SEP 11 Previously in Physics 11

- SI units / metric

Base units:		Derived units:	
distance/length →	metre	speed	m/s
mass →	kilograms	acceleration	m/s^2
time →	seconds	energy (J)	kgm^2/s^2

Unit conversion

Ex ① 1 m/s → km/h

$$\frac{1\,\cancel{m}}{\cancel{s}} \times \frac{3600\,\cancel{s}}{1\,h} \times \frac{1\,km}{1000\,\cancel{m}} = 3.6\ km/h$$

Ex ② The bus ride from Prague to České Budějovice is 203.81 CKZ. How much is that in Canadian?

26.99 CKZ = 1 EUR
0.69 EUR = 1 CAD

$$203.81\,\cancel{CKZ} \times \frac{1\,\cancel{EUR}}{26.99\,\cancel{CKZ}} \times \frac{1\,CAD}{0.69\,\cancel{EUR}} = 10.94\ CAD$$

- Motion variables

distance (d) vs displacement ($\vec{d}$)
speed (v) vs velocity ($\vec{v}$)
acceleration vs acceleration ($\vec{a}$)

- Uniform accelerated motion

① $\vec{d} = V_{avg}t$
② $V_{avg} = \frac{1}{2}(V_f + V_i)$
③ $V_f = V_i + at$

① + ② $\vec{d} = \frac{1}{2}(V_f + V_i)t$ — ④

④ + ③ $\vec{d} = \frac{1}{2}((V_i + at) + V_i)t$
$\vec{d} = V_i t + \frac{1}{2}at^2$

④ + ③ $\vec{d} = \frac{1}{2}(V_f + V_i)\left[\frac{V_f - V_i}{a}\right]$
$V_f^2 = V_i^2 + 2ad$

Ex ① You drive past a stationery police vehicle at 20 m/s (72 km/h) If the officer catches up to you in 10 seconds at constant acceleration, what is their acceleration and final velocity?

$d_{you} = V_{avg} t$
$d_{you} = (20)(10)$
$d_{you} = 200$ m

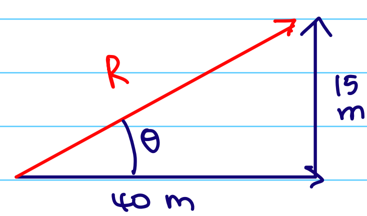
$d_{cop} = \cancel{v_i t}^{0} + \frac{1}{2}at^2$
$200 = \frac{1}{2}a(10)^2$
$200 = 50a$
$a = 4 \text{ m/s}^2$

$V_f = V_i + at$
$V_f = 0 + (4)(10)$
$= 40$ m/s
$= 144$ km/h

SEP 13 • Review of 2D vector

1) Adding vectors
vectors are added graphically by connecting head to tail
sum of 2+ vectors is called resultant

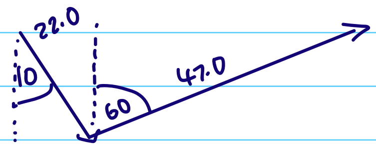
EXAMPLE A disc is thrown 40 m east but also pushed by wind 15 m north. Where is the disc?



$R = \sqrt{40^2 + 15^2}$
$= 42.72$ m

$\tan\theta = \frac{15}{40}$
$\theta = 20.56°$ N of E

EXAMPLE A pilot flies 10° E of S for 22.0 km and then flies at 60° E of N for 47.0 km. What is their displacement?



$\vec{①}y$ $\cos 10 = \frac{y}{22}$ $y = -21.66$
$\vec{①}x$ $\sin 10 = \frac{x}{22}$ $x = 3.82$
$\vec{②}y$ $\cos 60 = \frac{y}{47}$ $y = 23.5$
$\vec{②}x$ $\sin 60 = \frac{x}{47}$ $x = 40.7$

$y_T = -21.66 + 23.5 = 1.84$
$x_T = 3.82 + 40.7 = 44.52$

$R = \sqrt{1.84^2 + 44.52^2}$
$R = 44.55$ m

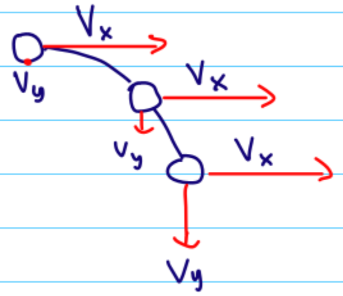
Assignment vector worksheet (odd / even)

SEP 15 • <u>Projectile Motion</u>

An object's motion in one dimension does not affect the motion in any other dimension

– <u>Side projectile</u>

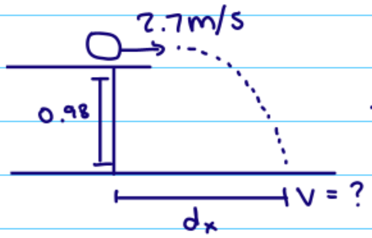
[redacted]



V_x = constant
V_y = accelerates

$V_R = \sqrt{V_x^2 + V_y^2}$
$\tan\theta = \dfrac{V_y}{V_x}$

Ex① An egg rolls off a table at $V_{ix} = 2.7$ m/s. What will be its horizontal distance from the table, and its final velocity, if the table is 0.98 m high?



$d_y = \cancel{V_{iy}t}^{\,0} + \frac{1}{2}a_y t^2$
$-0.98 = \frac{1}{2}(-9.81)t^2$
$t = 0.45$

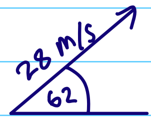
$d_x = V_{ix}t$
$d_x = (2.7)(0.45)$
$d_x = 1.22$ m

$V_{fy} = \cancel{V_{iy}}^{\,0} + a_y t$
$V_{fy} = (-9.81)(0.45)$
$V_{fy} = -4.41$ m/s

$V_f = \sqrt{V_{fx}^2 + V_{fy}^2}$
$V_f = \sqrt{(-4.41)^2 + (2.7)^2}$
$V_f = 5.17$ m/s

$\tan\theta = \frac{V_{fy}}{V_{fx}}$
$\theta = 58.36^\circ$ below horizontal

Ex ② Team Rocket is launched at 62° above the horizontal with $V_i = 28$ m/s. After 3.5s what is the max height reached? What is the rocket's final v at this time?



$V_x = V_i \cos 62 = 13.15$ m/s

$V_y = V_i \sin 62 = 24.72$ m/s

$V_{fy}^2 = V_{iy}^2 + 2a_y d_y$

$0 = (24.72)^2 + 2(-9.81)d_y$

$19.62 d_y = 611.0784$

$d_y = 31.11$ m

$V_{fy} = V_{iy} + at$

$V_{fy} = 24.72 + (-9.81)(3.5)$

$V_{fy} = -9.6$ m/s

$V_{fx} = 13.15$ m/s

$V_f = \sqrt{(-9.6)^2 + (13.15)^2}$

$V_f \approx 16.28$ m/s

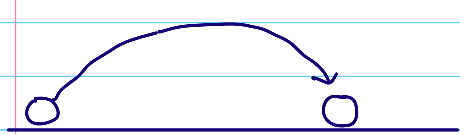
$\theta = \arctan\left(\frac{V_y}{V_x}\right)$

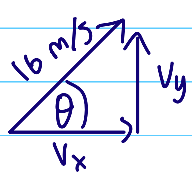
$\theta = 36.1°$ below horizontal

Assignment: Giancoli p.72 28-32; 38

SEP 21 • The Unknown Angle Problem

Ex ① Imagine you shoot a canonball from the ground at 16 m/s. If you want it to land 20.0 m away (still on ground) at what angle do you shoot





$V_x = 16 \cos\theta$

$V_y = 16 \sin\theta$

$d_x = 20$ m

$d_y = 0$ m

$d_x = V_{ix} t$

$20 = 16\cos\theta\, t$

$t = \frac{20}{16\cos\theta}$

$d_y = V_i t + \frac{1}{2}at^2$

$0 = 16\sin\theta t + \frac{1}{2}(-9.81)t^2$

$0 = \frac{20\sin\theta}{\cos\theta} - \frac{7.65625}{\cos^2\theta}$

$\frac{7.65625}{\cos^2\theta} = \frac{20\sin\theta}{\cos\theta}$

$7.65625 = 20\sin\theta\cos\theta$

$0.765625 = \sin 2\theta$

$\theta_1 = 24.98°$

$\theta_2 = 90° - \theta = 65.02°$

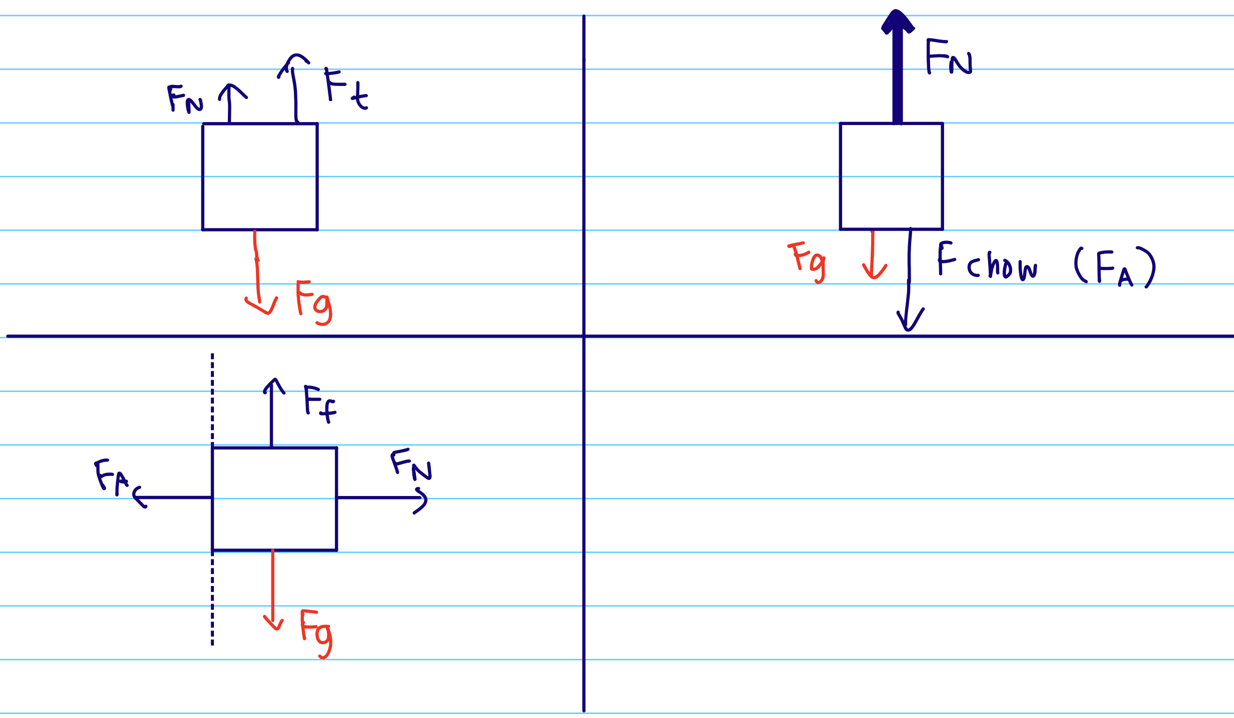
SEP 26

Dynamics

1. Forces affecting motion (macroscopic or observable)
   a) force of normal F_N
   b) force of gravity F_g

g = gravitational field strength

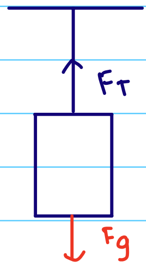
2. Free Body Diagrams
   - we do not draw F_{net} in free body diagrams



3. Force of friction (F_f)
   - kinetic $F_f = \mu_k F_N$ → already moving
   - static $F_f = \mu_s F_N$ → about to move

$\mu_s > \mu_k$

4. Tension



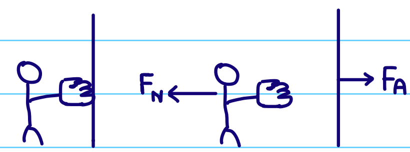
Tension force is directed along the length of wire/string and pulls equally on the different objects on the opposite ends

⑤ Newton's laws of Motion

1st law :
the law of inertia
when $F_{net} = \emptyset$ then objects continue with constant $\bar{v}$

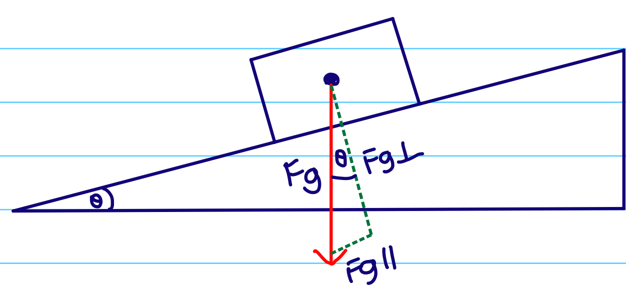
2nd law:
$F_{net} = m\vec{a}$

3rd law:
action-reaction force
if there is a reaction force on every force, how can we achieve any net?
THEY ACT ON DIFFERENT OBJECTS



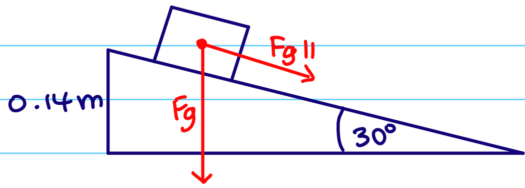
Assignment: Giancoli P. 104 # 4, 7, 8, 10, 12, 14, 16

SEP 28 • Blocks on ramps



$F_{g\perp} = F_g \cos\theta$
$F_{g\parallel} = F_g \sin\theta$

Ex ① A box is placed on a frictionless ramp at a height of 0.14 m off the ground. The ramp has an incline of 30° from the horizontal. What is the final speed at the bottom?

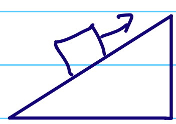


$$ma = F_g$$
$$\cancel{m}a = \cancel{m}g\sin\theta$$
$$a = (9.8)\sin(30^\circ)$$
$$a = 4.9\ m/s^2$$

length of ramp:
$$= \frac{0.14}{\sin 30^\circ}$$
$$= 0.28\ m$$

$$V_f^2 = V_i^2 + 2ad$$
$$V_f = \sqrt{0 + 2(4.9)(0.28)}$$
$$= 1.65\ m/s \ \#$$

Ex ② A small block of mass m is given initial velocity V_0 up a ramp inclined at angle θ to the horizontal. It travels up a distance d along the ramp and comes to rest. Determine a formula for the coefficient of kinetic friction between the block and ramp



$$F_f = \mu F_N$$
$$F_f = \mu mg\cos\theta$$

$$V_f^2 = V_i^2 + 2ad$$
$$0 = V_i^2 + 2ad$$
$$a = \frac{-V_i^2}{2d}$$

$$F_{net} = F_f + F_{g\parallel}$$
$$ma = \mu mg\cos\theta + mg\sin\theta$$

$$\frac{-V_i^2}{2d} = \mu g\cos\theta + g\sin\theta$$

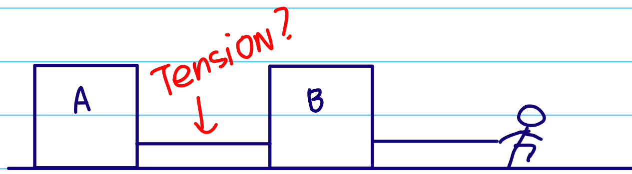
$$\frac{-V_i^2}{2d} - g\sin\theta = \mu g\cos\theta$$

$$\mu = \frac{-V_i^2}{2d \cdot g\cos\theta} - \frac{\cancel{g}\sin\theta}{\cancel{g}\cos\theta}$$

$$\mu = \frac{-V_i^2}{2dg\cos\theta} - \frac{\sin\theta}{\cos\theta}$$

Assignment P. 105 # 25, 27, 28, 53

OCT 3 • **Two Body Systems**



① Treat the two objects as a whole

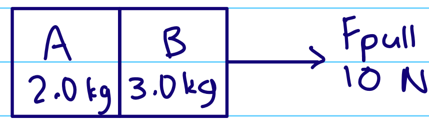
② Isolate one object. Draw the free body diagram then find tension

Ex ① $m_A = 2.0\,kg$

$m_B = 3.0\,kg$

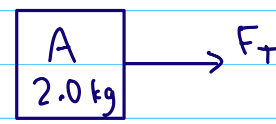
Find tension if $F_{pull} = 10.0\,N$

①



$$F_{net} = ma$$
$$10 = (2+3)a$$
$$a = 2.0\ m/s^2$$

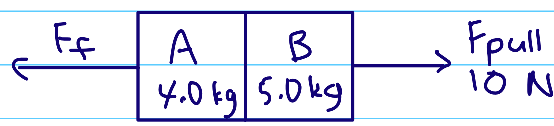
② Isolate



$$F_T = ma$$
$$F_T = (2)(2)$$
$$F_T = 4\ N$$

Ex ② set the same system as above but include friction with $\mu_k = 0.1$

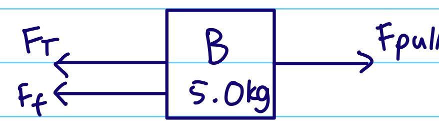
①



$$F_f = \mu_k mg$$
$$= (0.1)(4+5)(9.81)$$
$$= 8.829\ N$$

$$F_{net} = ma$$
$$F_{pull} - F_f = (4+5)a$$
$$10 - 8.829 = 9a$$
$$a = 0.13\ m/s^2$$

② Isolate



$$F_{net} = F_{pull} - F_T - F_f$$
$$ma = 10 - F_T - \mu_k F_N$$
$$(5)(0.13) = 10 - F_T - (0.1)(5)(9.81)$$
$$F_T = 10 - (5)(0.13) - (0.1)(5)(9.81)$$
$$F_T = 4.44\ N$$

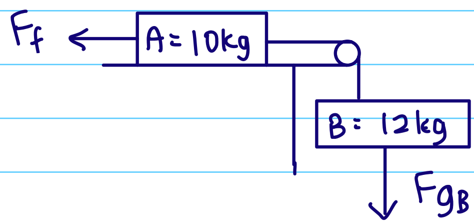
Assignment point P.36 # 19-24

OCT 5

The Force Awakens

Ex ① What is the tension in the rope if we let the system go?

Given: $m_A = 10\ kg$; $m_B = 12\ kg$; $\mu_k = 0.10$



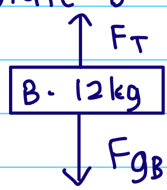
$F_{net} = F_{gB} - F_f$

$ma = m_B g - \mu_k m_A g$

$22a = (12)(9.8) - (0.1)(10)(9.8)$

$a = 4.9\ m/s^2$

Isolate B



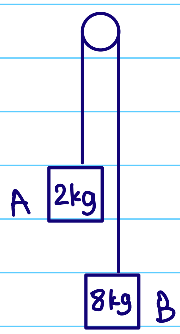
$F_{net} = F_{gB} - F_T$

$m_B a = m_B g - F_T$

$(12)(4.9) = (12)(9.8) - F_T$

$F_T = 58.8\ N$

Ex ② The rope has no friction nor mass



$F_{net} = F_{gB} - F_{gA}$

$ma = m_B g - m_A g$

$10a = (8)(9.8) - (2)(9.8)$

$a = 5.88\ m/s^2$

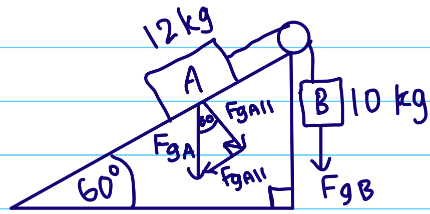
$F_{net} = F_{gB} - F_T$

$m_B a = m_B g - F_T$

$(8)(5.88) = (8)(9.8) - F_T$

$F_T = 31.36\ N$

Ex ③ Assume no friction



$\sin 60 = \frac{F_{gA\parallel}}{F_{gA}}$

$F_{gA\parallel} = m_A g \sin 60°$
$= (12)(9.8)\sin 60°$
$= 101.844\ N$

Find F_T

$F_{net} = F_{gB} - F_{gA\parallel}$
$ma = m_B g - 101.844$
$22a = (10)(9.8) - 101.844$
$a = -0.17\ m/s^2$

Isolate B

$F_{net} = F_T - F_{gB}$
$m_B a = F_T - m_B g$
$(10)(0.17) = F_T - (10)(9.8)$
$F_T = 99.7\ N$

Assignment p 110 #61, 63, 73, 81