

1 Which of the following is correct?

- a A rectangle is necessarily a diamond.
  - b A rectangle is necessarily a parallelogram.
  - c A rectangle is necessarily a square.
  - d A diamond is necessarily a rectangle.
- 

2 Which of the following exists?

- a a negative natural number
  - b a common divisor of 3 and 7 which is larger than one
  - c a prime even number
  - d an even number between 2 and 4
- 

3 The lengths of the altitude and the median of a triangle, sharing the same vertex, are denoted by  $h$  and  $\ell$ , respectively. Which of the following is always correct?

- a  $h = \ell$
  - b  $h \neq \ell$
  - c  $h \leq \ell$
  - d  $h \geq \ell$
- 

4 Argon is the most abundant noble gas in the atmosphere of the earth. Its volume fraction is 0.93%. The molecular mass of argon in the atmosphere of the earth is 40 amu, while the molecular mass of the argon in the whole universe is 36 amu. The molecular mass of the atmospheric air is 29 amu. Which of the following is closer to the value of the *mass* fraction of argon in the atmosphere of the earth?

- a 0.93%
  - b 1.2%
  - c 1.3%
  - d 1.4%
- 

5 Of the force, the torque, and the work, which have the same dimensions?

- a all of them
  - b only the torque and the work
  - c only the force and the work
  - d only the force and the torque
-

**6** In early universe, after the quarks had been hadronized in protons and neutrons, the neutrons combined with protons to produce helium nuclei. So after that event, the universe consisted of essentially only hydrogen and helium nuclei, which were subsequently recombined with electrons to produce neutral hydrogen and helium atoms. The mass ratios of hydrogen and helium were roughly 75% and 25%, respectively. At that time, what has been the ratio of the number of neutrons to the number of protons?

- a**  $\frac{1}{13}$                       **b**  $\frac{1}{7}$                       **c**  $\frac{1}{4}$                       **d**  $\frac{2}{3}$
- 

**7** One of the reactions which produces the radioactive nucleus carbon-14 is the capture of a neutron by an oxygen-17 nucleus. In this reaction, apart from a carbon-14 nucleus another object is produced as well. What could that object be?

- a** a proton  
**b** a neutron  
**c** a deuteron  
**d** an alpha particle
- 

**8** carbon-14 beta-decays into a stable nucleus. What is that nucleus?

- a** carbon-12  
**b** carbon-13  
**c** nitrogen-14  
**d** oxygen-16
- 

**9** A yard is a unit of length equal to 0.9144 meter. A yard is equal to 3 feet and a foot is equal to 12 inches. A mile is equal to 5280 feet. How many yards is a mile?

- a** 12                      **b** 36                      **c** 1760                      **d** 63 360
- 

**10** A light year is the distance traveled by light in vacuum during one year. What is the value of a light year in SI units?

- a** 1                      **b**  $6 \times 10^4$                       **c**  $3 \times 10^8$                       **d**  $10^{16}$
-

**11** Unstable nuclei decay towards stable nuclei. There are a variety of ways for the unstable nuclei to move towards stability, three ways being more common for naturally occurring unstable nuclei. These are the alpha- beta- and gamma-decays. During an alpha decay, the nucleus emits an alpha particle, a helium-4 nucleus. During a beta decay, the nucleus emits an electron (as well as an anti-neutrino). During a gamma decay, the nucleus emits a high energy photon. Of these three kinds of decay, it is only the alpha decay which results in a change in the mass number of the nucleus: it reduces the mass number by 4. A uranium-238 nucleus decays and produces a lead nucleus. Which of the following could be the mass number of the resulted lead nucleus?

- a** 204                      **b** 206                      **c** 207                      **d** 208
- 

**12** The densities of lead and mercury are 11.3 and 13.6 times the density of the water, respectively. When a piece of lead is put in a bowl of mercury, how much of the volume of the lead piece remains above the surface of mercury?

- a** none                      **b** 0.17                      **c** 0.83                      **d** 1
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**13** Good luck!

Please mark the correct answers in the answer sheet (the table below) and return it. In case some data is missing, find it.

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Student number: 0

	a	b	c	d
1		■		
2			■	
3			■	
4			■	
5		■		
6		■		
7				■
8			■	
9			■	
10				■
11		■		
12		■		