MACHAKOS UNIVERSITY

University Examinations 2016/2017

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PYSICAL SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FIRST YEAR SECOND SEMESTER EXAMINATION FOR DEGREE IN BACHELOR OF SCIENCE IN ENVIRONMENTAL SCIENCES

ERC 106: PHYSICAL SCIENCES FOR NATURAL RESOURCES

DATE: 29/5/2017 **TIME: 11:00 – 1:00 PM**

INSTRUCTIONS

Answer Question One and Any Other Two Questions

The following constants may be useful 1eV = 1.67 x 10^{-19} J

a) Use the process of compressing a spring as an example to distinguish work and energy (2 marks)

b) Explain why the following energy sources are regarded as renewable
   i) Hydroelectricity (2 marks)
   ii) Geothermal energy (2 marks)

c) State one energy source that remains unexploited due to lack of technology but thought to be the source of energy in the future. (1 mark)

d) Explain how water is capable of producing electricity (2 marks)

e) State THREE aspects important to consider when planning for energy resources or making decisions regarding energy (3 marks)

f) Define the term mechanical energy (2 marks)

g) i) Give the two meanings of the phrase " energy conservation" (2 marks)
   iii) Hence state two methods of conserving energy (2 marks)

h) Define the term albedo (2 marks)

i) A cylinder contains 4 litres of hydrogen gas at 400 k and 2.4 atmospheres. The gas is heated, causing a piston to expand outward. The heating causes temperature to increase to 800 K and the volume of the cylinder increases to 7 litres. What is the final gas pressure in Pascal's? (3 marks)

j) Define radioactivity (2 marks)

k) Gamma rays are simply high energy photons. What are alpha and beta particles? (2 marks)

l) 300 joules of energy are transferred to a system in the form of heat while the internal energy increases by 150 joules. How much work is done on or by the system? (3 marks)

SECTION B: ANSWER ANY OTHER TWO QUESTIONS

QUESTION TWO (20 MARKS)

a) i) Explain how sun's energy was stored before the dawn of civilisation for use in a later time. (4 marks)

ii) Explain why current use of energy resources, resources stored for millions of years is causing havoc to environment. (3 marks)

b) Find the activity of 2 g of radium whose half-life is 1620 years (5 marks)

c) Develop equations that model decay curves A and B in **figure 1** given that decay constant is $\lambda = 3$ (5 marks)

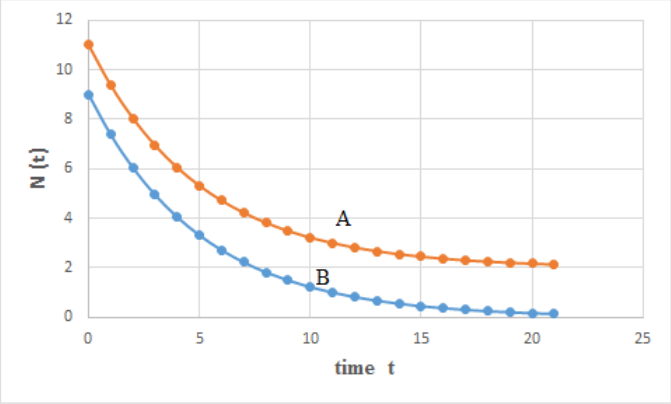

Figure 1

m) Describe the sun's source of energy (3 marks)

QUESTION THREE (20 MARKS)

a) Explain the process that can lead to global cooling (3 marks)

b) Explain how global warming is caused (3 marks)

c) Half-life of radon is 3.8 days. After how many days will only 18 % of original sample remain? (4 marks)

d) State the first law of thermodynamics (give the statement and its math equivalent) (2 marks)

e) i)With a well labelled diagram draw a sketch showing the basic parts of a nuclear plant (3 marks)

ii) What are the TWO environmental factors to consider when setting up a nuclear plant? (2 marks)

f) A 70 kg nuclear plant worker is exposed to 3 mJ of neutron radiation with an RBE of 9. What is the dose in mSv. (3 marks)

QUESTION FOUR (20 MARKS)

a) Describe acid rain using two chemical equations depicting formation of carbonic and sulphuric acid (4 marks)

b) An x-ray tube used for medical work has an accelerating voltage of 300 kV. What is the maximum energy of an x-ray photon that can be produced in this tube? What is the wavelength of this x-ray (4 marks)

c) The graph in figure 2 shows variation of Neutron (N) number as Proton number (Z) increases

i) What does the curve A and B signify (2 marks)

ii) When are light nuclei more stable (1 mark)

iii) Heavy nuclei are more stable when N > Z, why? (3 marks)

iv) What happens to elements whose proton number Z exceed 83 (2 marks)

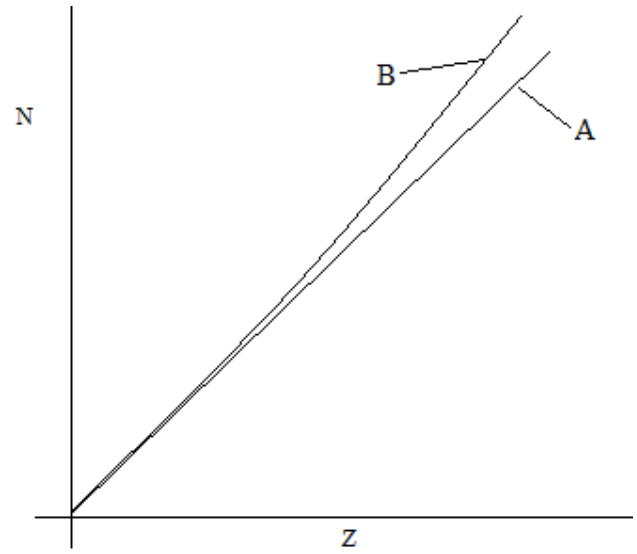

Figure 2

QUESTION FIVE (20 MARKS)

a) A 10 kg of a radioactive sample discovered in earths sister planet Venus is found to decay as follows

Time t (years)	0	2	4	6	8	10	12	14	16
Sample left (kg)	9	6.03	4.04	2.71	1.81	1.21	0.82	0.54	0.36
time	18	20							100000
sample	0.24	0.16							

i) Draw to scale a decay curve for this element for $0 < t < 20$ (5 marks)

ii) Develop an equation that models the data given that decay constant is 2.0×10^{-4} (4 marks)

iii) Use the equation to compute sample remaining when t = 100000 years. (2 marks)

iv) What happens to sample size as $t \rightarrow \infty$ (1 mark)

b) i) Illustrate with a well labelled diagram how geothermal energy is generated. (3 marks)

ii) In geothermal energy exploitation state two aspects of environmental consideration (2 marks)

c) Gamma rays with very high energy of 3.5×10^{14} eV are occasionally observed from distant astrophysical sources. What are the wavelengths and frequency corresponding to this photon energy? (3 marks)