1 a Nonlinear, since it contains a y^2 term.

b Nonlinear, since it contains an e^y term.

c Linear

d Nonlinear, since it contains a $\sin(y)$ term.

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2 a second order

b first order

c third order

d first order

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3 a $y' - 2y = -1$.

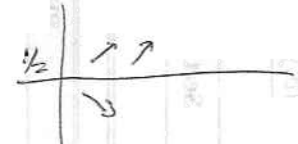
$$(e^{-2t}y)' = -e^{-2t}$$

$$e^{-2t}y = \frac{1}{2}e^{-2t} + C$$

$$\boxed{y(t) = \frac{1}{2} + Ce^{2t}}$$

b $y' = 2y - 1 = 0$ at $\boxed{y = \frac{1}{2}}$, the equilibrium value.

c It is $\boxed{\text{unstable}}$ since $y' > 0$ for $y > 1/2$ and $y' < 0$ for $y < 1/2$.



d $y(0) = \frac{1}{2} + C = 1 \Rightarrow C = \frac{1}{2}$

$$\boxed{\therefore\ y(t) = \frac{1}{2} + \frac{1}{2}e^{2t}.}$$

e No, the solution diverges from this equilibrium value.

(4) The amount A obeys the D.E.

$$A' = -rA \Rightarrow A(t) = A_0 e^{-rt},$$ where A_0 is the initial amount.

Since the half-life is 8 days, if t is given in days, we have $\frac{1}{2}A_0 = A_0 e^{-8r}$, that is, $e^{-8r} = \frac{1}{2}$.

This gives $-8r = \ln(\frac{1}{2}) = -\ln(2) \Rightarrow r = \frac{\ln(2)}{8}$

$$\Rightarrow A(t) = A_0 e^{-\frac{\ln(2)}{8}t} = A_0 \left(e^{-\ln(2)}\right)^{t/8} = A_0 \left(\frac{1}{2}\right)^{t/8}.$$

If T is the minimum time until it is safe to occupy the building, we have $A_0\left(\frac{1}{2}\right)^{T/8} = \frac{A_0}{1000}$,

that is, $\left(\frac{1}{2}\right)^{\frac{T}{8}} = \frac{1}{1000}$. Taking logarithms of both sides gives:

$$\frac{T}{8}\ln(\tfrac{1}{2}) = \ln(\tfrac{1}{1000}) \Rightarrow T = \frac{8\ln(\frac{1}{1000})}{\ln(\frac{1}{2})} = \boxed{\frac{8\ln(1000)}{\ln(2)}}$$

That is, $\boxed{T \approx 79.73 \text{ days}}$.

It would be safe to wait 80 days.