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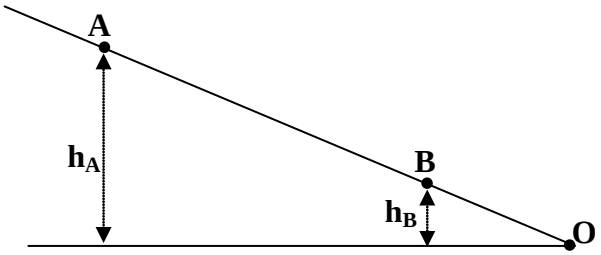
This Exam is constituted of three exercises on two pages.
The use of non- programmable calculators is allowed

First Exercise (6 ½ pts) Conversion of Energy

A skier, of mass M = 80 kg, descends down a slope along a straight path at a constant speed of 10 m/s. As the skier slides along the path, he passes through two positions A and B of respective altitudes h_A = 200 m and h_B = 35 m with respect to the horizontal plane through O. This plane is taken as a gravitational potential energy reference ($P.E_g = 0$).Take g = 10m/s^2.



1) Along the downward track, the system (skier-Earth) loses potential energy. Why?
2) a) Calculate the values, $M.E_A$ and $M.E_B$, of the mechanical energy of the system (skier-Earth) upon passing through A and through B.
b) Calculate the decrease E in the mechanical energy between A and B.
c) Due to what is this decrease?
d) In what form does this decrease in energy appear?
3) Absorbing 90 % of E, a certain amount of snow, of mass m, melts.
a) Calculate the value of the energy absorbed by snow along the path AB.
b) Knowing that 1 kg of snow has to absorb 336000 J of energy in order to melt, calculate m.

Second Exercise (7pts) Nuclear Fusion and Fission

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

« Nuclear fusion is a wonderful source of energy that causes the glow of stars. It is expected to offer humanity a non-depleting source of energy. Unlike nuclear fission that is used in nuclear reactors to produce electric energy, fusion is less polluting…

Indeed, while fission breaks down heavy atoms (uranium and plutonium) to liberate its force, fusion groups light atoms of deuterium ${}_1^2H$ and tritium ${}_1^3H$, two isotopes of hydrogen, to produce helium ${}_2^4He$ and another particle…

In reality, things are more precise since although man was able, for more than half a century, to liberate violently the forces of fission (atomic bomb) and those of fusion (hydrogen bomb) yet he was able to control only the first one…

It is worthy to note that 11 kg of hydrogen are enough to produce 10^9 W of electricity, whereas, for the same energy, a nuclear reactor consumes 500 kg of uranium and a thermal power plant requires 5 000 tons of fuel oil or10000 tons of coal ».

Le Monde: November 2003

Questions

1) Specify the origin of the energy that « causes the glow of stars ».

2) ${}_1^2H$ and ${}_1^3H$ are called isotopes. Why?

3) a) Write, using the laws of conservation, the equation of the reaction between a deuterium nucleus and a tritium nucleus.

b) Identify the emitted particle.

4) Fusion is less polluting than fission. Why?

5) In the selection we read:

« fission breaks heavy atoms (uranium and plutonium) to liberate its force».

a) Give the name of the particle that causes the fission of uranium 235.

b) Two words « atoms » and « force »are used in the above statement. Replace these two words by two other words that are in agreement with the nuclear terms.

6) Explain why the nuclear fusion requires very high temperature to be achieved.

7) Pick up from the selection,

a) a statement showing that, until these days, nuclear fission is exploited as a source of energy whereas nuclear fusion is not.

b) a statement showing that nuclear fusion is more energetic than nuclear fission.

Third exercise (6 ½ pts) Solar System

The table below gives some characteristics of the planets of the solar system.

Planet	Average distance from the Sun (A.U)	Period of revolution around the Sun (year)	Density (g/cm^3)	Surface Temperature (^oC)
Jupiter	**5.20**	**11.86**	**1.33**	**- 150**
Uranus	**19.19**	**84**	**1.30**	**- 200**
Venus	**0.72**		**5.24**	**480**
Earth	**1**	**1**	**5.51**	**22**
Saturn	**9.53**	**29.45**	**0.69**	**- 180**
Pluto	**39.53**	**247.7**	**2**	**- 230**
Mars	**1.52**		**3.94**	**-170 to35**
Mercury	**0.38**	**0.23**	**5.43**	**-170 to 400**
Neptune	**30**		**1.76**	**- 210**

Questions

1- The planets of the solar system are classified into two groups: the group of inner planets and that of outer planets.

a) The planets of one of these two groups are called terrestrial. What group is meant by that?

b) Name two planets of each group.

2- **a)** Pick up from the table two characteristic differences between the two mentioned groups.

b) The outer planets are gaseous except one. Which one?

3- The term, « Average distance from the Sun », indicates that the trajectory of a planet is not circular.

a) Specify the shape of the trajectory of a planet.

b) Give the name of the scientist who stated the law concerning this trajectory.

4- In the column « Period of revolution around the Sun », the values «1.88», «164» and «0.61» are missing. Match, with justification, the missing values for the corresponding planet.

5- Referring to the column « Density», specify, with justification, the planet that « may float on water ».

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Premier exercice (6 ½ pts.)

1) L'altitude diminue **(½ pt)**

2) a- Expression $E_m = ½ M(V)^2 + Mgh$ **(1½ pt)**

$E_{mA} = 164000$ J **(½ pt)**

$E_{mB} = 32000$ J **(½ pt)**

b- $E = 164000 - 32000 = 132000$ J. **(½ pt)**

c- A l'existence de forces de frottement. **(½ pt)**

d- L'énergie E apparaît sous forme d'énergie thermique (chaleur). **(½ pt)**

3) a- Chaleur absorbée par la neige:

$\frac{132000 \times 90}{100} = 118800$ J **(1 pt)**

b- Masse fondue $m = \frac{118800}{336000} = 0{,}353$ Kg. **(1 pt)**

Deuxième exercice (7 pts.)

1) Une énergie nucléaire de fusion **(½ pt.)**

2) Ils ont le même nombre de charge **(½ pt.)**

3) a- $^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + {}^{A}_{Z}X$ **(½ pt.)**

Lois de conservation de Z et de A =>Z=0 et A=1 **(1 pt.)**

b- La particule émise est un neutron. **(½ pt.)**

4) La fission produit des déchets nucléaires (ou les produits sont radioactifs). **(½ pt.)**

5) a- Le neutron **(½ pt.)**

b- Noyaux et énergie **(½ pt.)**

6) Pour vaincre les forces électriques répulsives des noyaux. **(1/2 pt)**

7) a- Dans la réalité, les choses sont plus délicates, car si l'homme est capable, depuis plus d'un demi-siècle, de libérer violemment les forces de la fission (bombe atomique) et celles de la fusion (bombe à hydrogène), il n'a cependant réussi à domestiquer que la première. **(1 pt)**

b- Il suffit de 11 kg d'hydrogène pour produire 10^9 W électriques alors que, pour la même énergie, un réacteur nucléaire consomme 500 kg d'uranium. **(1pt)**

Troisième exercice (6 ½ pts.)

1) a- groupe des planètes internes. **(½ pt.)**

b- Mercure et Vénus; Neptune et Pluton. Par exemple. **(1 pt)**

2- a-

- Les planètes externes sont plus éloignées du Soleil que les planètes internes. **(½ pt.)**
- Les planètes externes sont plus froides que les planètes internes. **(½ pt.)**
- Les planètes externes ont des masses volumiques inférieures à celles des planètes internes.

b- Pluton. **(½ pt.)**

3- a- La trajectoire est elliptique. **(½ pt.)**

b- Kepler **(½ pt.)**

4- La période de révolution d'une planète croît avec sa distance moyenne au Soleil. **(½ pt.)**

0,61 année pour Vénus (la plus proche); 164 années pour Neptune (la plus éloignée); 1,88 année pour Mars. **(1 pt)**

5-La planète qui peut flotter sur l'eau est celle qui a une masse volumique inférieure à 1 g/cm^3. **(½ pt.)**

- Saturne. **(½ pt.)**