DynaNotes™ Student Course Notes

PHY Physics

Category 1 – Force and Motion

MOTION GRAPHS AND CHARTS

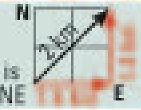
Graphs and charts are used to describe motion. Real-time technology, like motion detectors or photogates, can help quantify motion.

distance: scalar quantity; describes length of path between two points

displacement, Δd: vector quantity; describes change in position; length and direction of straight line from initial to final position; $\Delta d = d_{final} - d_{initial}$

Example 1: A balloon moves 2 m up and 3 m down. distance = 5 m, displacement = −1 m (1 m down)

Example 2: Lee jogs 1.4 km E and 1.4 km N. His distance is 2.8 km. $a^2 + b^2 = c^2$, so $\Delta d = \sqrt{(1.4\ km)^2 + (1.4\ km)^2} = 2$ km NE



change in time, Δt: amount of time elapsed; $\Delta t = t_{final} - t_{initial}$

speed: scalar quantity; equals distance per unit time (distance ÷ Δt)

velocity, v: vector quantity; equals displacement per unit time; $v_{avg} = \frac{\Delta d}{\Delta t}$

instantaneous velocity: v at a particular instant in time, like $v_{initial}$ (v_i)

acceleration, a: vector quantity; equals change in velocity per unit time (on Earth, $a_{gravity} = g = 9.8\ m/s^2$)

$a = \frac{v_f - v_i}{\Delta t}$ $a = \frac{v_f^2 - v_i^2}{2\Delta d}$

$\Delta d = v_i\Delta t + \frac{1}{2}a\Delta t^2$, at constan...

Example 1: motion graphs for a = constant **Example 2:** graphs fo...

Example 3: chart and motion diagram where time betwee...

time, s	0	1	2	3	4	5		7	8	
displacement, m	0	1	2	3	4.25				14	17
velocity, m/s	1	1	1	1	1.5					3
acceleration, m/s²	0	0	0	0.5	0.5					0

0 to 2 s: $a = 0$, $v = 1$ m/s (constant), Δd is stead...

3 to 6 s: $a = 0.5\ m/s^2$ (constant, $a > 0$), v is steadily i... increasing at an increasing rate (gr... of Δd vs. t ... urve

7 to 9 s: $a = 0$, $v = 3$ m/s (constant) ... lily incr...

MOTION IN ONE DIMENSION

Use equations to solve motion...

Example 1: A car traveling in a st... 55 km/h ... 12 km/h in 11 seconds. What is the ca... ion in m/s...

$a = \frac{v_f - v_i}{\Delta t} = \frac{(12 - 55)\ km/h}{11\ s} = \frac{-3.9\ km/h}{s} \times$ ... $= -1.1\ m/s^2$

Example 2: A roc... cliff in free-fall mo... r does it fall in 4.0 secon... $0 + \frac{1}{2}(9.8\ m/s...$ $= 78$ m

Example 3: Fin... velocity if red pa... ed in 2... m/h

MOTION IN TWO DI...S

projectile motion: mov... ob... tally (x) an... ing acted on b... ir friction): ... is co... v_i varie... to g...

	horizontal (x)	vertical (y)
	$d_x = v_x t$	$d_y = v_{iy}t + \frac{1}{2}a_y t^2$
	$v_x = v_{ix} =$ ...	$v_y = v_{iy} + a_y t$
	$a_x = 0$	$a_y = g = -9.8\ m/s^2$

Exampl... on aft... its initial ... ty was +16 m... its initial ... was 12 ... east ...

$d_x = v_x t = (12\ m/s)(2\ s) = 24$ m

$d_y = v_{iy}t + ...$

$d_y = (16 ... 2\ s) + \frac{1}{2}(-9.8\ m/s...$

$v_y = ... + a_y t = 16\ m/s + (-9.8 ...$ ... 3.6 m/s

Answ... all is 24 m ... sta... position. Its verti... y is −3.6 m/s (downward).

circular motion: motion along a circular path; has radial (r) and tangential (t) components; period (T) is time to complete one revolution; centripetal acceleration (a_c) acts toward the center of the circle (caused by a centripetal force, like gravity acting on a satellite)

$v_t = \frac{circumference}{period} = \frac{2\pi r}{T}$ $a_c = \frac{v_t^2}{r}$

Example: A ... circular trac... 30 m compl... every 22 se... is a_c (first fi...

$v_t = \frac{2\pi(30\ m...}{22\ s}$

$a_c = \frac{(8.6\ m/s)^2}{30\ m} = 2.5\ m/s^2$

RELATIVE MOTION

Motion appears differently from ... frames of reference (points of view). Use vector addition to ... city for a different frame of reference. For relative veloci... ect a to object c: $v_{a/c} = v_{a/b} + v_{b/c}$

Example 1: An observer ... red ca... 120 km/h east pass... a blue car moving 115 ... From th... ective of the red car, what is blue car's vel... observ... d car, a... blue car

$v_{b/c} = -115$ km/h, $v_{a/}$... $- v_{a/b}$

$v_{b/c} = -115$ km/h − 120 ...

Example 2: An airplane pilo... nort... A west wind also acts on the pl... ground, it flies northeast: $v_{ground/plane}$...

FREE BODY FORCE DIAGRAMS

force, ... ector quantity; a push or pull; nee... stop, ... or change the ... f motion of an object; m... sured in new... ($N = kg \cdot m/s^2$)

free ... ram: shows th... direction... acting o... t: ... (tension fo... ion for... surface ... posite d... on ... gravity o... acts ... ve... F_g = weight of object

• F... (force) acts ... cular to surface

... al forces (F) may also ... n an ... Use graphical vector ... ition to ... resultant force (**net force**, F_{net}).

Example: block sliding dow... lined plane (ramp)

Example: resultant force, F_{net}

$F_N = F_g$, so $F_{net,y} = 0$

$F_{net,x} = $ ...

...ULATION...

bal... ces: ... e forces that are equal in size; do not start, stop, o... ange ... rection of motion of an object; $F_{net} = 0$

unbalanced fo...: forces that are not equal in size and opposite in ...tion; F... cause a change in the motion of an object

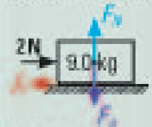
...wton's three **laws of motion** can be used to solve motion problems:

1st law: ... f inertia; an object at rest remains at rest, and ... ct in motion remains in motion at constant veloci... unless acted upon by an unbalanced force

2nd law: an object accelerates in the direction of the ... force; the rate of acceleration is directly proportional to the net force and inversely proportional to the object's mass; $F_{net} = ma$

3rd law: law of action and reaction; for every force (action) there is an equal, but opposite, force (reaction); these forces are called an **action-reaction pair**, where $F_{A\ on\ B} = F_{B\ on\ A}$

Example 1: Find normal force, F_N.



$F_N = F_g = mg = (9.0\ kg)(9.8\ m/s^2)$

$F_N = 88$ N

Example 2: Find force of friction (static friction) if the block does not move.

Because the block does not move, the horizontal forces must be balanced. $F_{static} = 1.1$ N

Example 3: Find the force of friction (kinetic friction) if ...

$F_{net} = ma$, where $F_{net} = 6.0\ N - F$...

$6.0\ N - F... = (9.0\ kg)(0.50\ m/s^2)$

...5 N

...ration ... 68 kg? ... circle ... to ... n ... 8 m/s²) ... 10^5 N

... the exhaust gas). What is the rocket's initial acceleration (ignore forces of air friction or pressure)?

$a = \frac{1.5 \times 10^5\ kg \cdot m/s^2}{1.4 \times 10^4\ kg} = 11\ m/s^2$

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