UNIVERSITY COLLEGE LONDON

EXAMINATION FOR INTERNAL STUDENTS

MODULE CODE	:	**MPHY0038**
ASSESSMENT PATTERN	:	**MPHY0038A6UD**
MODULE NAME	:	**MPHY0038 - Treatment with Ionising Radiation**
LEVEL:	:	**Undergraduate**
DATE	:	**26-May-2022**
TIME	:	**10:00**

Controlled Condition Exam: 2 Hours exam

You cannot submit your work after the date and time shown on AssessmentUCL – you must ensure to allow sufficient time to upload and hand in your work

This paper is suitable for candidates who attended classes for this module in the following academic year(s):

Year
2021/22

Additional material	N/A
Special instructions	N/A
Exam paper word count	N/A

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Answer ALL questions. THREE questions in section A and THREE questions in section B

The numbers in brackets in the right-hand margin indicate the provisional allocation of maximum marks per sub-section of a question.

SECTION A (answer ALL questions)

1. A radiographer spends 30 minutes per day preparing radioisotopes for treatments. The sources are prepared behind a 2 cm thick glass screen. Using the data below, and making assumptions about a typical working year, estimate her annual skin dose. [6]
Average source to radiographer distance = 50 cm;
Activity of source = 2 GBq;
Energy of source = 300 keV;
$1\ eV = 1.602 \times 10^{-19}\ J$;
Mass energy absorption coefficient for skin = $31.6\ cm^2\ kg^{-1}$
1 cm of glass transmits 90% of the beam

2. (a) Discuss the differences between the terms *collision kerma* and *absorbed dose*. Explain under what circumstances they are equal and why. Include in your answer figures to demonstrate their dependence on depth and energy. [5]

   (b) Explain how the equality in (a) and Bragg-Gray cavity theory helps us to measure the dose at a given depth within the material. [3]

3. (a) Modern radiotherapy has access to a range of treatment beams, for example 2 MV x-rays, 20 MeV electrons and 200 MeV protons. Explain why the different PDD (percentage depth dose) curves lead to different applications in radiotherapy. Give an example patient case for each beam type. Discuss for one of the cases the potential outcome of using each of the other beams. [6]

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SECTION B (answer ALL questions)

4. (a) Explain how the terms GTV, CTV and PTV are used in planning a radiotherapy treatment. [3]

   (b) How is the PTV margin calculated? [2]

   (c) A patient is diagnosed with breast cancer and will be treated with external beam radiotherapy. Describe the process leading up to the day of first treatment, including the 1st treatment (fraction). [5]

5. (a) Explain the reason for the shape of the radiation dose – response curve. Explain how the shape of the curve and differences between tumour and normal tissue can be exploited for therapeutic benefit. [4]

   (b) *Single strand breaks* and *double strand breaks* occur during irradiation of mammalian tissues. Discuss the potential consequences of each and their role in radiation-induced cell death. [8]

   (c) Describe each of the 4 Rs of radiobiology and explain their role in radiotherapy. [8]

6. A Cs-137 radioactive source is placed at a distance of 10 cm from an ionisation chamber. The chamber records a charge of 7.5 μC. Calculate the following:
   (i) exposure in the chamber; [2]
   (ii) absorbed dose to the wall of the chamber; [2]
   (iii) activity of the source. [6]

   (Cs-137 emits gamma rays with an energy of 662 keV; the chamber wall is made of graphite, and the chamber is filled with air; volume of air in the chamber is 1 cm^3; density of air = 1.205×10^{-3} g cm^{-3}; mass energy absorption coefficient of air at 662 keV = 29.2 cm^2 kg^{-1}; mass energy absorption coefficient of graphite at 662 keV = 29.3 cm^2 kg^{-1}; 1 eV = 1.602×10^{-19} J; W_{air}/e = 33.97 J C^{-1})

END OF PAPER