PHYS 1301 IDEAS OF MODERN PHYSICS *Example Essays*

THIS IS AN EXAMPLE - NOT THE EXAM TOPIC!

Write an essay (no figures, about 3-4 hand-written single-spaced single-side pages) based on the content of the textbook

Chapter 2 (Classical Physics)

Your essay should **describe** the key **principles** and the main **experiments and observations**. It should use the principles to **explain** these experiments and observations.

Tips

To receive credit your writing must be literate- & legible-enough to convey the meaning clearly.

Giving a historical or personal narrative, writing about science other than classical physics, just naming things, etc. will not earn any credit.

Correct, concise, and comprehensive descriptions and explanations of the science of chapter 2 (classical physics) will earn credit.

prin·ci·ple Noun

A fundamental truth or proposition that serves as the foundation for a system of belief or behavior or for a chain of reasoning

de·scribe Verb

Give an account in words of something, including all the relevant characteristics, qualities, or events.

ex·plain Verb

Account for (an action or event) by giving a reason as justification.

A bad example:

Dr. Dailey told us about the ideas of classacal physics before he told us about the ideas of modern physics so we know what the difference was especialy in relation to how the ideas of classical physics are easy to understand but ideas of modern physics are not. The ideas of modern physics are so important for the modern world and all the technology in it. Grt mndu jagu sglur qeyya kurfdio spabia. First we learnt about space time and motion and how that was described by newton in his grate book the Principa published in 1685 in England not long after the time of galileo. Then we were told about the 3 laws of newton. The 1st was that things continue to go in a straight line unless there is a force. The 2nd was F=ma. The 3rd was every reaction has an action. Then he told us about the subject of electromagnetism which was invented by James Maxwell in the 19th century 200 years after the time of netwon. This is about light which is a wave of electromagnetism and always travels at the same speed according to the 1st postulate of Special Relativity. A cell phone receives light to communicate except that the light is not visible it has a long wavelength. Cell phone receives microwaves or radiowaves which corresponds to a wavelength of about 10^{-6} m or longer. Without my cell phone I would simply die so that is a really good consequence of modern physics. Now I will describe in detail Newtons laws of motion. The 1st was that things continue to go in a straight line unless there is a force. The 2nd was F=ma. The 3rd was every reaction has an action. If you are driving in your car and step on the gas pedal you speed up which is what the 2nd law means. But if you are just cruising then it's the first law. When you lean on something like a table the reason you don't fall over is that the table pushes back. These observations explain and justify newtons three laws and help us understand the modern world around us in so many ways. I am really enjoying this course and feel that I've learnt a lot so far and hope to get a good grade. Sorry I ran out of time there was so much more I wanted to say.

A good example:

Classical physics developed principles to describe and then explain the directly observed motion of objects. They were based on the elementary notions of distance and time, which can be measured for any object relative to a given frame of reference by comparing to an agreed standard for units of distance and time. Subsidiary concepts such as speed (distance divided by time), velocity (speed and direction) and acceleration (rate of change of velocity) then enable one to quantitatively describe such movement by calculation. Intuitively, velocity is something an observer sees while acceleration is something that can also be felt. It is necessary to supplement these ideas with rules – Galilean relativity – for translating the results of measurement or calculation from one frame of reference to another in uniform relative motion. In particular, in classical physics time measurements were assumed to be absolutes, the same for all observers no matter their speed, while observers moving relative to one another would always come to different conclusions about the speed of a third object relative to their own frame.

To give reasons or explain a cause for movement, Newton formulated three laws employing the basic idea of force – a push or pull. These laws hold relative to inertial reference frames, ones in which a stationary observer feels no forces. Firstly, when there are no forces on an object (or forces are balanced) it moves with unchanging velocity. In the presence of an unbalanced force there will be acceleration, with the inertial mass of an object representing its resistance to acceleration under a given amount of force. The larger the inertial mass, the harder it is to alter its velocity. Lastly, all forces occur in pairs of equal size but opposite direction, acting respectively on pairs of objects interacting with one another. Together, these three laws provided a framework for understanding the behavior of any known object subject to any known force.

Within this general framework, two kinds of fundamental force of nature were identified, down to which all other forces could be reduced, namely the gravity force between masses and the electromagnetic force between charges and between moving charges (current). These masses or charges do not have to be in contact with one another to feel these forces. Classical physics imagined that the effects of forces were carried through space between objects by a field, causing action-at-a-distance. Both gravity and electromagnetism reduce in strength the further apart the masses or charges are, while the bigger the mass or charge, the bigger the corresponding force it feels and causes. One important difference is that while the force of gravity is always attractive and is felt by all matter, the forces of electromagnetism can be either attractive or repulsive or, for matter with no charge, be absent altogether.

Classical physics applies to the motion of directly observed objects ranging in size from matter visible with the naked eye to planets and stars visible through telescopes. For example, a planet orbiting the Sun is constantly changing its direction of motion, therefore accelerating, due to the force of gravity attracting it toward the Sun, in accordance with Newton's 2nd law. Without this force the planet would fly off into space, along a straight path and at constant speed according to the 1st law. Acceleration by speeding up can also be caused by the force of gravity when an object is dropped – free fall. The acceleration produced by any force is constrained by the inertial mass of an object, which coincidentally is exactly the same mass that is acted on by the particular force of gravity. There is no explanation for this coincidence in classical physics, but it does imply that the acceleration due to gravity of any object is independent of its mass. This can be verified experimentally, neglecting effects of air resistance, by dropping balls of different mass, timing their fall through a fixed height, and then calculating their acceleration.

The 3rd law concerns the way in which forces in nature are always paired. When one object causes or acts upon another with a force, there appears a reaction force acting back on the first object. Both the action and reaction force have the same size but are in opposite directions. For example, the jet engines of an airplane at takeoff generate an action force to accelerate the plane forward. They do this by accelerating exhaust gases backwards via the reaction force. Both the airplane and the exhaust gases feel the same size of force but in opposite directions and will suffer different accelerations (the gases accelerate much more because of their relatively small inertial mass).

The electric force of repulsion between charged matter is something we experience every day since it explains the basic impenetrability of solid objects. When two objects come close, the charged matter inside each object repels, resulting in us being able to stand on a floor without falling through, hold things without dropping them, etc. Another manifestation of the electric force occurs when charged matter moves – this produces magnetic force that can be felt by other moving charges. When electric current is passed through wire wound in coil, a magnetic force is created in the space inside the coil. This force is used in electric motors to rotate magnets and so produce useful motion. The reverse process is used for the basic means of electricity generation by moving magnets inside a coil of wire to create a current that wasn't there before. When electric charges oscillate back-and-forth, this acceleration produces an entirely new phenomenon called electromagnetic waves. These are waves that spread out from the charges through empty space, ripples in the electromagnetic field, carrying the effects of electric and magnetic force. When the waves reach charges elsewhere they will cause them to oscillate in a similar fashion. This is the basis of much technology such as radio and cell phone communication but also natural phenomena such as our ability to see things with our eyes. Depending on the frequency of oscillation of the waves, they are given different names: For example: radio waves for the lowest frequency; visible light for middle frequencies, which in turn are split into the different colors we see from red through to purple as the frequency increases; X-rays have some of the highest frequencies and can be used to image bones and other dense things inside a body.

An important assumption, when applying the laws of classical physics in different inertial frames of reference, is that not only are the laws of physics the same but the standard units for space and time measurements are too. In the case of inertial reference frames, Galilean relativity then dictates that, when calculating the speed of an object relative to one frame, we must simply add or subtract the speed of a second frame in order to obtain the speed of the same object relative to that second frame. In this way, classical physics seemed to consistently account for the different ways that the movement of the same object was seen relative to different frames of reference. But classical physics could not account for the fact, as measured in the Michelson-Morley interferometer experiments, that the speed of electromagnetic waves was always the same value in any inertial reference frame, a violation of Galilean Relativity. Since electromagnetic waves are a basic consequence of the laws of electromagnetism, classical physics, despite its very wide-ranging success, could not be considered a complete and self-consistent treatment of the laws of physics.