a neutron poison.  (iii) Uranium 238 produces neutrons in the fission reaction.  (iv) Deuterium reduces the speed of the neutrons.   1. (ii) and (iii) 2. (i), (ii) and (iv) 3. (ii) and (iii) 4. (i) and (iv) | (2)  b |
| **2.** | Choose the correct respons(es) for the role of the coolant.   1. The coolant material is used for energy production. 2. The coolant absorbs heat from the nuclear reaction. 3. Water as a coolant can act as a radiation shield. 4. The coolant is a neutron poison 5. (i) only 6. (i), (ii) and (iii) 7. (ii) only 8. (ii) and (iv) | (2)  b |
| **3** | For nuclear medicine, the most suitable radionuclides have   1. Short half-lives from several hours to 2 or 3 days 2. High energy radiation emitted from radioactive decay 3. Produce low energy γ rays. 4. Produce low energy α particles 5. (i) and (iii) 6. (i) and (iv) 7. (ii) and (iii) 8. (i) and (iv) | (2) |
| **4** | a) Write a reaction for nuclear fission?  10n + 23592U → 23692U\*  23692U\* → 9236Kr + 14156Ba + 3 10n  b) Explain the difference between a controlled nuclear reaction and an uncontrolled nuclear reaction.  Controlled reaction has 1 neutron per event used for the next event in the chain.  Uncontrolled reaction can have all 3 neutrons  c) State and describe two features of a nuclear reactor that enable a controlled nuclear reaction to continue and be controlled?   1. The moderator slows neutrons down so they can be absorbed   Deuterium and/or Tritium as a slightly larger mass than neutrons  slows the neutrons down due to multiple collisions- shares energy   1. The control rods contain neutron poisons   such as B and Cd  absorb neutrons | (1)  (2)  (2)  (2) |
| **5.** | The layout of a thermal nuclear power station is shown in the diagram below.  020C_HP11TRAD  a i control rod (1 mark)  ii moderator or fuel rod (1 mark)  iii fuel rod or moderator (1 mark)  iv turbine (1 mark)  b A: Reactor core, where fission occurs. (2 marks)  B: Heat exchanger, where coolant from reactor cools by giving its heat to normal water, turning the water into steam. (2 marks)  C: Generator, where steam turns turbine and generates electricity. (2 marks) | 4  3 |
| **6.** | (a)  (i)What high level nuclear waste products are produced in a nuclear facility?  Spent fuel rods  (ii) How are they stored?  Cooled in water for 5 to 50 years  Dry ventilated concrete containers, deep underground | (1)  (2) |
| 7 | 1. List two effects of radiation on humans?   Eg. Cancers, genetic damage, mutations, lymphatic system failure, seizures etc   1. List two ways to make it safer for humans working in the nuclear industry.   Shielding such as lead  Radiation monitoring | (2)  (2) |
| 8. | (a) In the following table list advantages and disadvantages of nuclear power   |  |  | | --- | --- | | Advantages | Disadvantages | | Efficient power production  Requires relatively small amount of uranium  Doesn’t produce greenhouse gases. | Radiation dangerous to humans and living animals and plants.  Leakage into the environment  Long storage times for radioactive waste.  Long term effects if something goes wrong, eg. Three Mile Island, Chernobyl and Fukishima |  1. Write a short paragraph explaining your view on nuclear power and whether it is a viable long term solution to global warming.   *(Be concise and use scientific reasons to support your statement)* | (3)  (3) |
| 9. | (a) State two applications of nuclear radioisotopes in Medicine and explain how it works.   1. Diagnosis – external detectors record the passage or localisation of radioactive nuclei. 2. Treatment- destroys cells and/or promotes healing. 3. ? Give a rough length of half-life (ie few seconds, few minutes, few hours, few days, few months, few years, several tens of years, several hundreds of years) required for nuclear radioisotopes in medicine and give two reasons why this is important?   A short half-life (few hours for treatment, but 2 to 3 days for transport) is required so it decays to a safe level quickly, needs to be long enough for transport. | (2)  (3) |