2.1

CHAPTER TWO

John Yang

CYU 2.1

a) $|\vec{A}| = |\vec{B}|$, orthogonal

b) Same direction, diff. magnitude

c) diff. direction, diff. magnitude

d) $\vec{A} = -\vec{B}$ e) $\vec{A} = \vec{B}$

Ex 2.1

$\hat{u}$ → direction towards door, 1 cm

$\Delta\vec{x} = 15\hat{u} - 56\hat{u} + 8\hat{u} + 25\hat{u} - 19\hat{u}$

$= -32\hat{u}$ = 32 cm, towards the wall

$x_f = 100\text{ cm} - 32\text{ cm} =$ 68 cm

CYU 2.2

$\hat{u}$ = 1 m of the tunnel

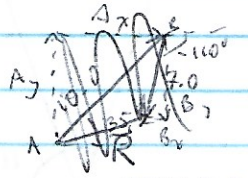
$\Delta\vec{x}_0 = -20\hat{u}$

$\Delta\vec{x}_f = -20\hat{u} + 6\hat{u} + 10\hat{u} =$ $-16\hat{u}$

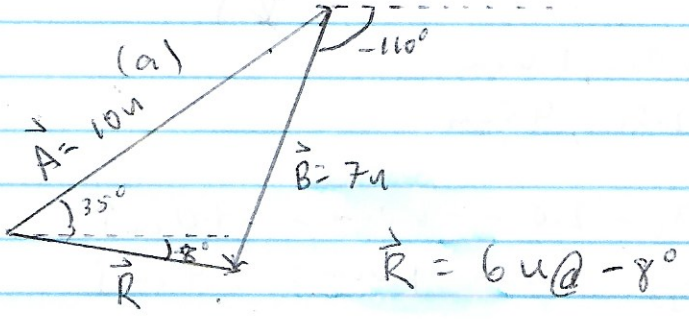
$x_f =$ 16 m in the tunnel

Ex. 2.2

a) $\vec{R} = \vec{A} + \vec{B}$



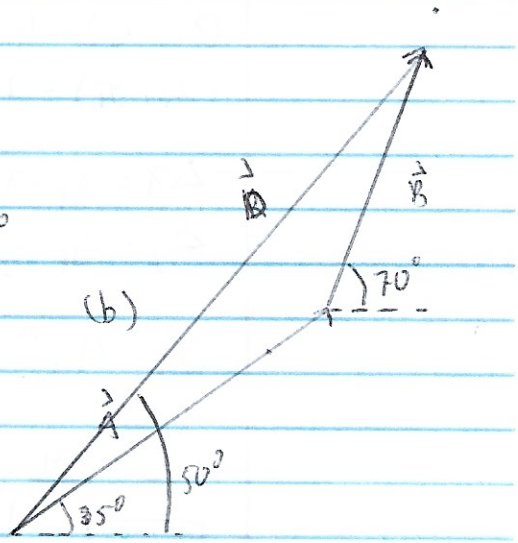
$|\hat{u}| = 0.5$ cm



$\vec{R} = 6u\ @ -8°$

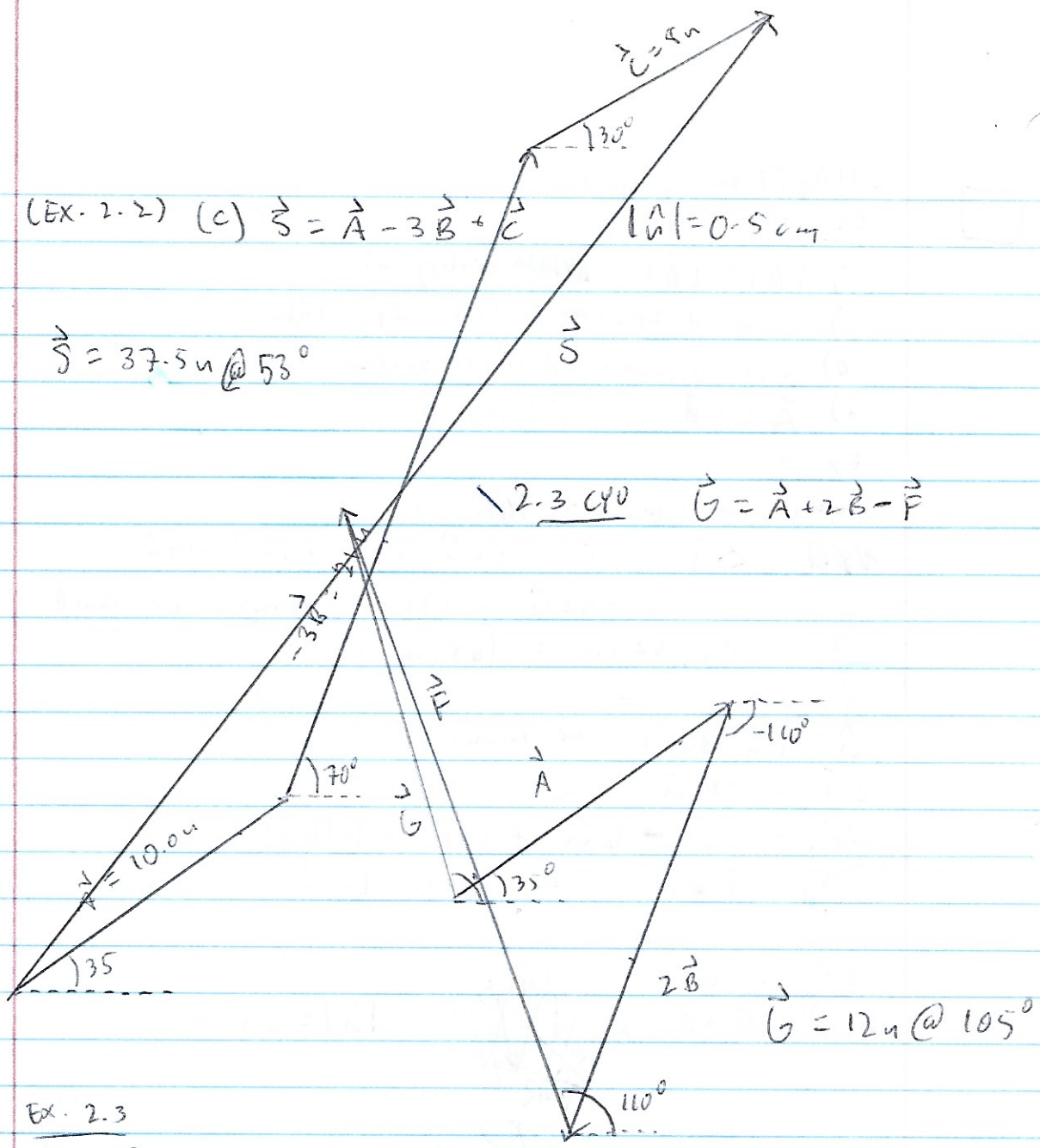
b) $\vec{D} = \vec{A} - \vec{B} = \vec{A} + (-\vec{B})$

$\vec{D} = 16u\ @\ 50°$



(EX. 2.2) (c) $\vec{S} = \vec{A} - 3\vec{B} + \vec{C}$ $|\hat{u}| = 0.5\,cm$

$\vec{S} = 37.5\,u \text{ @ } 53°$



2.3 CYU $\vec{G} = \vec{A} + 2\vec{B} - \vec{F}$

$\vec{G} = 12u \text{ @ } 105°$

2.2

Ex. 2.3

$(x_0, y_0) = 6.0\,cm, 1.6\,cm$

$(x_f, y_f) = 2.0\,cm, 4.5\,cm$

$\Delta x = x_f - x_0 = 2.0cm - 6.0cm = -4.0\,cm\,\hat{i}$

$\Delta y = y_f - y_0 = 4.5cm - 1.6cm = 2.9\,cm\,\hat{j}$

$\vec{A} = A_x\hat{i} + A_y\hat{j} = (-4.0\,cm\,\hat{i} + 2.9\,cm\,\hat{j})\,cm$

CYU 2.4

P(10, 8)

Q(5, 5)

$\vec{A}_x = x_f - x_0 = -5.0cm\,\hat{i}$

$\vec{A}_y = y_f - y_0 = -3.0cm\,\hat{j}$

$\vec{A} = (-5.0\,\hat{i} - 3.0\,\hat{j})\,cm$

Ex. 2.4

$A_x = x_f - x_0 = 2.0\,cm - 6.0\,cm = -4.0\,cm\,\hat{i}$

$A_y = y_f - y_0 = 4.5\,cm - 1.6\,cm = 2.9\,cm\,\hat{j}$

$\vec{A} = \sqrt{A_x^2 + A_y^2} = \sqrt{(-4.0\,cm)^2 + (2.9\,cm)^2} = \boxed{4.9\,cm}$

$\theta_A = \tan^{-1}\frac{A_y}{A_x} + 90^\circ = \boxed{126^\circ}$

CYO 2.5

$\vec{A} = \sqrt{A_x^2 + A_y^2} = \sqrt{(-5.00\,cm)^2 + (-3.00\,cm)^2} = \boxed{5.83\,cm}$

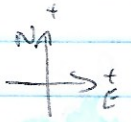
$\theta_A = \tan^{-1}\left(\frac{-3.00}{-5.00}\right) = 30.9^\circ + 180^\circ = \boxed{210^\circ}$

Ex. 2.5

$A_1 = 200.0\,m\ @\ 315^\circ$ $A_2 = 300.0\,m\ @\ 90^\circ$

$A_3 = 50.0\,m\ @\ 120^\circ$ $A_4 = 80.0\,m\ @\ 270^\circ$

$A_5 = 150.0\,m\ @\ 247^\circ$



x: $A_x = A\cos\theta$ y: $A_y = A\sin\theta$

$A_{1x} = 141.4\,m\,\hat{i}$ $A_{1y} = -141.4\,m\,\hat{j}$

$A_{2x} = 0\,m\,\hat{i}$ $A_{2y} = 300.0\,m\,\hat{j}$

$A_{3x} = -25.0\,m\,\hat{i}$ $A_{3y} = 43.3\,m\,\hat{j}$

$A_{4x} = 0\,m\,\hat{i}$ $A_{4y} = -80.0\,m\,\hat{j}$

$A_{5x} = -58.6\,m\,\hat{i}$ $A_{5y} = -138.1\,m\,\hat{j}$

CYO 2.6

$A = 20\,m\ @\ 180^\circ$

$A_x = A\cos\theta = (20\,m)\cos(180) = \boxed{-20\,m\,\hat{i}}$

$A_y = A\sin\theta = (20\,m)\sin(180) = 0\,m\,\hat{j}$

Ex. 2.6

$P(20\,m, 110^\circ)$ polar

$Q(100\,m, 110^\circ)$ polar

$x = r\cos\theta$

$y = r\sin\theta$

$P(-6.84, 18.8)$

$Q(-34.2, 94.0)$

Ex. 2.7

$A_x = 1200 - 300\ m\ \hat{i} = 900\ m\ \hat{i}$

$A_y = 2100\ m - 200\ m\ \hat{j} = 1900\ m\ \hat{j}$

$A_z = 250\ m - 100\ m\ \hat{k} = 150\ m\ \hat{k}$

$\vec{A} = (900\ m\ \hat{i} + 1900\ m\ \hat{j} + 150\ m\ \hat{k})$

$|A| = \sqrt{A_x^2 + A_y^2 + A_z^2} = \sqrt{(900\ m)^2 + (1900\ m)^2 + (150\ m)^2} = \boxed{2107\ m}$

2.7 CU

$|\vec{u}| = \sqrt{u_x^2 + u_y^2 + u_z^2} = \sqrt{(15.0\ \frac{m}{s})^2 + (31.7\ \frac{m}{s})^2 + (2.5\ \frac{m}{s})^2}$

$= \boxed{35.2\ \frac{m}{s}}$

2.3

Ex. 2.8

$\vec{v} = (4.0\hat{i} + 3.0\hat{j} + 0.1\hat{k})\ \frac{km}{h}$

$-\vec{v} = (-4.0\hat{i} - 3.0\hat{j} - 0.1\hat{k})\ \frac{km}{h}$

$\theta = \tan^{-1}\left(\frac{v_y}{v_x}\right) = \tan^{-1}\left(\frac{-3.0\ km/h}{-4.0\ km/h}\right) = 36.8°$

$\theta_v = \theta + 180° = 217°$, or $\boxed{36.8°\ S\ of\ W}$

Ex. 2.9

a) $\vec{R} = \vec{A} + \vec{B} + \vec{C}$

$R_x = A_x + B_x + C_x$

$= 12.73\ cm\ \hat{i}$

$R_y = A_y + B_y + C_y$

$= 3.16\ cm\ \hat{j}$

$\vec{R} = \sqrt{R_x^2 + R_y^2} = \boxed{13.1\ cm\ @}$

$\theta_R = \tan^{-1}\left(\frac{R_y}{R_x}\right) = \boxed{13.9°}$

	x	y
	$A_x = 8.19\ cm\hat{i}$	$B_x = -2.39\ cm\hat{i}$
		$C_x = 6.93\ cm\hat{i}$
$A_x = A\cos\theta$		$A = A\sin\theta = 5.74\ cm\hat{j}$
$B = B\cos\theta$		$B = B\sin\theta = -6.58\ cm\hat{j}$
$C = C\cos\theta$		$C = C\sin\theta = 4.00\ cm\hat{j}$

b) $\vec{D} = \vec{A} - \vec{B}$

$D_x = A_x - B_x = 8.19\ cm\hat{i} + 2.39\ cm\hat{i}$

$= 10.6\ cm\hat{i}$

$D_y = A_y - B_y = 5.74\ cm\hat{j} + 6.58\ cm\hat{j}$

$= 12.3\ cm\hat{j}$

$\vec{D} = \sqrt{D_x^2 + D_y^2} = \boxed{16.2\ cm\ @\ 49.2°}$

$\theta_D = \tan^{-1}\left(\frac{D_y}{D_x}\right)$

c) $\vec{S} = \vec{A} - 3\vec{B} + \vec{C}$

$S_x = (8.19\ cm\hat{i}) + 3(2.39\ cm\hat{i}) + 6.93\ cm\hat{i} = 22.3\ cm\hat{i}$

$S_y = (5.74\ cm\hat{j}) + 3(6.58\ cm\hat{j}) + (4.00\ cm\hat{j}) = 29.5\ cm\hat{j}$

$\vec{S} = \sqrt{S_x^2 + S_y^2} = \boxed{37.0\ @}$

$\theta_S = \tan^{-1}\left(\frac{S_y}{S_x}\right) = \boxed{52.9°}$

CYU 2.8 $\vec{A} = 10.00\text{ cm} \angle 35^\circ$

$\vec{B} = 7.00\text{ cm} \angle -110^\circ$

$\vec{F} = 20.00\text{ cm} \angle 110^\circ$

$A_x = A\cos\theta = 8.192\text{ cm}\hat{i}$ $A_y = A\sin\theta = 5.736\text{ cm}\hat{j}$

$B_x = B\cos\theta = -2.394\text{ cm}\hat{i}$ $B_y = B\sin\theta = -6.578\text{ cm}\hat{j}$

$F_x = F\cos\theta = -6.840\text{ cm}\hat{i}$ $F_y = F\sin\theta = 18.79\text{ cm}\hat{j}$

$\vec{G} = \vec{A} + 2\vec{B} - \vec{F}$

$G_x = (8.192\text{ cm}\hat{i}) + 2(-2.394\text{ cm}\hat{i}) + 6.840\text{ cm}\hat{i} = 10.24\text{ cm}\hat{i}$

$G_y = (5.736\text{ cm}\hat{j}) + 2(-6.578\text{ cm}\hat{j}) - 18.79\text{ cm}\hat{j} = -26.21\text{ cm}\hat{j}$

$G = \sqrt{G_x^2 + G_y^2} = 28.14\text{ cm}$

$\theta_G = \tan^{-1}\left(\frac{G_y}{G_x}\right) = -68.66^\circ$

Ex. 2.10

$\vec{D} = -\vec{A} - \vec{B} - \vec{C}$

$\vec{A} = 160.0\text{ N} \angle -55^\circ$

$\vec{B} = 200.0\text{ N} \angle 30^\circ$

$\vec{C} = 140.0\text{ N} \angle 145^\circ$

$A_x = A\cos\theta$ $A_y = A\sin\theta$

	x	y
A	$91.77\text{ N}\hat{i}$	$-131.1\text{ N}\hat{j}$
B	$173.2\text{ N}\hat{i}$	$100.0\text{ N}\hat{j}$
C	$-114.7\text{ N}\hat{i}$	$80.30\text{ N}\hat{j}$

$D_x = (-91.77\text{ N}) - 173.2\text{ N} + 114.7\text{ N}\hat{i}$

$= -150.2\text{ N}\hat{i}$

$D_y = (131.1\text{ N}) - 100.0\text{ N} - 80.30\text{ N}\hat{j} = -49.20\text{ N}\hat{j}$

$D = \sqrt{D_x^2 + D_y^2} = 158.1\text{ N}$

$\theta_D = \tan^{-1}\left(\frac{D_y}{D_x}\right) = 18.14^\circ + 180^\circ = 198.1^\circ$

CYU 2.9 ref. Ex. 2.10

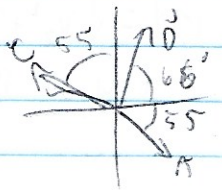
$\vec{D} = -\vec{A} - \vec{C}$

$D_x = -91.77\text{ N}\hat{i} + 114.7\text{ N}\hat{i} = 22.93\text{ N}\hat{i}$

$D_y = 131.1\text{ N}\hat{j} - 80.30\text{ N}\hat{j} = 50.80\text{ N}\hat{j}$

$D = \sqrt{D_x^2 + D_y^2} = 55.7\text{ N}$

$\theta_D = \tan^{-1}\left(\frac{D_y}{D_x}\right) = 65.7^\circ$



Ex. 2.11

$2\vec{A} - 6\vec{B} + 3\vec{C} = 2\hat{j}$; $\vec{A} = \hat{i} - 2\hat{k}$; $\vec{B} = -\hat{j} + \hat{k}/2$

$\vec{C} = \frac{(2\hat{j} - 2\vec{A} + 6\vec{B})}{3} = \frac{(2\hat{j} - 2\hat{i} + 4\hat{k} - 6\hat{j} + 3\hat{k})}{3}$

$= \frac{-4\hat{j}}{3} - \frac{2\hat{i}}{3} + \frac{7\hat{k}}{3} = \boxed{-\frac{2}{3}\hat{i} - \frac{4}{3}\hat{j} + \frac{7}{3}\hat{k}}$

$\vec{C} = \sqrt{C_x^2 + C_y^2 + C_z^2} = \boxed{2.77}$ or $\sqrt{\frac{4}{9} + \frac{16}{9} + \frac{49}{9}} = \sqrt{\frac{69}{9}} = \boxed{\sqrt{\frac{23}{3}}}$

Ex. 2.12

$\vec{R} = -\vec{A} - \vec{B} - \vec{C}$ $\quad \vec{A} = 5.0\text{ km} \angle 90^\circ$ $\vec{B} = 3.0\text{ km} \angle 180^\circ$

$\vec{C} = 4.0\text{ km} \angle 225^\circ$

$A_x = 0\text{ km}\hat{i}$ $A_y = 5.0\text{ km}\hat{j}$

$B_x = -3.0\text{ km}\hat{i}$ $B_y = 0\text{ km}\hat{j}$

$C_x = -2.8\text{ km}\hat{i}$ $C_y = -2.8\text{ km}\hat{j}$

$R_x = 3.0\text{ km}\hat{i} + 2.8\text{ km}\hat{i} = 5.8\text{ km}\hat{i}$

$R_y = -5.0\text{ km}\hat{j} + 2.8\text{ km}\hat{j} = -2.2\text{ km}\hat{j}$

$\vec{R} = \sqrt{R_x^2 + R_y^2} = \boxed{6.2\text{ km}}$

$\theta_R = \tan^{-1}\left(\frac{R_y}{R_x}\right) = \boxed{-20.9^\circ}$

Ex. 2.13

$\vec{D}_{ATT} = \vec{D}_{AB} - \vec{D}_{BT} = (-90.0\hat{i} + 30.0\hat{j})\text{m} - (-50.0\text{m}\hat{i})$

$= -40.0\text{m}\hat{i} + 30.0\text{m}\hat{j}$

200 steps - height of each step = $\vec{D}_{ATTy}/200 = \frac{30.0\text{m}}{200\text{ steps}} = \boxed{0.15\text{ m/step}}$

width = $\vec{D}_{ATTx}/200 = \frac{40.0\text{m}}{200\text{ steps}} = \boxed{0.20\text{ m/step}}$

if he makes a loop - $\vec{D}_{net} = \vec{0}$

Ex. 2.14

$|v| = \sqrt{v_x^2 + v_y^2 + v_z^2} = 5.001\text{ km/h}$

$\hat{v} = \frac{\vec{v}}{|v|} = \frac{(4.000\hat{i} + 3.000\hat{j} + 0.100\hat{k})\text{ km/h}}{5.001\text{ km/h}}$

$= (0.7998\hat{i} + 0.5999\hat{j} + 0.02000\hat{k})$

CYU 2.10 Ref. Ex. 2.14

$|\hat{v}| = \sqrt{.798^2 + 0.599^2 + 0.0000^2}$

$= 0.999 \approx 1$

$\vec{v}' = (4.000\hat{i} + 3.000\hat{j})\ \frac{km}{h}$

$|\vec{v}'| = \sqrt{4.000^2 + 3.000^2} = 5.000\ km/h$

$\hat{v} = \frac{(4.000\hat{i} + 3.000\hat{j})\ km/h}{5.000\ km/h} = 0.8000\hat{i} + 0.6000\hat{j}$

$\theta_{v'} = \tan^{-1}\left(\frac{v'_y}{v'_x}\right) = 36.9^\circ\ N\ of\ E$

2-4 Ex. 2.15 Ref. Fig. 2.13

$\vec{A} = 10.0\ cm\ @\ 35^\circ \quad \vec{F} = 20.0\ cm\ @\ 110^\circ$

$\vec{A} \cdot \vec{F} = (10.0)(20.0\ cm)\cos(110 - 35) = 51.8$

CYU 2.11 Ref. Fig. 2.13 $\vec{A}$, $\vec{F}$

$\vec{B} = 7.0\ @\ -110^\circ \quad \vec{C} = 8.0\ @\ 30^\circ$

$\vec{A} \cdot \vec{B} = (10.0)(7.0)\cos(-110 - 35) = -57.3$

$\vec{F} \cdot \vec{C} = (20.0)(8.0)\cos(110 - 30) = 27.8$

CYU 2.12

$\vec{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$

$\vec{A} \cdot \hat{i} = (A_x)(\hat{i}\cdot\hat{i}) + A_y(\hat{i}\cdot\hat{j}) + A_z(\hat{i}\cdot\hat{k})$

$= A_x$

$\vec{A} \cdot \hat{j} = (A_x)(\hat{j}\cdot\hat{i}) + A_y(\hat{j}\cdot\hat{j}) + A_z(\hat{j}\cdot\hat{k})$

$= A_y$

$\vec{A} \cdot \hat{k} = A_x(\hat{i}\cdot\hat{k}) + A_y(\hat{j}\cdot\hat{k}) + A_z(\hat{k}\cdot\hat{k})$

$= A_z$

Ex. 2.16

$\vec{F}_1 = (10.0\hat{i} - 20.0\hat{j} + 2.0\hat{k})$ N

$\vec{F}_2 = (-15.0\hat{i} - 6.2\hat{k})$ N

$\vec{F}_3 = (5.0\hat{i} + 12.5\hat{j})$ N

$$\theta_{1,2} = \cos^{-1}\left(\frac{\vec{F}_1 \cdot \vec{F}_2}{F_1 F_2}\right) = \cos^{-1}\left(\frac{F_{1x}F_{2x} + F_{1y}F_{2y} + F_{1z}F_{2z}}{\left(\sqrt{F_{1x}^2 + F_{1y}^2 + F_{1z}^2}\right)\left(\sqrt{F_{2x}^2 + F_{2y}^2 + F_{2z}^2}\right)}\right)$$

$$= \cos^{-1}\left(\frac{(10.0)(-15.0)\text{N} + (2.0)(-6.2)\text{N}}{\sqrt{(10.0^2 + 20.0^2 + 2.0^2)}\sqrt{15.0^2 + 6.2^2}}\right) = \boxed{116^\circ}$$

CYU 2.13 ref. ~~Ex. 2.16~~

$$\theta_{1,3} = \cos^{-1}\left(\frac{\vec{F}_1 \cdot \vec{F}_3}{F_1 F_3}\right)$$

$$= \boxed{132^\circ}$$

Ex. 2.17 ref. Ex. 2.16

$W_3 = \vec{F}_3 \cdot \vec{D} = (5.0\text{ N})\hat{i} \cdot (70\text{ cm})\hat{i}) + (12.5\text{ N})\hat{j})(-7.9\text{ cm})\hat{j}) + (0\text{ N})\hat{k})(-4.2\text{ cm})\hat{k})$

$= \boxed{-99\text{ N·cm}}$

CYU 2.14 ref Ex. 2.17 & Ex. 2.16

$W_1 = \vec{F}_1 \cdot \vec{D} = (10.0\text{N})(0\text{cm}\hat{i}) + (-20.4\text{N})\hat{j})(-7.9\text{cm})\hat{j}) + (2.0\hat{k}\text{N})(-4.2\hat{k}\text{cm})$

$= \boxed{153\text{ N·cm}}$ correct but dif. units

$W_2 = \vec{F}_2 \cdot \vec{D} = (-15.0\text{N}\hat{i})(0\text{cm}\hat{i}) + (0\text{N}\hat{j})(-7.9\text{cm}\hat{j}) + (-6.2\text{N}\hat{k})(-4.2\text{cm}\hat{k})$

$= \boxed{26\text{ N·cm}}$

Ex. 2.18

a) $\vec{\tau} = \vec{r} \times \vec{F} = rF\sin\theta = (0.25\text{ m})(20.0\text{ N})\sin(40^\circ) = \boxed{3.2\text{ N·m}, +z \text{ dir.}}$

b) $\vec{\tau} = \vec{r} \times \vec{F} = rF\sin\theta = (0.25\text{m})(20.0\text{N})\sin 45) = \boxed{3.54\text{ N·m}, -z \text{ dir.}}$

largest magnitude @ $\sin\theta = 1$, $\theta = 90^\circ$

CYU 2.15 ref. ~~Eq.~~ 2.13

$\vec{A} \times \vec{B}$, $\vec{C} \times \vec{F}$

$\vec{A} = 10.0 @ 35^\circ$ $\vec{C} = 8.0 @ 30^\circ$

$\vec{B} = 7.0 @ -110^\circ$ $\vec{F} = 20.0 @ 110^\circ$

$\vec{A} \times \vec{B} = AB\sin\theta = (10.0)(7.0)\sin(35 - (-110))^\circ = \boxed{-40.2\hat{k}}$

$\vec{C} \times \vec{F} = CF\sin\theta = (8.0)(20.0)\sin(-30 + 110^\circ) = \boxed{+158\hat{k}}$

Ex 2.14 $\vec{u} = -5.0\hat{i} - 2.0\hat{j} + 3.5\hat{k}$ $\vec{B}_a = 7.2\hat{i} - \hat{j} - 2.4\hat{k}$

a) $\vec{F}_a = q\vec{u}\times\vec{B}$

$= q\left((u_yB_z - u_zB_y)\hat{i} + (u_zB_x - u_xB_z)\hat{j} + (u_xB_y - u_yB_x)\hat{k}\right)$

$= q\left((-2.0\cdot -2.4 - 3.5\cdot -1)\hat{i} + (3.5\cdot 7.2 - (-5.0\cdot -2.4))\hat{j} + ((-5.0\cdot -1) - (-2.0\cdot 7.2))\hat{k}\right)$

$= q(11.5\hat{i} + 13.2\hat{j} + 19.4\hat{k})$

(b) $\vec{B}_b = 4.5\hat{k}$ $\quad F = q\sqrt{F_x^2+F_y^2+F_z^2} = \boxed{q(26.1)}\times$

$\theta = \cos^{-1}\left(\frac{\vec{F}\cdot\vec{B}}{FB}\right) = \cos^{-1}\left(\frac{F_xB_x + F_yB_y + F_zB_z}{F\sqrt{B_x^2+B_y^2+B_z^2}}\right)$

$= \boxed{83.4^\circ}\times$

$\vec{F}_b = q\vec{u}\times\vec{B} = q\left((u_yB_z - u_zB_y)\hat{i} + (u_zB_x - u_xB_z)\hat{j} + (u_xB_y - u_yB_x)\hat{k}\right)$

$= q\left((-2.0\cdot 4.5 - 3.5\cdot 0)\hat{i} + (3.5\cdot 0 - (-5.4.5))\hat{j} + (-5.0\cdot 0 - (-2.\cdot 0))\hat{k}\right)$

$= q(-9\hat{i} + 22.5\hat{j})$ $\quad F = q\sqrt{F_x^2+F_y^2} = \boxed{q(24.2)}$

$\theta = \cos^{-1}\left(\frac{\vec{F}\cdot\vec{B}}{FB}\right) = \cos^{-1}\left(\frac{F_xB_x + F_yB_y + F_zB_z}{F\sqrt{B_x^2+B_y^2+B_z^2}}\right)$

$= \cos^{-1}(0) = \boxed{90^\circ}$

C4U 2.1b

$\vec{A} = -\hat{i} + \hat{j}$ $\quad \vec{B} = 3\hat{i} - \hat{j}$ $\quad \vec{C} = \hat{i} + \hat{k}$

(a) $\vec{A}\times\vec{B} = (A_xB_y - A_yB_x)\hat{k} = (-1\cdot -1 - 1\cdot 3)\hat{k} = \boxed{-2\hat{k}}$

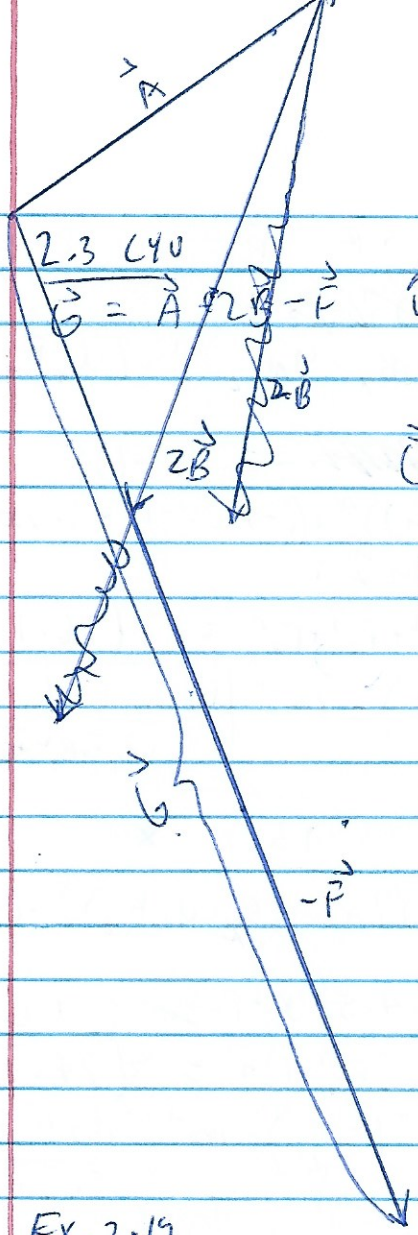
(b) $|\vec{A}\times\vec{B}| = \boxed{-2}$

(c) $\theta_{A,B} = \cos^{-1}\left(\frac{\vec{A}\cdot\vec{B}}{AB}\right) = \cos^{-1}\left(\frac{A_xB_x + A_yB_y}{\sqrt{A_x^2+A_y^2}\sqrt{B_x^2+B_y^2}}\right)$

$= \cos^{-1}\left(\frac{(-1)(3)+(1)(-1)}{\sqrt{(-1)^2+1^2}\sqrt{3^2+(-1)^2}}\right) = \boxed{153^\circ}$

(d) $\theta_{\vec{A}\times\vec{B},\,\vec{C}} = \cos^{-1}\left(\frac{(\vec{A}\times\vec{B})\cdot\vec{C}}{|\vec{A}\times\vec{B}||\vec{C}|}\right) = \cos^{-1}\left(\frac{(1\cdot 0)+(1\cdot -2)}{(2)\sqrt{1^2+1^2}}\right)$

$= \boxed{135^\circ}$



$\hat{u} = 0.5$ cm

$\vec{G} = \boxed{2r\,\hat{u} \angle -110^\circ}$

Ex. 2.4

$\theta = \tan^{-1}\left(\frac{A_y}{A_x}\right) = -36^\circ + 180^\circ$

$= \boxed{144^\circ}$

Ex. 2.6

$S(20\text{m}, 20^\circ)$

$G(10\text{m}, 160^\circ)$ > polar

$x = r\cos\theta$, $y = r\sin\theta$

$S(18.8, 6.8)$

$G(-9.4, 3.4)$

Ex. 2.14

a) $\vec{B} = 7.2\hat{i} - \hat{j} - 2.4\hat{k}$ & $\vec{u} = -5.0\hat{i} - 2.0\hat{j} + 3.5\hat{k}$

$\vec{F} = q\,\vec{u} \times \vec{B} = q\left((u_y B_z - u_z B_y)\hat{i} + (u_z B_x - u_x B_z)\hat{j} + (u_x B_y - u_y B_x)\hat{k}\right)$

$= q\left(((-2.0)(-2.4) - (3.5)(-1))\hat{i} + ((3.5)(7.2) - (-5.0)(-2.4))\hat{j}\right.$

$\left. + ((-5.0)(-1) - (-2.0)(7.2))\hat{k}\right)$

$= q(8.3\hat{i} + 13.2\hat{j} + 19.4\hat{k})$ $\quad F = \sqrt{F_x^2 + F_y^2 + F_z^2} = q(24.9)$

$\theta = \cos^{-1}\left(\frac{\vec{F}\cdot\vec{B}}{FB}\right) = \cos^{-1}\left(\frac{(8.3)(7.2) + (13.2)(-1) + (19.4)(-2.4)}{(24.9)\left(\sqrt{7.2^2 + 1^2 + 2.4^2}\right)}\right)$

$= \boxed{90^\circ}$

Ch. 2 HW

1) Scalar; no direction

5) 180°, max is $|A|+|B|$ smallest is 0°, $||A|-|B||$

9) 10,000/400 = 25, no mvmt. so displacement Δr is 0 since he can back to the starting point.

13) 2 vectors equal, same components, magnitude, and direction.

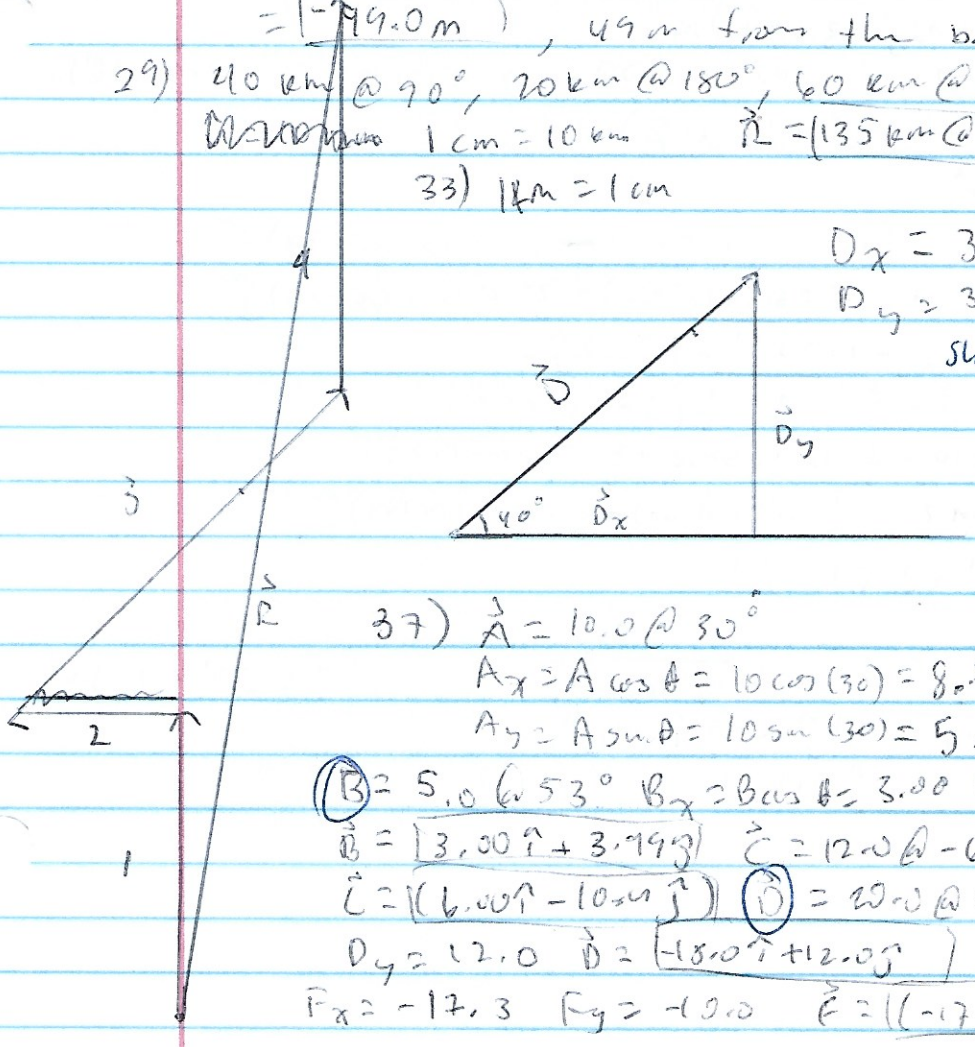
17) \ / same components.

21) a) needs a dot b) needs a cross c) $\vec{C}$ should be a vector
d) $\vec{C}$ should be a vector or $\vec{A}$ should be vector w/ dot product
e) $\vec{A}$ should be $|\vec{A}|$ or A w/o vector
f) $\vec{A}$ should be vector g) $\vec{A}\cdot\vec{B} \neq \vec{A}\times\vec{B}$ since they multiply vectors h) should be cross i) can't divide vectors
j) $\vec{A}$ shouldn't be a vector

25) $\vec{D} = -9.0\text{m} + 3.0\text{m} - 12.0\text{m} + 4.0\text{m} - 18.0\text{m} + 7.0\text{m} - 24.0\text{m}$
$= |-49.0\text{m}|$, 49 m from the boat

29) 40 km @ 90°, 20 km @ 180°, 60 km @ 45°, 50 km @ 90°
1 cm = 10 km $\vec{R} = |135\text{ km @ } 81°|$

33) 1 km = 1 cm



37) $\vec{A} = 10.0 \text{ @ } 30°$
$A_x = A\cos\theta = 10\cos(30) = 8.66$
$A_y = A\sin\theta = 10\sin(30) = 5.00$ $\vec{A} = |(8.66\hat{i} + 5.00\hat{j})|$

$|B| = 5.0$ @ 53° $B_x = B\cos\theta = 3.00$ $B_y = B\sin\theta = 3.99$
$\vec{B} = |3.00\hat{i} + 3.99\hat{j}|$ $\vec{C} = 12.0 \text{ @ } -60°$ $C_x = 6.00$ $C_y = -10.4$
$\vec{C} = |(6.00\hat{i} - 10.4\hat{j})|$ $\vec{D} = 20.0 \text{ @ } 180-37°$ $D_x = -16.0$
$D_y = 12.0$ $\vec{D} = |-16.0\hat{i} + 12.0\hat{j}|$ $\vec{F} = 20.0 \text{ @ } 180+30°$
$F_x = -17.3$ $F_y = -10.0$ $\vec{F} = |(-17.3\hat{i} - 10.0\hat{j})|$

41) $\vec{D} = 5.0\text{ km} \text{ @ } 40^\circ$. $D_x = D\cos\theta = 5.0\text{km}\cos 40 = 3.8\text{ km}\,\hat{i}$

$D_y = D\sin\theta = 5.0\text{ km}\sin 40 = 3.2\text{ km}\,\hat{j}$ $\quad \vec{D} = (3.8\hat{i} + 3.2\hat{j})\text{ km}$

45) $A(2.00\text{ m}, -4.00\text{ m})$ $\quad B(-3.00\text{ m}, 3.00\text{ m})$

$\vec{D} = (x_2 - x_1)\hat{i} + (y_2 - y_1)\hat{j} = -5.00\text{ m}\,\hat{i} + 7.00\text{ m}\,\hat{j}$

$|D| = \sqrt{D_x^2 + D_y^2} = 8.60\text{ m}$

$x = r\cos\theta \qquad 2.00 = r\cos\theta \qquad A\left(\sqrt{x^2+y^2}, \tan^{-1}\left(\frac{y}{x}\right)\right)$ polar

$y = r\sin\theta \qquad -4.00 = r\sin\theta$

$\theta = \cos^{-1}\left(\frac{2.00}{r}\right) = \sin^{-1}\left(\frac{-4.00}{r}\right) \quad A(4.47, -63.4^\circ)$

$B\left(\sqrt{x^2+y^2}, \tan^{-1}\left(\frac{y}{x}\right)\right) = B(4.24, -45^\circ)$

47) a) $\vec{C} = \vec{A} + \vec{B} \qquad \vec{A} = (3.00\hat{i} - 4.00\hat{j} + 4.00\hat{k})\text{m}$

$\vec{B} = (2.00\hat{i} + 3.00\hat{j} - 7.00\hat{k})\text{m}$

$\vec{C} = ((3.00 + 2.00)\hat{i} + (-4.00 + 3.00)\hat{j} + (4.00 - 7.00)\hat{k})\text{m}$

$\vec{C} = (5.00\hat{i} - 1.00\hat{j} - 3.00\hat{k})\text{m}$

b) $\vec{D} = 2\vec{A} - \vec{B} = ((6.00 - 2.00)\hat{i} + (-8.00 - 3.00\hat{j}) + (8.00 + 7.00)\hat{k})\text{m}$

$= (4.00\hat{i} - 11.00\hat{j} + 15.00\hat{k})\text{m}$

53) a) $\vec{D} + \vec{R} = \vec{F}$

$R = \vec{F} - \vec{D} = (20.0\cos(180+30) - 20.0\cos(180-37))\hat{i}$

$+ (20.0\sin(180+30) - 20.0\sin(180-37))\hat{j}$

$= (-1.35\hat{i} - 22.0\hat{j})$

b) $\vec{C} - 2\vec{D} + 5\vec{R} = 3\vec{F} \qquad \vec{R} = \frac{1}{5}(3\vec{F} - \vec{C} + 2\vec{D})$

$= \left(\frac{3}{5}\cdot 20.0\cos 210 - \frac{1}{5}\cdot 12.0\cos -60 + \frac{2}{5}\cdot 20.0\cos 143\right)\hat{i}$

$+ \left(\frac{3}{5}\cdot 20.0\sin 210 - \frac{1}{5}\cdot 12.0\sin(-60) + \frac{2}{5}\cdot 20.0\sin 143\right)\hat{j}$

$= (-18.0\hat{i} + 0.893\hat{j})$

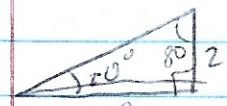
57) $\vec{R} = -4D\hat{j} - \vec{D} = -4\left(\sqrt{D_x^2 + D_y^2}\right)\hat{j} - \vec{D} \qquad \vec{D} = (3\hat{i} - 4\hat{j})\text{m}$

$= \left(-4\left(\sqrt{3^2 + 4^2}\right)\hat{j} - 3\hat{i} + 4\hat{j}\right)\text{m}$

$= (-3\hat{i} - 16\hat{j})\text{m}$

61) a) B → 2500 m, 10° above horiz. 30° N of W

D → 3000 m, 5° above horiz., W



$\vec{B}_{ground} = 2500_m \tan(80°) = 14200\ m$

$B_x = B_{ground}\cos\theta = 14200\cos(180-30) = -12300\ m\,\hat{i}$

$B_y = B_{ground}\sin\theta = 14200\sin(180-30) = 7100\ m\,\hat{j}$

$\vec{B} = (-12.3\hat{i} + 7.1\hat{j} + 2.5\hat{k})\ km$

$D_{ground} = 2000\tan(85) = 34300\ m$

$D_x = D_{ground}\cos\theta = 34300\ m\cos 180 = -34300\ m$

$\vec{D} = (-34.3\hat{i} + 3.00\hat{k})\ m$

b) $\vec{D} - \vec{B} = (-34.3\hat{i} + 12.3\hat{i}) + (-7.1\hat{j}) + (3.00 - 2.5)\hat{k})\ km$

$= (-22\hat{i} - 7.1\hat{j} + 0.5\hat{k})\ km$

$|\vec{D} - \vec{B}| = \sqrt{22^2 + 7.1^2 + 0.5^2} = 23.1\ km$

65) $\vec{D} = (2.0\hat{i} - 4.0\hat{j} + 1\hat{k})\ m$

$|\vec{D}| = \sqrt{2^2 + 4^2 + 1^2} = 4.6\ m$

$\theta_{xy} = \tan^{-1}\left(\frac{D_y}{D_x}\right) = -63.4°$ w/ x-axis, $26.6°$ w/ y-axis

$\theta_{xz} = \tan^{-1}\left(\frac{D_z}{D_x}\right) = 26.6°$ $\theta_z = 90 - \theta = 63.4°$ w/ z-axis

67) a) $(\vec{A}\times\vec{F})\cdot\vec{D}$ $\vec{A}\times\vec{F} = AF\sin\theta = (10.0)(20.0)\sin 180$

$= \vec{0}$

$\vec{0}\cdot\vec{D} = 0$

b) $(\vec{A}\times\vec{F})\times(\vec{D}\times\vec{B}) = 0$

c) $(A\cdot F)(\vec{D}\times\vec{B})$ $A\cdot F = AF\cos\theta = (10.0)(20.0)\cos 180$

$= -200$

$\vec{D}\times\vec{B} = DB\sin\theta = (5.0)(20.0)\sin 270 = -100\,\hat{k}$

$(A\cdot F)(D\times B) = (-200)(-100) = 20{,}000\,\hat{k}$

73) Polar (r, ϕ) rect. (x, y) $x = r\cos\phi$ $y = r\sin\phi$

a) $(-x, y)$ $r = \sqrt{x^2+y^2}$, $\phi = \tan^{-1}\left(\frac{y}{x}\right)$

$= (r, -\phi)$ b) $(-2x, -2y) = (2\sqrt{2}r, \phi + 180)$

c) $(3x, -3y) = (3\sqrt{2}r, -\phi)$

77) $\vec{A}+\vec{B}=\vec{C} \Rightarrow C^2 = A^2+B^2+2AB\cos\theta$

$C^2=(A+B)^2 = A^2+B^2+2\vec{A}\cdot\vec{B} = A^2+B^2+2AB\cos\theta$

81) $|\vec{u}| = \sqrt{u_x^2+u_y^2} = \sqrt{(-18.0)^2+(-13.0)^2} = \boxed{22.2 \text{ km/s}}$

$\theta_u = \tan^{-1}\left(\frac{u_y}{u_x}\right) = 35.8^\circ + 180 = \boxed{35.8^\circ \text{ S of W}}$

85) $\vec{A} = 3.0\hat{i}+4.0\hat{j}$ $|A|=|B|$; $A \perp B$

$|A| = \sqrt{3^2+4^2} = 5.0$ $\theta_A = \tan^{-1}\left(\frac{A_y}{A_x}\right) = 53^\circ$

$\theta_B = \theta_A + 90^\circ = 143^\circ$

$B_x = 5\cos 143 = -4.0$ $B_y = 5\sin 143 = 3.0$

$\vec{B} = \boxed{-4.0\hat{i}+3.0\hat{j}}$

87) $\vec{G} = (3.0\hat{i}+4.0\hat{j}+10.0\hat{k})N$ $\vec{H} = (1.0\hat{i}+4.0\hat{j})N$

$\hat{H} = \frac{\vec{H}}{|H|} = \frac{1.0\hat{i}+4.0\hat{j}\ N}{\sqrt{1^2+4^2}} = (0.24\hat{i}+0.97\hat{j})N$

$G_H = |G|\cos\theta = |G|\frac{\vec{G}\cdot\vec{H}}{|G||H|} = \frac{\vec{G}\cdot\vec{H}}{|H|} = \frac{(3.0\hat{i}+1\hat{j})\cdot(4.0\hat{j}+4.0\hat{j})}{\sqrt{1^2+4^2}}$

$= \boxed{4.6\ N}$

(37) b, d, (65), (73) a)

37) b) $\vec{B} = 5.0 \angle 53^\circ$

$B_x = B\cos\theta = (5.0)\cos 53 = 3.0$

$B_y = B\sin\theta = (5.0)\sin 53 = 3.99$ $\vec{B} = (3.00\hat{i}+3.99\hat{j})$

(may be issue w/ answer key)

d) $D = 20.0 \angle 143^\circ$

$D_x = D\cos\theta = (20.0)\cos 143 = -15.97$ $D_y = D\sin\theta = (20.0)\sin 143 = 12.03$

$\vec{D} = (-15.97\hat{i}+12.03\hat{j})$

65) $\vec{D} = (2.0\hat{i}-4.0\hat{j}+\hat{k})m$

$|\vec{D}| = \sqrt{2^2+4^2+1^2} = 4.58$ $\theta_x = \cos^{-1}\left(\frac{\vec{D}_x\cdot\vec{D}}{|D_x||D|}\right) = \cos^{-1}\left(\frac{2.0\cdot 2.0}{2.0\times 4.58}\right) = \boxed{64.11^\circ}$

$\theta_y = \cos^{-1}\left(\frac{\vec{D}_y\cdot\vec{D}}{D_y D}\right) = \boxed{150.9^\circ}$ $\theta_z = \ldots = \boxed{77.4^\circ}$

73) a) (x,y) $r = \sqrt{x^2+y^2}$ $\varphi = \tan^{-1}\left(\frac{y}{x}\right)$

$(r, \pi, -\varphi)$