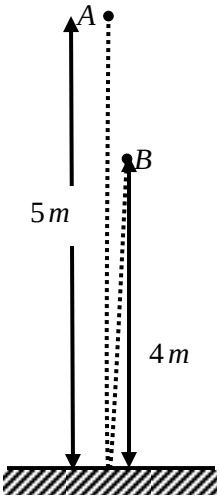
## Test Sample SE

### I- (7 pts)
### ME and Collision

A $160g$ ball is dropped without initial velocity from a height of $h_A = 5m$. The ball hits the ground and bounces back up reaching a height of $4m$.

Neglect air resistance, take $g = 10m/s^2$, and consider the ground as a reference level for the gravitational potential energy for the system (Ball, Earth).




**Part A**

Consider the downward of the ball:

1. Calculate the mechanical energy *ME* of the system (ball, Earth) when the ball is at $5m$.
2. State the law of conservation of *ME* ? Is the *ME* conserved during the fall of the ball?
3. Calculate the kinetic energy of the ball $KE'$, as it reaches the ground. Deduce the speed of the ball.

**Part B**

Consider the upward motion of the ball:

1. Calculate the mechanical energy $ME_1$ of the system when it's at height $4m$.
2. What is the value of the mechanical energy $ME''$ of the system when the ball is just leaving the ground?
3. Deduce the kinetic energy of the ball $KE''$, just after it leaves the ground. Compare $KE'$ and $KE''$.

**Part C**

Is there loss or gain in the kinetic energy of the ball during its collision with the ground? Find its value. In what form does it appear?

### II-(7 points)
### Chernobyl accident

The accident that took place in Ukraine, April 26th 1986 due to the explosion of the reactor of the thermonuclear power plant makes the nuclear fission that was produced as uncontrolled. A huge fire destroys the site and spreads a high radiation that contaminated quickly a zone over a radius of 30 kilometer. The formation, among others, of Iodine $^{131}_{53}I$ which is an $\beta^-$emitter, increases the radioactivity in the surrounding medium. In addition to the exposure to the radiations, the citizens are affected by the absorption of polluted air and the consumption of contaminated food.

**Given:**

| | |
|---|---|
| Mass of a $^{131}_{53}I$ nucleus = 131.01576 $u$ | 1u = $1.66 \times 10^{-27}$ kg |
| Mass of a $^{A}_{Z}X$ nucleus =130.2567$u$ | Speed of light in vacuum c = $3\times10^{8}$ m/s |
| Mass of an electron ($^{0}_{-1}$e) = 0.00055 u | |

**Questions**

1. What is the type of the nuclear reactions that is present in the nuclear reactor.
2. Pick up from text , the statement, that shows that: "the reactor produces radioactive nuclei"
3. What do the numbers 131 and 53represent with respect to the Iodine nuclide?
4. The balanced equation of the nuclear disintegration of Iodine 131 may be written as :

$$^{131}_{53}I \longrightarrow {}^{0}_{-1}e^{-} + {}^{A}_{Z}X .$$

a) Applying the laws of conservation, determine A and B.
b) Calculate, in u then in kg, the mass defect in this reaction.

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c) Deduce, in J, the energy liberated by this reaction.

6. Radioactive radiations are not always harmful. Give three useful applications of radioactivity.
7. List three dangers that the citizens are exposed to as a result of the reactor's explosion.

**III-(7 points)**

**Health and fuel**

"We have to be very immediately concerned about finding solutions for the toxic effects the combustion engine has on human health," bio-diesel fuel cuts asthma-causing particles and carbon monoxide in vehicle exhaust by nearly 50 percent, releases far fewer cancer-causing compounds into the air, and cuts down on ozone and smog now choking us and our planet. "***This*** affects all of the issues — our dependence on Middle East oil, the root problem in the world today,"

VW diesel cars are now available for less than $20,000. Next, they bought a unit to process the bio-diesel. Made by a California company specializing in small-scale bio-processors, the unit costs $7,000 and makes about 40 gallons of biodiesel in 48 hours.

**Questions**

1. Pick up from text the statement that confirm that:
    a. " The biodiesel fuel is healthier than fuel"
    b. The importance of fuel in our life.
2. Give two differences between renewable and non renewable source of energies.
3. What is the effect of combustion on Health?
4.

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5. **Solution:**

**I-**

**Part A**

1. $ME|_h = KE|_h + GPE|_h$ ; $KE|_h = 0$ ( Released from rest)

$= m\,g\,h_A = 0.16\times 10\times 5 = 8\,J$ .

2. Statement: When a system is energetically isolated, no exchange with the external medium then the mechanical energy of the system is conserved.

Yes, it is conserved. Since the forces of friction are negligible.

3. $ME|_{h=0,b} = ME|_h \Rightarrow ME|_{h=0,b} = GPE|_{h=0,b} + KE|_{h=0,b} = 8\,J$ . $GPE|_{h=0,b} = 0$ ( On reference)

Then $KE' = KE|_{h=0,b} = 8\,J$ .

And $KE' = KE|_{h=0,b} = 8\,J = \frac{1}{2} m\,v_b'^2 \Rightarrow v_b' = \sqrt{\frac{2\times 8}{m_A}} = 10\,m/s$ .

**Part B**

1. $ME_B = ME|_{h_B} = KE|_{h_B} + GPE|_{h_B}$ ; $KE|_{h_B} = 0$ ( Maximum distance reached)

$= m\,g\,h_B = 6.4\,J$ .

2.After collision, the mechanical energy is conserved.

$ME'' = ME_B = 6.4\,J$ .

3. $ME'' = KE'' + GPE'' = 6.4\,J$ ( $GPE'' = GPE|_{h-0} = 0$ , on reference).

Then $KE'' = 6.4\,J$ .

$KE'' = 6.4\,J < KE' = 8\,J$ .

**Part C**

The kinetic energy is reduced during collision $\Delta(KE) = |KE'' - KE'| = |6.4 - 8| = 1.4\,J$ .

The loss of energy is converted into a thermal energy (Heat) or energy to cause the system deformation.

**I-**

1.Nuclear fission.

2.″ Power plant makes the nuclear fission that was produced as uncontrolled″.

3.131 is the mass number while 53 is the atomic or charge number.

4.a)Conservation of mass number $131 = 0 + A \Rightarrow A = 131$

Conservation of charge number $53 = -1 + Z \Rightarrow Z = 54$

$^{131}_{53}I \longrightarrow {}^{0}_{-1}e^- + {}^{131}_{54}X$ .

b)The mass defect : $\Delta m = m_b - m_a = m(I) - m(\beta^-) - m(X) = 0.75845\,u$ .

$= 0.75845\times 1.66\times 10^{-27} = 1.259027\times 10^{-27}\,kg$ .

c)The energy liberated $E_\ell = \Delta m\,c^2 = 1.259027\times 10^{-27}\times\left(3\times 10^8\right)^2 = 1.133\times 10^{-10}\,J$ .

5. Radiotherapy (To treat patient affected by can cancer), Scintigraphy or tomography.

6. «Polluted air and the consumption of contaminated food».

***Note:*** The Geiger-Muller counter is used to detect the presence of radiations.

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