Federal Democratic Republic of Ethiopia
Ministry of Education

Minimum Learning Competencies

Physics, Grades 9 to 12

2009

Minimum Learning Competencies for Grades 9 & 10 Physics

Area of competency	*Grade 9*	*Grade 10*
	1. Vectors • Represent vectors analytically and graphically • List some properties of vectors • Find the sum and difference of two vectors; in the same direction, in opposite direction and perpendicular to each other. • Resolve a vectors in to its rectangular component • Find the magnitude and direction of resultant of several vectors using component method • Solve problems related to vectors • Demonstrate scientific enquiry skills such as ; observing, asking question, problem solving, applying concepts, measuring, making conclusion, interpreting illustrations data. **2. Motion in a straight line** • define the term uniformly accelerated motion • distinguish between velocity and acceleration • use equations of uniformly accelerated motion to solve numerical problems • identify displacement, velocity, acceleration as vector quantity in equations of uniformly accelerated motion • identify that free fall is a uniformly accelerated motion • distinguish between positive and negative accelerated motion • Mention the variation of acceleration due to gravity on the surface of the earth. • Plot S-t graph from distance and time data provided in a table. • Plot V-t graph from velocity and time data provided in a table • Interpret S-t, V-t and a-t graphs • Solve problems related to motion from graphs	**1. Motion in two dimension.** • Describe motion in two dimension • Define the term projectile and give common examples of projectile • Identify any projectile is moving under the influence of gravity • Describe the difference among the terms vertical, horizontal and inclined projection • Identify that projectile motion consists of two independent motions. • Solve problems related to projectile motion. • Identify the path followed by a projectile projected at an angle is parabolic. • Define uniform circular motion, tangential velocity, centripetal acceleration, centripetal force and centrifugal force. • Define rotational motion, angular displacement, angular velocity and angular acceleration. • Describe the relationship between angular quantities and linear quantities. • Solve problems related to uniform circular motion and rotational motion. • Describe rotational with constant angular acceleration • Solve problems using equations of motion with constant angular acceleration. • Define moment of inertia, torque, angular momentum and center of gravity. • State conservation of angular momentum and condition of equilibrium. • Describe rotational kinetic energy in terms of moment of inertia and torque in terms of angular acceleration and moment of inertia • State laws of universal gravitation and Kepler's Laws of planetary motion. • Describe the variation of acceleration due to gravity with altitude • Solve problems related to moment of inertia of a system of particles with respect to a given axis. • Solve problems related to rotational kinetic energy, torque, angular momentum, conservation of angular momentum, conditions of equilibrium and center of gravity.

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	• Determine the relative velocity of body with respect to another moving in a straight line • Demonstrate scientific enquiry skills such as observing, predicting, classifying, problem solving, interpreting graph (illustrations), interpreting data, drawing conclusion, applying concepts. **3. Force and Newton's laws of motion** • Identify the force in nature • State Newton's first law and explain the relation between mass and inertia • Associate Newton's first law to their daily life activities • Define momentum as the product of mass and velocity • State Newton's second law in terms of the change in momentum • Solve common problems involving net force, mass and linear acceleration. • Identify units appropriate for measuring force • Describe the effect of balanced and unbalanced forces on a body • Determine the relationship between net force, mass, and acceleration • Define impulse and describe the relation between impulse and linear momentum • Define the term weight • Distinguish between mass and weight. • Explain the state of weightlessness • Resolve a force in to its rectangular components • Define concurrent and collinear forces • Find the magnitude and direction of resultant force of several forces acting on a body • Solve common problems involving bodies suspended by strings attached to a celling • describe the effects of friction on motion	• Distinguish between orbital velocity and escape velocity • Describe about geostationary satellite and explain their uses • Apply the law of universal gravitation to solve common problems. • Demonstrate scientific enquiry skills such as observing, predicting, comparing, communicating, problem solving, asking questions, applying concepts, analyzing. **2. Electrostatics** • State the law of conservation of charge an law of electrostatics • Describe the charging processes and charge distribution on a conductor of different shape • Identify that lightening is an electrostatic phenomenon and explain the role of lightening rod • Describe about the electrostatic danger in aircraft ***** and some application of electrostatics. • State coulomb's law • Define the terms: Electric field, electric field strength, electric field lines, test charge • Determine the magnitude and direction of force between two point charges. • Identify electric field inside a conductor is zero • Define the terms: electric potential and distinguish between absolute potential and potential difference. • Determine the electric potential at a given point due to a point charge and system of charges • Describe about equipotential lines and surfaces • Calculate the electric potential energy between two charges • Define the terms: capacitor, capacitance, parallel plate capacitor, dielectric. • Calculate the effective capacitance of capacitors in series, parallel and in series parallel combinations. • Determine the capacitance of a parallel plate capacitor with and without a dielectric and the energy stored • List some applications of capacitors • Demonstrate scientific enquiry skills such as observing, inferring, communicating, comparing, solving problem, applying concepts,

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	• explain the differences among limiting, static and sliding friction • determine the relationship between frictional force, coefficient of friction and normal force • compare kinetic and static friction • state Hook's Law • Identify momentum as conserved quantity other than energy • State Newton's Third law and give examples where it is applied • Describe the first condition of equilibrium • Apply the first condition of equilibrium to solve related problems • Draw a free body diagram indicating all the force acting on a body • Demonstrate scientific enquiry skills such as; Observing, comparing, classifying, problem solving, applying concepts, making conclusion, interpreting data, relating cause and effect, designing experiment. **4. Work, Energy and power** • Define the term work • Define energy and its general classification as potential energy and kinetic energy • Describe the relationship between work and energy • Describe the relationship between force, displacement and the angle ǿ • Solve related problems involving work, force and displacement • Calculate the gravitational potential energy of a body in gravitational field • Calculate the kinetic energy of a moving body • Describe the law of conservation of mechanical energy and apply it in the solution of problems • Explain the energy changes that takes place in an	relating cause and effect, asking questions, experimenting. **3. current electricity** • Define the terms electric current, receptivity, conductivity and resistance • Describe flow of electric charge in a metallic conductor as conventional and electron current • State Ohm's law and calculate resistance, current and voltage using Ohm's law • Solve problems related to electric current, receptivity, conductivity • Draw simple electrical circuit with resistors in parallel and series in different position of switches • Calculate equivalent resistance, current through each resistance, current through entire circuit and voltage drop across each resistor in any connection. • Mention the merit of galvanometer in ammeter and voltmeter and describe the connection of ammeter and voltmeter in electric circuit. • Define the terminal voltage, electromotive force(emf), internal resistance of a cell and show their relation ship. • Identify series and parallel connection of cells and compute the total emf of cells • Express electrical energy using in terms of current, voltage and resistance • Calculate electrical energy consumed, power dissipated and cost of electrical energy. • Describe with the aid of diagrams for sketch installation of house hold circuit. • Demonstrate the scientific inquiry such as: observing, inferring, classifying, comparing, making models, measuring, asking questions, experimenting, interpreting illustration, applying concept, solving problems. **4. Electromagnetism** • Define the magnetic field and identify that the magnetic field lines around straight current carrying wires are concentric circles • Determine the direction of magnetic field lines around straight current loop, solenoid

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	oscillating pendulum and spring mass system • Identify collision as elastic and inelastic collision • Mention momentum and kinetic energy is conserved during elastic collision • Define mechanical power and use the definition to calculate the power of a mechanical system • Explain about the wise use of energy • Demonstrate scientific enquiry skills such as; observing, predicting , classifying, communicating, problem solving, asking question, drawing conclusion, interpreting illustration, relating cause and effect, applying concept, designing experiments **5. Simple machines** • Describe the purpose of machine • List the simple machines and explain their uses • Determine the relationship between MA, VR and efficiency of a machine • Calculate the MA, VR and efficiency of simple machines • Categorize simple machines as force multiplier or speed multiplier or direction changer • Explain the role of simple machines in technology • Demonstrate scientific enquiry skills such as: observing, classifying, communicating, comparing, making, conclusion, measuring, asking questions designing experiment, problem solving, applying concepts, interpreting illustration, making model. **6. Fluid statics** • Identify the term fluid refers to both liquids and gases • Define the terms: pressure, density, relative density • Identify units used to measure pressure • Solve common problems involving pressure, force	• Calculate the magnetic field strength at a point due to straight current carrying wire current loop and inside a solenoid • Identify that a moving charge in a magnetic field current carrying conductor experiences a magnetic force. • Describe how moving charged particles are deflected by uniform magnetic field. • Solve problems on motion of charged particles in a magnetic field and current carrying conductor in a magnetic field • Determine the magnitude and direction of a force between two parallel current carrying wires separated by a distance d. • Show with the aid of diagram the direction of the forces acting on each sides of a rectangular current carrying wire placed in a magnetic field. • Determine the magnitude and direction of the torque acting on a current loop in a magnetic field • Describe how a moving coil galvanometer operates • Describe the working principle of a DC motor. • Define the terms: magnetic flux • State Faraday's Law of induction and Lenz's Law • Determine the magnitude and direction of induced emf or current using faraday's law of induction and Lenz's law respectively • Define the terms: Electromagnetic induction, inductance, self and Mutual Inductance. • Explain the working principle of an AC and DC generator • Explain the principle of operation of transformer • Solve problems involving inductance and transformer • Demonstrate scientific enquiry skills such as: observing, inferring, comparing, making models, applying concepts, measuring, interpreting illustrations, solving problems, relating cause and effects. **5. Introduction to Electronics** • Define the term electronics • State what is meant by harmonic emission • Describe the function of CRT and its use • Describe semiconductors in terms of charge carrier and resistance • Describe how semiconductors can be used in half wave rectification • Describe the behavior of semiconductor devices such as thermistor,

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	and area. • Identify that pressure due to a liquid at rest depends on depth. • Demonstrate the relationship between pressure, force and area. • Calculate the pressure due to a liquid at rest at any depth • Convert pressure values from one unit to another • Explain pascal's principle and its application • Explain Archimede's principle and its application • Explain floatation principle • Identify the forces acting on a body that is immersed or floating in a fluid • Demonstrate the understanding of buoyant force and the relationship between weight of fluid displaced and mass of floating body. • Demonstrate the understanding of buoyant force and the relationship between weight of fluid displaced and mass of floating body. • Define the terms: surface tension, cohesion, adhesion • Describe devices used to measure pressure and pressure difference • Describe the relationship among gauge pressure, absolute pressure, and atmospheric pressure • Demonstrate scientific enquiry skills such as: observing, communicating, comparing, measuring, asking questions, designing experiments, applying concepts, problem solving. **7. Temperature and heat** • Compare heat and temperature • Explain about thermal expansion of solids, liquids and gases • Identify units used to measure energy in thermal system • Solve problems involving linear, real and volume	LDR, LED, photodiode, Zender diode, transistor • Demonstrate scientific enquiry skills such as classifying, comparing, relating cause and effect, interpreting illustrations, asking questions **6. Electromagnetic waves and geometrical optics** • Describe the circumstances in which electromagnetic waves are produced and the nature of electromagnetic waves • Identify all electromagnetic waves travel at the same speed in a vacuum • Identify that EM waves emitted by the sun has a very wide continuous range of frequencies and therefore continuous range of wavelength. • List the components of EM spectrum and describe their uses • State the laws of reflection and describe the image formation by a plane and curved mirrors with the aid of a diagram. • List the nature of the image formed by a plane mirror convex mirror and identify that the nature of the image by concave mirror depend on the position of the object • Use the mirror equation to determine the nature and position of the image formed. • Describe the conditions in which refraction takes place and draw a diagram representing the passage of light rays through rectangular block • State the laws of refraction • Express Snell's law in terms of the ration of refractive indices, wavelengths and speeds • Apply the law of refraction to determine the refractive index of the medium through which light passes • Explain why a pool looks shallower than they are • Explain how total internal reflection occurs and describe its uses. • Define the terms angle of deviations and refracting angle of a prism and trace the ray through a prism • Describe the nature of image formed by thin lenses using ray diagram • Use thin lens formula to determine the nature and position of the image formed • Apply the definition of magnification and power of a lens to determine magnification and power of a lens • Draw a ray diagrams showing how images are formed by a

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	expansion • Solve problems related to expansion of liquids • Define the terms :specific heat capacity, heat capacity, and latent heat • State the law of heat exchange • Solve problems involving heat exchange • Demonstrate scientific inquiry skills such as observing, communicating, comparing, measuring, inferring, making conclusion, problem solving, applying concept, and designing experiments **8.Wave motion and sound** • Define the terms: wave pulse, train of waves • Differentiate between mechanical and electromagnetic waves and give examples of each • Identify waves as transverse and longitudinal and give examples of each • Define the terms used to describe waves; crest, trough, wavelength and amplitude • Use wave speed formula to solve problems related to wave motion • Describe the common properties of waves: reflection. refraction diffraction and interference • Describe the production and propagation of sound • Compare the speeds of sound in different media • Determine the speed of sound in air at any give temperature • Explain reflection, refraction diffraction, and interference of sound • List some applications of reflections of sound • Define the terms used to describe the characteristics of sound • Demonstrate scientific inquiry skills as observing, classifying, communicating comparing asking questions, measuring and applying concepts	combination of lenses in simple microscope and simple telescope • Describe with the aid of a diagram how image is formed in the retina of human eye and identify the types of lenses used for correction of eye defects. • Describe how dispersion of light occurs in a prism with the aid of a diagram • Explain how colors can be mixed and objects obtain their colors • Demonstrate scientific enquiry skills such as: Observing, inferring, classifying, comparing, interpreting illustrations, applying concepts, problem solving, asking questions, measuring, making models, experimenting, relating cause and effect.

Minimum Learning Competencies for Grades 11&12 Physics

Area of competency	*Grade 11*	*Grade 12*
Measurement/thermodynamics	**1. Measurement and practical work** • Explain the importance of measurement in life. • explain about sources of errors and their types • differentiate between accepted and experimental values • add and subtract scientific notation, keeping significant figures properly • Multiply scientific figures keeping significant figures properly. • Define the term scientific method and State the steps of scientific methods • Explain the possible sources of errors and State the types of errors • Distinguish between systematic and random error	**1.Thermodynamics** • Define the scientific terms :isothermal change, adiabatic change, change of state of a gas, molar gas constant • State the first law of thermodynamics • State the second law of thermodynamics • Solve problems related to the first and second laws o f thermodynamics • Describe ways of changing the internal energy of a gas • Describe the fundamental principles of heat engine • Solve problems involving calculations of P,Vor T for a gas undergoing adiabatic changes • Use the expression for the pressure of an ideal gas in terms of its density and mean square speed of molecules to solve problems • Solve problems to determine P,V,T or r.m.s speed of gas molecules for an ideal gas, given relevant data • Show that the molar heat capacity at constant pressure is greater than the molar heat capacity at constant volume • Evaluate Cp-Cv for an ideal gas • Evaluate Cp/Cv for an ideal gas
Vectors/wave motion	**2.Vector quantities** • Distinguish between vector and scalar quantities, and give examples of each • Determine the resolved part of a vector in any given direction add vectors by graphical representation to determine a resultant • determine graphically a resultant of two vectors • add/subtract two or more vectors by the vector addition rule • determine the magnitude and direction of the resolution of two or more vectors using Pythagoras theorem and trigonometry	**2. Oscillations and waves** • Define and use the terms SHM, resonance • give simple examples of vibrating systems • explain the energy changes that occur when a body performs SHM • draw and interpret graphs to show how KE and PE of an oscillator vary with time • use expressions for the frequency and periodic time of oscillations of objects performing SHM • solve problems on SHM involving periods of vibration and energy changes • explain the effect of damping on the amplitude of a system which is vibrating • identify the properties of standing waves and, for both mechanical and

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	• solve problems related to scalar and vector products of two vectors in a plane • explain properties of vector operations • identify vectors represent the real quantities	sound waves • explain the conditions required for standing waves to occur • explain the Doppler effect, and predict in qualitative terms the frequency change that will occur in a variety of conditions • explain the modes of vibrations of strings and solve problems involving vibrating strings • Explain the way air columns vibrate • solve problems involving vibrating air column
Kinematics/electrostatics	**3.Kinematics** • use the scientific terms: speed, velocity. distance, displacement, acceleration, instantaneous velocity and acceleration correctly and state their SI units • explain the difference between average speed(or velocity)and instantaneous speed(or velocity) • solve numerical problems involving average velocity, instantaneous velocity and acceleration • explain uniform circular motion in the horizontal and vertical planes with reference to the forces involved • explain uniform circular motion in the horizontal and vertical planes with reference to the forces involved • identify circular motion requires the application of a constant force directed toward the center of the circle • solve problems involving objects moving in two dimensions • describe the behavior of motion of a freely falling body	**3.Electrostatics** • define the terms: electric field strength, electric potential, electric dipole, electric dipole moment ,dielectric, electric flux, dielectric constant • explain coulomb's law using the ideas of vectors • map an electric field lines pattern using electric lines of force • define capacitors and capacitances • solve problems related to the capacitances of parallel plate capacitors • state Gauss law qualitatively • compare the characteristics of electric potential energy with those of gravitational potential energy • explain the electric field and the electric forces produced by a single point charge, two point charges, and two oppositely charged parallel plate • describe and explain, in qualitative terms, the electric field that exists inside and on the surface of a charged conductor • apply the formula the electric field strength at a point due to an isolated point charge • use the formula for the electric potential at a point due to an isolated point charge
Energy/electricity	**4.Work, energy and power** • define and use the terms work, energy, and power • Use the principle of conservation of energy	**4.Steady electric current and circuit properties** • Explain the meaning of a coulomb ,a volt, an ohm, potential difference, resistance, emf, KWH • identify the SI units of electric current, current density, resistance,

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	in the solution of problems • Distinguish between elastic and inelastic collisions and solve problems involving such collisions • identify the relationship between work and change in kinetic energy • distinguish between conservative and non conservative forces • explain the energy transformation occurring during oscillations • Solve problems involving elastic and inelastic collisions in one and two dimension by using the principles of conservation of momentum and energy.	resistivity, conductivity, temperature coefficient of resistance • distinguish between electrostatic and non electrostatic fields • differentiate between emf and p.d of a source • solve electrical circuit problems involving the relationship between emf, current and résistance for a complete circuit • Distinguish between emf and p.d,ohmic (linear)and non ohmic (non linear) devices • state kirchhoff's laws • solve problems involving network resistors • solve problems in which meter resistance is involved • describe how a galvanometer can be modified to measure a wide range of currents and potential differences • calculate shunt and multiplier value for use with a meter to give different current and voltage ranges • explain the principle of Wheatstone bridge solve problems involving it • explain the principle of potentiometer and how it can be used for measurement of emf, p.d, resistance and current
Dynamics/magnetism	**5.Dynamics** • state and use Newton's laws • state Newton's 2nd law interims of momentum • apply Newton's laws of motion to explain and predict the behavior of bodies acted by external forces • use the principle of momentum conservation • explain qualitatively how frictional forces depend on the nature of surfaces and normal contact force • use free body diagram representing forces on a point mass to solve problems • solve numerical problems involving Newton's laws of motion • determine the forces needed to keep an object moving in a horizontal and vertical circles • define the centre of mass of a body and that	**5.Magnetism** • describe and illustrate the magnetic field produced by an electric current in a long straight conductor and in a solenoid • predict by applying the right-hand rule, the direction of the magnetic field produced when electric current flows through a long straight conductor and through a solenoid • use the expression for the force on a current carrying conductor in a magnetic field • use the expression for the force on a charged particle in a magnetic field • state Ampere's law and use it in solving problems • solve problems on the motion of charged particles in electric and magnetic fields • distinguish between the terms: dia, para, and Ferro magnetic materials • describe the causes of earth's magnetism • describe an experiment to obtain the flux pattern around a bar magnet, straight carrying wire, a solenoid carrying a current

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	of a system of particles	
Mechanics/ electromagnetism	**6.Rotational motion** • Define and use the terms: angular displacement, angular velocity, angular acceleration, moment of inertia ,angular momentum, angular impulse and torque • Use the equations for uniformly accelerated angular motion • Use the equations relating linear and angular motions • State the similarities and differences between the behavior of rotating bodies and bodies traveling with linear velocity • Identify the factors which determine the moment of inertia of a body • State and apply the law of conservation of angular momentum • determine the velocity and acceleration of a point in the rotating body • demonstrate the direction of angular velocity ,angular acceleration and angular momentum using the right –hand rule	**6.Electromagnetic induction and AC circuits** • Use the terms: induced emf, back emf, magnetic flux, flux linkage, eddy current • State the laws of electromagnetic induction • Use the laws of electromagnetic induction which predict the magnitude and direction of the induced emf • Use the expression for the force on a current carrying conductor in a magnetic field • Use the force on a charged particle in a magnetic field • Use the flux density near a long straight wire, at the centre of circular coil, inside and at the end of a long solenoid • Solve problems on the motion of charged particles in electric and magnetic fields • Describe in words ,or by sketch, the general shape and relative intensities of magnetic field strength around a long straight current carrying wire,a long solenoid • apply Lenz's law to explain, predict, and illustrate the direction of the electric current induced by a changing magnetic field, using the right-hand rule • explain Ampere's law • Use an expression for the induced emf in a conductor moving through a uniform magnetic field by considering the forces on the charges • Solve problems involving calculations of the induced emf,indued current • compare direct current (DC) and alternating current (AC) in qualitative terms • define the terms: self inductance L,mutual inductance M,and henry • Use the terms:r.m.s.current,r,m,s,potential difference, peak current, peak potential difference, half cycle average current, phase difference, phase lag, phase lead • Apply the relationship between r.m.s.and peak values for the current and potential difference for a sinusoidal waveform • Use the terms: reactance, impedance, power factor with their correct scientific meaning • Solve problems involving the magnitude and phase of current and

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		applied p.d in an a.c circuits which include resistors, capacitors and inductors • Draw phasor diagrams for R,L and C circuits • explain what are meant by r.m.s. values • explain the behavior of a capacitor in an a.c circuit • explain the behavior of an inductor in an a.c circuit
Static/wave optics **Mechanics/atomic physics**	**7.Equilibrium** • Distinguish between coplanar and concurrent forces • Find the resultant of a number of concurrent forces acting at a point • Solve problems involving the equilibrium of coplanar forces • State the conditions for there to be no rotation of a body • State the equilibrium conditions for a body acted on by coplanar forces **8.Properties of bulk matter** • Define the scientific terms :elastic limit, stress, strain, Young modulus, Shear modulus, viscous flow, viscosity, stream line flow, turbulent flow • Use equation of continuity to solve numerical problems • Describe the application of Bernoulli's principle in everyday life situation • State and use Bernoulli's equation to solve problems • Define surface tension and surface energy • Define the angle of contact and account for the shapes of liquid surfaces • Determine the relationship for the capillary rise and use it in problems • Define the terms: calorimetery, change of phase, latent heat, heat capacity, specific heat capacity	**7.Wave optics** • Describe an experiment to illustrate interference of waves • Draw diagrams to illustrate reflection and refraction of waves • Explain diffraction at a single slit • Explain beats • solve problems involving interference and diffraction, of waves • state the conditions necessary for the interference of light to be shown • explain the principle of Young's double slit experiment • carry out calculations involving Young's double slit experiment **8.Atomic physics** • Describe Rutherford's model of atom • State the nature ,charge, and properties of alpha, beta and gamma radiation • State the law of radioactive decay and explain the meaning of a half life • Write equations to illustrate alpha and beta decay • State how many protons and neutrons their are in a nuclide for which you are given the symbol • Interpret equations representing nuclear reactions indicating the nature of energy released • Identify the relationship between mass and energy • Explain what is meant by photo electric effect • Describe an experiment to demonstrate the emission of photo electrons • State how the rate of emissions of photo electrons and their energy depend upon the intensity and frequency of the incident radiation • Work through simple problems on half –life • Associate the release of energy in a nuclear reaction with a change in mass

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	• Distinguish between the concepts: heat, temperature, internal energy, work • Identify the units for heat, heat capacity, specific heat capacity, latent heat • Solve problems involving thermal conductivity, change of state and expansivity • Describe properties that can be used for temperature measurement • Explain the methods used for the measurement of specific heat capacities • Relate latent heat to intermolecular forces	• Discus problems posed by radioactive waste • Represent nuclear reactions in the form of equations • Distinguish between fission and fission