مسابقة في الثقافة العلمية: مادة الفيزياء
المدة: ساعة واحدة

الاسم:
الرقم:

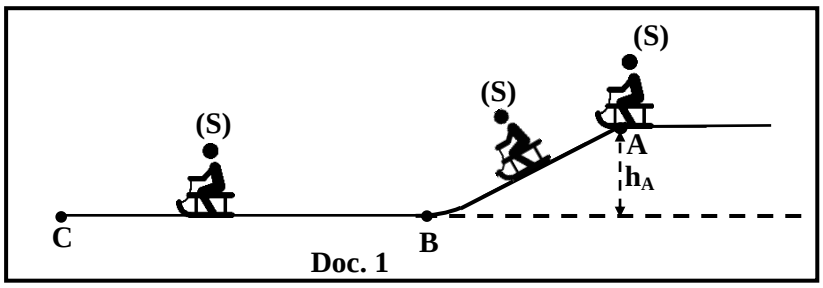
This exam is formed of three exercises in two pages.
The use of non-programmable calculator is recommended.

Exercise 1 (7 pts)

Motion of a sled

A child sitting on a sled slides on a track ABC, located in a vertical plane. The system (Child, Sled), considered as a particle (S), of mass m = 85 kg, is at rest at point A of height h_A = 1.8 m above the horizontal part BC of the track (Doc. 1). (S) slides down without friction on the inclined part AB.
Take:

- the horizontal plane containing BC as the reference level for gravitational potential energy of the system [(S), Earth];
- g = 10 m/s^2.



Doc. 1

1) Calculate the value of the gravitational potential energy $GPE_{(A)}$ of the system [(S), Earth] at A.
2) Deduce the value of the mechanical energy $ME_{(A)}$ of the system [(S), Earth] at A.
3) Show, using the principle of the conservation of mechanical energy between A and B, that the value of the kinetic energy of (S) at B is $KE_{(B)}$ = 1530 J.
4) Deduce the value of the speed V_B of (S) at B.
5) (S) continues its motion on the horizontal part BC and stops at point C.
Choose with justification the correct answer.

5.1) During the motion of (S) between B and C, the kinetic energy of (S):
a) increases **b)** decreases **c)** remains the same

5.2) During the motion of (S) between B and C, the gravitational potential energy of the system [(S), Earth]:
a) increases **b)** decreases **c)** remains the same

5.3) The value of the mechanical energy $ME_{(C)}$ of the system [(S), Earth] at C is:
a) 0 J **b)** 1530 J **c)** 6 J

5.4) The loss in the mechanical energy of the system [(S), Earth] between B and C is:
a) 1524 J **b)** 1530 J **c)** 6 J

Exercise 2 (7 ½ pts)

Uranium-235

The uranium atom is the heaviest atom present in the natural environment. All isotopes of uranium are radioactive.

1) The two main isotopes of uranium are $^{238}_{92}U$ and $^{235}_{92}U$.

1.1) The nuclides $^{238}_{92}U$ and $^{235}_{92}U$ are isotopes. Why?

1.2) Indicate the composition (number of protons and number of neutrons) of the uranium $^{235}_{92}U$.

2) Uranium-235 naturally decays into thorium-231 by emitting α particle according to the following nuclear decay:

$$^{235}_{92}U \rightarrow {}^{231}_{Z}Th + \alpha$$

2.1) Indicate the name and the symbol of the emitted α particle.
2.2) Calculate Z, indicating the used law.
2.3) The disintegration of $^{235}_{92}U$ is sometimes accompanied with the emission of γ radiation. Indicate the cause of the emission of γ radiation.

3) Uranium $^{235}_{92}U$ is also a fissile nucleus, because it may undergo fission reaction under the impact of a thermal neutron. One of the uranium-235 nuclear fission reactions is the following:

$$^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{94}_{38}Sr + {}^{139}_{54}Xe + 3\ {}^{1}_{0}n$$

Given:

Particle or nucleus	Neutron $^{1}_{0}n$	Uranium $^{235}_{92}U$	Strontium $^{94}_{38}Sr$	Xenon $^{139}_{54}Xe$
Mass in u	1.0087	234.9942	93.8945	138.8892

$1u = 1.66\times10^{-27}$ kg; speed of light in vacuum: $c = 3\times10^{8}$ m/s.

3.1) Define « nuclear fission».
3.2) Show that the mass defect due to this reaction is $\Delta m = 0.1931$ u.
3.3) Determine, in joule, the energy liberated by the fission of one nucleus of uranium-235.

Exercise 3 (5 ½ pts)

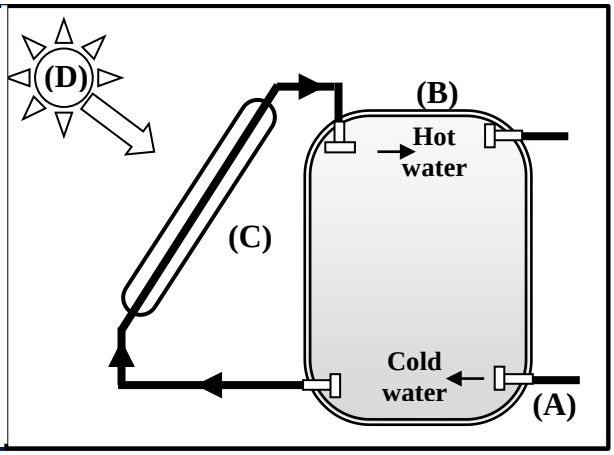
Solar water heater

The text and the diagram of document 2 explain the function of a solar water heater.
Read carefully document 2 and then answer the questions.

Cold water enters through an inlet **(A)** into an insulated storage tank **(B)**. It flows through a panel **(C)** which absorbs solar radiation **(D)**. The water absorbs the solar energy and becomes hot. The hot water re-enters the tank where it exchanges heat with the rest of the water through convection. The hot water exists at the top of the tank, since its density is less than that of the cold water.

https://commons.wikimedia.org/

Doc. 2



1) Pick up from document 2:
1.1) the two mentioned forms of energy;
1.2) the statement that shows that "when the water in the heater gains heat energy its temperature rises";
1.3) the name of the part of the water heater where water absorbs the energy from the Sun;
1.4) the reason why the hot water remains at the top of the tank.

2) Copy and then complete correctly each of the following statements:
2.1) The solar water heater converts the …… energy into ……. energy.
2.2) The form of energy transferred between two bodies as a result of a difference in their ……. is called the heat energy.

3) Electric water heater is another device used to heat water. Name the form of the energy received by this device.

وزارة التربية والتعليم العالي
المديرية العامّة للتربية
دائرة الامتحانات الرسميّة

امتحانات الشهادة الثانوية العامة
فرعا: الاجتماع والاقتصاد والآداب والإنسانيات

دورة العام 2021 العاديّة

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المدة: ساعة واحدة

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Exercise 1 (7 pts) Motion of a sled

Part		Answer	Mark
1		$GPE_{(A)} = mgh_A = 85 \times 10 \times 1.8 = 1530$ J	1
2		$ME_A = KE_A + GPE_{(A)} = 0 + 1530 = 1530$ J	1
3		$ME_A = ME_B = KE_B + GPE_{(B)}$ B is on the gravitational potential energy reference, so $GPE_{(B)} = 0$ J Then, $KE_B = ME_A = 1530$ J	0.25 0.5 0.25
4		$KE_B = \frac{1}{2} m V_B^2$. Then, $V_B^2 = \frac{2KE_B}{m}$; So: $V_B = \sqrt{\frac{2\times1530}{85}} = 6$ m/s	1
5	5.1	**b)** decreases: the speed of (S) at B is $V_B = 6$ m/s and at C is $V_C = 0$ m/s **OR** because (S) stops at C	0.75
	5.2	**c)** remains the same: all along BC, (S) is on the PE_g reference level $PE_g = 0$ J at any time on BC **OR:** The height remains constant	0.75
	5.3	**a)** $ME_C = 0$ J: $ME_C = KE_C + GPE_{(C)} = 0 + 0 = 0$ J	0.75
	5.4	**c)** $ME_{loss} = 1530$ J; $ME_{loss} = ME_B - ME_C = 1530 - 0 = 1530$ J	0.75

Exercise 2 (7 ½ pts) Uranium-235

Part		Answer	Mark
1	1-1	Because they have same charge number Z = 92 and different mass number A.	1
	1-2	Number of protons: Z = 92 Number of neutrons: N = 235 – 92 = 143	0.5 0.5
2	2-1	Name: Helium nucleus Symbol: ^4_2He	0.5 0.5
	2-2	Using the law of conservation of charge number: 92 = Z + 2 ; Z = 90	0.5 0.5
	2-3	Gamma radiation is emitted due to the downward transition (de-excitation) of the daughter nucleus.	0.5
3	3-1	A heavy nucleus is divided into lighter nuclei under the impact of a thermal neutron.	1
	3-2	$\Delta m = m_{before} - m_{after} = (234.9942 + 1.0087) - (138.8892 + 93.8945 + 3\times1.0087)$ Then: $\Delta m = 0.1931$ u	0.5 0.5
	3-3	$E_{lib} = \Delta m \times c^2$ $\Delta m = 0.1931 \times 1.66\times10^{-27} = 3.2054\times10^{-27}$ kg $E_{lib} = 3.2054\times10^{-27} \times (3\times10^8)^2 = 2.8848 \times10^{-11}$ J	0.25 0.25 0.5

Exercise 3 (5 ½ pts) **Solar water heater**

Part		Answer	Mark
1	1.1	Solar energy Thermal energy	0.5 0.5
	1.2	The water absorbs the solar energy and becomes hot.	0.75
	1.3	Solar panel **(C)**	0.75
	1.4	The hot water exists at the top of the tank, since its density is less than that of the cold water.	1
2	2.1	Temperature The solar water heater converts the ***solar*** energy into ***thermal*** energy.	1
	2.2	The form of energy transferred between two bodies as a result of a difference in their ***temperature*** is called the heat energy.	0.5
3		Electric Energy	0.5