Unit Review : Dynamics

① a) gravitational force

b) gravitational force
electromagnetic force

c) strong nuclear force

d) electromagnetic force

② a) the net force on the book is zero, so it remains at rest

b) the hand introduces an unbalanced force, so the net force is no longer zero — so the book moves

c) friction creates an unbalanced force in the direction opposite to motion. this causes a negative acceleration so the book slows down

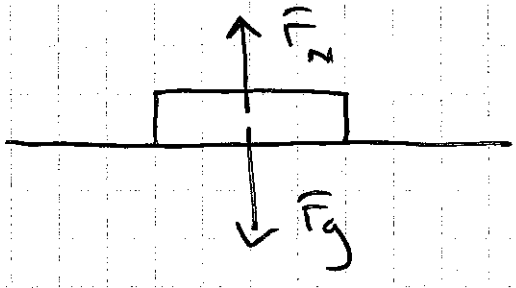
d) if the net force on the book was zero while it was moving

③ The Earth has a very large mass (5.98×10^{24} Kg). The small gravitational force exerted by the rock does not produce an observable acceleration of the Earth.

④ 3.0 Kg (mass is the same everywhere)

⑤ No, it means the forces acting on it are cancelling out.

e.g. a book at rest on a table.



$\vec{F}_N = \vec{F}_g$

$\therefore \Sigma F = 0$

⑥ $\Sigma F = ma$

$= (1750)(1.35)$

$\Sigma F = \boxed{2362.5\ N}$

⑦ $m = \frac{\Sigma F}{a} = \frac{3 \times 10^3}{4} = \boxed{750\ kg}$

⑧ $v_f^2 = v_i^2 + 2ad$

$12^2 = 0^2 + 2a(5)$

$144 = 10a$

$a = 14.4\ m/s^2$

$\Sigma F = ma$

$= (5.2)(14.4)$

$\Sigma F = \boxed{74.88\ N}$

⑨ a) $v_f = v_i + at$

$26.3 = 0 + a(0.59)$

$a = \frac{26.3}{0.59} = \boxed{44.6 \text{ m/s}^2}$

b) $\Sigma F = ma$

$= (873)(44.6)$

$\Sigma F = \boxed{38\,915.1 \text{ N}}$

c) $\Sigma F = ma$

$= (68)(44.6)$

$\Sigma F = \boxed{3031.2 \text{ N}}$

⑩ $d = v_i t + \frac{1}{2}at^2$

$402.3 = \frac{1}{2}a(4.936)^2$

$402.3 = 12.182a$

$a = \boxed{33.02 \text{ m/s}^2}$

$v_f = v_i + at$

$= (33.02)(4.936)$

$v_f = \boxed{163.0 \text{ m/s}}$

⑪ $\Sigma F = ma$

$= (0.7)(-6500)$

$\Sigma F = -4550 \text{ N}$

or

$\boxed{4550 \text{ N}}$ [opposite to hand's motion]

(12) $v_f = v_i + at$

$30 = 10 + a(10)$

$20 = 10a$

$a = 2 \text{ m/s}^2$

$\Sigma F = ma$

$= (1550)(2)$

$\Sigma F = \boxed{3100 \text{ N}}$

(13) $d = v_i t + \frac{1}{2} a t^2$

$40 = \frac{1}{2} a (3)^2$

$40 = 4.5a$

$a = 8.89 \text{ m/s}^2$

$\Sigma F = ma$

$= (710)(8.89)$

$\Sigma F = \boxed{6311.1 \text{ N}}$

(14) $a = \frac{\Sigma F}{m} = \frac{-9000}{1500} = -6 \text{ m/s}^2$

$v_f^2 = v_i^2 + 2ad$

$0 = 20^2 + 2(-6)d$

$0 = 400 - 12d$

$d = \frac{400}{12} = \boxed{33.3 \text{ m}}$

(15) Child

$\Sigma F = ma$

$= (20)(0.5)$

$\Sigma F = 10 \text{ N}$

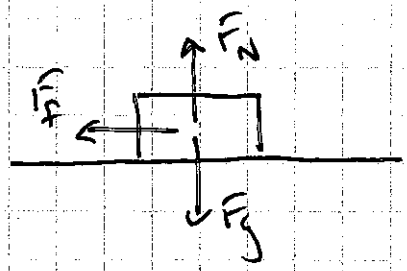
Board

$a = \frac{\Sigma F}{m}$

$= \frac{10 \text{ N}}{3 \text{ kg}}$

$a = \boxed{3.\overline{3} \text{ m/s}^2}$

(16) a)

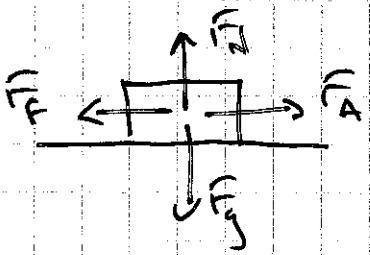


$$\vec{F}_f = \mu \cdot \vec{F}_N$$
$$= \mu \cdot mg$$
$$= (0.01)(70)(9.8)$$
$$\vec{F}_f = \boxed{-6.86\ N}$$

b) $$a = \frac{\Sigma F}{m} = \frac{\vec{F}_f}{m} = \frac{-6.86}{70} = -0.098\ m/s^2$$

$$v_f = v_i + at$$
$$0 = 1 - 0.098t$$
$$t = \frac{1}{0.098} = \boxed{10.2\ s}$$

(17)



$$\Sigma \vec{F} = \vec{F}_A - \vec{F}_f$$
$$ma = \vec{F}_A - \mu mg$$
$$F_A = ma + \mu mg$$
$$F_A = (10)(2) + (0.35)(10)(9.8)$$
$$F_A = \boxed{54.3\ N}$$

(18) $d = \left(\frac{v_f + v_i}{2}\right) t$

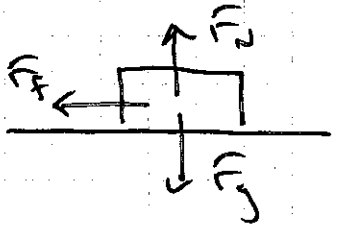
$6 = \left(\frac{0 + v_i}{2}\right) 2.2$

$v_i = \frac{2(6)}{2.2} = 5.45 \text{ m/s}$

$v_f = v_i + at$

$0 = 5.45 + a(2.2)$

$a = \frac{-5.45}{2.2} = -2.479 \text{ m/s}^2$



$\Sigma \vec{F} = \vec{F}_f$

$ma = \mu mg$

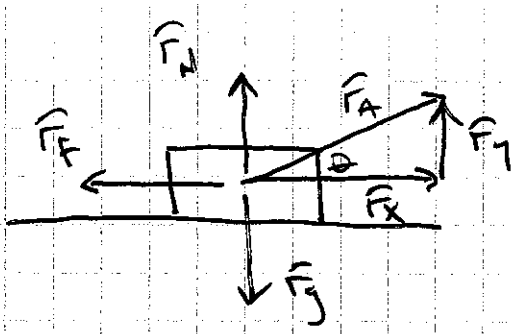
$a = \mu \cdot g$

$\mu = \frac{a}{g}$

$\mu = \frac{-2.479}{-9.8}$

$\mu = \boxed{0.253}$

(19)



a) $\vec{F}_N + \vec{F}_y = \vec{F}_g$

$\vec{F}_N = \vec{F}_g - \vec{F}_y$

$= mg - \vec{F}_A \sin\theta$

$F_N = (50)(9.8) - 200 \sin 30$

$\vec{F}_N = \boxed{390 \text{ N}}$

b) $\vec{F}_f = \mu \cdot \vec{F}_N$

$= (0.3)(390)$

$\vec{F}_f = \boxed{-117 \text{ N}}$

c) $\Sigma \vec{F} = \vec{F}_x - \vec{F}_f$

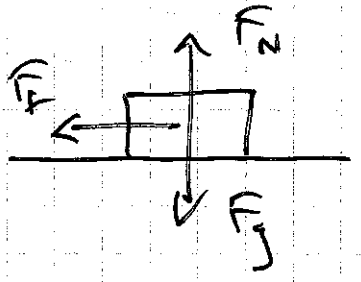
$ma = \vec{F}_A \cos\theta - \vec{F}_f$

$50a = 200 \cos 30 - 117$

$a = \frac{56.205}{50}$

$a = \boxed{1.12 \text{ m/s}^2}$

(20)



$\Sigma F = F_f$

$ma = \mu mg$

$a = \mu g$

$= (0.2)(9.8)$

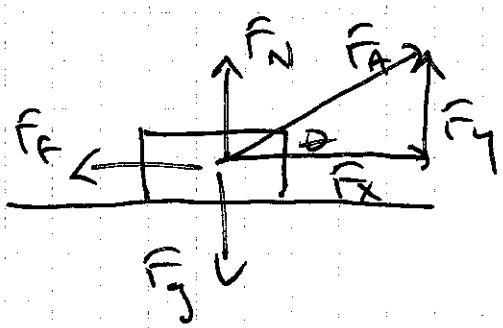
$a = -1.96 \text{ m/s}^2$

$v_f^2 = v_i^2 + 2ad$

$0 = 2^2 + 2(-1.96)d$

$d = \frac{4}{3.92} = \boxed{1.02 \text{ m}}$

(21)



a) $F_x = F_f = 27 \text{ N}$ ($\Sigma F = 0$ b/c constant v)

$F_A = 43 \text{ N}$

$\cos\theta = \frac{F_x}{F_A}$

$\theta = \cos^{-1}\left(\frac{27}{43}\right)$

$\theta = \boxed{51.1^\circ}$

(21) b) $\vec{F}_N + \vec{F}_y = \vec{F}_g$

$\vec{F}_N = \vec{F}_g - \vec{F}_y$

$= mg - \vec{F}_A \cdot \sin\theta$

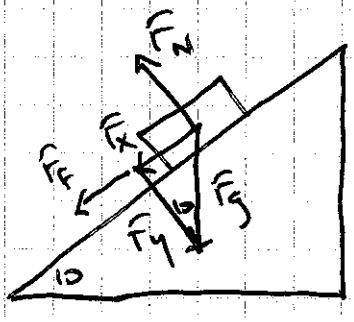
$= (18)(9.8) - 43 \sin 51.1$

$\vec{F}_N = \boxed{142.9 \text{ N}}$

c) $\vec{F}_f = \mu \cdot \vec{F}_N$

$\mu = \frac{\vec{F}_f}{\vec{F}_N} = \frac{27}{142.9} = \boxed{0.19}$

(22)



$\vec{F}_x = mg \sin\theta$

$\vec{F}_y = mg \cos\theta$

$\vec{F}_N = \vec{F}_y$

$\sum \vec{F} = -(\vec{F}_x + \vec{F}_f)$

$ma = -(mg\sin\theta + \mu mg\cos\theta)$

$a = -[9.8 \sin 10 + 0.1(9.8)\cos 10]$

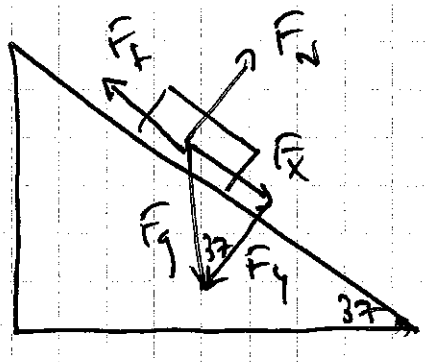
$a = -2.67 \text{ m/s}^2$

$v_f^2 = v_i^2 + 2ad$

$0 = 25^2 + 2(-2.67)d$

$d = \frac{25^2}{2(2.67)} = \boxed{75 \text{ m}}$

(23)



$F_x = mg \sin\theta$

$F_y = mg \cos\theta$

$F_N = F_y$

$\Sigma F = F_x - F_f$

$ma = mg\sin\theta - \mu mg\cos\theta$

$a = (9.8)\sin 37 - (0.15)(9.8)\cos 37$

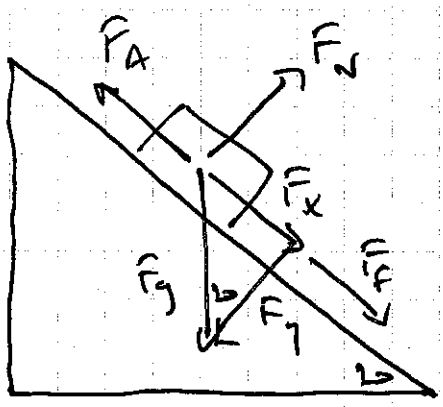
$a = 4.724 \ m/s^2$

$v_f = v_i + at$

$= 0 + (4.724)(5)$

$v_f = \boxed{23.6 \ m/s}$

(24)



a) $F_x = F_g \sin\theta$

$= 325 \sin 25$

$F_x = \boxed{111 \ N}$

b) $\Sigma F = \boxed{0}$ (constant v)

(14) c) $\vec{F}_A = \vec{F}_x + \vec{F}_f$

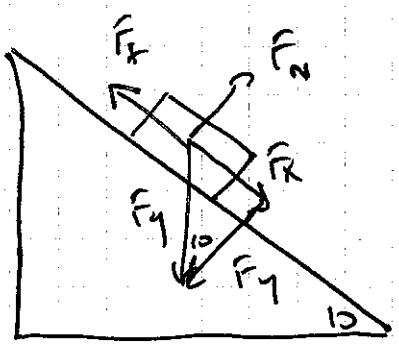
$211 = 111 + \vec{F}_f$

$\vec{F}_f = \boxed{100\ N}$ [DTS]

d) $\mu = \frac{\vec{F}_f}{\vec{F}_N} = \frac{\vec{F}_f}{F_y} = \frac{\vec{F}_f}{F_g \cos\theta} = \frac{100}{325\cos 20}$

$\mu = \boxed{0.33}$

(15)



a) $v_f^2 = v_i^2 + 2ad$

$(0.65)^2 = 0 + 2a(1.6)$

$0.4225 = 3.2a$

$a = \boxed{0.132\ m/s^2}$

b) $\Sigma \vec{F} = \vec{F}_x - \vec{F}_f$

$ma = mg\sin\theta - \mu mg\cos\theta$

$0.132 = 9.8\sin 10 - \mu(9.8)\cos 10$

$0.132 = 1.702 - 9.651\mu$

$\mu = \frac{1.702 - 0.132}{9.651}$

$\mu = \boxed{0.16}$

c) no

(26) a) $m = \boxed{95\ kg}$ (constant, does not depend on location)

b) $F_g = mg$

$= (95)(9.782)$

$F_g = \boxed{929.29\ N}$

c) $m = \boxed{95\ kg}$

d) $F_g = mg$

$= (95)(9.832)$

$F_g = \boxed{934.04\ N}$

(27) $m = \frac{F_g}{g} = \frac{245}{9.8} = \boxed{25\ kg}$

(28) $g = \frac{F_g}{m} = \frac{78.4}{7.5} = \boxed{10.45\ m/s^2}$

(29) a) $g = \frac{F_g}{m} = \frac{180}{50} = \boxed{3.6\ m/s^2}$

b) $F_g = mg = (50)(9.8) = \boxed{490\ N}$

(30) $F_g = mg = (1.672 \times 10^{-27})(9.8) = \boxed{1.64 \times 10^{-26}\ N}$