This exam is formed of three exercises in two pages.
### *The use of a non - programmable calculator is allowed.*

First exercise   *(7 points)*

A child on an inclined track

A child, of mass M = 45 kg, starts from rest from the point A of an inclined track AB as shown in the adjacent figure (AC = 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 V_B = 40 m/s.
3. In reality, the child reaches B with the speed 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?
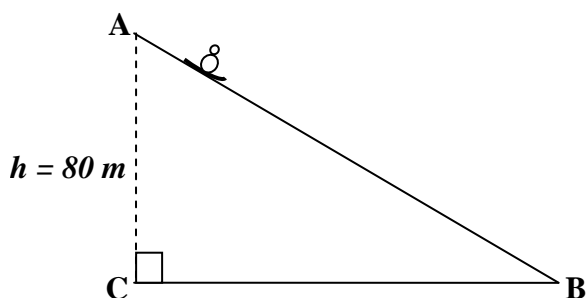
Second exercise   *(7 points)*   *Cobalt-60*

Read carefully the following text then answer the questions that follow.

"The use of ionizing radiations in medicine reveals the importance of nuclear physics in various fields. In particular, the radiotherapy contributes significantly in treating cancer. Cobalt 60 ($_{27}^{60}\text{Co}$), β^- emitter, is used in medicine as a radioactive source.

The disintegration of $_{27}^{60}\text{Co}$ gives an isotope of the element nickel ($_Z^A\text{Ni}$) as a daughter nucleus.

Questions

1. What are the constituents of the cobalt 60 nucleus?
2. Identify the emitted β^- particle.
3. Calculate Z and A specifying the laws used.
4. The disintegration of $_{27}^{60}\text{Co}$, is in general, accompanied by the emission of a γ radiation. Due to what is this γ emission?
5. The source of cobalt, implanted in a cancerous tissue, produces 6×10^8 disintegrations per second. Each disintegration produces, on the average, an energy of 5×10^{-13} J.
    a) Give the value of the activity of the source.
    b) Determine the energy absorbed by the tissue at the end of one second.
    c) The energy absorbed by the tissue becomes dangerous when its value exceeds 3 J. What must be then the maximum duration of this treatment?

Third exercise   (6 points)

Jupiter

Read carefully the following text then answer the questions that follow:

"Jupiter is the largest planet of the solar system. It rotates around the Sun in 11 years, 10 months and 15 days and turns around itself in 9 hours 55 minutes…

Jupiter is the fourth most visible object in the sky (after the Sun, the Moon and Venus)…

The Galileo's discovery, in 1610, of the four moons of Jupiter, now known as the Galilean moons, was the first discovery of a motion that is not centered on the Earth. It was a major point in favor of the theory of Copernicus…

Jupiter is a gaseous and a giant planet. It has no solid surface…

Its atmosphere is formed of hydrogen (85 %) and helium (14 %) and traces of ammonia and methane."

Questions

1. In the text, two sentences refer to two theories in astronomy.
   a) Give the names of these two theories.
   b) One of the two theories is that of Copernicus. Give the name of a scientist who is a supporter of the other theory.

2. The planets of the solar system are classified into two groups. Jupiter belongs to one of these two groups.
   a) Which one?
   b) Pick up, from the text, the expression which denotes that Jupiter belongs to this group.

3. Pick up , from the text, the value of:
   a) The period of revolution of Jupiter.
   b) The period of rotation of Jupiter.

4. Before Galileo, it was not possible to see the four satellites of Jupiter. In 1610, Galileo was able to observe these satellites. How did he proceed?

5. The speed of rotation of Jupiter around its axis is greater than that of the Earth around its axis. Justify.

First exercise (7 points)

Part of the Q	Answer	Mark
1.a	$(PE)_A = mgh = 45 \times 10 \times 80 = 36000$ J.	1¼
1.b	$(ME)_A = (KE)_A + (PE)_A$. But $(KE)_A = 0 \Rightarrow (ME)_A = (PE)_A = 36000$ J	1
2.a	Since forces of friction are negligible $(ME)_A = (ME)_B = 36000$ J	1
2.b	$(ME)_B = \dfrac{1}{2} mV_B^2 = 36000 \Rightarrow V_B = 40$ m/s.	¾
3.a	$(ME)_B = \dfrac{1}{2} mV_B'^2 = \dfrac{1}{2} \times 45 \times (35)^2 = 27562.5$ J	¾
3.b	$\Delta ME = 27562.5 - 36000 = -8437.5$ J	¾
3.c	Energy dissipated by forces of friction $E_f = -\Delta ME = 8437.5$ J	1
3.d	In the form of heat.	½

Second exercise (7 points)

Part of the Q	Answer	Mark
1	$^{60}_{27}\text{Co}$: 27 protons and 33 neutrons.	1
2	electron	¾
3	$^{60}_{27}\text{Co} \rightarrow ^{A}_{Z}\text{Ni} + ^{0}_{-1}\text{e}$ Conservation of mass number: A = 60. Conservation of charge number: Z = 28.	1½
4	Due to the de-excitation of the daughter nucleus.	¾
5.a	6×10^8 dis./s	¾
5.b	$E = 6 \times 10^8 \times 5 \times 10^{-13} = 3 \times 10^{-4}$ J/s.	1
5.c	$3 = 3 \times 10^{-4} \times t \Rightarrow t = 10^4$ s = 2.78 h	1¼

Third exercise (6 points)

Part of the Q	Answer	Mark
1.a	The geocentric theory and the heliocentric theory	1
1.b	Ptolemy or Plato or Aristotle.	1
2.a	The outer group of planets.	½
2.b	Jupiter is a gaseous giant planet.	½
3.a	The period of revolution of Jupiter is 11 years, 10 months and 15 days	½
3.b	The period of rotation of Jupiter is 9h55mn.	½
4	The invention of an astronomical telescope.	1
5	$T_{Jupiter} = 9$ h 55 mn ; $T_{Earth} = 24$ h $\Rightarrow T_J < T_{Earth}$	1