Admission test - Physics – 2014 - A

Note: In the test questions we do not consider any relativistic effects unless otherwise stated. The frame of reference (coordinate system), in case we need any, is inertial and connected with the observer. In the questions oriented on mechanics we consider incompressible solid bodies and liquids unless otherwise stated. The gravitational field is homogeneous (except question Nr. 11). In geometrical optics all lenses are considered thin and the light rays are paraxial.

1. Which of the following sets of units consists of *fundamental* SI units *only*?
a) second, joule, candela, mole, newton
b) gram, second, ampere, newton, mole
c) second, mole, kilogram, candela, kelvin
d) kelvin, candela, second, radian, gram
e) No answer is correct.

2. Which of the following sets of quantities consists of *scalars only*?
a) position, intensity of electric field, electric current
b) electric voltage, pressure, energy
c) permittivity of vacuum, magnetic flux density, velocity
d) surface tension, luminous intensity, magnetic flux density
e) No answer is correct.

3. Which of the following units is a unit of power?
a) $J \cdot s$ b) $J \cdot m^{-3}$ c) $J \cdot m^{-1}$ d) $J \cdot s^{-1} \cdot m^{-1}$ e) No answer is correct.

4. Which of the quantities is connected with a non-proper (wrong) unit?
a) intensity of electric field $[V \cdot m^{-1}]$
b) amount of substance $[mol]$
c) electric charge $[A \cdot s^{-1}]$
d) heat $[J]$
e) No answer is correct.

5. Which of the quantities below is dimensionless?
a) capacitance   b) efficiency   c) absolute air humidity   d) area
e) No answer is correct.

6. A stone is thrown normally upwards above the surface of a small planet ($a_g = 2.00$ m·s^{-2}) and reaches a maximum altitude of 100 m above the surface. What is its initial velocity? (There is no air friction, the body trajectory begins at the zero altitude.)
a) 100 m·s^{-1} b) 20.0 m·s^{-1} c) 10.0 m·s^{-1} d) 14.1 m·s^{-1} e) No answer is correct.

7. A force of 50 N acts on a free body ($m = 5$ kg) in its centre of gravity for 5 s. What is the final velocity of this body which was at rest at the beginning of acceleration? (there is no air friction or other forces acting on this body)
a) 50 m·s^{-1} b) 25 m·s^{-1} c) 0.5 m·s^{-1}
d) Input data are insufficient to calculate the body velocity.   e) No answer is correct.

8. A paper swallow (a flying toy) with a mass of 3.0 g moves in the air horizontally straightforward at a constant velocity of 3.0 m·s^{-1}. What is the lift force acting on the toy during the flight? (acceleration due to gravity $a_g = 10$ m·s^{-2})
a) We cannot calculate it because we do not know what are the dimensions of the swallow.
b) 0.003 N   c) 0.009 N   d) 0.03 N   e) No answer is correct.

9. Peter lifts a load by means of simple pulley. What is the Peter's average power during this work in comparison with Joseph's power who does the same by means of "block and tackle" (a system of two or more pulleys with a rope or cable threaded between them)**, but should do it during the same time?** (we do not consider any friction, the load is lifted always to the same level)
a) solution is ambiguous   b) smaller   c) the same   d) greater   e) No answer is correct.

10. A body with a mass of 1.00 kg circles around a pivot ($r = 10.0$ m), and the sling (suspension rope) is exposed to a drawing force of 1000 N. What is the velocity of the circling body? (Influence of gravitation, the proper mass of the sling and air friction are neglected.)
a) 31.6 m·s^{-1} b) 100 m·s^{-1} c) 1 m·s^{-1}
d) It cannot be calculated as we do not know the frequency of circling.   e) No answer is correct.

11. Two homogeneous metallic spheres which centres were initially in a distance of *r* changed their mutual position. It caused increase of the gravitational force between them by a factor of 1000. What is the new distance between the spheres?
a) r/1000   b) r/100   c) r/10   d) 10r   e) No answer is correct.

12. Why do the bubbles grow in size when ascending towards the water level? (Suppose the bubble surface is not permeable for any gas.)
a) That is a wrong question – they do not grow in size.   b) Since their surface tension decreases.
c) Since their surface tension increases.
d) Since the ambient hydrostatic pressure decreases in the process.   e) No answer is correct.

13. Objects made of the same material, with the same mass but of different shape are placed down on the bottom of a vessel filled by water, so that (suppose density of the bodies is higher than water density):
a) force of buoyancy (upward hydrostatic pressure) acting on these bodies is different.
b) these bodies do not act by the same force on the bottom.
c) the sphere is buoyed up more than a lying flat disc.
d) the sphere is buoyed up less than a lying flat disc.   e) No answer is correct.

14. A liquid flows through a pipe of varying radius. When the ratio of cross-sectional areas of the pipe is 1:1.5 in its narrower and broader segment, the ratio of liquid velocities in these two segments has to be:
a) 2.25:1   b) 1.5:1   c) 2:1   d) 1:1.5   e) No answer is correct.

15. A swinging pendulum is in a harmonic oscillatory motion. Its velocity reaches maximum when
a) its displacement equals the square root of its amplitude.
b) it reaches maximum acceleration.   c) it reaches minimum potential energy.
d) its displacement just equals its amplitude.   e) No answer is correct.

16. If we change the term $\omega t+\varphi_0$ (i.e. the phase) in the equation for instant displacement *y* of a particle in harmonic oscillatory motion, it can cause that the resulting displacement *y'* of the oscillating particle *may* reach an opposite value (direction) of the same magnitude. Such a change of phase is for *each y* equal, for example:
a) -1   b) $\pi/2$ c) π d) 2π e) No answer is correct.

17. Sound with a frequency of 1 kHz has a sound intensity level of 80 dB in given place. It means that its intensity is (considering the value of the reference threshold intensity $I_0 = 10^{-12}$ W·m^{-2}):
a) 8 W·m^{-2} b) 80 W·m^{-2} c) 10^{-8} W·m^{-2} d) 10^{-4} W·m^{-2} e) No answer is correct.

18. Find a true sentence about sound and ultrasound. (Source is always in rest.)
a) Ultrasound has longer wavelength than sound (in water).
b) Acoustic oscillations with a frequency of 100 kHz can be called ultrasound.
c) Sound does not propagate in liquids by longitudinal waves as a rule.
d) Ultrasound does not propagate in the air.   e) None of the sentences a) to d) is true.

19. The term *kT*, where *k* is Boltzmann constant and *T* is thermodynamic temperature, has the same unit as:
a) energy   b) Avogadro constant   c) Poisson constant   d) pressure
e) No answer is correct.

20. Find a thermodynamic process during which temperature can be lowered at constant pressure, volume and amount of substance. The process should take place in a perfect gas.
a) isothermal   b) isobaric   c) isochoric (V = const.)   d) adiabatic
e) No answer is correct.

21. Pressure of an ideal gas was increased 4-times at an isothermal process in a vessel closed by a movable piston. Thus
a) gas volume decreased to one fourth.   b) gas temperature decreased to one fourth.
c) gas volume decreased to one half.   d) gas volume increased 4-times.   e) No answer is correct.

22. Crushed ice was mixed with NaCl at constant pressure in a well thermally insulated vessel which resulted in its partial melting. During this process temperature of the mixture
a) first decreased and then increased.   b) remained constant.   c) lowered.   d) increased only.
e) No answer is correct.

23. We observe capillary phenomena in a clean glass narrow tube which is partly immersed inside a vessel with distilled water. The water surface inside the capillary is
a) concave and elevated in comparison with free water surface in the vessel.
b) convex and elevated in comparison with free water surface in the vessel.
c) concave and depressed in comparison with free water surface in the vessel.
d) convex and depressed in comparison with free water surface in the vessel.   e) No answer is correct.

24. A wire with a cross-sectional area of 5 mm² is made of a metal which Young's coefficient of elasticity is 100 GPa. What is the relative elongation of this wire due to a tensile force of 1 kN?
a) $2 \cdot 10^{-6}$ b) $2 \cdot 10^{-4}$ c) 0.2 %   d) 2 %   e) No answer is correct.

25. An electrostatic force acting in vacuum between two electrons in distance of 1 m equals
a) $1.602 \cdot 10^{-19}$ N   b) to their electric charge (numerically).   c) relative permittivity of medium.
d) difficult to say, data are insufficient.   e) No answer is correct.

26. We have three identical capacitors available, each of 60 nF capacitance. How to produce a substitution of a 20 nF capacitor from them?
a) connecting them in series   b) connecting them in parallel
c) connecting two of them in series, and the third in parallel to them,
d) We can use all the three previous ways.   e) No answer is correct.

27. Filament of a light bulb carries a constant electric current of 20 mA at a voltage of 3 V. What is the time necessary to transmit an electric charge of 5 C through the filament?
a) 10 s   b) 250 s   c) $2.5 \cdot 10^{-8}$ s   d) more than 5 hours   e) No answer is correct.

28. Two parallel insulated conductors carry electric current of the same direction. Thus
a) they are attracted.   b) they are repulsed.   c) they are repulsed only at switching current on.
d) there is no repulsion or attraction when using alternating current.   e) No answer is correct.

29. The equation $\omega.L - \dfrac{1}{\omega.C} = 0$, which can apply to a circuit consisting of a condenser, resistor and a solenoid (resistances of the solenoid and connecting wires can be neglected)
a) allows to calculate impedance of a simple circuit.
b) allows to find the resonance frequency of alternating current in an RCL circuit.
c) expresses that the inductance of a circuit is always greater than its capacitance.
d) expresses that the inductance of a circuit is always smaller than its capacitance.
e) No answer is correct.

30. The most frequent way how to utilise the PN junction in semiconductors is an electronic circuit called
a) one-way rectifier.   b) current amplifier.   c) emitter.   d) voltage transformer.
e) No answer is correct.

31. A beam of light travels parallel to principal axis of a lens and is focussed on a point which is 20 cm from the centre of the lens after passage through this lens. What is the dioptric power of this lens?
a) -0.20 m^{-1} b) $+0.20$ m^{-1} c) $+5$ m^{-1} d) -0.80 m^{-1} e) No answer is correct.

32. Light rays travel through a converging lens and intersect in a single point on the principal axis of the lens, which distance from the centre of the lens is 80 cm (twice its focal distance). A point source of these rays is located on the principal axis

a) between the object focus and the lens.

b) 0.4 m from the centre of the lens in object space.

c) 0.8 m from the centre of the lens in object space.

d) Data are insufficient to solve the problem.

e) No answer is correct.

33. In a physical process a part of photon energy (with a wavelength of 700 nm) transformed in some other form of energy. Hence, it holds that

a) the resulting photo cannot be a photon of green light.

b) the resulting photon can be a photon of ultraviolet light.

c) there is no need of light wavelength change.

d) a part of photon energy cannot transform in another energy at all.   e) No answer is correct.

34. The unit of illumination (illuminance) is

a) lumen   b) candela   c) $W \cdot m^{-2}$ d) lux second   e) No answer is correct.

35. We can get energy by fission of uranium-235 nuclei because

a) the fission products very easily react with ambient medium.   b) they are radioactive.

c) the nuclei of produced nuclides have greater mass difference per one nucleon than the uranium nucleus.

d) they easily react with heavy water.   e) No answer is correct.

36. If the number of neutrons in a nucleus decreases by one, it is possible that only one of the following particles is emitted (neutrinos or antineutrinos are not considered)**:**

a) α b) β^+ c) β^- d) gamma   e) No answer is correct.

37. In a common mathematical form of the radioactive decay law ($N = N_0 \cdot e^{-\lambda t}$) the right meaning of the symbol „N" is

a) the number of atoms transformed in the sample during time t elapsed from the start of observation.

b) the number of particles emitted by the sample during time t elapsed from the start of observation.

c) a mistake, it should be I (i.e. radiation intensity) there.

d) number of nucleons in the nucleus in the end of the transformation.   e) No answer is correct.

38. Which of the particles is *not* deflected from its original trajectory by a magnetic field? (We do not consider spin of the particle.)

a) hydrogen atom   b) β^+-particle   c) proton   d) α -particle   e) No answer is correct.

39. The wavelength of the de Broglie waves (connected with a particle) can be represented by ratio

a) of Planck constant and momentum of the particle.   b) of energy and mass of the particle.

c) of position and mass of the particle.

d) of oscillation period and momentum of the particle.   e) No answer is correct.

40. The basic function of an active medium of a laser is:

a) absorption of light with unwanted wavelength.   b) guidance of light by means of mirroring.

c) to enable stimulated emission of photons.   d) to set conditions for spontaneous emission of electrons.

e) No answer is correct.