1. Detail of Unit Revision

Subject Name	Physics
Course Name	Physics 01 (Physics Part 1, Class XI)
Module Name/Title	Unit 2: Kinematics Revision
Objectives	After going through this lesson, the learners will be able to • Plan ways to study kinematics • Consolidate the unit on kinematics
Keywords	Rest, motion, frame of reference, distance and displacement, velocity, speed, uniform and non-uniform motion, average velocity, instantaneous velocity, constant acceleration, graphical representation of motion vectors, projectile motion, circular motion in a horizontal plane.

2. Development Team

Role	Name	Affiliation
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Study Guide

Unit 2: Kinematics, Physics01 2019

INTRODUCTION

The idea of revision modules is to help the student assimilate the concepts learnt in the unit.

This is required for conceptual clarity as well as for examinations and tests.

The rationale being if the learner understands the reasons for study of a concept, its application will be easier. In order to move from rote learning to fun learning, the team has designed the revision week under the following:

Study guide- this will provide, how to consolidate the unit? How to prepare notes?

How to check if the entire syllabus has been covered? Check out the formulae, derivations, graphs required to complete the unit, any special features for which the learners should be ready for evaluation.

Activities that you can do: suggestions for activities that may be done at home**,** in order to understand a phenomenon or a method.

Problems for tests: these will be problems which students may use for understanding as well as for getting ready for tests and examinations**.** These include questions asked by various boards. Solving these will enhance the confidence.

To make life easier, this will be guided solutions to remove misconceptions, may be in the form of film clips, power point presentations, or even a text document.

STUDY GUIDE

In order to compile all the concepts in this unit, carefully go through the unit syllabus.

Read it slowly making sure you follow the literal meaning of the words.

Here is how to do this

There are two parts to the kinematics unit

A). Motion in a straight line

Frame of reference, motion, position – time graph Speed and velocity
Elementary concepts of differentiation and integration for describing motion, uniform and non-uniform motion, average speed and instantaneous velocity, uniformly accelerated motion, velocity –time and position time graphs relations for uniformly accelerated motion - equations of motion (graphical method)

B). Motion in a plane
Scalar and vector quantities, position and displacement vectors, general vectors and their notations, multiplication of vectors by a real number, addition and subtraction of vectors,

relative velocity, unit vector, resolution of a vector in a plane, rectangular components, scalar and vector product of vectors
Motion in a plane, cases of uniform velocity and uniform acceleration projectile motion uniform circular motion

Now arrange the syllabus in a list format. This list should be numbered.
The reason for this is that, you now have a check list.

Tick mark a concept only after you truthfully understand it.

Remember that it is ok if you do not get it right first or second time.
Go over the concept again,
See the videos
read the book,
Discuss with a friend.
Teach a friend, hear yourself explain the concept.

1. Motion in a straight line
2. Frame of reference,
3. Rest and motion,
4. Position –time graph
5. Speed and velocity
6. Elementary concepts of differentiation and integration for describing motion,
7. Uniform and non-uniform motion,
8. Average speed and
9. Instantaneous velocity,
10. Uniformly accelerated motion,
11. Velocity –time and position time graphs
12. Relations for uniformly accelerated motion -**equations of motion** (graphical method)
13. Motion in a plane
14. Scalar and vector quantities,
15. Position and displacement vectors,
16. General vectors and their notations,
17. Multiplication of vectors by a real number,
18. Addition and subtraction of vectors
19. Relative velocity,
20. Unit vector,
21. Resolution of a vector in a plane,
22. Rectangular components,
23. Scalar and vector product of vectors
24. Motion in a plane,
25. Cases of non-uniform velocity and uniform acceleration
26. Projectile motion
27. Uniform circular motion

Divide your study into **three** sections

1. Motion of a rigid body taken as point object in a straight line
   a) uniform and non-uniform motion
   b) speed velocity

c) average speed, instantaneous speed
d) position time graphs
e) acceleration
f) body moving with constant acceleration along the direction of motion
g) velocity time graphs
h) equations of motion for constant acceleration

$$v = u + at$$
$$s = ut + \frac{1}{2}at^2$$
$$v^2 = u^2 + 2as$$

Or considering vectors

$$v(t) = v(0) + at$$
$$x\,(t) = x(\,0) + v(\,0)t + \frac{1}{2}at^2$$
$$v(t)^2 = v(0)^2 + 2a\ [x(t) - x(\,0)]$$

Solve as many simple problems using the equations. Remember every time you read the question, imagine the situation, and quickly explain the problem to yourself, draw a diagram if that helps.

Work only in SI units, calculate carefully.

2. **Learn vector algebra**
   This is new to you and so vector operations have their own rules of addition subtraction, multiplication.
   Do the experiment on vector addition to verify law of parallelogram of vectors in the laboratory.
3. Consider projectile motion and circular motion in a horizontal plane as special cases of motion in 2 dimensions.
   Read the modules well see the videos
   A special video is dedicated to solving problems on projectiles. Please watch the same.

Do your assignments, they have been prepared to help you get a variety of problems.

You may make your notes. These should be as brief as possible and made by you not copied from any book.

QUESTIONS FOR PRACTICE

Motion in One –Dimension

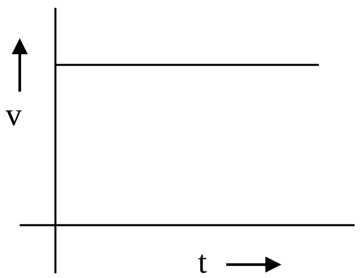
1. Complete the following:
   V = __ + at   s = ut + _____

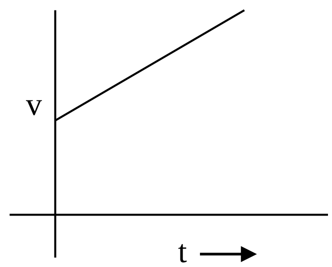
   ____= u + v /2 $v^2 = u^2 + 2a$__

   s_n = u + __________

2. True or False:
   a) Displacement = distance
   b) Velocity gives the direction of motion and not acceleration.
   c) A body at rest may be accelerating.
   d) Velocity and acceleration must always be in the same direction
   e) Velocity and acceleration need not be zero simultaneously
   f) Distance travelled in the nth second is average of velocity at the end of (n-1)th s and nth s
   g) When a body starts from rest and moves with a constant acceleration, the distances covered in equal successive intervals of time have ratio 1;3;5;7
   h) When a body performs a journey in two parts of equal times with speed v_1 and v_2 the average speed is = $v_1 + v_2$
   i) When a body performs a journey in two parts of equal distances with speed v_1 and v_2 the average speed is = $v_1 + v_2$ /2

3. What do the following graphs represent?





4. A car accelerates uniformly from 18 km/s to 36 km/s in 5 sec. Calculate acceleration, distance covered by the car in the time, draw a graph to show the motion.
   [1 ms^{-2}, 37.5m]

5. The brakes of a car produce a deceleration of 6 ms^{-2}. If a car takes 2 s to stop calculate the stopping distance. [12 m]

6. A body is moving with a velocity of 10m/s. If the motion is uniform, what will be the velocity after 10 s.

7. A drunkard walking in a narrow lane takes 5 steps forward and 3 steps backwards, followed by 5 steps forward and 3 steps backwards, so on. Each step measures 1 m long and requires 1 s. Plot the distance time graph of his motion. Find how long it would take the drunkard to fall in a pit 13m away from start.
[37s]

8. A body moves a velocity of 2 m/s for 5 s then its velocity uniformly increases to 10m/s in next 5s. Thereafter its velocity begins to decrease at a uniform rate until it comes to rest after 10s.
a) Plot a velocity –time and distance –time graph for the motion.
b) From the graph find the total distance moved by the body after 2 s, 12 s, and in the last 10 s.

9. A car covers the first half distance between two places with a speed of 40 km/hr and the second half of it at 60 km/hr. Find the average speed.
[48km/hr]

10. A body travels 2m in the first 2 s and 2.2m in the next 4 s. What will be the velocity at the end of the seventh s from start. [a = - 0.15 ms^{-2}, v= 0.10 m/s]

11. A car accelerates from rest at a constant rate 'a' of sometime after which it decelerates at a constant rate ' b' to come to rest ,If the total time is t. Calculate a) the maximum velocity reached
b) The total distance travelled
[v = (ab/a+b) t s = ½ (ab/a+b)t^2]

11. Two buses start simultaneously towards each other from towns A and B, which are 480 km apart. It took the first bus travelling from A to b 8 hrs and the second travelling from B to a 10 hrs. Determine when the buses meet after starting and at what distance from A [40/9 hrs, 266.67km from A]

12. A weight is dropped from the top of a building 135m high. How fast will it move just before it strikes the ground? [51.43 m/s]

13. During the last s of its free fall, a body covers half of the total distance travelled. Calculate the height from which the body falls, the duration of its fall.
[57m, 3.4 s]

14. A ball thrown vertically with a speed of 19.6m/s from the top of a tower returns to the earth in 6 s. Find the height of the tower [58.8m]

15. A body travels a distance of 20m in the 7^{th} s and 24m in the 9^{th} s How much distance will it travel in the 15^{th} s { a= 2 ms^{-2} u = 7 m/s s= 36m]

16. Give appropriate diagram with notation for Piya's movements

Piya left home 20 mins ago; she went to her friends' place a km away from her house. They then walked to the market 2 km and took 20mins for it, after window shopping for 30 mins they headed for her friends place reaching in 20 mins. She then walked to her house covering the distance in 15 mins. Draw a position time graph, state your assumption for it.

17. Fill in the blanks :

a) When a body is having uniform motion along a straight line in a given direction, the _______________ is equal to the distance travelled by the body in a given interval of time.
b) The ____________ and _________________ velocity in uniform motion are equal in magnitude.
c) The ______________ of a body can never be negative.
d) The slope of position time graph of a stationary body is ____________.
e) When two objects are moving in the same direction, the magnitude of relative velocity of one with respect to the other is equal to the _______ of the two velocities.
f) If a body A is moving on a body B, the velocity of body A relative to the _______ is the sum of the two velocities if body A is moving on body B in the same direction: and is equal to the difference of two velocities if they are moving in opposite directions.
g) The equations of motion are true only when _____________ is ________.

18. Can a body have constant speed but varying velocity?
19. Can body have constant velocity but varying speed?
20. A to pass a physical fitness test ,Sudhir must run1000m at an average rate of 4.0 m/s. He runs the first 900m in 250 s . How fast must he run the last 100m to pass the test?

Motion in 2 and 3 Dimension

1. **True or False:**

a) when the acceleration is along the direction of motion the body moves along a straight line

b) When the direction of acceleration is not along the direction of motion the body moves in a parabolic path.

c) When the acceleration is perpendicular to the direction of motion the body travels in a circular path

d) For projecting a Javelin or shot put from the height of shoulder, angle of projection should be slightly greater than 45^0

e) Change in velocity at the end of flight =2v(0) sin θ

2. A ball is thrown with a velocity of 100m/s at an angle of 30^0 to the horizontal in a park

Find a) time of flight of the ball

b) peak height reached by the ball

c) The horizontal distance travelled by the ball

d) The velocity with which the ball strikes the ground at the end of the flight

e) Would your answers change it the ball was projected from a balcony of a house near the park. The balcony is 10m above the park level

[10.2s 883.3m 100m/s]

3. A packet is released from an aeroplane when it was at a height of 1960m above the ground and was moving horizontally with a speed of 100m/s. Find the point where the packet strikes the ground. [2000m]

4. A stone is thrown up with a velocity of 39.2m/sat 30^0 to the horizontal. Find at what times it will be at a height of 14.7m [1.0s 3.0s]

5. An aircraft, flying upwards at an angle of 53^0 with the vertical, releases a bag at an altitude of 800m. The bag strikes the ground 20s after the release find
   a) The velocity of the aircraft at the time of release of the bag
   b) The maximum or peak height attained by the bag

   c) The horizontal distance travelled by the bag before it strikes the ground

   d) The velocity (magnitude and direction) of the bag just when it strikes the ground

   sin 53 = 0.8 cos 53 =0.6

   [100m/s , 980m , 1600m ,161.2m/s at $60^0$15' to the horizontal]

6. A revolver can fire a bullet with a muzzle velocity of 63m/s
   Is it possible to hit the top of a tower 400m away , its height being 30m
   [no]

7. A missile fired at an angle of 30^0 with the horizontal hits the ground 3 km away. By adjusting its angle of projection, can one hope to strike a target 5 km away? Assume muzzle speed to be fixed. [no]

8. The ceiling of a long hall is 25m high. What is the maximum horizontal distance that a ball thrown with a speed of 40m/s can go without hitting the ceiling of the hall? [150.5m]

9. A cricketer can throw a ball to a maximum horizontal distance of 100m.how high above the ground can the cricketer throw the same ball? [50m]

10. A fighter plane flying horizontally at an altitude of 1.5km with a speed of 720km/h passes directly over an anti-aircraft gun. At what angle from the vertical should the gun be fired for the shell with muzzle speed 600m/s to hit the plane At what minimum altitude should the plane fly in order to avoid being hit $\sin^{-1}1/3 = 19.5^0$, 16km)

VECTORS

1. **A** + **B** = 0 is it necessary that both **A** and **B** should be zero

2. Can two vectors of different magnitudes be added to give a null vector? Can three vectors not lying in a plane add up to give zero resultant? Explain.

3. Can any of the rectangular components of a given vector have magnitude greater than the vector itself?

4. Can two vectors of same magnitude have resultant equal to either of them ?

5. Can scalar product of two vectors be a negative quantity?

6. |**A** + **B**| = |**A** – **B**| Give suitable condition

7. If **A** = 3**i** + 4**j** and B = 7**i** + 24**j** Find the vector having the same magnitude as **B** and parallel to **A**.

8. Under what condition the magnitude of the sum of two vectors is equal to the magnitude of difference between them.

9. What is the angle made by vector **A** = 2i + 2j with x axis?

10. A boat is moving with a velocity 3 I + 4j with respect to ground , the water in the river is moving with a velocity –3i – 4j with respect to ground what is the relative velocity of boat with respect to the water.

11. A body constrained to move along the z axis , is subjected to a force **F** = i + 2j = 3k , calculate the work done if it moves 5m .

12. What is the angle between vectors **A** = **i + j + k** **B** = **-2i –2j -2k**

13. A force **F = i + 5j +5k** acts on a particle and displaces it through **s = 6i + 9k**

Calculate the work done

14. Show that **I + 2j +3k** is perpendicular to **2i – j**

15. Show that the angle between **A = i + j + k** and B = **-i –j +2k** is zero

16. If A = 4i –5j+6k and B = 3i +6j-7k find A-b and the angle between them

17. Two forces of magnitude in the ratio 3:5 act at an angle 60^0 and have a resultant = 35N find their magnitudes.

18. Can two vectors of different magnitudes be added to give a null vector? Can three vectors not lying in a plane add up to give zero resultant? Explain.

19. Can any of the rectangular components of a given vector have magnitude greater than the vector itself?

20. Can two vectors of same magnitude have resultant equal to either of them ?

21. What is the maximum value of the sum of two vectors ? What is the condition for the same?

22. |A + B | = | A - B | Give suitable condition

23. If A = 3i + 4j and B = 7i + 24j Find the vector having the same magnitude as B and parallel to A.

24. Under what condition the magnitude of the sum of two vectors is equal to the magnitude of difference between them.

25. What is the angle made by vector A = 2i + 2j with x axis?

26. A particle is moving on a circular path of constant radius. What will be the change in its velocity when it completes half the revolution?

27. If a particle moving towards north direction changes its direction and moves towards east with the same speed, then what will be the change in its velocity?

28. A boat is moving with a velocity 3 i + 4j with respect to ground , the water in the river is moving with a velocity –3i – 4j with respect to ground what is the relative velocity of boat with respect to the water.

29. A body constrained to move along the z axis , is subjected to a force F = I + 2j = 3k , calculate the work done if it moves 5m .

30. What is the angle between vectors A = i + j + k B = -2i –2j -2k

31. Show that i+ 2j +3k is perpendicular to 2i – j

32. Show that the angle between A = i + j + k and B = -i –j +2k is zero

33. If A = 4i –5j+6k and B = 3i +6j-7k find A-B and the angle between them

34. Two forces of magnitude in the ratio 3:5 act at an angle 60^0 and have a resultant = 35N. Find their magnitudes.

35. The sum and difference of two vectors are perpendicular to each other. Prove that the vectors are equal.

Relative velocity

1. Two cars are driving toward each other on a straight highway. One of them an Innova id travelling at 82 km/h and a wagon R is travelling at 48 km/h both measured relative to the road and seen in the respective speedometer what is the velocity of the Innova as seen by a passenger in wagon R?

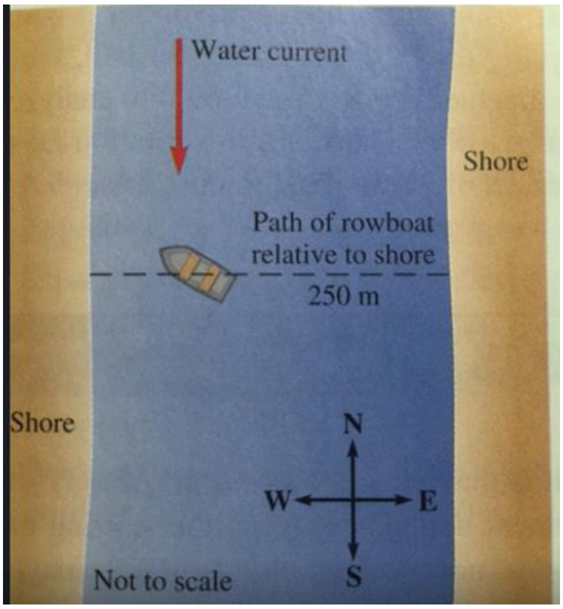
2. A car is driving directly north on a highway with a speed of 110km/h and a truck is leaving the high way driving at 85 km/h in a direction that is 35^0 west of north . What is the velocity of the truck for a passenger in the car?

3. A small aeroplane is flying directly towards east with speed relative to the ground of 210m/s. The pilot measures his air speed (speed of the plane relative to the air) to be 160m/s. What is the minimum wind velocity possible?

4. Radhey wants to row directly across a river from the east shore to a point on the west shore. The width of the river is 250m and the river current flows from north to south at 0.61m/s. The trip takes 4.2 min. in what direction did he head his boat to follow a course due

west across the river? At what speed with respect to still water is Radhey able to row the boat?

Hint: Observe the figure carefully



Velocity of river water is the velocity with respect to the shore V_{WS}

if the velocity of boat relative to the shore be V_{BS}

velocity of boat with respect to water V_{BW}

then

$V_{BW} + V_{WS} = V_{BS}$

5Aboy is attempting to swim directly across a river, he is able to swim at a speed of 0.5 m/s relative to the water. the river is 25.0 m wide and the boy ends up 50.0m down stream from his starting point.

a) How fast is the river current?
b) What is the speed of the boy relative to a friend standing on the riverbank?