**Questions for final exams**

1. Mechanical motion. Material point, absolute rigid body. Space and time.
2. Kinematics of a material point. Trajectory, path, displacement, velocity, acceleration
3. Motion of a point along a circle. Angular velocity and angular acceleration
4. Tangential, normal and total acceleration during rotational motion.
5. Relationship between linear and angular characteristics of motion
6. Dynamics of a material point. Force. Mass. Impulse. Write the formulas and give the definition.
7. Newton's first, second and third laws. Write the formulas and give the definition.
8. Moment of inertia of a body relative to the axis of rotation. Steiner's theorem.
9. Formulas for calculating moments of inertia for bodies of different shapes.
10. Fundamental equation of the dynamics of rotational motion of a rigid body.
11. Torque. Moment of impulse relative to the axis of rotation.
12. Law of change and conservation of impulse. Write the formulas and give the definition.
13. Law of change and conservation of angular impulse
14. Mechanical work. Power. Write the formulas and give the definition.
15. Kinetic energy of a mechanical system and its relationship with the work of external and internal forces.
16. Conservative and non-conservative forces.
17. Potential energy. Relationship of potential energy with work and force. Write the formulas and give the definition.
18. Law of conservation of energy in mechanics. Write the formulas and give the definition.
19. Non-inertial counting system. Inertial force.
20. Inertial reference frames. Galileo's transformations.
21. Einstein's postulates.
22. Lorentz transformations.
23. Thermodynamic parameters. Ideal gas. Equation of state of an ideal gas.
24. Isoprocesses. Gas laws.
25. Fundamental equation of molecular kinetic theory.
26. Number of degrees of freedom of solid molecules of an ideal gas.
27. Distribution of energy by degrees of freedom.
28. Work done by a gas. Heat capacity. Write the formulas and give the definition
29. First law of thermodynamics, its application to isoprocesses and adiabatic processes.
30. Second law of thermodynamics. Entropy. Write the formulas of Entropy to isoprocesses.
31. Efficiency of a heat engine. Carnot cycle. Describe the phenomenon.
32. Electrical interaction. Electric charge and its discreteness.
33. Coulomb's law. Electric field. Write the formulas and give the definition
34. Electric field strength. Superposition principle.
35. Vector flux of electric field strength. Gauss's theorem. Write the formulas and give the definition.
36. Application of Gauss's theorem: for a dipole, an infinite plane, for two planes.
37. Application of the Ostrogradsky-Gauss theorem: for a sphere and a thread.
38. Work done when moving a charge in a uniform electrostatic field.
39. Work done to move a charge in a central electrostatic field.
40. Theorem on the circulation of the electric field vector.
41. Potential energy of a charge in an electric field. Field potential.
42. Relationship between electric field strength and potential.
43. Electric capacitance of conductors. Capacitance of a charged sphere.
44. Capacitors and their capacitance. Capacitors of various geometric shapes.
45. Series and parallel connection of capacitors.
46. Energy of interaction of electric charges. Energy density of the electric field.
47. Electric current. Current strength and density. Conditions for the existence of current.
48. Resistance of conductors. Series and parallel connection of resistances
49. Electromotive force (EMF). Potential difference. Voltage. Write the formulas and give the definition.
50. Magnetic field induction vector. Magnetic induction lines.
51. Bio-Savart-Laplace law. Write the formulas and give the definition.
52. Motion of a charged particle in electric and magnetic fields. Lorentz force.
53. Hall effect. Describe the phenomenon.
54. Gauss's theorem for magnetic fields. Write the formulas and give the definition
55. Work done when a current-carrying conductor moves in a magnetic field.
56. Ampere's law. Write the formulas and give the definition
57. Circulation of the magnetic induction vector.
58. Magnetic field of a solenoid and a toroid.
59. Phenomenon of electromagnetic induction. Faraday's law. Lenz's rule.
60. Kinematics (displacement, velocity, acceleration) of harmonic oscillatory motion.
61. Force, Kinetic energy, Potential energy and full energy of harmonic oscillatory motion.
62. Differential equation of harmonic oscillations and its solution.
63. Describe Mathematical and spring pendulums. Their period of oscillation and frequency
64. Describe Physical pendulum. Period and frequency of its oscillations
65. Describe Oscillatory circuit. Thomson's formula. Draw the contour of electromagnetic oscillations.
66. Damped mechanical vibrations and their equations.
67. Damping coefficient, logarithmic damping decrement and quality factor of the system.
68. Damped electromagnetic oscillations and their equations.
69. Forced mechanical oscillations and their equations.
70. Forced electromagnetic oscillations and their equations.
71. Resonance phenomenon. Write the formulas and give the definition.
72. Describe the properties of waves. Transverse and longitudinal waves.
73. Displacement and differential equation of waves.
74. Physical quantities describing waves.
75. Wave energy. Umov vector
76. Principle of wave superposition. Coherent waves.
77. Wave interference. Conditions for observing minimum and maximum.
78. Standing waves. Equation and properties.
79. Electromagnetic waves and their differential equation.
80. Energy of electromagnetic waves and its density. Umov-Poynting vector.

**Problems**

1. A car which is traveling at a velocity of 1.6 m/s undergoes an acceleration of 9.2 m/s2 over a distance of 540 m. How fast is it going after that acceleration?
2. An object is traveling at a constant velocity of 25 m/s when it experiences a constant acceleration of 1.5 m/s2 for a time of 38 s. What will its velocity be after that acceleration?
3. A Martian weighs 17 N on the surface of Mars. Calculate his weight on Earth and on the Earth’s moon. Does his mass change during the flight from Mars to the Moon to the Earth? The acceleration due to gravity on Mars is 3.8 m/s2 and the acceleration due to gravity on the Moon is 1.6 m/s2.
4. A hockey puck with a mass of 0.18 kg is at rest on the horizontal frictionless surface of the rink. A player applies a horizontal force of 0.5 N to the puck. Find the speed and the traveled distance 5 s later.
5. A 1280-kg car pulls a 350-kg trailer. The car exerts a horizontal force of against the ground in order to accelerate. What force does the car exert on the trailer? Assume an effective friction coefficient of 0.15 for the trailer.
6. A horizontal force of 310 N is exerted on a 2.0-kg ball as it rotates (at arm’s length) uniformly in a horizontal circle of radius 0.90 m. Calculate the speed of the ball
7. A 7150-kg railroad car travels alone on a level frictionless track with a constant speed of A 3350-kg load, initially at rest, is dropped onto the car. What will be the car’s new speed?
8. You drop a 14-g ball from a height of 1.5 m and it only bounces back to a height of 0.85 m. What was the total impulse on the ball when it hit the floor?
9. A bowling ball of mass 7.25 kg and radius 10.8 cm rolls without slipping down a lane at Calculate its total kinetic energy.
10. What is the angular momentum of a 0.270-kg ball revolving on the end of a thin string in a circle of radius 1.35 m at an angular speed of 10.4 rad/s?
11. A 1.65-kg mass stretches a vertical spring 0.215 m. If the spring is stretched an additional 0.130 m and released, how long does it take to reach the (new) equilibrium position again?
12. Your grandfather clock’s pendulum has a length of 0.9930 m. If the clock runs slow and loses 21 s per day, how should you adjust the length of the pendulum?
13. A fisherman notices that wave crests pass the bow of his anchored boat every 3.0 s. He measures the distance between two crests to be 7.0 m. How fast are the waves traveling?
14. A 0.650-kg mass oscillates according to the equation where x is in meters and is in seconds. Determine (a) the amplitude, (b) the frequency, (c) the period, (d) the total energy, and (e) the kinetic energy and potential energy when x is 15 cm.
15. If 61.5 L of oxygen at 18.0°C and an absolute pressure of 2.45 atm are compressed to 38.8 L and at the same time the temperature is raised to 56.0°C, what will the new pressure be?
16. What speed would a 1.0-g paper clip have if it had the same kinetic energy as a molecule at 22°C?
17. The electric field between two parallel square metal plates is 130 N/C. The plates are 0.85 m on a side and are separated by 3.0 cm. What is the charge on each plate (assume equal and opposite)? Neglect edge effects.
18. An electric field of 525 is desired between two parallel plates 11.0 mm apart. How large a voltage should be applied?
19. The work done by an external force to move a -6.50μ C charge from point A to point B is If the charge was started from rest and had of kinetic energy when it reached point B, what must be the potential difference between A and B?
20. An alpha particle (which is a helium nucleus, Q=+2e, ) is emitted in a radioactive decay with .What is its speed?
21. How much energy is stored by the electric field between two square plates, 8.0 cm on a side, separated by a 1.5-mm air gap? The charges on the plates are equal and opposite and of magnitude 370μ C.
22. An electric field of point A to point B is is desired between two parallel plates, each of area 4.50 cm2 and separated by 2.45 mm of air. What charge must be on each plate?
23. How much current is flowing in a wire 4.80 m long if the maximum force on it is 0.625 N when placed in a uniform 0.0800-T field?
24. Determine the magnitude and direction of the force between two parallel wires 25 m long and 4.0 cm apart, each carrying 25 A in the same direction.
25. A 32-cm-long solenoid, 1.8 cm in diameter, is to produce a 0.050-T magnetic field at its center. If the maximum current is 6.4 A, how many turns must the solenoid have?
26. An 18.5-cm-diameter loop of wire is initially oriented perpendicular to a 1.5-T magnetic field. The loop is rotated so that its plane is parallel to the field direction in 0.20 s. What is the average induced emf in the loop?
27. An electron has a horizontal velocity of 6.0 x 105 m/s towards the east. It travels through a 0.24 T uniform magnetic field which is directed straight down. What is the direction and magnitude of the magnetic force on the electron?
28. An electron (me = 9.1 x 10-31kg) traveling south at a constant speed of 5.0 x 106 m/s enters a region where the downward component of earth’s magnetic field is 3.5 x 10-5 T. What is the magnitude and direction of the acceleration of the electron at this instant?
29. Two parallel and opposite currents, 2.6 A and 5.7 A, are separated by a distance of 3.0 cm. The length of the wires carrying the currents is 3.4 m. What is the magnitude and direction of the force between the wires?
30. What is the magnitude and direction of the magnetic force between two identical parallel wires, 30.0 m long and 5.0 cm apart, if each carries a current of 40.0 A in the same direction?