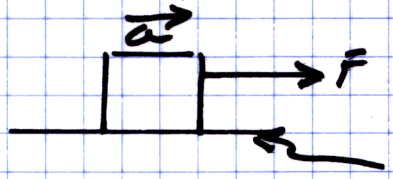
FORCE & MOTION I

NEWTON'S 1ST LAW - IF NO FORCE ACTS ON A BODY THEN THE BODY'S VELOCITY CANNOT CHANGE; i.e. THE BODY CANNOT ACCELERATE

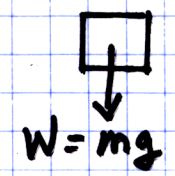
FORCE - A FORCE CAUSES A BODY TO ACCELERATE

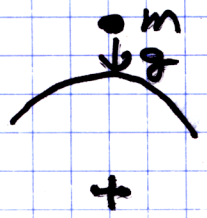


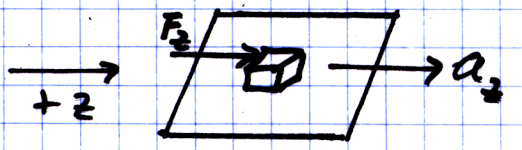
A FORCE OF 1 NEWTON CAUSES A MASS OF 1 kg TO ACCELERATE AT $1 m/s^2$

NEWTON'S 2ND LAW $\Sigma \vec{F} = m\vec{a}$

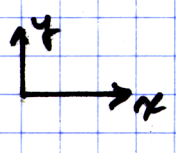
THE WEIGHT OF A BODY = THE GRAVITATIONAL FORCE ON THE BODY

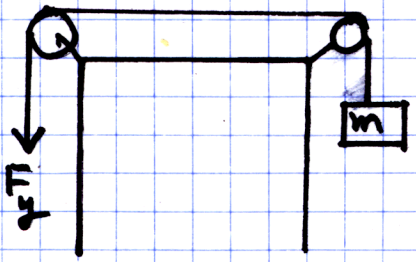






$$F_z = m a_z$$





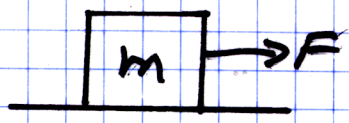
$$\Sigma F_y = m a_y$$

THE CORD DOES NOT SHRINK OR ELONGATE

SYSTEMS OF UNITS

SYSTEM	FORCE	MASS	ACCEL
SI	N	kg	m/s^2
CGS	DYNE	gm	cm/s^2
BRITISH	lb	SLUG	FT/s^2

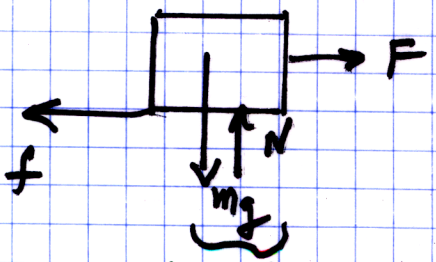
FBD - FREE BODY DIAGRAMS



$m = 5$ kg

$F = 7$ N

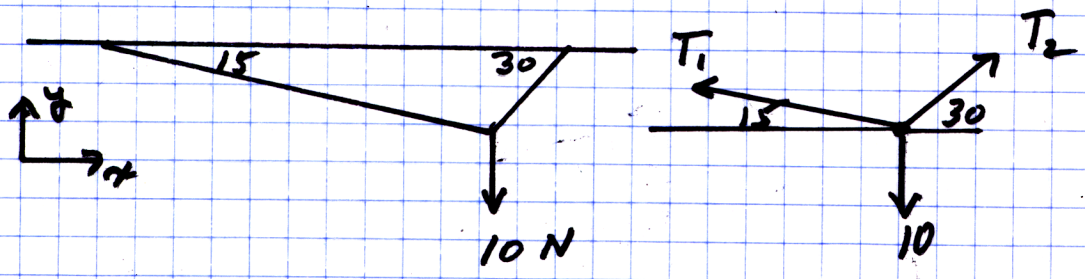
$a = \frac{F}{m} = \frac{7}{5} = 1.4\ m/s^2$



ACTION REACTION PAIR (THIRD LAW)

NEWTON'S 3RD LAW - WHEN TWO BODIES INTERACT, THE FORCES ON THE BODIES FROM EACH OTHER ARE ALWAYS = IN MAGNITUDE & OPPOSITE IN DIRECTION

EXAMPLE 1 - FIND THE TENSION IN THE CORDS



$\Sigma F_x = 0 \quad T_2 \underset{.866}{\cos 30} - T_1 \underset{.966}{\cos 15} = 0$

$T_2 = T_1 \left(\frac{.966}{.866} \right) = 1.115\ T_1$

$\Sigma F_y = 0 \quad T_1 \underset{.259}{\sin 15} + T_2 \underset{.500}{\sin 30} - 10 = 0$

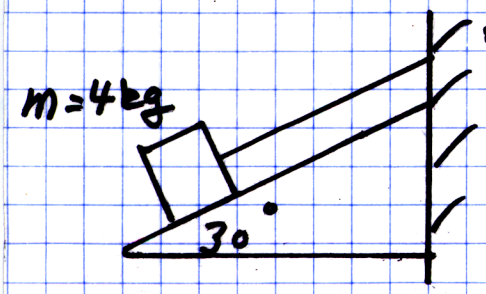
$T_1(.259 + .5(1.115)) = 10$

$T_1(.259 + .558) = 10$

$T_1 = \frac{10}{.817} = 12.24\ N$

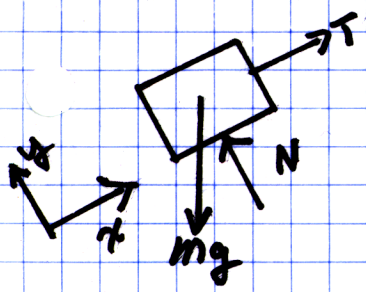
$T_2 = 12.24(1.115) = 13.65\ N$

EXAMPLE 2 FIND THE TENSION IN THE ROPE & THE NORMAL FORCE



$\Sigma F_x = 0 \quad T - 4g \underset{.5}{\sin 30} = 0$

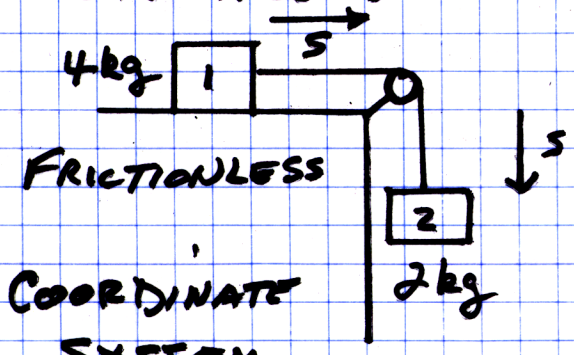
$T = 4(9.8)(.5) = 19.6\ N$

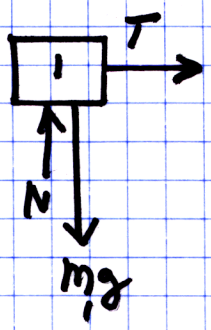


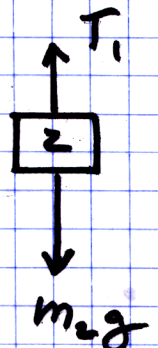
$\Sigma F_y = 0 \quad +N - mg \underset{.866}{\cos 30} = 0$

$N = mg\cos 30 = 4(9.8)(.866) = 33.9\ N$

EXAMPLE 3







FOR BODY 1

$\Sigma F_s = m_4 a$

$T = 4a$

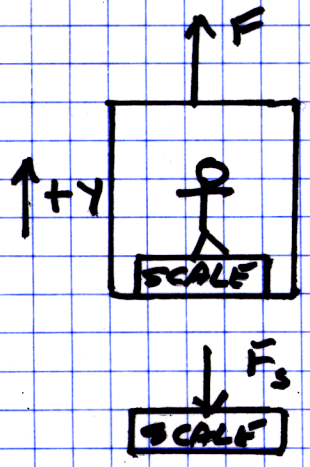
$T = 4(3.27) = 13.08\ N$

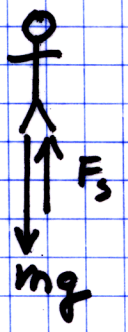
FOR BODY 2

$2g - 4a = 2a$

$a = \frac{2g}{6} = 3.27\ m/s^2$

EXAMPLE 4 - FIND THE FORCE ON THE SCALE F_s





$\Sigma F_y = m a_y$

THREE POSSIBILITIES

$a=0$ $a<0$ $a>0$

IF $a=0$ $\quad F_s - mg = m(0) = 0$

$F_s = mg$

$a>0$ $\quad F_s - mg = ma$

$F_s = ma + mg$ $\quad +a \uparrow$

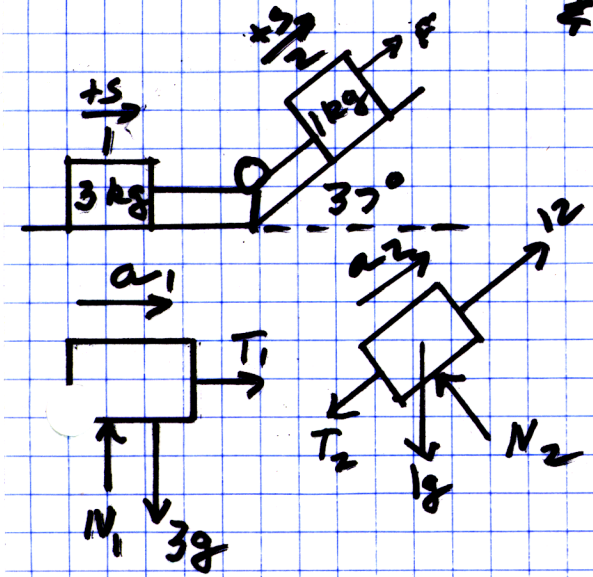
$a<0$ $\quad F_s - mg = -ma$

$F_s = m(g-a)$

IF $|g| = |a|$

$F_s = 0$ $\quad$ FREE FALL

EXAMPLE 5 IF $F = 12\,N$ FIND THE TENSION & ACCELERATION



SINCE THE CORD HAS CONSTANT LENGTH

$T = T_1 = T_2 \rightarrow a_1 = a_2 = a$

Body 1

$\Sigma F_s = m a$

$T = 3a$

$a = \frac{T}{3} = .33T$

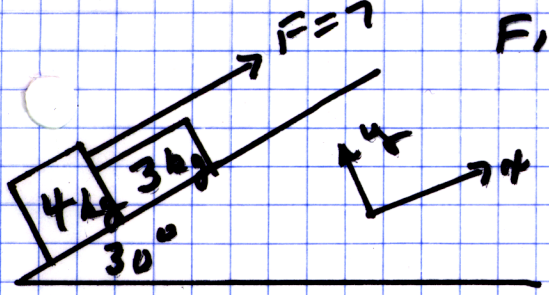
Body 2

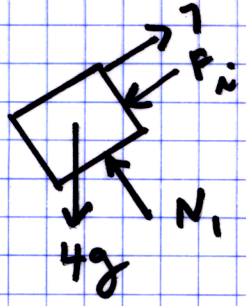
$F - T - g \sin 37 = 1a$

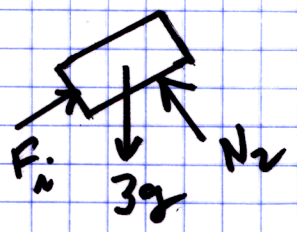
$12 - T - 0.6g = a = .33T$

$T = 4.6\,N \quad a = 1.53\,m/s^2$

EXAMPLE 6 - FOR THE FIGURE AT THE LEFT FIND THE FORCE BETWEEN BLOCKS







FOR BODY 1 $\Sigma F_y = 0$ $N_1 - 4g\cos 30 = 0$

$N_1 = 33.9$

$\Sigma F_x = ma$ $7 - F_N - N_1 \sin 30 = 4a$

$$\boxed{7 - F_N - 33.9(.5) = 4a}$$

FOR BODY 2 $\Sigma F_y = 0$ $N_2 - 3g\cos 30 = 0$

$N_2 = 25.5$

$\Sigma F_x = ma$ $F_N - N_2 \sin 30 = 3a$

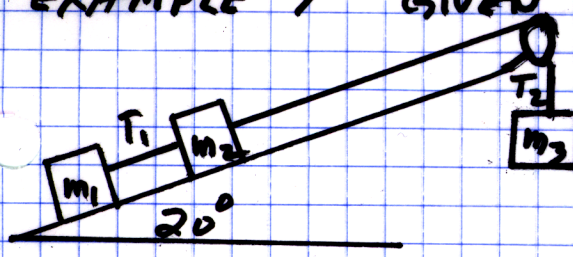
$F_N - 25.5(.5) = 3a$

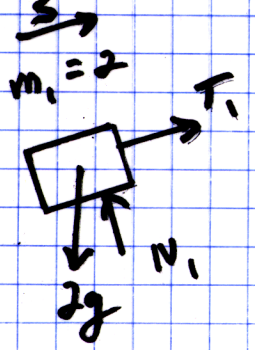
$$\boxed{F_N = 3a + 12.75}$$

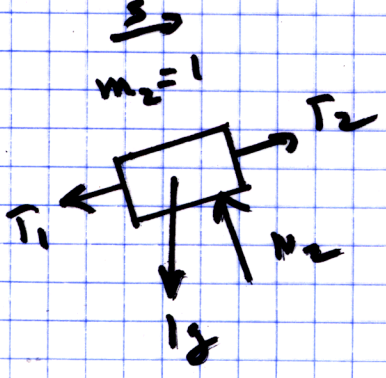
$a = -3.25\ m/s^2$ $F_N = 3.00\ N$

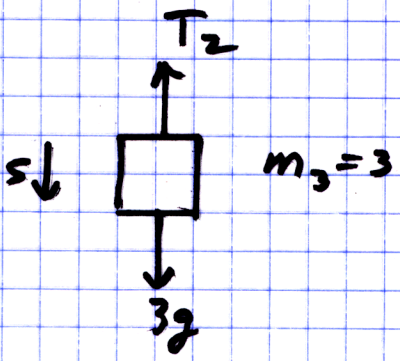
//

EXAMPLE 7 GIVEN $m_1 = 2\ kg$, $m_2 = 1\ kg$, $m_3 = 3\ kg$ } FIND T_1 T_2 & a









$T_1 - 2g\sin 20 = 2a$ $\quad T_2 - T_1 - 1g\sin 20 = 1a$ $\quad 3g - T_2 = 3g$

3 EQUATIONS 3 UNKNOWNS

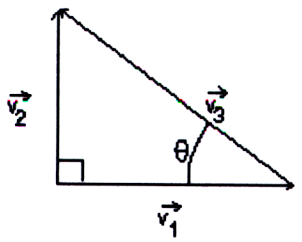
T_1 T_2 & a

PHYS 111 SAMPLE QUIZ I

1. 1 mi is equivalent to 1609 m so 55 mph is:

A) 15 m/s
B) 25 m/s
C) 66 m/s
D) 88 m/s
E) 1500 m/s

2. The vector V_3 in the diagram is equal to:



A) $V_1 - V_2$
B) $V_1 + V_2$
C) $V_2 - V_1$
D) $V_1 \cos\theta$
E) $V_1/(\cos\theta)$

3. A vector has a component of 10 in the +x direction, a component of 10 in the +y direction, and a component of 5 in the -z direction. The magnitude of this vector is:

A) zero
B) 15
C) 20
D) 25
E) 225

4. The average speed of a moving object during a given interval of time is always:

A) its speed at any point
B) the distance covered during the time interval divided by the time interval
C) one-half its speed at the end of the interval
D) its acceleration multiplied by the time interval
E) one-half its acceleration multiplied by the time interval.

5. A car starts from Hither, goes 50 km in a straight line to Yon, immediately turns around, and returns to Hither. The time for this round trip is 2 hours. The average speed of the car for this round trip is:

A) 0 km/h
B) 50 km/h
C) 100 km/h
D) 200 km/h
E) cannot be calculated without knowing the acceleration

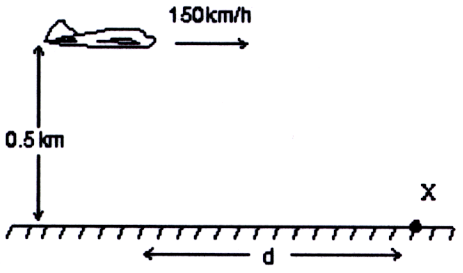
6. An object with an initial velocity of 12 m/s west experiences a constant acceleration of 4 m/s^2 west for 3 seconds. During this time the object travels a distance of:

A) 12 m
B) 24 m
C) 36 m
D) 54 m
E) 144 m

7. An object is thrown straight up from ground level with a speed of 50 m/s. If g = 10 m/s^2 its distance above ground level 6.0 s later is:

A) 480 m
B) 270 m
C) none of these
D) 0.00 m
E) 330 m

8. The airplane shown is in level flight at an altitude of 0.50 km and a speed of 150 km/h. At what distance d should it release a heavy bomb to hit the target X? Take $g = 10\ m/s^2$.

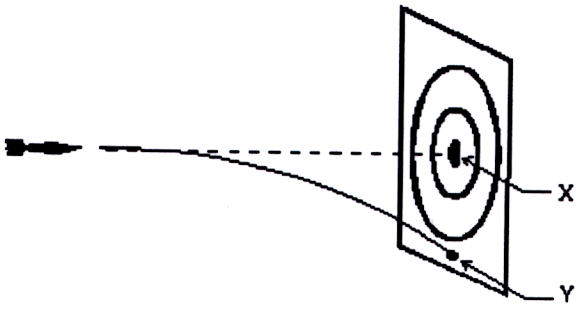


A) 150 m
B) 295 m
C) 417 m
D) 2550 m
E) 15000 m

9. A large cannon is fired over level ground at an angle of 30°above the horizontal. The muzzle velocity is 980 m/s. Neglecting air resistance, the projectile will travel what horizontal distance before striking the ground?

A) 4300 m
B) 8500 m
C) 43,000 m
D) 85,000 m
E) 170,000 m

10. A dart is thrown horizontally toward X at 20 m/s as shown. It hits Y 0.1 s later. The distance XY is:

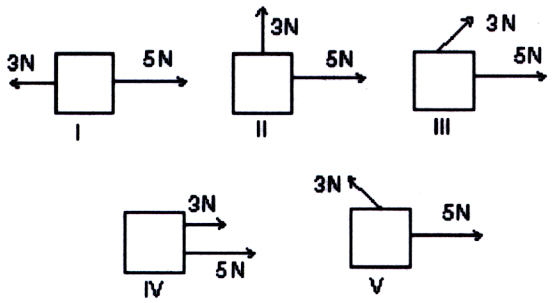


A) 2 m
B) 1 m
C) 0.5 m
D) 0.1 m
E) 0.05 m

11. A stone is tied to a 0.50 m string and whirled at a constant speed of 4.0 m/s in a vertical circle. Its acceleration in m/s^2 at the top of the circle is:

A) 9.8, up
B) 9.8, down
C) 8.0, down
D) 32, up
E) 32, down

12. Two forces, one with a magnitude of 3 N and the other with a magnitude of 5 N, are applied to an object. For which orientations of the forces is the magnitude of the acceleration of the object the least?



A) IV
B) V
C) I
D) II
E) III

13. A 700-kg elevator accelerates downward at 3.0 m/s^2. The force exerted by the cable on the elevator is:

A) 2.1 kN, up
B) 2.1 kN, down
C) 4.8 kN, up
D) 4.8 kN, down
E) 9.0 kN, up

14. A 150 lb man stands on a spring scale in an elevator that is accelerating upward at 16 ft/s^2. The scale will read (in lbs):

A) 300
B) 225
C) 175
D) 150
E) 75

15. When a 40-N force, parallel to the incline and directed up the incline, is applied to a crate on a frictionless incline that is 30° above the horizontal, the acceleration of the crate is 2.0 m/s^2, up the incline. The mass of the crate is:

A) 3.8 kg
B) 4.1 kg
C) 5.8 kg
D) 6.2 kg
E) 10 kg

Answer Key

1. **B**
2. **C**
3. **B**
4. **B**
5. **B**
6. **D**
7. **C**
8. **C**
9. **D**
10. **E**
11. **E**
12. **C**
13. **C**
14. **B**
15. **C**