Dynamics Review Sheet Solutions

9. answer: D

$\Sigma F_y = 0 \Rightarrow F_k - F_g = 0$

$F_k = F_g = mg = (60\text{ kg})(9.8\text{ m/s}^2) = \boxed{588\text{ N}}$

10. answer: B

$F_g = \dfrac{Gm_1m_2}{r^2}$ so $F_g \sim m_1 \cdot m_2$ and $F_g \sim \dfrac{1}{r^2}$

now $F = \dfrac{G2m_1 2m_2}{(3r)^2} = \dfrac{4Gm_1m_2}{9r^2} = \boxed{\tfrac{4}{9}F}$

11. answer: D

$F_c = \dfrac{mv_t^2}{r} \Rightarrow$ if v_t is doubled, F_c is $\boxed{\text{quadrupled}}$

12. answer: D

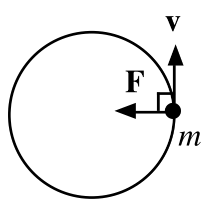
$v_f = v_i + at \Rightarrow 0 = 10 + a(0.10) \Rightarrow a = -100\text{ m/s}^2$

$\Sigma F_x = ma = (1{,}200\text{ kg})(-100\text{ m/s}^2) = -120{,}000\text{ N}$

magnitude of force $= \boxed{120{,}000\text{ N}}$

13. answer: C

An object moving in circular motion has tangential velocity and centripetal (radial) acceleration, so F and v are perpendicular.



14. answer: D

If the sum of all forces is zero on an object, then the object's acceleration is zero, so it continues to move with constant velocity. (Its inertia keeps in going.)

15. answer: C

Newton's 3rd Law says that an action force from one object to a second object must create an equal and opposite reaction force back on the first object. The earth's mass pulls the ball down while the ball's mass pulls the earth up.

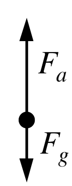
16. answer: B

$\Sigma F = ma \Rightarrow 10 = 5m \Rightarrow m = 2\text{ kg}$

$\Sigma F = ma = (2\text{ kg})(1\text{ m/s}^2) = \boxed{2\text{ N}}$

17. answer: C

The force diagram has an upward applied force (thrust) and a downward weight.



$\Sigma F = ma \Rightarrow F_a - F_g = ma$

$F_a - mg = ma$

$F_a - (100)(9.8) = (100)(15)$

$F_a = \boxed{2480\text{ N}}$

18. answer: A

$v_f^2 = v_i^2 + 2a\Delta x$ | $\Sigma F = ma$

$0 = 38^2 + 2a(100)$ | $\Sigma F = (1000)(-7.22)$

$a = -7.22\text{ m/s}^2$ | $\Sigma F = -7220\text{ N}$

new force is doubled:

$2(-7220) = -14{,}400$ | $v_f^2 = v_i^2 + 2a\Delta x$

$-14{,}400 = 1000a$ | $0^2 = v_i^2 + 2(-14.4)(100)$

$a = -14.4\text{ m/s}^2$ | $v_i = \boxed{53.7\text{ m/s}}$

19

$v_f = 80\ \dfrac{\text{km}}{\text{hr}}\left(\dfrac{1000\text{ m}}{1\text{ km}}\right)\left(\dfrac{1\text{ hr}}{3600\text{ s}}\right) = 22.2\text{ m/s}$

$v_f = v_i + at \Rightarrow 22.2 = 0 + a(9.4) \Rightarrow a = 2.36\text{ m/s}^2$

$\Sigma F = ma = (1060\text{ kg})(2.36\text{ m/s}^2) = \boxed{2506\text{ N}}$

20.

$F_g = mg \Rightarrow m = \dfrac{F_g}{g} = \dfrac{54}{9.8} = 5.51\text{ kg}$

$\Sigma F_y = ma \Rightarrow F_T - F_g = ma$

$F_T - 54 = (5.51)(0.77)$

$F_T = \boxed{58.2\text{ N}}$

21a.

$F_g = mg \Rightarrow m = \dfrac{F_g}{g} = \dfrac{960\text{ N}}{9.8\text{ N/kg}} = \boxed{98\text{ kg}}$

21b.

$F_g = mg_{moon} = (98\text{ kg})(1.63\text{ N/kg}) = \boxed{160\text{ N}}$

21c.

Mass is universal, so it is still $\boxed{98\text{ kg}}$!

22.

$F_g = \dfrac{Gm_1m_2}{r^2} \Rightarrow 3.4\times10^{-11} = \dfrac{(6.67\times10^{-11})(m^2)}{(2.1)^2}$

$m = \sqrt{(2.1)^2(3.4\times10^{-11})/(6.67\times10^{-11})} = \boxed{1.50\text{ kg}}$

23a.

$F_g = mg = (6)(9.8) = 58.8\text{ N}$

$\Sigma F_y = 0 \Rightarrow F_n - F_g = 0 \Rightarrow F_n = F_g = mg$

$F_k = \mu_k F_n = \mu_k mg = (0.22)(6)(9.8) = \boxed{12.9\text{ N}}$

$\Sigma F_x = ma \Rightarrow F - F_k = ma$

$75 - 12.9 = (6)a \Rightarrow a = \boxed{10.3\text{ m/s}^2\text{, right}}$

23b.

$\Sigma F_y = 0 \;\Rightarrow\; F_n - F_g - F\sin\theta = 0$

$F_n = 58.8 + 75\sin 53° = 118.7\text{ N}$

$F_k = \mu_k F_n = (0.22)(118.7) = \boxed{26.1\text{ N}}$

$\Sigma F_x = ma \;\Rightarrow\; F\cos\theta - F_k = ma$

$75\cos 53° - 26.1 = 6a \;\Rightarrow\; a = \boxed{3.17\text{ m/s}^2\text{, right}}$

23c.

$\Sigma F_y = 0 \;\Rightarrow\; F_n - mg\cos\theta = 0$

$F_n = (58.8)(\cos 37°) = 46.9\text{ N}$

$F_k = \mu_k F_n = (0.22)(46.9) = \boxed{10.3\text{ N}}$

$\Sigma F_x = ma \;\Rightarrow\; F - F_k - mg\sin\theta = ma$

$75 - 10.3 - (58.8)(\sin 37°) = 6a$

$a = \boxed{4.88\text{ m/s}^2\text{, right}}$

24a.

$\Sigma F_x = ma \;\Rightarrow\; F_T = (m_1 + m_2)a$

$58 = (3+8)a \;\Rightarrow\; a = \boxed{5.27\text{ m/s}^2}$

24b.

$\Sigma F_y = 0 \;\Rightarrow\; F_n - F_g = 0 \;\Rightarrow\; F_n = F_g = mg$

$F_k = \mu_k F_n = \mu_k mg = (0.33)(3+8)(9.8) = 35.6\text{ N}$

$\Sigma F_x = ma \;\Rightarrow\; F_T - F_k = (m_1 + m_2)a$

$58 - 35.6 = (3+8)a \;\Rightarrow\; a = \boxed{2.04\text{ m/s}^2}$

24c.

$\Sigma F_x = ma$ on 3 kg mass only

$F_T = ma$

$F_T = (3)(5.27) \;\Rightarrow\; F_T = \boxed{15.8\text{ N}}$

with friction:

$F_T - F_k = ma$

$F_T - 0.33(3)(9.8) = 3(2.04) \;\Rightarrow\; F_T = 15.8\text{ N}$

25a.

$2\text{ min} = 120\text{ s} \qquad 1.6\text{ km} = 1{,}600\text{ m}$

$$a_c = \frac{4\pi^2 r}{T^2} = \frac{4\pi^2(1{,}600)}{(120)^2} = \boxed{4.39\text{ m/s}^2}$$

25b.

$$F_s = F_c = \frac{mv_t^2}{r} \;\Rightarrow\; 1200 = \frac{500(v^2)}{1600}$$

$v_t = \boxed{62.0\text{ m/s}}$

26.

$\Sigma\tau = 0$ (about fingers point, F)

$(T)d - (m_1 g)d_1 - (m_2 g)d_2 - (m_3 g)d_3 = 0$

$T(.04) - (.28)(9.8)(.2 - .1) - (1.0)(9.8)(.24 - .1)$
$\qquad - (.295)(9.8)(.38 - .1) = 0$

$T = \boxed{61.4\text{ N}}$

$\Sigma F_y = 0$

$F - T - m_1 g - m_2 g - m_3 g = 0$

$F = 61.4 + 0.28(9.8) + 1.0(9.8) + 0.295(9.8) = \boxed{78.6\text{ N}}$

check your answer:

$\Sigma\tau = 0$ (about thumb point, T)

$(F)d - (m_1 g)d_1 - (m_2 g)d_2 - (m_3 g)d_3 = 0$

$F(.04) - (.28)(9.8)(.2 - .06) - (1.0)(9.8)(.24 - .06)$
$\qquad - (.295)(9.8)(.38 - .06) = 0$

$F = 76.8\text{ N}$

27.

$$F_g = \frac{Gm_1 m_2}{d^2} = \frac{(6.67\times 10^{-11})(7\times 10^{41}\text{ kg})(6\times 10^{41}\text{ kg})}{(2\times 10^{22}\text{ m})^2}$$

$F_g = \boxed{7.0\times 10^{28}\text{ N}}$

28.

$$T = 15.95\text{ dy}\times\left(\frac{24\text{ hr}}{\text{dy}}\right)\times\left(\frac{3600\text{ s}}{1\text{ hr}}\right) = 1.38\times 10^6\text{ s}$$

$$T^2 = \left(\frac{4\pi^2}{GM}\right)r^3 \;\Rightarrow\; (1.38\times 10^6)^2 = \left(\frac{4\pi^2}{GM_s}\right)(1.22\times 10^9)^3$$

$M_s = \boxed{5.66\times 10^{26}\text{ kg}}$

29.

$\Sigma F_A = m_A a \;\Rightarrow\; m_A g - F_T = m_A a \;\Rightarrow\; 5.1g - F_T = 5.1(3)$

$\Sigma F_B = m_B a \;\Rightarrow\; F_T - m_B g = m_B a \;\Rightarrow\; F_T - 2.7g = 2.7(3)$

substitute and solve: $5.1g - (2.7g + 2.7(3)) = 5.1(3)$

$$g = \frac{3(5.1+2.7)}{5.1-2.7} = \boxed{9.75\text{ m/s}^2}$$

30.

$\Sigma\tau = 0$ (about hinge point) use L for beam length

$$(1220)\frac{L}{2}\sin 120° + (1960)L\sin 120° - F_T(L)\sin 100° = 0$$

$F_T = \boxed{2260\text{ N}}$ (L drops out of the equation)

$\Sigma F_x = 0 \;\Rightarrow\; F_H - F_T\cos\theta = 0$

$F_H = 2260\cos 50° = \boxed{1453\text{ N}}$

$\Sigma F_y = 0 \;\Rightarrow\; F_V + F_T\sin\theta - Mg - mg = 0$

$F_V = 1960 + 1220 - 2260\sin 50° = \boxed{1449\text{ N}}$