Admission test - Physics A – 2022

Note: In the test questions any relativistic effects are not considered unless otherwise stated. The frame of reference (co-ordinate system), in case one is needed, 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 for question Nr. 10). In optics-oriented questions all lenses are considered thin, and the light rays are paraxial. Use 3.14 as the value of π. Express the results as round numbers with three significant digits (figures).

1. Which of the following physical units is dimensionless (i.e., it is only a number)?
a) hertz   b) decibel   c) electron volt   d) lumen   e) No answer is correct.

2. Which of the following units can be substituted by a product of a time unit and a power unit?
a) joule   b) farad   c) volt   d) coulomb   e) No answer is correct.

3. Find the quantity which unit can be substituted by the term [J·s].
a) power   b) surface tension   c) impulse of force   d) torque   e) No answer is correct.

4. Find the group, which consists only of vector quantities?
a) luminous flux, force, acoustic power   b) electric voltage, inductance, speed
c) torque, velocity, magnetic flux density
d) activity, angular frequency, magnetic flux density   e) No answer is correct.

5. A sphere moved 100 m without friction down a constant angle slope. It was at rest before starting to roll down and then moved at a constant acceleration of $a = 1.00\,\text{m·s}^{-2}$. What time was necessary to travel the whole distance?
a) 10 s   b) 12 s   c) 14.1 s   d) 20 s   e) No answer is correct.

6. A particle performs a uniform circular motion ($r = 50$ cm) at a speed of 40 m·s⁻¹. What is the frequency of this motion?
a) 0.159 Hz   b) 6.37 Hz   c) 12.7 Hz   d) 40 Hz   e) No answer is correct.

7. A body with a mass of 100 tons moving in vacuum at a constant velocity is stopped by a force which impulse is 1000 N.s during deceleration of the body. What was the original speed of the body?
a) The instructions given are not sufficient to calculate it.   b) 1 cm·s⁻¹   c) 10 cm·s⁻¹
d) 1 m·s⁻¹   e) No answer is correct.

8. A small agricultural machine driven by a motor with the mechanical power of 250 W moves on a horizontal field with a constant speed of 2 m·s⁻¹. What is the force exerted against the friction which brakes the machine movement?
a) 50 N   b) 125 N   c) 250 N   d) The instructions given are not sufficient to calculate it.
e) No answer is correct.

9. Children are playing on a seesaw (see the picture). Peter (45 kg) sits 1 m from the pivot, Paul sits on the opposite side 1.5 m from the pivot. The seesaw is balanced now. However, somebody gave to Paul a 15 kg backpack. How much must Peter move away from the pivot to restore the balance of the seesaw? (The children and the backpack are considered particles!)
a) 50 cm   b) Peter need not to move.   c) 100 cm
d) The instructions given are not sufficient to calculate it.   e) No answer is correct.

10. A lift is going down through a very deep shaft aiming at the centre of Earth. During its movement
a) the size of gravitational force acting on the objects inside the lift is growing.
b) the size of gravitational force acting on the objects inside the lift is decreasing.
c) the size of gravitational force acting on the objects inside the lift does not change.
d) no forces are acting on the objects inside the lift.   e) No statement is correct.

11. A body is thrown upwards perpendicularly to the Earth's surface (air friction is neglected). As a result of it
a) its potential energy decreases, and its kinetic energy remains constant.
b) its potential energy remains constant, and its kinetic energy is growing.
c) its kinetic energy and potential energy are decreasing.
d) the sum of its kinetic and potential energy is constant.   e) No answer is correct.

12. Which of the following values of the atmospheric pressure can be expected at the seashore?
a) 760 hPa   b) 1000 hPa   c) 1000 Pa   d) 1000 mm of mercury
e) No answer is correct.

13. Find the sentence giving the best „definition" of the Archimedes principle.
a) The hydrostatic force is directly proportional to the density of immersed body and depth of the liquid.
b) The hydrostatic pressure is the same in all places of the liquid body.
c) The buoyant force acting on totally immersed bodies of the same volume is the same in the whole volume of the liquid.
d) The hydrostatic pressure is directly proportional to the depth of the liquid.   e) No answer is correct.

14. The buoyant force acting on totally immersed bodies of the same volume in the same liquid is
a) always greater in a sphere than in a cube.   b) always greater in the cube than in the sphere.
c) smaller in a sphere compared with body of irregular shape.
d) independent of the immersed body shape.   e) No answer is correct.

15. What was the depth of the ideal liquid in an open vessel, if the liquid started to escape from the vessel trough an outlet very near the bottom at a speed of 8 m·s^{-1}? (Acceleration of gravity is 10 m·s^{-2}, density of the liquid is 1000 kg·m^{-3}, viscosity of the liquid is not considered.)
a) 16.0 m   b) 8.00 m   c) 3.20 m   d) The instructions given are not sufficient to find it.
e) No answer is correct.

16. If the diameters of different parts of a pipe are in ratio of 5:2, the speeds of the liquid streaming inside the pipe are in ratio of:
a) 5:2   b) 25:4   c) 4:25   d) 2:5   e) No answer is correct.

17. What is approximate number of molecules in one litre of the oxygen gas (under normal temperature and pressure)? ($N_A = 6.022·10^{23}$ mol^{-1})
a) $2.7·10^{22}$ b) $9·10^{27}$ c) $6.022·10^{23}$ d) $1·10^{10}$ e) No answer is correct.

18. The Avogadro constant is:
a) a dimensionless quantity (i.e., a number).   b) proportional to the mass of atoms.
c) given by the ratio of the universal gas constant and Boltzmann constant.
d) a product of the universal gas constant and the Boltzmann constant.   e) No answer is correct.

19. It is well known that in high mountains meat must be cooked longer than at the seashore. Choose right explanation of this fact.
a) Due to lower atmospheric pressure water boils at lower temperature than at the normal pressure. Therefore, the meat cooks slower.
b) In the mountains, the pot with meat is cooled due to thinner air so that the cooking takes longer time.
c) The above statement about duration of cooking is false. The high humidity of the air at the seashore increases the

boiling point so that the meat is cooked faster.
d) If the pot is covered by a lid the boiling water cannot be cooled by evaporation which leads to lower boiling temperature in the pot. The duration of cooking is not influenced.   e) No statement is correct.

20. The pressure of a perfect gas is lowered to one third of initial value by a reversible adiabatic process, thus
a) gas temperature is lowered.   b) the volume must remain constant.   c) the temperature remains constant.
d) the gas volume increases three times   e) No answer is correct.

21. A reversible isobaric compression of a perfect gas can be described by the equation:
a) $p_1 \cdot V_1 = p_2 \cdot V_2$ b) $V_1/T_1 = V_2/T_2$ c) $p_1 \cdot T_2/V_1 = p_2 \cdot T_1/V_2$ d) $V_1 \cdot T_1 = V_2 \cdot T_2$
e) No answer is correct.

22. A droplet of some sort of oil is floating in water. After addition of a small amount of a detergent, the surface tension of the droplet decreased. Therefore, this droplet
a) can be easier divided into smaller droplets.   b) can be divided in smaller droplets only with difficulties.
c) surface becomes rainbow coloured.   d) will rapidly grow and consequently forms a foam
e) No answer is correct.

23. A small body of a mass _m_ is hanging on a vertically oscillating spring. The oscillations of angular frequency ω are harmonic. The body displacement is _y_, velocity is _v_, and _T_ is the oscillation period. We can write the following equation for its acceleration _a_:
a) $a = y \cdot \omega$ b) $a = m \cdot y$ c) $a = 2\pi \cdot T$ d) $a = \omega/v$ e) No answer is correct.

24. The sound power level increases by 40 dB. It means that the sound power increases:
a) 40000-times   b) 200-times   c) 40-times   d) by 4 $W \cdot m^{-2}$ e) No answer is correct.

25. Which of the following phenomena is caused by mechanical oscillations of a solid body?
a) Newton rings   b) Sound of a bell   c) sound of a pipe organ   d) Seebeck effect
e) No answer is correct.

26. Intensity of an electric field in a defined place near a charged particle (with charge Q) can be explained/described as
a) the ratio of electric potentials in given place and in infinity.   b) electric voltage in given place.
c) the work done by electric forces to moves a charge of unit size from given place to the Earth's surface.
d) the electric force acting in given place on a positive electric charge of unit size.
e) No answer is correct.

27. A capacitor is in a circuit with alternating voltage. As a result of it, force acting on its plates
a) is equal to zero (no attraction or repulsion).   b) is only attractive.   c) is only repulsive.
d) is alternatively attractive and repulsive.   e) No answer is correct.

28. An electric heater power is 690 W. If alternating current at effective voltage of 230 V passes through the heater, what will be the effective value of the alternating current?
a) 0.3 A   b) 1 A   c) 3 A   d) 4 A   e) No answer is correct.

29. The cathode rays studied by W.C. Roentgen in a discharge tube filled by a gas under low pressure were actually
a) identical with electrons attracted to the anode.   b) the x-rays.
c) photons of electromagnetic radiation produced in the cathode.
d) the radioactivity discovered later in the uranium ore.   e) No answer is correct.

30. The vector B value inside a very long solenoid (coil) passed by a constant direct current (we do not consider places close to the ends of the solenoid)
a) has the maximum size in the axis of the solenoid.

b) has the same size in any place inside the solenoid.   c) has maximum size in the middle of the solenoid.
d) has zero value.   e) No answer is correct.

31. How to increase the impedance of a circuit consisting only of a capacitor and a source of alternating voltage?
a) by increasing the capacitance of the capacitor.   b) by decreasing the capacitance of the capacitor.
c) by increasing the current frequency.   d) by adding a resistor in parallel.   e) No answer is correct.

32. To produce one gram of arbitrary substance in one second by an electrochemical process we *always* need an electric charge equal to
a) Faraday constant   b) the charge of one mole of electrons.   c) one coulomb.
d) the product of Faraday and Avogadro constant.   e) No answer is correct.

33. The total reflection of light can occur when
a) light rays propagate from the medium in which they propagate slower to the medium in which they propagate faster.
b) the water surface is illuminated from above.   c) the angle of incidence equals the angle of reflection.
d) it is possible that the angle of incidence is greater than the angle of reflection.
e) No answer is correct.

34. The focus of a converging lens is
a) a point where all rays going through the lens are intersecting.
b) a point on the principal axis of the lens which is the centre of the lens curvature.
c) a point in which all rays entering the lens in parallel with the principal axis are intersecting.
d) its centre.   e) No answer is correct.

35. Dioptric power of a converging lens is 0.2 D. What is the focal length of the lens?
a) 1/5 m   b) 0.5 m   c) 50 cm   d) 500 cm   e) No answer is correct.

36. The objective of a common light microscope produces the image
a) as a converging lens with an object placed between the lens focus and a point lying in double the focal distance.
b) like magnifying glass.   c) which is magnified and virtual.   d) in the focal plane.
e) No answer is correct.

37. The x-rays differ from the ultraviolet light
a) by their higher frequency.   b) the fact that they are radioactive.   c) the fact they are accelerated electrons.
d) by their longer wavelength.   e) No answer is correct.

38. We can irradiate a metallic surface by a light with increasing frequency. It is possible that this light
a) starts to provoke the photoelectric effect.   b) stops to provoke the photoelectric effect.
c) will enable emission of the so-called „bremsstrahlung".
d) will evoke some diffraction patterns on the metallic surface.   e) No answer is correct.

39. Which of the following particles does not change its trajectory and/or velocity in a homogeneous electric field?
a) hydrogen atom   b) electron   c) α particle   d) Fe^{2+} ion   e) No answer is correct.

40. If the half-life of a radionuclide is 30 seconds, what time is necessary to reduce original number of nuclei to one sixteenth?
a) 30/16 s   b) 16/30 s   c) 480 s   d) 2 min   e) No answer is correct.