Contest 1a

	A 1 μF, a 2 μF, and a 3 μF capacitor are connected in series.
(1)	The equivalent capacitance of the series network equals 6 μF. **Ans: False**
(2)	The equivalent capacitance of the series network is less than 6 μF. **Ans: True**
(3)	The equivalent capacitance of the series network is less than 3 μF. **Ans: True**

Contest 1b

(4)	The activity of a radioactive sample decreases as the temperature of the sample is increased. **Ans: False**
(5)	The activity of a radioactive sample increases as the pressure on the sample is increased. **Ans: False**
(6)	The activity of a radioactive sample decreases as the temperature of the sample is decreased. **Ans: False**

Contest 2a

	Suppose a uranium fission reactor were operated without a moderator.
(1)	Excessive heat will be generated. **Ans: False**
(2)	Meltdown of the reactor will occur. **Ans: False**
(3)	The fuel rods will become enriched in uranium-235. **Ans: False**

Contest 2b

(4)	The impulse of a force is a vector quantity. **Ans: True**
(5)	The impulse of a force and the work of a force have dimensionally equivalent units. **Ans: False**
(6)	The impulse of a force and linear momentum have dimensionally equivalent units. **Ans: True**

Contest 3a

(1)	The terrestrial magnetic field is horizontal everywhere on the surface of the earth. **Ans: False**
(2)	The terrestrial magnetic field varies with time. **Ans: True**
(3)	The terrestrial magnetic field is mainly a magnetic dipole field. **Ans: True**

Contest 3b

	An object is projected from level ground at an angle to the horizontal. Air resistance and other non-idealities are negligible.
(4)	The horizontal range of the object increases then decreases as the angle of projection is increased from zero to 90°. **Ans: True**
(5)	The horizontal range of the object is greatest when the angle of projection is 45°. **Ans: True**
(6)	For a fixed angle of projection, the horizontal range varies linearly with speed of projection. **Ans: False**

Contest 4a

(1)	In an ideal step-up transformer, the current in the primary winding is greater than the current in the secondary winding. **Ans: True**
(2)	In an ideal step-up transformer, the primary-to-secondary current ratio equals the primary-to-secondary voltage ratio. **Ans: False**
(3)	In an ideal step-up transformer, the power dissipated in the primary equals the power dissipated in the secondary. **Ans: True**

Contest 4b

(4)	The impulse of a time-dependent force equals the time integral of the force. **Ans: True**
(5)	A weak force acting over a long period can produce an impulse of greater magnitude than that produced by a strong force acting over a short period. **Ans: True**
(6)	The impulse of the net force acting on an object only equals the change in the linear momentum of the object when the force acts for a short duration. **Ans: False**

Contest 5a

	One of the effects of global warming is an increase in mean sea-level.
(1)	The melting of the ice in icebergs floating in the sea does not lead to mean sea-level rise. **Ans: True**
(2)	The melting of the ice in glaziers and ice sheets on coastal land does not lead to mean sea-level rise. **Ans: False**
(3)	Thermal expansion of seawater does not lead to mean sea-level rise. **Ans: False**

Contest 5b

(4)	If the net force on a moving object is zero, the object moves in a straight line. **Ans: True**
(5)	If the net force on a moving object is zero, the object eventually stops. **Ans: False**
(6)	If the net force on a moving object is zero, the acceleration of the object is zero. **Ans: True**

Contest 6a

	A photoelectric effect experiment is conducted with photons of frequency greater than the threshold frequency.
(1)	The maximum kinetic energy of photoelectrons depends on the rate at which photons strike the photocathode. **Ans: False**
(2)	The photocurrent depends on the rate at which photons strike the photocathode. **Ans: True**
(3)	There is a time lag between the illumination of the photocathode and the first emergence of photoelectrons during which the photocathode warms up. **Ans: False**

Contest 6b

(4)	The electric field produced at any point by a uniformly charged sphere is directed along a radial line from the center of the sphere. **Ans: True**
(5)	The magnitude of the electric field produced at any point by a uniformly charged sphere is inversely proportional to the square of the distance from the center of the sphere. **Ans: False**
(6)	The magnitude of the electric field produced at any point outside a uniformly charged sphere is inversely proportional to the square of the distance from the center of the sphere. **Ans: True**

Contest 7a

(1)	Current measurements are made by connecting an ammeter across the device under investigation. **Ans: False**
(2)	The best ammeter to use for current measurements must have a very low internal resistance. **Ans: True**
(3)	Voltage measurements are made by connecting an ammeter across the device under investigation. **Ans: False**

Contest 7b

(4)	Torque is a vector quantity whereas work is a scalar quantity. **Ans: True**
(5)	Torque and work have dimensionally equivalent units. **Ans: True**
(6)	The joule is the SI unit for both torque and work and it is equivalent to the newton meter. **Ans: False**

Contest 8a

	A very long straight wire carries a steady electric current that is uniformly distributed across its cross section.
(1)	The magnitude of the magnetic flux density outside the wire decreases as the distance from the center of the wire increases. **Ans: True**
(2)	The magnitude of the magnetic flux density inside the wire decreases as the distance from the center of the wire increases. **Ans: False**
(3)	The magnitude of the magnetic flux density inside the wire is zero. **Ans: False**

Contest 8b

(4)	The thermal efficiency of a heat engine equals the work done by the engine divided by the heat the engine absorbs at its hot reservoir. **Ans: True**
(5)	The thermal efficiency of a heat engine is greatest when the temperature difference between its hot and cold reservoirs is the smallest value it can have. **Ans: False**
(6)	The thermal efficiency of a heat engine cannot exceed the temperature difference between its hot and cold reservoirs divided by the temperature of its hot reservoir. **Ans: True**

Contest 9a

(1)	The net external torque on a system equals the rate of change of its angular momentum. **Ans: True**
(2)	A system is in mechanical equilibrium if the net external force is zero and the net external torque on it is also zero. **Ans: True**
(3)	The net external force on a system equals the rate of change of its linear momentum. **Ans: True**

Contest 9b

(4)	The magnitude of the electric force on a charged particle moving in an electric field is proportional to the speed of the particle. **Ans: False**
(5)	The electric force on a charged particle moving in an electric field is either in the same direction as the velocity of the particle or it is in the opposite direction. **Ans: False**
(6)	The electric force on a charged particle moving in an electric field is either in the same direction as the electric field or it is in the opposite direction. **Ans: True**

Contest 10a

(1)	The elastic potential energy of a stretched spring equals the product of the tension and the extension of the spring. **Ans: False**
(2)	The elastic potential energy of a stretched spring is greater than the product of the tension and the extension of the spring. **Ans: False**
(3)	The elastic potential energy of a stretched spring is proportional to the square of the extension of the spring. **Ans: True**

(4)	The electric field in the region between two infinite parallel metal plates carrying equal but opposite charge has the same magnitude and direction everywhere between the plates. **Ans: True**
(5)	The scalar potential in the region between two infinite parallel metal plates carrying equal but opposite charge has the same value everywhere between the plates. **Ans: False**
(6)	The equipotential surfaces in the region between two infinite parallel metal plates carrying equal but opposite charge are planes parallel to the plates. **Ans: True**

Contest 11a

	A power source of emf $\mathcal{E}$ has a fixed internal resistance R independent of the current drawn from it.
(1)	The power source delivers maximum power to a resistive load when the load resistance equals R. **Ans: True**
(2)	The maximum power the power source can deliver is $\mathcal{E}^2/R$. **Ans: False**
(3)	The maximum current the power source can deliver is half $\mathcal{E}/R$. **Ans: True**

(4)	The work done by an ideal gas in a constant pressure process equals the product of the pressure and the change in volume of the gas. **Ans: True**
(5)	The work done by an ideal gas in a constant volume process equals the product of the volume and the change in pressure of the gas. **Ans: False**
(6)	The work done by an ideal gas in a constant temperature process equals the product of the temperature and the change in volume of the gas. **Ans: False**

Contest 12a

	Two parallel polarizers are arranged in such a manner that the angle between their transmission axes can be freely changed. Unpolarized light is incident on the arrangement.
(1)	The intensity of the transmitted light is greatest when the angle between the axes of the polarizers is zero. **Ans: True**
(2)	The intensity of the transmitted light is smallest when the angle between the axes of the polarizers is $180°$. **Ans: False**
(3)	The intensity of the light transmitted by the arrangement is at most half the incident intensity. **Ans: True**

Contest 12b

(4)	If the horizontal component of the linear momentum of an object is conserved, then the vertical component of the linear momentum of the object is also conserved. **Ans: False**
(5)	If the horizontal component of the linear momentum of an object is conserved, then the vertical component of the linear momentum of the object is zero. **Ans: False**
(6)	If the horizontal component of the linear momentum of an object is conserved, then the horizontal component of the net force on the object is zero. **Ans: True**

Contest 13a

(1)	The energy stored by a charged parallel plate capacitor in vacuum is proportional to the volume of the space between its plates. **Ans: True**
(2)	The energy stored by a charged parallel plate capacitor in vacuum is proportional to the magnitude of the electric field between its plates. **Ans: False**
(3)	The energy stored by a charged parallel plate capacitor in vacuum is proportional to the squared magnitude of the electric field between its plates. **Ans: True**

Contest 13b

	Consider an ideal gas at a fixed temperature.
(4)	The mean molecular speed is less than the most probable molecular speed. **Ans: False**
(5)	The mean molecular speed is less than the root-mean-square molecular speed. **Ans: True**
(6)	The mean molecular speed is the average of the most probable and root-mean-square molecular speeds. **Ans: False**

Contest 14a

(1)	The electric field near an infinite charged plane metal sheet has the same magnitude on each side of the sheet. **Ans: True**
(2)	The electric field near an infinite charged plane metal sheet has the same direction on each side of the sheet. **Ans: False**
(3)	The electric field near an infinite charged plane metal sheet is everywhere perpendicular to the sheet. **Ans: True**

Contest 14b

(4)	The activity of a sample containing a radioactive nuclide decreases as the quantity of the nuclide in the sample is increased. **Ans: False**
(5)	The activity of a sample containing a radioactive nuclide increases as the quantity of the nuclide in the sample is increased. **Ans: True**
(6)	The activity of a sample containing a radioactive nuclide that decays to a stable nuclide decreases as time progresses. **Ans: True**

Contest 28a

	The displacement with time t of a certain object moving along a straight line is given by $x(t) = a + bt + ct^2$.
(1)	The parameter a is dimensionless. **Ans: False**
(2)	The parameter b has the same dimensions as the parameter a. **Ans: False**
(3)	The SI unit for the parameter c is m s^{-2}. **Ans: True**

Contest 28b

(4)	In a double-slit experiment conducted with monochromatic light, the phenomenon of light polarization can be observed. **Ans: False**
(5)	In a double-slit experiment conducted with monochromatic light, the phenomenon of rectilinear propagation of light can be observed. **Ans: False**
(6)	In a double-slit experiment conducted with monochromatic light, the particle behavior of light can be observed. **Ans: True**

Contest 29a

(1)	Longitudinal waves do not exhibit diffraction phenomena. **Ans: False**
(2)	Longitudinal waves do not exhibit polarization phenomena. **Ans: True**
(3)	Longitudinal waves do not exhibit interference phenomena. **Ans: False**

Contest 29b

(4)	When an object moves with uniform velocity, its displacement from a fixed reference point changes with time. **Ans: True**
(5)	When an object moves with uniform velocity, its velocity relative to a fixed reference point changes with time. **Ans: False**
(6)	When an object moves with uniform velocity, its direction of motion is fixed. **Ans: True**

Contest 30a

(1)	The slope of the velocity-time graph equals acceleration. **Ans: True**
(2)	The slope of the force-time graph equals linear momentum. **Ans: False**
(3)	The slope of the momentum-time graph equals impulse. **Ans: False**

Contest 30b

(4)	Paramagnetism arises from strong interaction between atomic dipoles that results in spontaneously magnetized regions. **Ans: False**
(5)	Under suitable conditions, the magnetic susceptibility of a paramagnetic substance is inversely proportional to absolute temperature. **Ans: True**
(6)	Magnetic domains in a paramagnetic substance are generally small and randomly oriented. **Ans: False**

Contest 31a

(1)	The centripetal force on an object moving slowly in a circle is proportional to the kinetic energy of the object. **Ans: True**
(2)	The kinetic energy of an object moving slowly in a circle equals the square of the linear momentum divided by the mass of the object. **Ans: False**
(3)	The kinetic energy of an object moving slowly in a circle equals half the product of the radius of the circle and the centripetal force on the object. **Ans: True**

Contest 31b

(4)	The magnetic force on a charged particle moving at an angle to a magnetic field is perpendicular to the magnetic flux density. **Ans: True**
(5)	The magnetic force on a charged particle moving at an angle to a magnetic field is perpendicular to the velocity of the particle. **Ans: True**
(6)	The magnetic force on a charged particle moving in a magnetic field changes the kinetic energy of the particle. **Ans: False**

Contest 32a

(1)	An SI unit for magnetic flux density is $\mathrm{Wb\ m^{-2}}$. **Ans: True**
(2)	An SI unit for magnetic flux is V s. **Ans: True**
(3)	An SI unit for capacitance is $\mathrm{A\ s\ V^{-1}}$. **Ans: True**

Contest 32b

(4)	The range of a projectile launched at 30° equals its range when launched at 60° with the same speed. **Ans: True**
(5)	The range of a projectile launched at 15° equals its range when launched at 30° with the same speed. **Ans: False**
(6)	The range of a projectile is greatest when the projectile is launched at 45°. **Ans: True**

Contest 33a

	An object slides at constant velocity down a rough inclined surface.
(1)	Because the object moves down the plane at constant velocity the friction force on it is zero. **Ans: False**
(2)	The normal force on the object equals its weight. **Ans: False**
(3)	Because the object moves down the plane at constant velocity, the friction force on it plus the normal force on it plus its weight equals zero. **Ans: True**

Contest 33b

(4)	Any amount of charge on a charged body is an integer multiple of the electron charge. **Ans: True**
(5)	Any amount of charge on a charged body is an integer multiple of the proton charge. **Ans: True**
(6)	A negatively charged grounded copper block contains fewer protons than the same grounded copper block when it is neutral. **Ans: False**

Contest 34a

(1)	A concave spherical mirror with a radius of curvature of 24 cm forms a real image of a paraxial real object placed 16 cm from the pole of the mirror. **Ans: True**
(2)	A concave spherical mirror with a radius of curvature of 24 cm forms a real image of a paraxial real object placed 8 cm from the pole of the mirror. **Ans: False**
(3)	A concave spherical mirror with a radius of curvature of 24 cm forms a virtual image of a paraxial real object placed less than 12 cm from the pole of the mirror. **Ans: True**

Contest 34b

(4)	The magnitude of the magnetic flux density produced by a long straight current-carrying conductor varies as the inverse square distance from the wire. **Ans: False**
(5)	The magnetic flux density produced by a long straight current-carrying conductor does not obey the Biot-Savart law. **Ans: False**
(6)	The magnitude of the magnetic flux density produced by a long straight current-carrying conductor is proportional to the current in the wire and inversely proportional to the distance from the wire. **Ans: True**

Contest 35a

(1)	A p-type semiconductor is obtained by introducing a trivalent element into the pure semiconductor. **Ans: False**
(2)	P-type silicon may be obtained by introducing controlled amounts of a trivalent element such as boron into pure silicon. **Ans: True**
(3)	Gallium arsenide containing silicon impurities is an intrinsic semiconductor. **Ans: False**

Contest 35b

	In three separate experiments, a collimated neutron beam, a collimated alpha particle beam, and a collimated electron beam are passed perpendicularly through an inhomogeneous magnetic field.
(4)	The electron beam is deflected by the inhomogeneous magnetic field. **Ans: True**
(5)	The alpha particle beam is deflected by the inhomogeneous magnetic field. **Ans: True**
(6)	The neutron beam is deflected by the inhomogeneous magnetic field. **Ans: True**

Contest 36a

(1)	All charged particles moving in the electromagnetic field of a nucleus radiate bremsstrahlung energy. **Ans: True**
(2)	Bremsstrahlung spectra are characterized by a continuous background on which a number of sharp isolated spectral lines can be identified. **Ans: False**
(3)	Bremsstrahlung X-rays have continuous spectra whereas characteristic X-rays have line spectra. **Ans: True**

Contest 36b

(4)	The loudness of a sound note increases as the intensity of the sound note is increased. **Ans: True**
(5)	The pitch of a sound note increases as the frequency of the note is increased. **Ans: True**
(6)	The intensity of a sound note is proportional to the amplitude of the note. **Ans: False**

Contest 37a

(1)	The total electric flux out of a closed surface equals the total charge enclosed by the surface divided by the permittivity of free space. **Ans: True**
(2)	An SI unit for electric flux is the $\mathrm{V\,m^{-1}}$ and it is equivalent to the $\mathrm{N\,C^{-1}}$. **Ans: False**
(3)	Electric flux is a scalar quantity whereas electric field is a vector quantity. **Ans: True**

Contest 37b

(4)	A plano-convex spherical lens is a positive lens. **Ans: True**
(5)	A plano-concave spherical lens has one surface with negative refracting power. **Ans: True**
(6)	A thin spherical lens with one convex and one concave refracting surface is a positive lens. **Ans: False**

Contest 38a

(1)	A virtual image is formed by an apparent intersection of rays and cannot be received on a screen. **Ans: True**
(2)	A plane mirror forms a real image of a virtual object. **Ans: True**
(3)	A virtual image formed by an optical system cannot be seen by a human eye because a virtual image cannot be received on a screen. **Ans: False**

Contest 38b

(4)	Magnetic saturation in a ferromagnetic material is accompanied by precipitation of excess magnetic domains. **Ans: False**
(5)	Magnetic saturation in a single ferromagnetic crystallite occurs when the whole crystallite is occupied by a single favorably aligned magnetic domain. **Ans: True**
(6)	Magnetic saturation cannot occur in paramagnetic materials. **Ans: False**

Contest 39a

	A student seeks to organize lenses in a grab bag of lenses by placement into two boxes, one for converging lenses and another for diverging lenses. The student only judges the type of each lens by the curvatures of its refracting surfaces.
(1)	Any lens with two convex surfaces must be placed in the box for converging lenses. **Ans: True**
(2)	Any lens with at least one convex surface must be placed in the box for converging lenses. **Ans: False**
(3)	Any lens with at most one convex surface must be placed in the box for diverging lenses. **Ans: False**

Contest 39b

(4)	The double-slit experiment can be used to demonstrate the so-called wave nature of light. **Ans: True**
(5)	The double-slit experiment can be used to demonstrate the so-called wave nature of hydrogen atoms. **Ans: True**
(6)	The double-slit experiment can be used to demonstrate the so-called particle nature of light. **Ans: True**

Contest 40a

(1)	The electrostatic field is a conservative field. **Ans: True**
(2)	The electric field is a conservative field. **Ans: False**
(3)	The Newtonian gravitational field is a conservative field. **Ans: True**

Contest 40b

(4)	A hydrogen atom in the $6h$ state can have an orbital angular momentum quantum number of 7. **Ans: False**
(5)	A hydrogen atom in the $6h$ state can have an orbital angular momentum quantum number of 6. **Ans: False**
(6)	A hydrogen atom in the $6h$ state can have a magnetic quantum number of -5. **Ans: True**

Contest 27a

(1)	**Ans:**
(2)	**Ans:**
(3)	**Ans:**

Contest 27b

(4)	**Ans:**
(5)	**Ans:**
(6)	**Ans:**

Contest 28a

(1)	Part of the sun's energy comes from spontaneous fission of deuterium. **Ans: False**
(2)	The fusion of two protons is forbidden by energy conservation because of the Coulomb repulsion which increases indefinitely as the protons approach each other. **Ans: False**
(3)	The fusion of two protons is exoergic. **Ans: True**

Contest 28b

	A cylindrical conductor carries an electric current that is uniformly distributed over its cross-sectional area.
(4)	The magnetic force on the conductor due to its current tends to elongate the cylinder, thereby inducing a longitudinal tensile stress in the conductor. **Ans: False**
(5)	The magnetic force on the conductor due to its current tends to increase the radius of the cylinder, thereby inducing a transverse tensile stress in the cylinder. **Ans: False**
(6)	The current in the conductor cannot exert a magnetic force on the same conductor. **Ans: False**

Contest 29a

(1)	The Bohr model result for the ground state electronic orbital angular momentum of the hydrogen atom deviates from the actual value of the electronic orbital angular momentum. **Ans: True**
(2)	Experiments show that the difference between the Bohr model prediction for the ground state orbital angular momentum of the hydrogen atom and the actual value of the electronic orbital angular momentum is insignificant. **Ans: False**
(3)	The orbital angular momentum assigned by the Bohr model to a hydrogen atom in its ground state is greater than the actual value of the ground state electronic orbital angular momentum. **Ans: True**

Contest 29b

	An isolated vessel has two equal-volume compartments separated by an impermeable rigid but movable partition. Each compartment contains the same quantity of the same ideal gas at the same temperature and pressure.
(4)	When the partition is removed and the two gases mix, the equilibrium temperature of the mixture equals the temperature of the gases before mixing. **Ans: True**
(5)	When the partition is removed and the two gases mix, the internal energy of the mixture equals the sum of the internal energies of the gases before mixing. **Ans: True**
(6)	When the partition is removed and the two gases mix, the entropy of the mixture equals the sum of the entropies of the gases before mixing. **Ans: False**

Contest 30a

	A battery has a fixed internal resistance which is independent of the current supplied by the battery.
(1)	The battery supplies maximum power to a resistive load when its terminal voltage is half the emf of the battery. **Ans: True**
(2)	The battery supplies maximum power to a resistive load when the load resistance equals half the internal resistance of the battery. **Ans: False**
(3)	The battery supplies maximum power to a resistive load when the load draws half the short-circuit current of the battery. **Ans: True**

Contest 30b

	The thermal conductivity of a gas is proportional to its molar heat capacity at constant volume and inversely proportional to the product of the square of its molecular radius and the square root of its molar mass.
(4)	The thermal conductivity of a monoatomic gas and that of a diatomic gas are nearly the same. **Ans: False**
(5)	The thermal conductivity of a gas of hydrogen molecules is greater than that of a gas of hydrogen atoms. **Ans: False**
(6)	The thermal conductivity of helium gas is less than the thermal conductivity of hydrogen gas. **Ans: True**

Contest 31a

(1)	The resolving power of a microscope objective depends on the diameter of the lens aperture. **Ans: True**
(2)	The resolving power of a microscope objective increases as wavelength decreases. **Ans: True**
(3)	The resolving power of a microscope objective increases as the diameter of the lens aperture increases. **Ans: False**

Contest 31b

	The emissivity of human skin is unity. Take the average normal human body temperature as 36 ℃.
(4)	Humans at normal body temperature emit strongly in the ultraviolet region of the electromagnetic spectrum but the emitted radiation is invisible to the human eye. **Ans: False**
(5)	Normal human body temperature corresponds to a blackbody whose peak spectral radiancy occurs at about 9.4 μm. **Ans: True**
(6)	Humans at normal body temperature emit infrared radiation in a narrow band centered at 9.4 μm. **Ans: False**

Contest 32a

	A freely moving charged particle enters a uniform electric field whose direction is perpendicular to the velocity of the incoming particle. No other fields are present.
(1)	The velocity of the particle remains perpendicular to the electric field. **Ans: False**
(2)	The trajectory of the particle in the field is a circle. **Ans: False**
(3)	The speed of the particle remains constant. **Ans: False**

Contest 32b

	A collection of identical particles each of mass m is prepared so that each particle is in the same state and the collection is divided into three groups. A group is selected for measurements of the x-coordinate x, another for the x-component of linear momentum p_x and the third for kinetic energy K. The expectation value and the uncertainty for each of the three quantities are determined from the measurements on their respective group.
(4)	The product of the uncertainty in x and the uncertainty in p_x is greater than or equal to the Planck constant divided by 4π. **Ans: True**
(5)	The product of the uncertainty in x and the uncertainty in K is greater than or equal to the Planck constant times the expectation value of p_x divided by $4\pi m$. **Ans: True**
(6)	The product of the uncertainty in p_x and the uncertainty in K is greater than or equal to the Planck constant times the expectation value of p_x divided by $4\pi m$. **Ans: False**

Contest 33a

(1)	The flux of the magnetic induction out of a closed surface equals the total current enclosed by the surface multiplied by the permeability of free space. **Ans: False**
(2)	The flux of the magnetic induction out of a closed surface equals the total charge enclosed by the surface divided by the permeability of free space. **Ans: False**
(3)	The flux of the magnetic induction out of any closed surface is zero. **Ans: True**

Contest 33b

	A point charge q is located on the z-axis a distance d above a very large grounded conducting plane lying in the x-y plane.
(4)	The induced surface charge density on the plane has the greatest magnitude at the origin. **Ans: True**
(5)	The induced charge on the plane is $-q$ at the origin and increases to zero at points far from the origin. **Ans: False**
(6)	The induced charge on the plane attracts q with the same force as a charge $-q$ located on the z-axis a distance d below the plane. **Ans: True**

Contest 34a

(1)	The energy of a magnetic dipole in a uniform magnetic field is greatest when the angle between the magnetic dipole moment of the dipole and the magnetic flux density is zero. **Ans: False**
(2)	The magnitude of the force on a magnetic dipole in a uniform magnetic field increases as the angle between the dipole moment of the dipole and the magnetic flux density increases. **Ans: False**
(3)	The magnitude of the force on a magnetic dipole in a uniform magnetic field vanishes at any orientation of the dipole with respect to the field. **Ans: True**

Contest 34b

	A double-slit experiment is conducted with a collimated light beam whose spectrum only contains a green line and a red line.
(4)	Since the light beam is not monochromatic, no interference pattern is observed. **Ans: False**
(5)	The center of the interference pattern is bright and contains the red and green components of the light in the same proportion as in the incident beam. **Ans: True**
(6)	All bright fringes other than the zero-order fringe are either green or red and a green fringe is closer to the center of the pattern than a red fringe in the same diffraction order. **Ans: True**

Contest 35a

	A conducting sphere of radius R has charge q. A second sphere of radius $R/2$ located very far from the first also has charge q. The two spheres are later joined by a very thin wire so the charges on the two spheres are redistributed.
(1)	All the charge from the two spheres concentrates on the sphere with radius $R/2$. **Ans: False**
(2)	The charge on the sphere of radius $R/2$ decreases to $2q/3$. **Ans: True**
(3)	The surface charge density on the sphere of radius R increases to $2q/3\pi R^2$. **Ans: True**

Contest 35b

(4)	When a pole of a magnet is plunged into a coil, the emf induced in the coil depends on the strength of the pole and its speed. **Ans: True**
(5)	No emf is induced in a plane loop that is stationary in a uniform magnetic field that is perpendicular to the plane of the loop and whose magnitude is increasing slowly. **Ans: False**
(6)	When a pole of a magnet is plunged into a coil, the emf induced in the coil depends on the number of turns in the coil but not on the orientation of the coil. **Ans: False**

Contest 36a

	A single-slit experiment is conducted to study diffraction of monochromatic microwave radiation. The separation between the slit and the screen is fixed whereas the width of the slit is varied.
(1)	The width of the central diffraction peak decreases as the slit width is decreased. **Ans: False**
(2)	The first diffraction minimum shifts farther away from the center of the diffraction pattern as the slit width is decreased. **Ans: True**
(3)	For any slit width at which a diffraction pattern is observed, each diffraction peak is equally as bright as an adjacent diffraction peak. **Ans: False**

Contest 36b

	A GM counter is used to determine background activity by recording the number of counts in 10 s intervals.
(4)	The GM counter records different counts in different 10 s intervals. **Ans: True**
(5)	The error in the count recorded by the GM counter in each 10 s interval is $\sqrt{10}$. **Ans: False**
(6)	The error in the count recorded by the GM counter in each 10 s interval is $1/\sqrt{10}$. **Ans: False**

Contest 37a

	A particle moves on a circle of radius R centered on the origin.
(1)	The velocity of the particle is always perpendicular to its position vector. **Ans: True**
(2)	The acceleration of the particle is always perpendicular to its position vector. **Ans: False**
(3)	The acceleration of the particle is always directed towards the origin. **Ans: False**

	An accelerated proton whose kinetic energy is at least six times the proton rest energy collides with a stationary proton.
(4)	Because of the Coulomb repulsion between the protons, only two protons can emerge from such a collision. **Ans: False**
(5)	Because the kinetic energy of the incident proton is sufficiently high, particles other than the two protons can emerge in such a collision. **Ans: True**
(6)	Because the kinetic energy of the incident proton is sufficiently high, three protons and an antiproton may emerge from such a collision. **Ans: True**

Contest 38a

	A student in a physics laboratory studies the properties of electrons using a cathode ray tube with an electron gun that generates a horizontal collimated beam of electrons. The tube is equipped with sets of plates and coils between the cathode and anode that generate uniform electric and magnetic fields in planes perpendicular to the electron velocity.
(1)	The trajectory of an electron from cathode to anode is a straight line when the electric and magnetic fields are both zero. **Ans: False**
(2)	A horizontal electric field causes a deflection of an electron in a horizontal plane. **Ans: True**
(3)	The trajectory of an electron from cathode to anode is a parabola when the electric and magnetic fields are both zero. **Ans: True**

Contest 38b

(4)	Only photons whose energy exceed a threshold value can scatter off a stationary free electron and cause motion of the electron. **Ans: False**
(5)	When a photon scatters off a stationary free electron, the energy of the scattered photon depends on the scattering angle. **Ans: True**
(6)	When a photon scatters off a stationary free electron, the energy difference between the incident photon and the scattered photon is greatest for a scattering angle of 180°. **Ans: True**

Contest 39a

(1)	If two events are observed to occur simultaneously, every inertial observer agrees the two events are simultaneous. **Ans: False**
(2)	If two events are observed to occur simultaneously, only inertial observers near the two events agree they are simultaneous. **Ans: False**
(3)	If two events are observed to occur simultaneously at the same location, every inertial observer agrees the two events are simultaneous. **Ans: True**

Contest 39b

(4)	In Rutherford scattering using low-energy alpha particles, the scattered alpha particles follow hyperbolic paths. **Ans: True**
(5)	In Rutherford scattering using low-energy alpha particles, the hyperbolic trajectory of scattered alpha particles arises because of the Coulomb interaction between the alpha particles and the target nuclei. **Ans: True**
(6)	In Rutherford scattering using low-energy alpha particles, the distance of closest approach between an alpha particle and a nucleus increases indefinitely as scattering angle decreases from 180° to 0°. **Ans: True**

Contest 40a

(1)	A charge q outside a grounded conducting sphere at a distance a from the center of the sphere which has a radius R induces a total charge of $-qR/a$ on the sphere. **Ans: True**
(2)	A charge q inside a hollow grounded conducting sphere at a distance a from the center of the sphere which has an inside radius R induces a total charge of $-qR/a$ on the inside surface of the sphere. **Ans: False**
(3)	A charge q inside a hollow grounded conducting sphere cannot induce any charge on the inside surface of the sphere because all charge on a conductor reside on the outside surface of the conductor. **Ans: False**

Contest 40b

(4)	The neutron is composed of one up and two down quarks and undergoes beta decay in which a proton is produced. **Ans: True**
(5)	In the beta decay of a neutron, a down quark becomes an up quark with the release of an electron and an electron antineutrino, with the result that a proton is produced. **Ans: True**
(6)	The proton, which is composed of one down and two up quarks, is unconditionally stable because an up quark cannot transform into a down quark. **Ans: False**