

GET1024
Radiation – Scientific Understanding and Public Perception
Term Test 1
(19 March 2019)

Answer all questions by shading the best answer in the Answer Sheet. No marks will be deducted for wrong answer. All questions carry equal weightage.

(1) Which of the following forms of radiation are ionizing?

- A. Radio waves, microwaves, x-rays
- B. Gamma rays, x-rays light, infra-red radiation
- C. X-rays, alpha particles, gamma rays
- D. Ultra violet radiation, Visible light, infra-red radiation
- E. X-rays, infra-red radiation, beta particles

(2) Which of the following statements is **false**?

- A. Special theory of relativity states the speed of light in vacuum is constant in all inertial frames of reference.
- B. Photoelectric effect demonstrated that light can behave as particles.
- C. Neutrino was proposed by Pauli to explain the riddle of the non-conservation of energy and momentum in beta decay.
- D. Max Planck used the special theory of relativity to explain the phenomenon of black body radiation.
- E. Rutherford gold scattering experiment showed the existence of a very heavy but small positively charged nucleus in the atom.

(3) The Balmer series consists of

- A. the four distinct lines in the visible range emitted by hydrogen in a discharge tube.
- B. the first five elements in the third row of the periodic table.
- C. the three smallest rings of electrons when they are scattered through the graphite film.
- D. the four quantum numbers needed to fully define the state of hydrogen atom.
- E. the four smallest closed orbits formed by standing waves to describe the lowest hydrogen electronic states.

(4) The de Broglie wavelength of a moving electron is

- A. proportional to its kinetic energy.
- B. proportional to its momentum.
- C. inversely proportional to its kinetic energy
- D. inversely proportional to its momentum
- E. independent of both its momentum and kinetic energy.

(5) A positron is

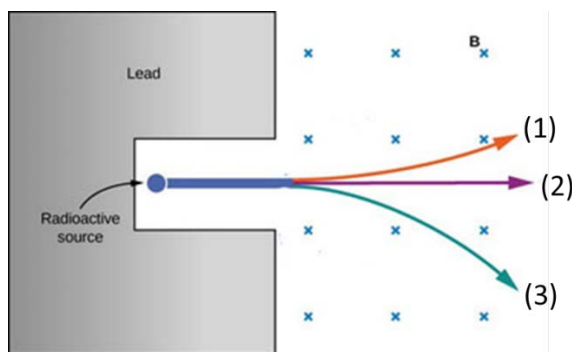
- A. a device to accelerate positive ions.
- B. the anti-particle of electron.
- C. an imaginary positively charged particle with zero mass.
- D. present in abundant amount in the universe.
- E. emitted during an alpha decay.

(6) A radionuclide is denoted by ${}^{218}_{84}\text{Xx}$, where Xx is the not the actual chemical symbol. Which of the following statement(s) is / are true?

- 1. The nuclide has 84 protons and 218 neutrons
- 2. The nuclide is definitely radioactive
- 3. If it decays by emitting an alpha particle, it will become ${}^{214}_{82}\text{Yy}$ where Yy is also not the actual chemical symbol.
- 4. If it decays by emitting an electron, it will become ${}^{238}_{83}\text{Zz}$ where Zz is also not the actual chemical symbol.

- A. 1 only
- B. 2 and 3 only
- C. 2 and 4 only
- D. 1, 3 and 4 only
- E. 2, 3 and 4 only

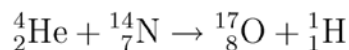
(7) The figure below showed how α , β and γ radiations would behave in a magnetic field B at right angle to the direction of the radiations.



Which of the following correctly identify the three radiations?

- A. (1) = α , (2) = β , (3) = γ
- B. (1) = γ , (2) = β , (3) = α
- C. (1) = β , (2) = γ , (3) = α
- D. (1) = α , (2) = γ , (3) = β
- E. (1) = β , (2) = γ , (3) = α

- (8) Consider the following nuclear reaction:



Given that the masses of the nuclides are $M_N = 14.003074$ u, $M_{He} = 4.002603$ u, $M_O = 16.999132$ u and $M_H = 1.007825$ u where u is the unified mass unit = 1.66×10^{-27} kg, what is the reaction energy Q of this process? *Other information that you may need: Speed of light $c = 3.00 \times 10^8$ m/s, $1 \text{ MeV} = 1.60 \times 10^{-13} \text{ J}$.*

- A. 200 MeV
- B. 8.1 MeV
- C. 4.2 MeV
- D. 0.0 MeV
- E. -1.2 MeV

- (9) For a medical procedure, a man's thyroid gland was exposed to 1 Gy of radiation coming from a proton source. What was his equivalent dose (H_T) and his effective dose (E)? (The radiation weighting factor for protons is 5. The weighting factor for the thyroid gland is 0.05).

- A. $H_T = 1 \text{ Sv}$ and $E = 0.05 \text{ Sv}$
- B. $H_T = 5 \text{ Sv}$ and $E = 0.25 \text{ Sv}$
- C. $H_T = 0.2 \text{ Sv}$ and $E = 4 \text{ Sv}$
- D. $H_T = 5 \text{ Sv}$ and $E = 0.01 \text{ Sv}$
- E. $H_T = 1 \text{ Sv}$ and $E = 20 \text{ Sv}$

- (10) A man was accidentally injected with an unknown water-soluble radioisotope. Which of the following statements is correct?

- A. He should wear a lead apron to reduce the amount of dose that he will receive.
- B. Analysis using a whole body gamma counter will lead to the identification of the radioisotope that is in his body.
- C. The dose that he receives is negligible because water-soluble radioisotopes will be removed from the body through his bodily excretions.
- D. Analysis of the radioactivity in his bodily excretions will allow doctors to determine the likely dose that he will receive.
- E. None of the statements are correct.

- (11) An engineer was tasked with investigating an unknown radioactive chemical spill in a factory. Which of the following equipment would be most useful for his own personal safety?

- A. An in-vivo gamma spectrometer
- B. A thermoluminescent dosimeter
- C. An electronic dosimeter
- D. A full face mask with oxygen breathing tank
- E. A hand held Geiger Muller counter

(12) It was suspected that a man was accidentally exposed to a radiation source. Which of the following information would not help in determining the amount of radiation that he was exposed to?

- A. The identity of the radioactive element.
- B. The distance of the radioactive source from the man.
- C. The mass of the radioactive element present.
- D. The length of the exposure.
- E. All of the above information would be helpful.

(13) Which of the following describes deterministic effects of radiation exposure?

- 1. It only occurs after a threshold dose
 - 2. The severity increases with increasing dose
 - 3. The likelihood increases with increasing dose
 - 4. It generally arises due to an accumulation of mutations
- A. 1 only
 - B. 1 and 2 only
 - C. 1, 2, and 3 only
 - D. 1, 2, and 4 only
 - E. None of the statements are true

(14) Which of the statement(s) is / are true?

- 1. When using mice as an animal model to study biological effects of ionising radiation, one should bear in mind that mice are generally more radiosensitive than humans
 - 2. An example of an epidemiological study on the biological effects of radiation exposure is the study of cancer incidence in astronauts that fly frequently into space
 - 3. The number of dicentric chromosomes found in a cell can be used as a readout for DNA damage caused by radiation exposure
- A. 1 only
 - B. 2 only
 - C. 1 and 3 only
 - D. 2 and 3 only
 - E. All statements are true

(15) A man received a lung exposure of 2 mGy of x-rays, and an internal dose to the bladder of 2 mGy of alpha particles. The tissue weighting factor for the lung is 0.12 and that for the bladder is 0.04, the radiation weighting factor is 1 for x-ray and 20 for alpha particles. Which statement is **false**?

- A. The effective dose to the lung is 0.24 mSv
- B. The equivalent dose to the bladder is 40 mSv
- C. The effective dose to the bladder is greater than the effective dose to the lung
- D. The equivalent dose to the lung is equal to the equivalent dose to the bladder
- E. The total effective dose received is 1.84 mSv

(16) Which of these statements is most likely to be true?

- A. A mouse was exposed to 8 Gy of x-rays and then returned to its cage. Within 30 days its cage-mates will begin to exhibit signs of acute radiation syndrome.
- B. A pregnant woman underwent a CT scan on the torso. As long as she did not experience any radiation-related effects, her fetus will not be affected as well.
- C. A person was exposed to an acute dose of 3 Gy of gamma radiation. He is likely to experience deterministic effects but not stochastic effects.
- D. Exposure to a high dose of ionising radiation has no effect on red blood cells (which have no nuclei).
- E. A new species of fish was found to have an efficient DNA repair mechanism and was able to thrive in a habitat with high background radiation.

(17) The mass attenuation coefficients of body parts are given in the table below.

Photon Energy (keV)	Tissue ($\rho = 0.95 \text{ g cm}^{-3}$)	Muscle ($\rho = 1.00 \text{ g cm}^{-3}$)	Bone ($\rho = 1.85 \text{ g cm}^{-3}$)
10	3.268	5.356	28.51
20	0.568	0.821	4.000
40	0.239	0.269	0.666
60	0.197	0.205	0.315
80	0.180	0.182	0.223
100	0.169	0.169	0.186

If 20 keV X-ray is used for imaging of a 5-cm thick tissue, the fraction of photon energy that will pass through is about

- A. 22%
- B. 15%
- C. 7%
- D. 2%
- E. 0.5%

(18) Examples of the radioisotopes used in Positron Emission Tomography (PET) are:

- A. ^{99m}Tc , ^{123}I , ^{85}Sr
- B. ^{11}C , ^{15}O , ^{18}F
- C. ^{198}Au , ^{111m}In , ^{85}Sr
- D. ^{14}C , ^{40}K , ^3H
- E. ^{222}Ra , ^{60}Co , ^{232}Th

(19) Cobalt-60, molybdenum-99 and iridium-192 are three common radioactive sources used in the medical application. For which applications are they most likely to be applied?

	Cobalt-60	Molybdenum-99	Iridium-192
A.	Medical Imaging	External Beam Radiotherapy	Brachytherapy
B.	External Beam Radiotherapy	Brachytherapy	Medical Imaging
C.	Brachytherapy	Medical Imaging	External Beam Radiotherapy
D.	Brachytherapy	External Beam Radiotherapy	Medical Imaging
E.	External Beam Radiotherapy	Medical Imaging	Brachytherapy

(20) Which of the following statements on the proton beam therapy is **false**?

- A. Proton beam therapy significantly spares of healthy tissues and critical organs of unwanted irradiation, as compared to conventional radiotherapy.
- B. Proton beam therapy requires a particle accelerator.
- C. Proton beam therapy is expensive and may be limited very few hospitals.
- D. Proton beam therapy should not be used to treat cancer in children.
- E. Proton beam therapy is especially indicated for cancer treatment of the central nervous system.

(21) A person stays in his house for about 60% of his time. Assuming that the equivalent factor for radon indoor is 0.4, for what level of indoor radon level in this house will the dose due to radon and its decay products result in an annual effective dose of about 6 mSv? Use a dose conversion factor of 9 nSv/h for every Bq/m³.

- A. 20 Bq/m³
- B. 100 Bq/m³
- C. 300 Bq/m³
- D. 800 Bq/m³
- E. 1500 Bq/m³

- (22) Which of the following radioisotopes do not contribute to the radiation we get from the ground?
- A. U-235
 - B. U-238
 - C. Th-232
 - D. K-40
 - E. H-3
- (23) In the demonstration during the lecture where a balloon was rubbed and left hanging in the air for about 30 minutes, the higher count of radiation from the balloon is due to
- A. the radon that is in the balloon.
 - B. the K-40 radionuclides that are attracted to the balloon.
 - C. the secondary cosmic rays that hit the balloon.
 - D. the dust containing decay products of radon attracted to the balloon.
 - E. the positrons formed from energetic gamma rays.
- (24) Many objects in everyday life such as pots and glassware contain some level of radioactivity
- A. due to the presence of primordial radionuclides such as plutonium-244.
 - B. and thus should be avoided at all cost as they present a high risk to our health.
 - C. resulting in the highest contribution to the annual dose of ionizing radiation we receive.
 - D. that can be removed quite easily in the manufacturing process.
 - E. that cannot and need not be avoided.
- (25) Radium was discovered by Marie and Pierre Curie in 1898 and was subsequently used in many applications such as in the luminous paint on the hands of clocks. Its use in the clocks was subsequently replaced by promethium and tritium because
- A. radium is a very rare element due to its relatively short half-life and is depleted since its discovery.
 - B. it is much cheaper to use promethium or tritium for this purpose.
 - C. of the health concerns due to high dose of radiation from radium.
 - D. promethium and tritium have better radioluminescence property than radium.
 - E. radium has a shorter half-life in comparison to promethium and tritium.

*End of paper. Please go back and check all your answers.
Answer all questions as no marks will be deducted for any wrong answer.*