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SUMMARY OF PHY101 WITH PAST QUESTIONS

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If yes, it means you have an idea of what we shall be discussing in this unit. This unit is very important because it sets the stage for understanding that branch of Physics that deals with motion, which we call mechanics. Everything in the universe is in constant motion including the tree or the rock which you probably think is not moving. The topics we shall cover in this unit which includes frame of reference, space and time will help you to understand that all motion is relative.

Define a frame of reference explain the concept of time draw and specify the position of a point in a two dimensional space with reference to a fixed origin, O list the two polar coordinates of point, P a distance r from the origin of a fixed frame of reference. Under the frame of reference, we shall discuss rest and motion, relative motion, inertial and non-inertial frame of reference and related issues.

Rest and motion

One of such observations is that a body is said to be at rest when it does not change its position with time. It is said to be in motion when it changes its position with time. But to know if the position of an object changes with time or not, we require a point absolutely fixed in space to be known. Such a fixed or stationary point is not known to exist in the universe.

This is because physicists have observed that everything in the universe is in constant motion including this earth we are living in. The sun itself together with the planets bound to it is in constant whirling motion among the galaxy of stars. We now see that even if a wrist watch you place on the surface of the earth seems to be at rest it is actually in motion because the earth in which it rests is in motion. Everything in the room where you are only seems to be at rest.

They are not actually at rest because they are actually moving relative to the earth. We can then conclude that absolute rest has no meaning in reality. When we say that the wrist watch you placed on the ground is at rest we mean that it does not change position with respect to the earth. To help you appreciate this concept of relative rest better, think of passengers seated in a luxury bus moving along the road.

The passenger is at relative rest with respect to other passengers in the same luxury bus while he or she is actually moving with respect to the objects along the road side.

All motion is relative

Now, let us go back to our discussion on relative motion. From this fixed point, the change in position can be known or measured. But as explained earlier, no such fixed point is realistic in nature because every object is in constant motion in the universe. This means that every moving

object is changing position with respect to some known object.

All bodies in our earth move with respect to the earth. Since we now know that every object is at rest or in motion relative to another object, it means that the position or motion of the object can be designated with reference to a fixed point in a rigid frame work. This so called fixed point is called the ORIGIN, O. At this point, which is the origin, we draw three mutually perpendicular axes to represent the X, Y and Z axes respectively. So the initial position of the object or the final position of the object can be designed with reference to this fixed frame work X, Y and Z axes at the origin.

Y`

A new system of reference with 01 as the origin is drawn as shown where, for convenience, 01 is taken along the X axis of the first system. Let 01X, 01Y1 and 01Z1 be the corresponding axes of the new system. At this point, I would like to call your attention to the fact that in nature inertial frames do not exist. This is because, on prolonged observation all motions, including the motions of the earth, planets and even the stars, are found to be non-inertial.

But for most of the ordinary purposes any system of coordinates situated on the earth's surface may be regarded as an inertial system. Any one of them may be P considered to be at rest because the motions are relative. This is known as a moving frame of reference.

What do you understand by the statement that the speed of a car is

This means that the car is changing its position relative to the earth and covers a distance of 100km in one hour. There are various ways you can specify a point in space. These intersecting straight lines are called the axes of reference. The distances from the point in space to the axes are found by drawing parallel lines from it to the axes.

When the axes of reference are mutually perpen-dicular to each other for example, in a two dimensional plane, they are called rectangular axes. When they are inclined to each other at an angle, other than a right angle, they are called oblique axes. The rectangular axes are more commonly used because they are more convenient to draw. The coordinates referred to either rectangular or oblique axes are called Cartesian co-ordinates.

This is shown in Figure The horizontal and vertical lines XX1 and YY1 in Figure 3.2 represent the rectangular axes fixed at origin, 0. The coordinates of any point in space for example P referred to the axes XX1 and YY1 are respectively given by x and y. The former is called the abscissa and the latter, the ordinate. The distance r = 0P of the point from the origin can be evaluated in terms of the coordinates X and Y as follows.

0P = r =

This follows from our knowledge of the properties of a right angled triangle which you did at the senior secondary school level. In this case, r and are known as polar coordinates.

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So, we get the same relation r2 y2 + x2 or that

These two methods of specifying a point in a rectangular plane are used in our daily life. Draw a diagram showing the Cartesian co-ordinates of a point P in a plane surface. The Cartesian coordinates of a point P is as shown in the diagram Fig 3.3 . It means that with reference to some fixed origin O , the location of the point is 2 units along X-axis from the origin ,O and 4 units from O along the y-axis.

Setting the standard of time

The sun appears to us to move across the sky because of this diurnal rotation of the earth about its polar axis. The sun is said to be in the meridian when it reaches the highest position in the course of its apparent journey in the sky. The interval of time between two successive transitions of the centre of the sun's disc across the meridian at any place is called a solar day. The mean of the actual solar days averaged over a full year is called the mean solar day.

So, this periodic appearances of the sun overhead, averaged over a year and called the mean solar day had helped us to capture the concept of time. The mean solar day is divided into 24 hours. An hour is divided into 60 minutes and a minute is divided into 60 seconds.

Seconds

This gives the unit of time known as the second. Using the standard of time as the periodic time associated with a transition between two energy levels of cesium-133 atom, 1 second = 9, 192,631,170 cesium periods. In this unit you have learnt that every object in space is in motion. that the periodic appearance of the sun at a particular location on earth or any other periodic happening has helped us understand the concept of time.

What you have learnt in this unit

you have learnt that rest and motion are all relative. you have learnt how time is determined. Explain what is meant by frame of reference.

What is a Dimensional Equation?

Our minds will go readily to traders in the market who sells grains like rice, garri or others who sell clothing materials. These traders do one form of measurement or the other, depending on what they are selling. For example, the garri seller measures the garri with a specific type and size of measuring cup. The particular type and size of cup has been accepted by the grarri traders union as the unit of measurement.

Another example is that when you measure the height of a man, you are comparing him to a meter stick. Science takes note of what is around us and tries to explain it. Therefore, we say that science speculates, observes and analyses etc. The whole basis of science is rooted in measurement.

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Definition of the Standards for Length, Time and Mass

A very long time ago, people used what was available as standards for measurement. Measurement of length using the “foot” came into use in this manner. They defined the meter, the second and the kilogram. The metre was defined as one ten-millionth of the distance along Earth’ssurface between the equator and the North pole.

The second was defined as 1/86,400 of a mean solar day. The kilogram was defined as the mass of a certain quantity of water. In 1889, an International organization called the General conference on weights and measures was formed. The F.P.S. system The metre, the second and the kilogram are the units we use in measuring length, time and mass.

Hence we define the unit as The convenient quantity used as the standard of measurement of a physical quantity.

To explain this further I can say that the numerical measure of a given quantity is the number of times the unit for it is contained in the

Assuming you measured out five lengths of the metre. It means that the length of the stick you brought is 5 times the length of the metre rule which is 1metre. I would like to draw your attention to the fact that every physical quantity requires a separate unit for its measurement.

What is a fundamental unit?

What this means is that length, time or mass can not be derived from any other quantity in physics and are independent of each other. So these three quantities are called the fundamental units.

What is a derived unit?

This is how to get derived unit from fundamental unit.

Area = 1m x 1m = 1m2

We see that the unit of area or that of the volume is derived from the unit of length which is a fundamental unit.

Mathematically, we write

The unit of velocity is metres per second written as ms-1 . We conclude that area, volume, velocity etc are all derived units. All the mechanical units, and units of all non-mechanical quantities like magnetism, electric, thermal, optical, etc can, with the help of some additional notions be derived from the three fundamental units of length, time and mass.

Some units of length in common use in science are

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The device used to subdivide the standard of mass, the kilogram, into equal Submasses is called the equal arm balance.

Other units for measuring long distances are

Light-year = Distance traveled by light in one year = 0.31 parsec = 5.94 x 1012 miles The unit of time as we discussed in unit 1 of this module is the mean solar second.

If you recall from our discussions in unit 1, the solar day is divided into

The mean solar second is taken to be the unit of time .

What is dimension?

Three basic ways to describe a physical quantity are the space it occupies, the matter it contains and how long it persists. From our discussion on derived units above, we saw that any physical quantity, no matter how complex, can be expressed as an algebraic combination of these three basic quantities. For example we saw that velocity is length per time The relation of the unit of any physical quantity to the fundamental units is indicated by what is known as the dimensions of the unit concerned. Let us explain this further using the example of volume.

The numerical value of volume, the unit volume is indicated by . The dimensions of volume will therefore be given by or simply .

The equation such as = or = is called dimensional equation. These dimensional equations tell us the relation between the derived units and the fundamental units, length, mass and time of any system of measurement. So, if all the exponents q, r, and s are zero the combination will be dimensionless. Note that the exponents q, r and s can be positive integers, negative integers, or even fractional powers.

The study of the dimensions of an equation is called dimensional analysis. Any equation that relates physical quantities must have consistent dimensions i.e, the dimensions on one side of an equation must be the same as those on the other side. The second use is that dimensional analysis helps us convert the units of a physical quantity from one absolute system to another absolute system.

Your answer shows that the units of acceleration is ms-2

In this Unit you have learnt that in making a measurement of any physical quantity, some definite and convenient quantity of the same kind is taken as the standard in terms of which the quantity as a whole is expressed. You have learnt also that this convenient quantity used as the standard of measurement is called a unit. You also learnt that some physical quantities are known as fundamental quantities. You learnt that the fundamental quantities are used to derive the units of all other physical quantities by using dimensional analysis.

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What you have learnt in this unit concerns the meaning of a fundamental quantity meaning of the unit of a fundamental quantity different systems of measurement. The knowledge you have acquired in this unit will help you to do correct calculations and measurements in the whole of your physics and mathematics courses.

Tutor Marked Assignments and Marking Scheme

When you read the topic of this unit which is 'Vectors', I know that in your mind you may be wondering why you have to study vectors. Questions like, of what use are they in physics? can also crop up in your mind. What you have learnt in Units 1 and 2 will definitely aid your quick understanding of this Unit. In this Unit, we shall look afresh at vectors and build upon what you knew before now.

We shall begin by defining vectors in a precise manner. You will learn how vectors are denoted and represented in the literature. You have learnt about physical quantities like mass, length, time, area, frequency, volume and temperature etc. You recall that a scalar quantity is completely specified by a single number. Any physical quantity which requires both magnitude and direction for it to be completely specified is called a vector.

Before we proceed to learn how vectors are represented, let us refresh our minds about vector notation.

Vector notation

The magnitude of a vector is simply denoted by the letter without an arrow mark as In this course, we shall use the notation to denote a vector.

−A

In Figure 3.1 below, vector is represented by the line. But if the direction of another vector be opposite but has the same magnitude as vector then it will be represented as vector shown in Figure 3.1. Now draw a vector P along a horizontal axis going from left to right from point P to point Q. Draw another vector equal to vector P and opposite in direction.

=A drawing from somewhere and

This shows you that there are three things you must consider while representing a vector.

These are: a starting point also

Now that we have reached this point, let us proceed to study the composition of vectors. It is possible to have different vectors representing the same physical quantity . When these three Rvector act at the same point, a resultant vector can be obtained by the composition of these different vectors. Vector composition is done by the method of vector addition.

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OAand and OB

The resultant of these two vectors acting at point O is given by which is the diagonal of the parallelogram through O. If we choose to represent the resultant vector by a letter C, then it is written as. This method of composition of vectors is known as the parallelogram law. Once you have this law always at the back of your mind you will be able to do addition and subtraction of vectors.

AB + BC = AC

4 will help you understand the rule better. A are its starting and end points respectively. This is r = 50 N completed. Then the side taken in the reverse order i.e. represents the resultant vector.

If a force of 40N, acting in the direction due East and a force of

This is because applying our knowledge of Pythagoras theorem r 2 = P 2 + q 2 .

AB + BC + CD + DE

I would want you to pay particular attention to this. It tells us that the sum or resultant of those vectors is zero.

[...]

Find the sum of you notice that some vector terms here are negative.

[...]

As you recall, two vectors can be added graphically using either the triangular law or the parallelogram law.

From the definition of vector addition it follows that

A b c a b c Thus, the order in which you add vectors does not matter as shown in figure 3.11. If I asked you the question, ‘What is the vector’. From vector addition you can is a vector three times as vector and is in the same as vector giving. Note that if m is less than zero, is acting in the opposite direction to vector but its magnitude is .

So, for m = -1, the new vector is and it is equal and opposite in direction to. We readily find a practical example of this in physics where it is depicted in Newton’s second law, F = ma. Here, force is expressed as product of mass and acceleration .

Can you think of more examples?

This is similar to what we did during addition of vectors. The difference is that here we shall only be adding negative values to positive quantities. So, subtraction of a vector from vector

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i.e. can be seen as adding the vector . We touched on this earlier vector addition.

3.13 to a We multiply vector by -1 and add the new vector using either the triangular law or the parallelogram law.

The Null Vector

Now, we are going to F + = F − F look at another scenario. Secondly, we see that we can not define a direction for it. So, to define a null vector we say that, A Null vector is a vector, whose magnitude is zero and whose direction is not defined. It is normally denoted by O. We also get a null vector or zero vector when we multiply a vector by the scalar zero.

Unit Vector We want to explain what we mean by a unit vector. You already known what unit means.

Now consider the product of vector with a scalar

Note that the unit vector could be denoted by the symbol Thus we can write a = a. a A unit vector is used to denote direction in space. This means that a vector in any direction can be represented as the product of its magnitude and Y the unit vector in that direction. By convention, unit vectors are taken to be dimensionless.

Let us now go on to define vectors in terms of their components. Components of a Vector The vector is defined by its magnitude, r and its direction, . It could also be defined by its two components in the OX and OY directions. What we are saying here is that is a vector ba acting along a plane and could be resolved into its components.

If we take to be unit vector in the OX direction then a = ai

Since we have defined the unit vectors, we shall in practice omit the sign above, i and j, but always remember that they are vectors. A = 2 i + 4 j and b = 5i + 2 j a + b, To find draw the two vectors in a chain as shown below, Figure 3. = 7i + 6 j i.e. we add up the vector components along OX and add up the vector components, along OY.

= 12i P − Q − R = − −

From the end point of vector draw a perpendicular PC and PD on X and Y-axes respectively. Then, OC and OD represent the resolved parts of the vector in magnitude and direction.

Any vector can be expressed as a = a aa$

Where is a unit vector in the direction of Vectors can be expressed in terms of unit vectors along the X and Y axes of a plane Cartesian coordinate system.

[...]

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Teacher Marked Assignments and marking scheme The importance of vectors in physics cannot be over emphasised. These include electric flows, magnetic flux, forces, velocities, etc. Also, we recall that in unit 2 we discovered that every object in the universe is in constant motion. By so doing we get an understanding of why certain occurrences in nature behave as they do.

[...]

This is how to solve it.

Resolution of Vectors perpendicular axes three mutually

Here we want to resolve a vector in space into its components in a three dimensional rectangular coordinate system.

But we know that OP2 = OL2 + OM2 + ON2 = x2 + y2 + 22

Cos2 ∀ + Cos2∃ + Cos2 r = l2 + m2 + n2 = 1 where l, m, n are called the direction cosines.

= Cos x + Cos β y + Cos rz

= lx + my + nz Thus the vector OP can be complete resolved in magnitude by the coordinate of its starting point and end point and in direction by the three direction cosines . Resolution of Vectors in Three Mutually perpendicular axes in terms of the Unit Vectors The vectors we have considered thus far are two dimensional and Unit vectors in three dimensions. This is same as considering a vector in space. A vector in three dimensions can be specified with Cartesian set of axes x, y and z as we discussed earlier in this Unit.

The orientation of the axes is best described using the right -hand rule. In Figure 3.4 visualize the z axes as pointing out of the plane of the paper and perpendicular to both the x and y axes. The right-hand rule says that if you curt your fingers from the x-axes to the y-axes, your thumb will be pointing towards the positive z-axis. This right hand rule is a well established convention and you will come across it in many areas of physics like in your course in magnetism.

[...]

This is the same thing as saying that the projection OA along x, y and z axes are Ax, Ay and Az respectively.

Ax 2 + Ay 2 + Az 2

Where A, B are absolute values or magnitudes of the vectors A and B , and 2 is the angle between A and B when they are drawn with a common tail. The scalar product denoted by A. B is . OB in Figure 3.8 not that the dot sign means multiplication sign. Try it, before checking on the answer below.

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= 35 x

Now, what is the dot product of the vectors shown in the diagram below i.e. The scalar product of a and b is The scalar product of a and b = a .

What happens if the two vectors are in the

When the vectors are expressed in terms their Unit vectors in component form of we have, A = a1i + b1 j + c1k B = a2i + b2 j + c2 k A. B = . Just be careful when expending such brackets above. This will simplify soon, so no need to worry. We see that the following terms will also varnish i.e. .

For any non zero vector only if a = 0

This is written as A. B for the cross product of vectors A and B The result of the cross product is another vector. The The expression A x B is pronounced as A magnitude of A is , where is A sin, i.e. The unscrewing motion is like the right hand rule and you notice that the cork moves upward perpendicular to the direction of unscrewing wise motion of the car. Also, unscrewing means anti clockwise motion while screwing means clockwise which will make the cork more vertically downwards in opposite direction to the 1st case. We conclude that the vector product is not commutative.

The properties and follow directly from the is zero.

2ixi=jxj=kxk=0

This last expression may remind you of the pattern of expression of determinant.

[...]

What you have learnt in this Unit concerns the determination of the magnitude of a vector in space.

B = b1i + b2 j + b3 k B = B = b12 + b2 2 + b32

The scalar product of two vectors are defined as A .

Where 2 is the angle between A and B such that

The direction of c$ is obtained by the right hand rule.

= a1 b1

You would have observed a cyclic pattern in the cross products.

Motion in a Straight line and parameters for describing Acceleration

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A living thing that does not undergo one form of motion or the other is assumed to be dead. No doubt, you have studied motion at the secondary school level years ago. That could be termed as just scratching the subject. This Unit will treat rectilinear motion, that is, motion in one dimension in more details.

The topics covered in Units 1 to 4 will help you to understand this unit better-so, relax. The stage has already been set for you. I wish you happy reading.

By the end of this unit, you will be able to

Maybe you are wondering why this question when it is so obvious to everybody as something we do everyday. Besides in unit 1, we learnt that everything in the universe is in motion continuously. We say that an object is moving if it changes its location at different times. The actual motion can be reconstructed from the motions of these three projections.

But firstly, we shall discuss one dimensional motion also known as rectilinear motion and later extend it to two and three dimensional motions.

Motion in a Straight Line and Parameters for describing Motion

This section describes motion in a straight line and the parameters for describing motion.

[...]

In going from one point to another irrespective of the path taken to do the journey the motion is said to be over a distance A to B. For example the cases cited in Fig. 3.1 such a journey undertaken during a time interval possess speed. Distance does not have any specified direction, hence it is a scalar quantity. Consider a particle moving along the x-axis as in Figure 3.2a above.

At a later time t2 whose coordinate is x it has moved to point 2. The corresponding points on Figure 3.2b are labelled p and q. The displacement of this particle is then given by the x with magnitude x vector 2 - x1 along a specified direction the x-axis which is a straight line. The magnitude of the average velocity is x 2 − x1 Δ x t 2 − t1 Δ t In figure 3.2b, the average velocity is represented by the slope of the chord pq given by the ratio of x 2 − x 1 , or Δx to t 2 − t 1 or Δt i .

Slope =

If we take the time the particle starts its journey to be time t = 0, then the corresponding position is taken as x0 . After a later time t, the particle is taken to be at position x then equation 3.6 becomes Δt The velocity of a particle at some one instant of time, or at some one point of its path, is called its instantaneous velocity. We have seen that average velocity is associated with the entire displacement and the entire time interval. Note that as point Q approaches point p in Figure 3.2a, point q approaches point p in Figure 3.2b, in the limiting case the slope of the chord

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pq equals the slope of the tangent to the curve at point p.

At a point where the tangent is horizontal, its slope is zero and its velocity is zero. If distance is given in meters and time in seconds, velocity is expressed in meters per second .

Acceleration: Average and instantaneous acceleration

Figure 3.3 shows a particle, P moving along the x-axis. The vector v1 is its instantaneous velocity at point P and the vector v2 represents its instantaneous velocity at point Q. Its instantaneous velocities between points P and Q are plotted against time in Figure 3.3b as shown above. Note that since are vectors, the quantity is a vector difference and must be found by the method of vector subtraction you learnt in units 3 and 4. In Figure 3.3b the magnitude of the average acceleration is represented by the slope of the chord pq.

Δt The instantaneous acceleration, of a body i.e. its acceleration at some one instant of time or at some one point of its path is defined in the same way as for instantaneous velocity. Hence it is defined as the limiting value of the average acceleration when the second position of the particle is taken much closer to the first position as tends to zero. Note that the direction of the instantaneous acceleration is the limiting direction of the vector change in velocity. Instantaneous acceleration plays an important role in physics and is more frequently used than average acceleration.

Subsequently, the term acceleration will be used to mean instantaneous acceleration. Acceleration, of course, is a vector quality and the definition just given above applies to whether the path of motion of the particle is straight or curved. In Figure 3.3b the instantaneous acceleration is equal to the slope of the tangent to the curve at any point say, p of a velocity-time graph. If velocity is expressed in metres per second, then acceleration is expressed in metres per square second .

Note that when a body is slowing down its motion, we say it is decelerating.

Rectilinear motion with constant acceleration

When the acceleration is not constant the velocity time graph is curved as in Figure 3.3.

$2 = 2\ 0 + 2a$

Note that the following equations 3.13, 3.16, 3.17 and 3.18 are called the equations of motion with constant acceleration. You are required to know these equations of motion by root so that you can easily apply them in solving problems in physics. The ball possesses an initial velocity of 2m5-1 when the boy release it and it shown down with constant negative acceleration of -0 2m 5-2.

The acceleration is negative along t x-direction and has constanted value a = - 2m 5-1

We do not know the final position of the ball or the time elapsed. We look at the equations of

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motion and find out by process of elimination which are to apply here to help us arrive at the answer.

[...]

Now, having concluded this section, let us move on to the discussion of motion in more than one dimension for which you will find your knowledge of resolution of vectors treated in units 3 and 4 very. In the unit you have learnt that The language used to describe motion is distance displacement, velocity and acceleration.

Velocity is vector quantity

That when the velocity of a particle changes with time it results in the acceleration or deceleration of the particle depending or whether the motion is increasing in speed or decreasing i.e. .

TUTOR MARKED ASSIGNMENT

If she has gone 8.0m after 2.0s, what are her acceleration and velocity at this time?.

The Answers are

It continues with this velocity for the next 20s until it is brought to rest after another 10s.

[...]

This is the same thing as discussing motion in a plane and in three dimensions. So, as a particle moves, its co-ordinates with reference to a specified frame changes in two or three dimensions depending on where the motion is taking place. Having realised from unit 5 that the parameters for describing motion which include displacement/distance, velocity and acceleration are vector quantities, we shall draw on our knowledge of vectors from units 3 and 4 to understand this Unit better. We shall also study circular motion which will give us an insight into satellite motion, and then conclude the Unit with studies of Relative Motion.

Other types of motion and causes of motion will be developed in the subsequent Units. Determine the displacement, velocity and acceleration of a particle in two or three dimensions in any given frame of reference.

B'

Recall that the position of a particle in a particular frame of reference is given by a position vector drawn from the origin of the coordinate system in that frame to the position of the particle. The displacement of the particle in the time interval is equal to in the direction AB. Thus, the average velocity of the particle during the time Δt is given by The direction is the same as that of since Δt is a scalar quantity. We note that is the velocity at which the particle would have travelled the distance AB in uniform and rectilinear motion during the time interval

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Δt.

If the displacement versus time equation of a particle falling freely from rest is given by x = t 2

When you solved exercises 3.1, you noticed that the values of average velocities during the two time intervals are not the same. Such a motion is described as non-uniform motion. A practical example of non uniform motion is the motion of a bus leaving one bus stop and travelling up to the next bus stop. The velocity of the bus at a given instant of time can be found.

We remark that the velocity of a particle may change as a result of change in magnitude, direction or both. In Figure 3.1b above, the average velocity during the time interval t is directed along the chord AB but the motion has taken place along the arc . Δt the magnitude equal to the limit of the ratios called the instantaneous velocity of the particle at time t. The instantaneous velocity is the direction of the tangent to the curve at the given moment of motion.

In other words, the instantaneous velocity is the derivative of respect to time. Note that if we were using coordinates alone to write the equations for velocity, we would have to write three equations as in Equation 3.2b. The advantage of the use of vectors is that it enables us to write a single equation as in equation 3.2a. Representing the instantaneous velocities of the particle when it passes through points A and B of its path as shown in Figure 3.2, We see that the velocity at B is different from that at A. This means that the velocity is changing in magnitude and direction.

If a frictionless bead slides down along the wire , and its position r = i + j − 21 ct2 k vector varies with time as where b and c are constants, find and , where are the velocity and acceleration expressed as functions of t. From the expression for given.

= B 1+ 4 A 2t 2 B 2

We shall now use the concepts we have developed so far to study uniform circular motion and you will see how simple it will all become. Now, t seconds later, it is at point P after describing an angle 2 . = r costi + r sin wtj, T is also known as the angular speed of the particle. We have found that for circular motion, the particles velocity constantly changes direction because it is always along the tangent at any point.

So, we conclude that the velocity vector is not constant, i.e., the particle has an acceleration.

2 r 2

This is known as centripetal acceleration.

Example

Let us calculate the period of revolution of a satellite moving around the circular equatorial orbit,. Let the velocity of the satellite in the orbit be, and the radius of the orbit be r. Like any free object near the earth’s surface, the satellite has an acceleration towards the centre of the

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earth , which is the centripetal acceleration. It is this acceleration that causes it to follow the circular path.

Thus the time taken for the satellite to complete one revolution round the earth was m m s −2

28 min A flat horizontal road is being designed for 60kmh speed limit. If the maximum acceleration of a car travelling on the road is to be 1.5 m s2 at the above speed limit, what must be the minimum radius of curvature for curves in Pthe road?.

In this case eqns yield

It means that the velocity of the moving object decrease a little, while the object initially at rest picks up almost twice the velocity of the incoming object.

v 3 = − v 1 and v 4 = v 1

If mass We see that the moving object very nearly reverses its velocity, while the object initially at rest recoils with a very small In the limit that approaches infinity, we neglect the velocity of recoil and the final velocity of the first object is equal and opposite to its incident velocity.

[...]

Scenario where total momentum is zero. The two objects under discussion approach each other with velocities such that the initial and total momentum is zero.

Answer is 1ms-1

How to apply the collision principle in the study of rocket propulsion. That collision is the sudden impact felt between two objects.

PHY101 List of Questions
Latex formatted questions may not properly render

Q1 in a perfectly inelastic collision

- heat is gained
- energy is lost
- energy is gained
- power is lost

Q2 in an inelastic collision which of the following is not true?

- kinetic energy is not conserved
- kinetic energy is conserved
- potential energy is conserved

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- potential energy is not conserved

Q3 The collision between two or more objects during which no energy is lost is called

- conserved collision
- material collision
- inelastic collision
- elastic collision

Q4 The sudden impact felt between two or more objects is called

- explosion
- conservation
- collision
- None of these

Q5 Linear momentum is always conserved when the rate of change of momentum is

- zero
- one
- linear
- circular

Q6 Work is a product of

- force x distance
- force x time
- force x momentum
- force x velocity

Q7 The path followed by the projectile is known as

- curve
- range
- flight time
- Trajectory

Q8 The range of a projectile launched from the ground is the

- vertical distance
- perpendicular distance
- horizontal distance

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- None of these

Q9 In a projectile motion, at maximum height the verticle component of velocity is

- greatest
- zero
- downwards
- upwards

Q10 Projectile motion is an example of motion in how many dimensions?

- one
- two
- three
- four

Q11 The transfer of heat through solids is known as

- Conduction
- radiation
- convection
- Thermodition

Q12 The constant -volume gas thermometer is normally refered to as the

- mercury thermometer
- liquid thermometer
- standard thermometer
- gas thermometer

Q13 Force is equal to the product of mass and

- acceleration
- velocity
- time
- distance

Q14 Which of the following is the SI Unit of momentum

- N/s
- kgm
- N

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- kg/m

Q15 The product of force and time is equal to

- momentum
- watts
- acceleration
- impulse

Q16 A symmetrical body rotating about an axis with one point fixed at the centre of gravity is called ----------

- Top
- gyroscope
- rotor
- None of these

Q17 A body starts from rest and accelerates uniformly at a rate of 5m/s2. calculate its velocity after 90m

- 18m/s
- 30m/s
- 25m/s
- 13m/s

Q18 A ball is thrown vertically upwards from the ground with an initial velocity of 50m/s. The total time spent by the ball in the air will be ----------

- 10sec
- 15sec
- 20sec
- 25sec

Q19 A man will exert the greatest pressure on a bench when he ----------

- lies flat on his back
- lies flat on his belly
- stands on the toes of one foot
- stand on both feets

Q20 The slope of a straight line displacement time graph gives the ----------

- distance travelled

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- uniform velocity
- acceleration
- uniform speed

Q21 The force of ----------allow cars to move on the roads without skidding

- engine
- centripetal
- centrifugal
- friction

Q22 Acceleration due to gravity is ---------- at the poles than at the equator

- minimal
- tighter
- greater
- lost

Q23 The ---------- velocity is the minimum velocity needed by an object to be project into space from the surface of the earth.

- escape
- vertical
- initial
- final

Q24 Acceleration due to gravity increases with ----------

- magnitude
- altitude
- latitude
- longitude

Q25 Below the earth's surface, the accelaration due to gravity decreases linearly with

- density
- depth
- height
- None of these

Q26 which of the following is not a fundamental force

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- gravitational
- electroweak
- strong
- minute

Q27 The acceleration due to gravity vary from location to location because of the effect of earth's

- rotation
- radius
- weight
- mass

Q28 The ◆??2gr is known as the

- uniform velocity
- escape velocity
- fixed velocity
- constant velocity

Q29 The height of the parking orbit above the surface of the is given by

- h=R+r
- h=R-V
- h=R-r
- h=r-R

Q30 The internal energy U of a system depends on the

- power of the system
- state of the system
- energy equation
- internal resistance

Q31 The velocity of orbiting satellite is given by

- ◆??2gr
- ◆??GM
- r/t
- ◆??GM/r

Q32 The gravitational force on a sattelite produces the centripetal acceleration that keeps the

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satellite in

- orbit
- constant position
- radial path
- freefall

Q33 The path describe by a satellite round the sun is a

- conical section
- spherical
- full circle
- None of these

Q34 When there is no reaction force to an objects weight, the object becomes

- strong
- weightless
- gravitating
- freefall

Q35 The path of a satellite whose period of revolution is equal to the period of rotation of the earth about its axis is known as

- rotating orbit
- stationary orbit
- parking orbit
- space orbit

Q36 The process in which energy is transfered by means of electromagnetic waves is known as

- Conduction
- convection
- radiation
- resistation

Q37 1kg mass placed on the moon will weigh

- 9.8N
- 9.7N
- 1.67kg
- 1.67N

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Q38 Which of the quantities vary from point to point on the surface of the earth

- gravitational constant
- mass
- moon
- weight

Q39 Energy expended per time is called

- power
- work
- joule
- kinetic

Q40 The quantity of matter contained in a body is called

- weight
- mass
- matter
- gravity

Q41 Newton's second law states that the rate of change of momentum is directly proportional to the

- pressure
- force
- energy
- power

Q42 Stable equilibrium happens when the forces in the displaced position act such that they return the body to its

- original position
- unstable position
- final position
- neutral position

Q43 In a circular motion which of the following quantities is constant

- velocity
- time

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- mass
- accelaration

Q44 When a body accelerates in motion it means that its

- path is linear
- velocity is uniform
- velocity changes continously
- None of these

Q45 The velocity of a particle at some point of its path is called

- uniform velocity
- instantaneous velocity
- regular velocity
- All of these

Q46 Velocity is defined as

- distance/time
- speed/time
- displacement/time
- variation/time

Q47 A car that takes 2hrs to travel from kaduna to kagoro along a winding road over a distance of 200km is said to have an average speed of

- 100km/hr
- 10km/hr
- 1000km/hr
- 10,000km/hr

Q48 If you run on a winding path from point A to point B and travel a distance of 240m in 20sec then your average speed is

- 6m/s
- 12m/s
- 16m/s
- 20m/s

Q49 Which of the following is a vector quantity?

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- distance
- speed
- temperature
- displacement

Q50 The result of the cross product of two vectors is a

- scalar
- zero quantity
- determinant
- vector

Q51 The scalar product of any two vectors at right angles to each other is always

- 1
- 90
- zero
- None of these

Q52 The degree of hotness or coldness of a body is called

- pressure
- heat
- temperature
- kelvin

Q53 if Vector P = 5i -2j and Q=3i+3j and R=4i-j . What is P+Q+R?

- 6i
- 12i
- 7i
- 14i

Q54 A Null vector is a vector whose magnitude is

- zero
- very large
- continous
- available

Q55 If a force of 40N acting in the direction due East and a force of 30N is acting in the

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direction due North. Then the magnitude of the resultant forces will be

- 40N
- 30N
- 20N
- 50N

Q56 A Scalar quantity has only

- direction
- velocity
- magnitude
- time

Q57 A Vector quantity has both direction and

- unit
- magnitude
- speed
- quantity

Q58 the change in the thermo-electric e.m.f per degree Celsius in temperature between the hot and cold junctions is known as

- clinical power
- thermo-electric power
- electric
- power

Q59 The dimension of coefficient of linear expansion is

- K
- degrees
- Lxdegrees
- L

Q60 The thermometer that is constructed by using the Seebeck effect is known as

- Thermo-electric
- clinical
- mercury
- None of these

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Q61 Which of the following gives the dimension of velocity?

- TxLxL
- LxT
- L/T
- L/M

Q62 Which of the following will give the dimension of Area

- LxL
- LxLxL
- MxM
- MxMxM

Q63 The SI Unit of time is

- minute
- seconds
- day
- year

Q64 Which of the following quantities have a derived unit?

- length
- time
- area
- mass

Q65 which of the following gives the meaning of pressure?

- forceXtime
- force/time
- force/distance
- force/area

Q66 Which the following is the unit of force?

- kgm/s
- mkgs
- N
- m

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Q67 The SI Unit of velocity is

- m/v
- m/s
- v/m
- s/m

Q68 The SI unit of absolute temperature is

- Kelvin
- thermometer
- celcius
- centigrade

Q69 The convenient quantity used as the standard of measurement of a physical quantity is called

- vector
- unit
- scalar
- None of these

Q70 Which of the following quantities have a fundamental unit?

- velocity
- volume
- density
- length

Q71 Units of measurement are classified into fundamental and

- standard
- derived
- ordinary
- dimension

Q72 the mean solar day is equal to how many mean solar seconds?

- 86400
- 86200
- 86100

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- 86300

Q73 A car is moving at a speed of 100kmh-1 what will be the distance covered after 20 seconds?

- 5.6m
- 5.7m
- 555.6m
- 55.56m

Q74 The first Newton's law of motion is also called the

- law of inertia
- law of rest
- law of areas
- law of time

Q75 The coordinate system in which the motion of any object depends only on the interactions of the constituents particles is called

- polar reference frame
- cartesian reference frame
- inertial reference frame
- All of these

Q76 The reluctance of an object to start or stop moving is known as

- time variance
- acceleration
- velocity
- inertia

Q77 When coordinates of an object changes over time the object is said to be

- in motion
- elapsing
- at rest
- inertia

Q78 when coordinates of an object remain fixed despite the time , the object is said to be

- at rest
- in motion

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- a reference frame
- constant

Q79 Every object on the surface of the earth is in constant motion with respect to

- the sun
- earth
- moon
- None of these

Q80 A body is said to be at rest when it does not change position with

- acceleration
- velocity
- distance
- time

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