This is a Class 1 exam

Lebanon Evangelical School
for Boys and Girls
Loueizeh - Baabda

Stage Exam 06

19, 20, 21JUN2023

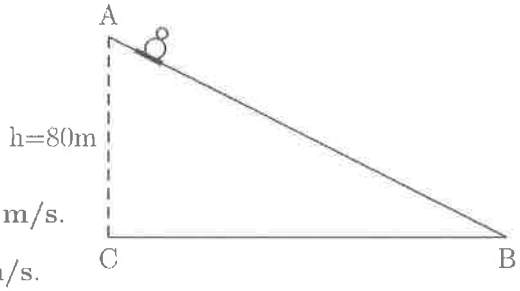
Do NOT write in this box. Your MARK will be placed here.

Subject :	Physics	
Class :	11SE	
Teacher :	Mr. Ali Moukalled	
Duration :	1 hour	
Your name :		*Time taken to complete exam*
Your Class :		
Exam Room :		
How many sheets, including cover sheet :		

- Do not open this paper until the teacher in charge instructs you to do so.
- The most important thing to remember in taking an exam is NEVER PANIC.
- If you are caught cheating in this exam, you will be awarded zero for ALL exams that are taken on this day.

EXERCISE 1 (7 points)

A child, of mass $\mathbf{M = 45\,Kg}$, starts from rest from the point A of an inclined track AB as shown in the adjacent figure (AC= $\mathbf{h = 80\,m}$). The horizontal plane through BC is taken as a gravitational potential energy reference. Take $g = 10\,m/s^2$.



1. Calculate at A:
   (a) The gravitational potential energy of the system (S) formed of the child and the Earth.
   (b) The mechanical energy of the system (S).
2. Neglect the forces of friction.
   (a) Determine the value of the mechanical energy of the system (S) at B.
   (b) Deduce that the speed of the child at B is $\mathbf{V_B = 40\,m/s}$.
3. In reality, the child reaches B with the speed $\mathbf{V'_B = 35\,m/s}$.
   (a) Calculate then the mechanical energy of the system (S) at B.
   (b) Determine the variation in the mechanical energy of (S) when it passes from A to B.
   (c) Deduce the value of the energy dissipated due to the forces of friction between A and B.
   (d) In what form does this dissipated energy appear?

EXERCISE 2 (6 points)

1. The Radium isotope $^{226}_{88}Ra$, of period (or half-life) T, is an alpha α emitter.
   (a) What is meant by an isotope of an element?
   (b) The α radiation indicates a nuclide. Name this nuclide.
   (c) Define the period of a radioactive substance.
2. The radio-nuclide $^{226}_{88}Ra$ decays into radon Rn according to the equation :

$$^{226}_{88}Ra \longrightarrow \ldots\ldots\ldots + {}^{A}_{86}Rn$$

   (a) Complete the equation and specify the used law.
   (b) A sample of $^{226}_{88}Ra$ has a mass $m_0 = 8\ g$ at the instant $t = 0$. Find the mass of radium remaining at the instant $t = 3T$.
   (c) The decay of a nucleus of $^{226}_{88}Ra$ liberates an amount of energy of 4.881 MeV. Find the value of this energy in joules and calculate the corresponding mass defect.
   Take: $1\ MeV = 1.6 \times 10^{-13}\ J$
   Speed of light in vacuum*colon* $c = 3 \times 10^8\ m/s$.
3. The α decay is generally accompanied with the emission of another radiation.
   (a) Identify this radiation (Name and nature)?
   (b) This radiation is dangerous. Why?

EXERCISE 3 (7 points)

A nuclear power plant generates electricity from the nuclear energy produced inside its nuclear reactors. Suppose that the nuclear reaction that takes place inside a reactor is :

$$^{235}_{92}U + ^{1}_{0}n \longrightarrow ^{144}_{56}Ba + ^{89}_{36}Kr + 3^{1}_{0}n$$

Nucleus	$^{1}_{0}$n	$^{235}_{92}$U	$^{144}_{56}$Ba	$^{89}_{36}$Kr
Mass in u	1.008	234.994	143.922	88.917

Speed of light in vacuum $\mathbf{c = 3 \times 10^{8} m/s}$; $\mathbf{1u = 1.66 \times 10^{-27} Kg}$; $\mathbf{1MeV = 1.6 \times 10^{-13} J}$

1. The above nuclear reaction is fission. Justify.
2. Show that the loss of mass in this reaction is: $\mathbf{\Delta m = 0.139u}$.
3. Determine, in joules, the energy E liberated by this reaction.
4. Show that the value of this energy in **MeV** is $\mathbf{E = 129.8MeV}$.
5. Knowing that **34%** of the nuclear energy E is transformed into electrical energy E', calculate E' in **MeV**.

GOOD LUCK

SE06/2022 2023/ Physics / IIS E "Solution"

Exercise 1

$M = 45\ kg$, $V_A = 0\ m/s$, $h = 80m$, $g = 10\ m/s^2$

1) a) $G.P.E_A = mgh = 45 \times 10 \times 80$

$$\boxed{G.P.E_A = 36000\ J}$$ (1)

b) $M.E_A = G.P.E_A + K.E_A$

$= 36000J$

$$\boxed{M.E_A = 36000J}$$ (1)

2) a) In the absence of friction the M.E is conserved

$M.E_A = M.E_B = 36000J$ (0.5)

b) $M.E_B = K.E_B + G.P.E_B$

$36000 = \frac{1}{2} m V_B^2$

$36000 = 22.5\ V_B^2$

$V_B^2 = 1600$

$$\boxed{V_B = 40m/s}$$ (1)

3) $V_B' = 35m/s$

a) $M.E_B = K.E_B + G.P.E_B = \frac{1}{2} m V_B'^2 = 0.5(45)(35)^2$ (1) (1)

$$\boxed{M.E_B = 27562.5\ J}$$

b) $\Delta M.E = M.E_B - M.E_A$

$= 27562.5 - 36000$ (1)

$= -8437.5\ J$

c) $W_{Br} = -8437.5J$ (1)

d) Heat (0.5)

Exercise 2

1) a) Isotopes: Two or more nuclei that have same atomic number but different mass number.

b) $\alpha: {}^{4}_{2}He$ (Helium) (1)

c) Period: Is the time needed by a radioactive sample to get half decayed.

2) a) ${}^{226}_{88}Ra \longrightarrow {}^{4}_{2}He + {}^{A}_{86}Rn$

(1) Due to Soddy's law

$226 = 4 + A$ (1)

$\Rightarrow A = 222$

${}^{226}_{88}Ra \longrightarrow {}^{4}_{2}He + {}^{222}_{86}Rn$

b) $m_0 = 8g \qquad t = 3T$ (1)

$m_{rem} = \frac{m_0}{2^3} = \frac{8}{8} = 1g$

c) $E_{liberated} = 4.881\ MeV$

$E_{lib} = 4.881 \times 1.6 \times 10^{-13}$

$E_{lib} = 7.8096 \times 10^{-13}\ J$

* $E_{lib} = \Delta m\, c^2$

$\Delta m = \frac{E_{lib}}{c^2} = \frac{7.8096 \times 10^{-13}}{(3 \times 10^8)^2} = 8.67733 \times 10^{-30}\ kg$ (1)

$$\boxed{\Delta m = 8.67733 \times 10^{-30}\ kg}$$

3) a) γ radiation (electromagnetic radiation)

b) It has high penetrating power. (1)

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Exercise 3

$$^{235}_{92}U + {}^{1}_{0}n \longrightarrow {}^{144}_{56}Ba + {}^{89}_{36}Kr + 3\,{}^{1}_{0}n$$

1) Since a heavy nucleus is breaking down to give two lighter nuclei: (1)

2) $\Delta m = m_{before} - m_{after}$

$= (m_U + m_n) - (m_{Ba} + m_{Kr} + 3m_n)$

$= (234.994 + 1.008) - (143.922 + 88.917 + 3 \times 1.008)$ (2)

$= 0.139\ u$

3) $\Delta m = 0.139\ u = 0.139 \times 1.66 \times 10^{-27}$

$= 2.3074 \times 10^{-28}\ kg$

$E_{lib} = \Delta m c^2$ (2)

$= 2.3074 \times 10^{-28} \times (3 \times 10^8)^2$

$= 2.07666 \times 10^{-11}\ J$

$$\boxed{E_{lib} = 2.07666 \times 10^{-11}\ J}$$

4) $E_{lib} = 2.07666 \times 10^{-11} \div 1.6 \times 10^{-13}$ (1)

$= 129.79125\ MeV$

$\simeq 129.8\ MeV$ (1)

5) $E' = 0.34 \times 129.8$

$E' = 44.132\ MeV$

(4)