1.

(a) $y = (t^2 - 3t)^{1/2}$

$$\frac{dy}{dt} = \frac{1}{2}(t^2 - 3t)^{-1/2}(2t - 3)$$

$$\boxed{\frac{dy}{dt} = \frac{1}{2}(t^2 - 3t)^{-1/2}(2t - 3)}$$

(b) $y = (t^2 - 3t)^{-1/2}$

$$\frac{dy}{dt} = -\frac{1}{2}(t^2 - 3t)^{-3/2}(2t - 3)$$

$$\boxed{\frac{dy}{dt} = -\frac{1}{2}(t^2 - 3t)^{-3/2}(2t - 3)}$$

(c) $y = (1 + e^{-x})^{-1}$

$$\frac{dy}{dx} = -(1 + e^{-x})^{-2}(-e^{-x})$$

$$\boxed{\frac{dy}{dx} = e^{-x}(1 + e^{-x})^{-2}}$$

(d) $y = \ln(8 - t^3)$

$$\frac{dy}{dt} = \frac{1}{8 - t^3}(-3t^2)$$

$$\boxed{\frac{dy}{dt} = \frac{-3t^2}{8 - t^3}}$$

(e) $y = \ln(\cos^2 x + 1) \cdot (e^x + \sin x)^3$

$$\boxed{\frac{dy}{dx} = \frac{1}{(\cos^2 x + 1)}(-2\cos x \sin x)(e^x + \sin x)^3 + \ln(\cos^2 x + 1)\left[3(e^x + \sin x)^2(e^x + \cos x)\right]}$$

(No further simplification required)

2.

(a) $r(t) = \frac{5t^4 - 2t}{\sqrt{t}} = 5t^{7/2} - 2t^{1/2}$

$$r'(t) = 5\left(\frac{7}{2}\right)t^{5/2} - 2\left(\frac{1}{2}\right)t^{-1/2}$$

$$\boxed{r'(t) = \frac{35}{2}t^{5/2} - t^{-1/2}}$$

(b) $r(t) = \frac{\sin(7t)}{t^3}$

$$r'(t) = \frac{7\cos(7t)(t^3) - \sin(7t)(3t^2)}{t^6}$$

$$\boxed{r'(t) = \frac{7\cos(7t)}{t^3} - \frac{3\sin(7t)}{t^4}}$$

---

3. Given: $\vec{a} = \langle 1, 2, 3\rangle$, $\vec{b} = \langle 0, -1, 1\rangle$, $\vec{c} = \langle 2, 4, 6\rangle$.

(a) $\vec{a} + \vec{b} = \langle 1+0, 2-1, 3+1\rangle$

$$\boxed{\langle 1, 1, 4\rangle}$$

(b) $\vec{b} - 3\vec{c} = \langle 0, -1, 1\rangle - \langle 6, 12, 18\rangle$

$$\boxed{\langle -6, -13, -17\rangle}$$

(c) $||\vec{a} - \vec{b}|| = ||\langle 1, 3, 2\rangle|| = \sqrt{1^2 + 3^2 + 2^2}$

$$\boxed{\sqrt{14}}$$

(d) $\vec{b} \cdot \vec{c} = (0)(2) + (-1)(4) + (1)(6) = 0 - 4 + 6$

$$\boxed{2}$$

4.

(a) $\vec{a} = \langle 1, k, 3\rangle \perp \vec{b} = \langle 2, -3, 4\rangle$.

Step 1: Set dot product to 0.

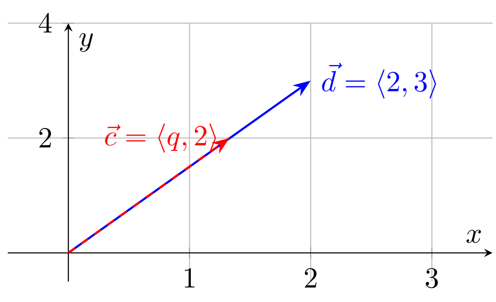
$$\vec{a} \cdot \vec{b} = (1)(2) + (k)(-3) + (3)(4) = 0$$

Step 2: Solve for k.

$$2 - 3k + 12 = 0 \implies 14 = 3k$$

$$\boxed{k = \frac{14}{3}}$$

(b) $\vec{c} = \langle q, 2\rangle \parallel \vec{d} = \langle 2, 3\rangle$.



Step 1: Set components proportional ($\vec{c} = k\vec{d}$).

$$\langle q, 2\rangle = k\langle 2, 3\rangle = \langle 2k, 3k\rangle$$

Step 2: Solve system of equations.

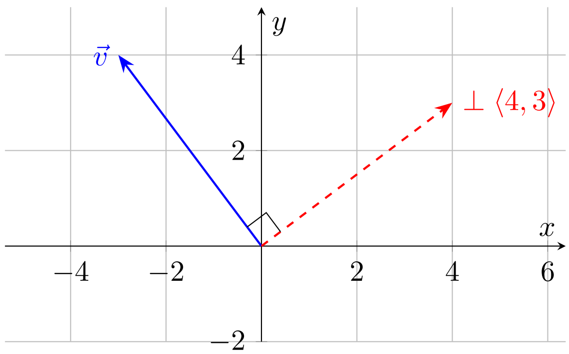
$$y\text{-components: } 2 = 3k \implies k = \frac{2}{3}$$

$$x\text{-components: } q = 2k \implies q = 2\left(\frac{2}{3}\right)$$

$$\boxed{q = \frac{4}{3}}$$

---

5. Find unit vector $\perp$ to $\vec{v} = \langle -3, 4 \rangle$.



Step 1: Find perpendicular vector (swap coordinates, flip one sign).

$$\text{Try } \vec{u} = \langle 4, 3 \rangle$$

Check: $\vec{v} \cdot \vec{u} = (-3)(4) + (4)(3) = -12 + 12 = 0$. (Verified)

Step 2: Normalize to find unit vector.

$$||\vec{u}|| = \sqrt{4^2 + 3^2} = \sqrt{16 + 9} = 5$$

$$\hat{u} = \frac{\vec{u}}{||\vec{u}||} = \frac{1}{5}\langle 4, 3 \rangle = \boxed{\left\langle \frac{4}{5}, \frac{3}{5} \right\rangle}$$

---

6. Find vector $\perp$ to $\langle 10, -4, 7 \rangle$.

Step 1: Set up dot product equation.

$$\langle 10, -4, 7 \rangle \cdot \langle a, b, c \rangle = 0$$

$$10a - 4b + 7c = 0$$

Step 2: Identify simplest solution. Since the right side is 0, setting all components to 0 satisfies the equation.

$$\boxed{\langle 0, 0, 0 \rangle}$$