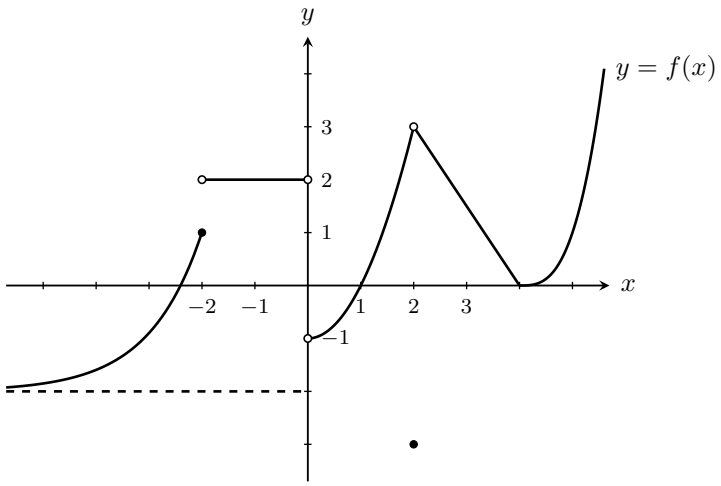
**Question 1: (*3 pts*)** A grain silo is in the shape of a cylinder, with a hemisphere on top of it. If the diameter of the silo is 8.24m, and its total height is 27.45m, find the volume of the silo.

**Question 2: (*10 pts*)** For the function $f(x)$ given in the graph below, find each of the following limits. Write DNE, UND, $-\infty$ or $+\infty$ where appropriate.




**a)** $\lim_{x\to-\infty} f(x) =$

**b)** $\lim_{x\to-2^-} f(x) =$

**c)** $\lim_{x\to0^+} f(x) =$

**d)** $\lim_{x\to2} f(x) =$

**e)** $f(2) =$

**f)** $\lim_{x\to-2} f(x) =$

**g)** $\lim_{x\to1} f(x) =$

**h)** $\lim_{x\to+\infty} f(x) =$

**i)** List the points of discontinuity

**Question 3: (*4 pts*)** The blade on a jig saw moves up and down at 600 strokes per minute. The distance between the tip of the blade and the guide varies between 1.5in and 3in. Before the saw starts operating, the tip of the blade is at its closest point to the guide. Let $f(t)$ represent the distance (in inches) between the tip of the saw blade and the guide after $t$ <u>seconds</u>. Find:

[1] **a)** the amplitude of $f(t)$.

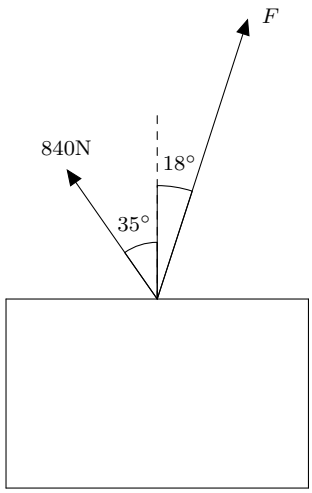
[1] **b)** the period of $f(t)$.

[2] **c)** a formula for $f(t)$.

**Question 4: (*3 pts*)** Solve for $y$ **only**, using Cramer's rule: $\begin{cases} 3x + 7y = 2 \\ -5x + y = -1 \end{cases}$

**Question 5: (*4 pts*)**

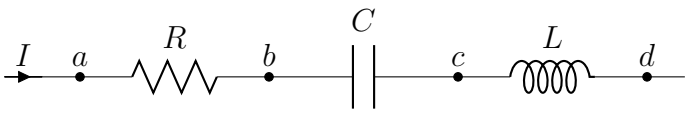
To raise a crate, two ropes are attached to its top (see figure). The force in one rope is 840N, at 35° from the vertical. If the second rope is at 18° from the vertical, what should its force $F$ be in order to lift the crate straight up?




**Question 6: (*5 pts*)** Solve the following system of equations for each unknown:

$$\begin{cases} x + 4y - 2z = -5 \\ 3x + 10y - 4z = -9 \\ -2x - 5y + 3z = 11 \end{cases}$$

**Question 7: (*8 pts*)** Consider the electrical circuit below:




- The current is $I = 1.05$A (with a frequency of 60Hz);
- The resistance is $R = 35.0\Omega$;
- The capacitance is $C = 1.75 \times 10^{-4}$F;
- The inductance is $L = 0.120$H;

[2] **a)** Determine the voltage across the resistor (between points $a$ and $b$).

[2] **b)** Determine the voltage across the inductor (between points $c$ and $d$).

[2] **c)** Determine the voltage across the RCL combination (between points $a$ and $d$).

[2] **d)** Determine if the voltage leads or lags the current, and by what angle.

**Question 8: (*4 pts*)** A submarine leaves its base and travels at 31.7km/h, along a course of 24.7° north of west. After 2.00 hours, it turns an additional 32.5° north of west, and travels for another 1.00 hour. How far from the base is it?

**Question 9: (*6 pts*)** Solve the following equations for $x$:

[3] **a)** $\log_3(x-4)+\log_3(x+4)=\log_3(4x+5)$

[3] **b)** $9^{x+3}=\left(\dfrac{1}{27}\right)^{1-2x}$

**Question 10: (*6 pts*)** Solve the following equations for $x$ such that $0 \leqslant x < 2\pi$:

[3] **a)** $\cos^2(x)-3\cos(x)=\sin^2(x)+1$

[3] **b)** $\tan^2(x)-\tan(x)+3=\sec^2(x)$

**Question 11: (*12 pts*)** Evaluate the following limits:

[3] **a)** $\lim\limits_{x\to 2}\dfrac{3x^2-5x-2}{x^3-8}$

[3] **b)** $\lim\limits_{x\to -3}\dfrac{1-\sqrt{4+x}}{x^2+2x-3}$

[3] **c)** $\lim\limits_{x\to -\infty}\dfrac{(x^2-3)(x+2)}{(x^2+1)^2}$

[3] **d)** $\lim\limits_{x\to 4}\dfrac{x^2-16}{\frac{1}{2x-9}+\frac{1}{x^2-15}}$

**Question 12: (*10 pts*)** Perform the indicated operations, and write your answer in the form $a+bj$.

[3] **a)** $(2-3j+j^2-2j^3)(j^{10}-2j^{15})$

[3] **b)** $\dfrac{4-j}{2+3j}+\dfrac{-2+7j}{3-2j}$

[4] **c)** $(2-j)^{14}$ Hint: Use DeMoivre's Theorem

**Question 13: (*4 pts*)** Find the equation of the line that is tangent to the graph of $3x^2y^3-2x-4y^2=6$ at the point $(1,2)$.

**Question 14: (*4 pts*)** Find all the points on the curve $y=x^3-6x^2-11x+10$ where the tangent line is parallel to the line $y=4x+7$

**Question 15: (*5 pts*)** Consider the function $f(x)=\sin(\sqrt{x})$. Find:

[2] **a)** $f'(x)=$

[2] **b)** $f''(x)=$

[1] **c)** $f''(\pi^2)=$

**Question 16: (*12 pts*)** find $y'$. **Do not simplify your answers**.

[3] **a)** $y = 3^{\cos(x)} + 5x^{10} - \sqrt{x^2+2} + \log(40)$

[3] **b)** $\tan(x+y) = e^x + 3y^2$

[3] **c)** $y = \dfrac{x^4 \sec(2x^3+5)}{(4x-7)^8}$

[3] **d)** $y = \ln\left(\dfrac{x^8\ \sqrt{2x^2+1}}{(x+4)^5\ \sqrt[7]{x-3}}\right)$ Hint: Simplify using properties of ln before differentiating.

**ANSWERS:**

**1.)** $1390.58 \to 1390\text{m}^3$ **2.)** **a)** $-2$ **b)** $1$ **c)** $-1$ **d)** $3$ **e)** $-3$ **f)** DNE **g)** $0$

**h)** $+\infty$ **i)** $-2,\ 0,\ 2$ **3.)** **a)** $0.75$ **b)** $0.1\text{s}$ **c)** $-0.75\cos(20\pi t) + 2.25$ **4.)** $\dfrac{7}{38}$

**5.)** $1559.15 \to 1600\text{N}$ **6.)** $(-3,\ 2,\ 5)$ **7.)** **a)** $36.8\text{V}$ **b)** $47.5\text{V}$ **c)** $48.5\text{V}$

**d)** Voltage leads the current by $40.7°$ **8.)** $91.8181 \to 91.8\text{km}$ **9.)** **a)** $x = 7$ **b)** $x = \dfrac{9}{4}$

**10.)** **a)** $x = \dfrac{2\pi}{3}$ or $\dfrac{4\pi}{3}$ **b)** $x = 1.107\text{rad}$ or $4.249\text{rad}$ **11.)** **a)** $\dfrac{7}{12}$ **b)** $\dfrac{1}{8}$ **c)** $0$ **d)** $\dfrac{-4}{5}$

**12.)** **a)** $1+3j$ **b)** $\dfrac{-15}{13} + \dfrac{3}{15}j$ **c)** $76\,443 - 16\,124j$ **13.)** $y = \dfrac{-23}{10}x + \dfrac{43}{10}$

**14.)** $(-1, 14)$ and $(5, -70)$ **15.)** **a)** $\dfrac{\cos(\sqrt{x})}{2\sqrt{x}}$ **b)** $\dfrac{-\sqrt{x}\sin(\sqrt{x}) - \cos(\sqrt{x})}{4x\sqrt{x}}$ **c)** $\dfrac{1}{4\pi^3}$

**16.)** **a)** $-3^{\cos(x)}\ln(3)\sin(x) + 50x^9 - \dfrac{x}{\sqrt{x^2+2}}$ **b)** $\dfrac{e^x - \sec^2(x+y)}{\sec^2(x+y) - 6y}$

**c)** $\dfrac{\Big(4x^3 + 6x^6\tan(2x^3+5)\Big)\sec(2x^3+5)(4x-7) - 32x^4\sec(2x^3+5)}{(4x-7)^9}$

**d)** $\dfrac{8}{x} + \dfrac{2x}{2x^2+1} - \dfrac{5}{x+4} - \dfrac{1}{7(x-3)}$