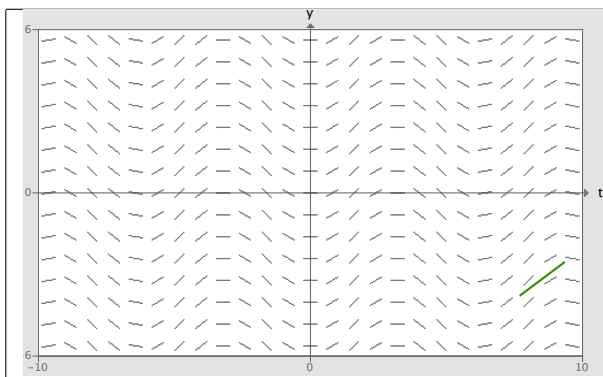In order to receive full credit, SHOW ALL YOUR WORK. Full credit will be given only if all reasoning and work is provided. When applicable, please enclose your final answers in boxes.
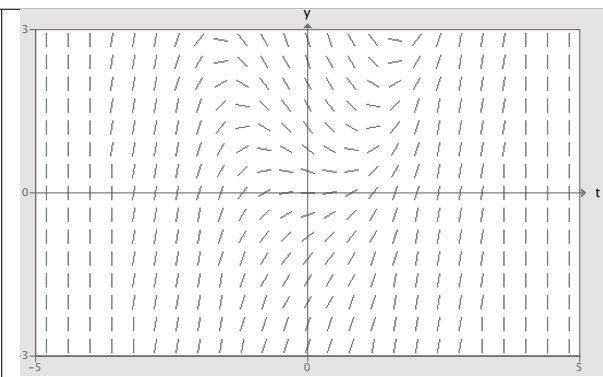
1. Match the following differential equations to their slope fields.

   (a) $\dfrac{dy}{dt} = t^2 - y$ _____   (b) $\dfrac{dy}{dt} = \sin(y)$ _____
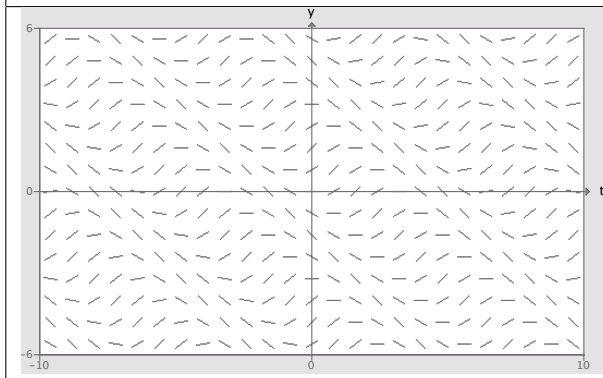
   (c) $\dfrac{dy}{dt} = \sin(t)$ _____   (d) $\dfrac{dy}{dt} = \sin(t + y)$ _____
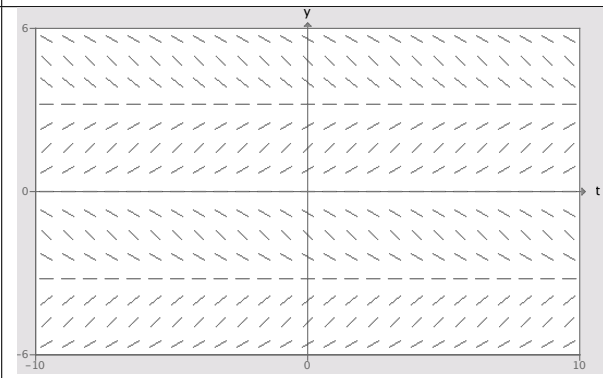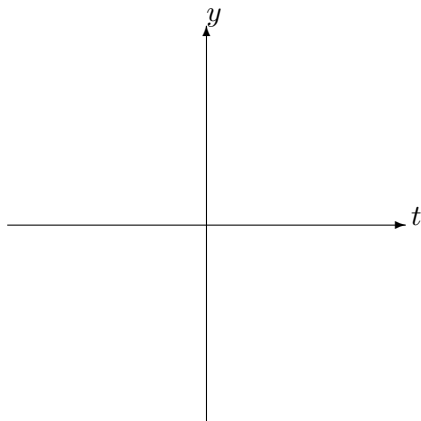

I

II

III

IV

2. Find the solution to the IVP, $y' + y = \sin(t)$, $y(0) = -1$.

3. Given the first-order autonomous ODE,

$$\frac{dy}{dt} = \sin(y) \tag{1}$$

(a) Find and classify all equilibrium solutions to the ODE.

(b) Using a phase line analysis draw possible solution trajectories in the $ty-$plane for $y \in [-2\pi, 2\pi]$.

4. Suppose that $\frac{dy}{dt} = 5y + b(t)$. In the following table write down the 'guess', which would lead to a solvable undetermined coefficient problem. DO NOT SOLVE FOR YOUR UNKNOWN COEFFICIENTS

$b(t)$	$y_p(t)$
$\cos(\beta t)$	
$e^{5t} + t^4$	
$e^{5t}\sin(\beta t)$	
$t^2 e^t \cos(\beta t)$	

5. Given, $\frac{dy}{dt} = f(t, y)$. If f is discontinuous at $(0,0)$ but $\frac{\partial f}{\partial y}$ is not then do solutions to the ODE passing through $(0,0)$ exist? Are these solutions unique? Explain.

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