98 = $\frac{98}{108} \times 100$ (108)

112 / 112

Exam 4: Force

1. A rubber ball weighs 49 N.
   a. What is the mass of the ball?

5

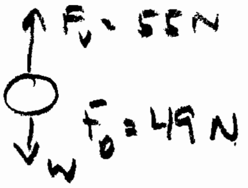
$w = m\,g$

$49\,N = m \; 9.8\frac{m}{s^2}$

$m = 5\,kg$

   b. What is the acceleration of the ball if an upward force of 55 N is applied?

10



$F_{NET} = F_U - F_D$

$= 55N - 49N$

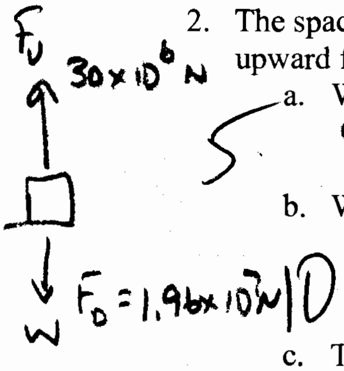
$F_{NET} = 6N$

$F = m\,a$

$6N = 5\,kg\; a$

$a = 1.2\frac{m}{s^2}$

2. The space shuttle has a mass of 2 x 10^6 kg. At lift-off the engines generate an upward force of 30 x 10^6 N.



   a. What is the weight of the shuttle?

5

$W = m\,g$

$= 2\times10^6\,kg \; 9.8\frac{m}{s^2} = 1.96\times10^7 N$

   b. What is the acceleration of the shuttle when launched?

10

$F_{NET} = F_U - F_D$

$= 30\times10^6 N - 1.96\times10^7 N = 1.04\times10^7$

$F = m\,a$

$1.04\times10^7 = 2\times10^6\,a$

$a = 5.2\frac{m}{s^2}$

   c. The average acceleration of the shuttle during its 10 minute launch is 13 m/s². What velocity does it attain?

7

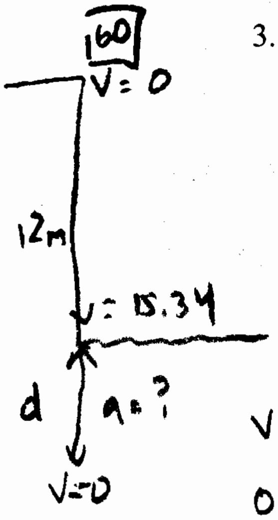
$?s = 10\,min \times \frac{60\,s}{1\,min} = 600\,s$

$V = V_i + a\,t$

$= 0 + 13\frac{m}{s^2}\;600\,s$

$= 7.8\times10^3\frac{m}{s}$

3. A 60 kg swimmer jumps off a 12 m tower.



   a. Find the swimmer's velocity when hitting the water.

5

$V^2 = V_i^2 + 2ad$

$= 0 + 2(9.8\frac{m}{s^2})12m$

$= 15.34\frac{m}{s}$

   b. The swimmer comes to a stop 3 m below the surface. Find the net force exerted by the water.

$V^2 = V_i^2 + 2ad$

$0 = (15.34)^2 + 2a\,3m$

$a = -39.22\frac{m}{s^2}$

$F_{NET} = m\,a$

$= 60kg(-39.22\frac{m}{s^2})$

$F_{NET} = 2353.2N$

$F_D = W = m\,g$

$= 60kg(9.8\frac{m}{s^2})$

$F_D = 588N$

$F_{NET} = F_U - F_D$

$2353.2N = F_U - 588N$

$F_U = 2.94\times10^3 N$

20

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4. A worker pushes a small crate with a mass of 5 kg on a horizontal surface with a constant speed of 9.5 m/s/ The coefficient of sliding friction between the crate and the surface is 0.2. What horizontal force must be applied by the worker to maintain the motion.

$\mu = .2$

$F_{NET} = 0$ [5kg] ← F_{fr}

$v = 9.5\,\frac{m}{s}$

$F_f = \mu m g$

$= .2(5)9.8$

$F_f = 9.8N$

10

$F_{NET} = F_m - F_{fr}$

$F_m = F_{fr} = \boxed{9.8N}$

b. If force is removed how soon does the crate come to rest?

$F_{NET} = F_m - F_{fr}$

$F_{NET} = 0 - 9.8N$

$F_{NET} = -9.8\,N$

$-9.8N = ma$

$-9.8N = 5kg\, a$

$a = -1.96\,\frac{m}{s^2}$

$V = V_i + at$

$0 = 9.5\frac{m}{s} + -1.96\frac{m}{s^2}\, t$

$\boxed{t = 4.85s}$

15

c. A sled of mass 50 kg is pulled along snow covered, flat ground. The static friction coefficient is 0.3, and the sliding friction coefficient is 0.1.

a. What does the sled weigh?

$W = mg$

$= 50kg\; 9.8\,\frac{m}{s^2}$

$= \boxed{4.90 \times 10^2 N}$

5

b. What force will be needed to start the sled moving?

$F_{NET} = F_m - F_{fr}$

$0 = F_m - \mu W$

$F_m = (.3)(490N) = \boxed{1.47 \times 10^2 N}$

10

c. What force is needed to keep the sled moving at a constant velocity?

$F_{NET} = F_m - F_{fr}$

$0 = F_m - \mu W$

$F_m = (.1)(490N) = \boxed{4.9 \times 10^1 N}$

10

d. Once moving, what total force must be applied to the sled to accelerate it 3 m/s2?

$F_{NET} = ma$

$= 50kg(3\frac{m}{s^2})$

$F_{NET} = 150N$

$F_{NET} = F_m - F_{fr}$

$150N = F_m - 49N$

$\boxed{F_m = 1.99 \times 10^2 N}$

10

60