

Name _____

Date _____

Score: _____ / 15

30 minutes · 15 marks · calculator and data booklet allowed

- Answer all the questions.
- For each question, choose the answer you think is best and circle the letter.
- Each question is worth 1 mark.

1. In the Geiger-Marsden-Rutherford experiment, most alpha particles passed through the gold foil with no deflection. What does this show?

- A.** Most of the atom is empty space.
- B.** The nucleus is positively charged.
- C.** Electrons are much lighter than alpha particles.
- D.** The nucleus contains neutrons.

2. Which observation in the Geiger-Marsden-Rutherford experiment showed that the positive charge of an atom is concentrated in a very small volume?

- A.** Most alpha particles passed straight through the foil.
- B.** The alpha particles were all deflected by small angles.
- C.** A very small number of alpha particles were deflected through more than 90°.
- D.** Some alpha particles were absorbed by the foil.

3. A nucleus of cobalt is $^{59}_{27}\text{Co}$. How many neutrons are in the nucleus, and how many electrons are in the ion Co^{2+} ?

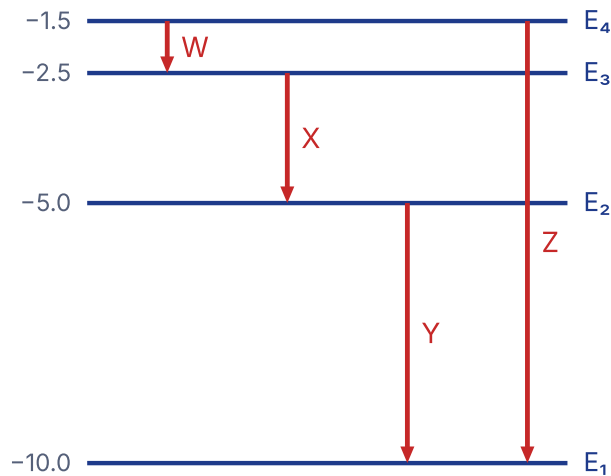
- A.** 27 neutrons, 25 electrons
- B.** 32 neutrons, 25 electrons
- C.** 32 neutrons, 29 electrons
- D.** 59 neutrons, 27 electrons

4. Which observation is evidence that atoms have discrete energy levels?

- A.** A hot solid emits a continuous spectrum.
- B.** Alpha particles are scattered by a thin gold foil.
- C.** The spectral lines of a distant galaxy are shifted towards red.
- D.** A gas at low pressure emits light of only certain wavelengths.

5. The diagram shows four energy levels of an atom and four transitions W, X, Y and Z.

energy / eV



Which transition emits the photon with the longest wavelength?

- A. W
- B. X
- C. Y
- D. Z

6. Use the diagram in question 5. The photon emitted in transition X has wavelength λ . What is the wavelength of the photon emitted in transition Y?

- A. 2λ
- B. $\lambda/4$
- C. $\lambda/2$
- D. 4λ

7. An atom makes a transition in which its energy decreases by 3.0 eV. What is the wavelength of the emitted photon?

- A. $6.6 \times 10^{-26} \text{ m}$
- B. $1.4 \times 10^{-15} \text{ m}$
- C. $2.1 \times 10^{-7} \text{ m}$
- D. $4.1 \times 10^{-7} \text{ m}$

8. White light passes through a cool gas, and the transmitted light shows dark lines. Why are the lines dark?

- A. The atoms keep the absorbed energy permanently.
- B. The absorbed photons are re-emitted in all directions.
- C. The gas emits no light at all.
- D. The photons are reflected back towards the source.

9. Hydrogen atoms are in the ground state (-13.6 eV). The next levels are -3.40 eV and -1.51 eV.

- I. a photon of 10.2 eV
- II. a photon of 11.0 eV
- III. a photon of 14.0 eV

Which photons can be absorbed by an atom?

- A.** I and III only
 - B.** I only
 - C.** I and II only
 - D.** I, II and III
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10. An electron of kinetic energy 12.5 eV collides with a hydrogen atom in the ground state (levels -13.6 eV, -3.40 eV, -1.51 eV, -0.85 eV). What is the highest level the atom can be raised to?

- A.** $n = 2$
 - B.** $n = 4$
 - C.** $n = 3$
 - D.** the atom is ionised
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11. (HL) An alpha particle is fired head-on at a nucleus. Its initial kinetic energy is doubled. What happens to the distance of closest approach?

- A.** It is doubled.
 - B.** It is divided by four.
 - C.** It does not change.
 - D.** It is halved.
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12. (HL) The radius of a nucleus with nucleon number 27 is R . What is the radius of a nucleus with nucleon number 216 ?

- A.** $8R$
 - B.** $2R$
 - C.** $4R$
 - D.** $\sqrt{8} R$
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13. (HL) At high energies, the number of alpha particles scattered by a nucleus differs from Rutherford's prediction. What is the reason?

- A.** The alpha particles lose energy in the foil.
 - B.** The electrons of the atom deflect the alpha particles.
 - C.** The alpha particles come within range of the strong nuclear force.
 - D.** The alpha particles move faster than light.
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14. (HL) In the Bohr model of hydrogen, what is the ratio (radius of the orbit $n = 3$)/(radius of the orbit $n = 1$)?

- A.** 3
 - B.** $1/9$
 - C.** $\sqrt{3}$
 - D.** 9
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15. (HL) In a one-electron ion the energy levels are $E = -K/n^2$. A photon of energy 30 eV moves the electron from $n = 1$ to $n = 2$. What photon energy moves it from $n = 2$ to $n = 3$?

- A.** 7.5 eV
 - B.** 5.6 eV
 - C.** 10 eV
 - D.** 3.3 eV
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