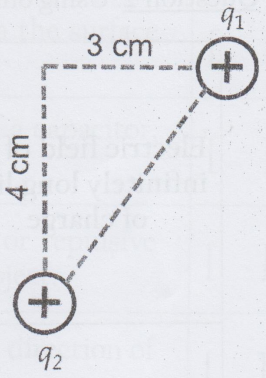
What is the electric field *inside* a uniformly charged sphere? What happens when we calculate the electric field at a large distance outside the sphere? (7 marks)

Discuss the effect of distance on the electric field in a graph of E vs r.

Two circular electrodes of diameter 5 cm are placed 2 mm apart to form a parallel plate capacitor. What charge must be placed on each electrode to create a uniform electric field of strength 2.0×10^6 N/C? How many electrons must be moved from one electrode to the other to accomplish this? If the plates are replaced by 2.0×3.0 rectangular plates calculate the electric field inside and outside the capacitor. (7 marks)

Question 3: answer the following (22 marks)

Two positively charged particles q_1 and $q_2 = 5q_1$ are placed as in the figure. Where (other than at infinity) could a third charge q_3 be placed so as to experience no net force? (5 marks)



The water molecule H_2O has a permanent dipole moment of magnitude 6.2×10^{-30} C.m. A water molecule is located 8 nm from a positive ion Z^+ in a solution. Calculate the electric force the ion exerts on the water molecule? (3 marks)

Question 2: Using only equations define the following: (8 marks)

Electric field of an infinitely long line of charge	
Gauss's law	
Electric field of an electric dipole	
Potential difference between two points	

10	The area vector $\vec{A}$ is always perpendicular on the surface and points inside the area.	[ ]
11	Charges that enetering between the plates of a capacitor, move in a straigth line.	[ ]
12	Neutral objects cannot exert any attractive or repulsive reaction when they interact with a charged object.	[ ]
13	The gravitational acceleration depends on the direction of the electric field acceleration.	[ ]
14	The electric flux through a closed surface may equal zero even if $Q_{enclosed} \neq 0$.	[ ]
15	The electric potential increases in the direction of the electric field.	[ ]
16	The direction of the Coulomb's force is determined from the distance between any two charges.	[ ]
17	In a uniform electric field, there are no net force acting on an electric dipole.	[ ]
18	A neutral object cannot produce an electric field.	[ ]
19	An ideal gaussian surface can provide sufficient screening for some sensitive applications.	[ ]
20	Materials on or in which the charges are not moving freely, are not sensitive to applied electric field.	[ ]

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If needed use the following constants:

$e = 1.6 \times 10^{-19} C$, $\epsilon_0 = 8.85 \times 10^{-12}\ C^2/Nm^2$, $K = 9 \times 10^9\ Nm^2/C^2$.

Question I: Justify the correct answer with corrections if found. (20 marks)

1	Neutral objects cannot be charged.	[ ]
2	Two charges of equal magnitudes and opposite signs, in order to determine their values a gaussian surface must contain both charges at the same time.	[ ]
3	The direction of dipole moment vector $\vec{p}$ is directed from positive to negative ends of the dipole.	[ ]
4	When an electric charge is placed in a uniform electric field. The electric field exerts a *constant* force on the charge in the opposite direction of motion.	[ ]
5	Electric dipoles can occur in conductors and insulators.	[ ]
6	The electric field is zero inside any hole within a conductor unless there is a charge in the hole.	[ ]
7	In an ideal battery, the electromotive force (*emf*) is slightly larger than the potential difference ($\Delta V_{battery}$) in the battery.	[ ]
8	Electric field of a dipole is directly proportional to r^3.	[ ]
9	The law of conservation of charges states that the net charge is not equal to zero, there are always some positive or negative charge.	[ ]

iv- Fred is driving his car with a steady speed of 45 m/s when he passes Betty sitting at rest. Betty instantly begins accelerating at 15.0 m/s^2. How far does Betty have to drive to overtake Fred? (4 marks)

ii- A robe inclined upward at a 45° angle pulls a suitcase for 6500 cm through the airport. The tension in the robe is 30 N. How much work does the tension force do on the suitcase? (3 marks)

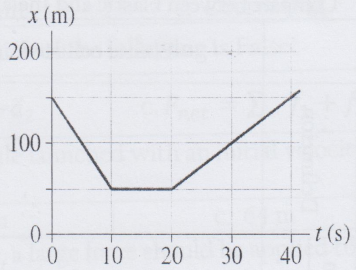
iii- How much energy is consumed by (a) a 2.2 kW hair dryer used for 5.0 min and (b) a 6.0 W LED bulb left on for 24 h? (4 marks)

- Compare between Projectile and circular motions. (5 marks)

	Projectile motion	Circular motion
Motion diagram with the direction of $\vec{v}$ and $\vec{a}$		
Equations used for v and a		

Question 4: Answer the following (15 marks)

i- The following graph is the position-versus-time graph of a bicycle. What is the bicycle's velocity at (a) t = 5 s, and (b) t = 30 s? Does this bicycle move with an acceleration? (4 marks)



Question 3:

(15 marks)

- Compare between Average and Instantaneous velocities. (5 marks)

	Average velocity	Instantaneous velocity
Definition		
Equation		
Calculation from position graphs		

- Compare between Elastic and Inelastic collisions. (5 marks)

		Elastic collision	Inelastic collision
Definition			
Graphical representation	Before		
	After		

Question 2: Choose the correct answer from the following: (10 marks)

1. A process that transfers energy to or from a system by mechanical means is called		
a. Work	b. Heat	c. Equilibrium
2. A particle does not have a memory of the forces that was exerted on it, that is inferred in Newton's ..... law.		
a. Second	b. First	c. Zeroth
3. When energy is transferred into the system and the particle speeds up, leading to an increase in kinetic energy. The angle between the force vector and the velocity vector should be		
a. $\theta < 90$	b. $\theta = 90$	c. $\theta > 90$
4. In an elastic collision, after collision *ball 1* hardly slows down and *ball 2* is knocked forward at $v_{f2} \approx 2v_{i1}$ when		
a. $m_1 \gg m_2$	b. $m_1 = m_2$	c. $m_1 \ll m_2$
5. An engine is designed to operate with 33 hp, this power is equivalent to.....		
a. 3300 W	b. 25 kW	c. 44 mW
6. In order to apply Newton's laws, the acceleration must be		
a. Increasing	b. Constant	c. Decreasing
7. In Newton's third law interpretation, which of the following is False?		
a. $\vec{F}_{1\,on\,2} = -\vec{F}_{2\,on\,1}$	b. $\vec{a}_1 = -\vec{a}_2$	c. $F_{net} = \sum f_1 + f_2$
8. What is the maximum range of a projectile launched with an initial velocity of 25 m/s?		
a. 72 m	b. 45 m	c. 64 m
9. To pull an object on a horizontal surface, a large force should be applied to overcome the ..... force.		
a. Gravitational	b. Normal	c. Static friction
10. For an object that is slowing down, the acceleration vector should be		
a. Opposite to the velocity vector	b. In the same direction as the velocity	c. Perpendicular to the velocity vector.

If needed use acceleration due to gravity (g=9.8 m/s^2)

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Question 1: Justify the correct answer with corrections if found. (10 marks)

1	The difference between a particle's momentum before and after any collision is termed the impluse.	[ ]
2	Newton's laws are dependent on the type of the force acting on the particle.	[ ]
3	The force acting in the opposite direction of motion in a liquid is called the Drag force.	[ ]
4	Friction force is a conservative force.	[ ]
5	Increasing the launch angle (θ) for a projectile will always lead to an increase in the projectile range.	[ ]
6	Inside an isolated system any type of energy does not change, and the total energy is conserved.	[ ]
7	Newton's laws are only applied in inertial reference frames where $\vec{a} \neq 0$.	[ ]
8	A particle in uniform circular motion has a net force acting towards the center of the circular path.	[ ]
9	The conservation of mechanical energy means that the potential energy of the system remains constant.	[ ]
10	Gravitational force can be attractive or repulsive depending on the masses interacting.	[ ]