Name: _____ (please print)

Signature: _____

ECE 2201 – Quiz #1
February 7, 2023

- This quiz is closed book, closed notes.
- Show all work on these pages. Show all work necessary to complete the problem. A solution without the appropriate work shown will receive no credit. A solution which is not given in a reasonable order will lose credit.
- Show all units in solutions, intermediate results, and figures. Units in the quiz will be included between square brackets.
- If the grader has difficulty following your work because it is messy or disorganized, you will lose credit.
- Do not use red ink. Do not use red pencil.
- You will have 30 minutes to work on this quiz.

_____/25

Room for extra work

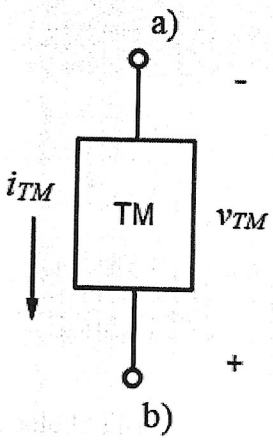
A new electronic device called the TrombettaMax is shown in the diagram and labeled 'TM'. The voltage v_{TM} and current i_{TM} for the TrombettaMax are plotted in the graphs below. Reference polarities are shown in the figure.

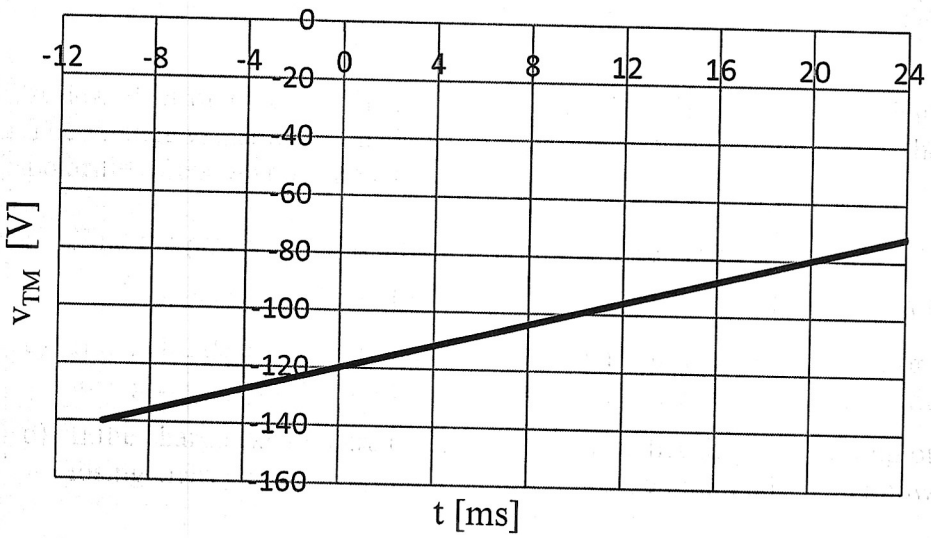
a) Find the power delivered by the TrombettaMax at t = 16 [ms].

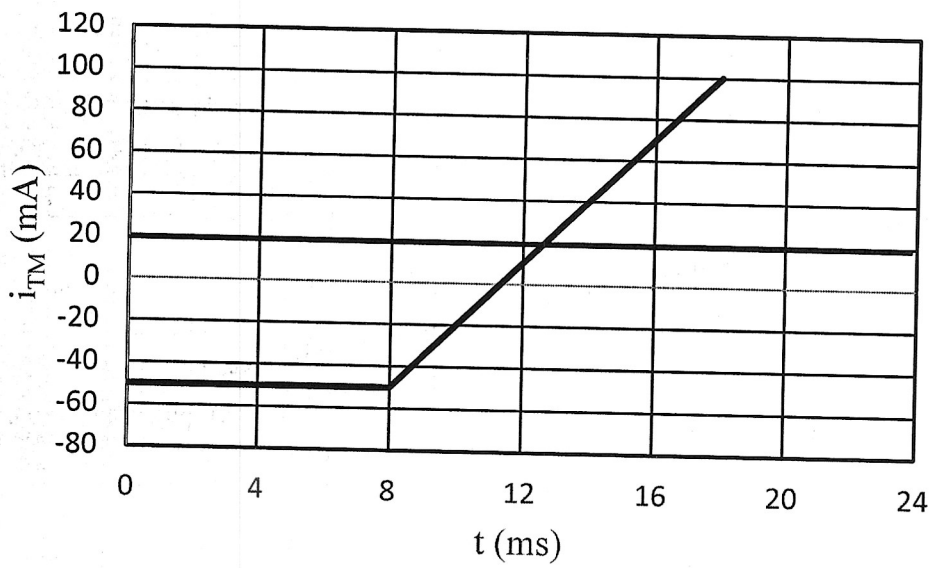
b) Find the energy delivered by the TrombettaMax from 5 [ms] to 15 [ms].

c) If the charge carriers are positive, state whether they are gaining or losing energy at t = 16 [ms]. In a few words, explain how you know this.

d) If the charge carriers are electrons, state whether they are gaining or losing energy at t = 16 [ms]. In a few words, explain how you know this.







Room for extra work

Room for extra work

We can simply read v_{TH} & i_{TH} from the graph at $t = 16\,[ms]$ but we need equations for these at part b), so...

+3 $v_{TH} = 2\left[\frac{V}{ms}\right]t - 120\,[V]$

$i_{TH} = -50\,[mA] \quad 5 \le t \le 8\,[ms]$

+3 $i_{TH} = 15\left[\frac{mA}{ms}\right](t - 8\,[ms]) - 50\,[mA] = 15\left[\frac{mA}{ms}\right]t - 170\,[mA] \quad t \ge 8\,[ms]$

a) The diagram is active sign relationship, so...

+3 $P_{del\ by\ TH} = +\,v_{TH} \cdot i_{TH}$ Convert to [V], [A], [s]:

$P_{del\ by\ TH} = (2000\left[\frac{V}{s}\right]t - 120\,[V])(15\left[\frac{A}{s}\right]t - 0.170\,[A])$

$= 30000\left[\frac{W}{s^2}\right]t^2 - 2140\left[\frac{W}{s}\right]t + 20.4\,[W]$

+2 $\boxed{P_{del\ by\ TH}(0.016\,[s]) = -6.16\,[W]}$

b) $w_{del\ by\ TH} = \int_{0.005\,[s]}^{0.008\,[s]} (-0.05\,[A])(2000\left[\frac{V}{s}\right]t - 120\,[V])\,dt$

+4 $+ \int_{0.008\,[s]}^{0.015\,[s]} (30000\left[\frac{W}{s^2}\right]t^2 - 2140\left[\frac{W}{s}\right]t + 20.4\,[W])\,dt$

+4

$= 16.05\,[mJ] - 0.840\,[mJ]$

+2 $\boxed{w_{del\ by\ TH} = 15.21\,[mJ]}$

Room for extra work

$\therefore \boxed{w_{\text{del by TH}} = -66.27 \text{ [mJ]}}$

c) At 16 [ms], power delivered by TH is negative, so power is being absorbed. That power is coming from the positive charge carriers, so they are losing energy.

+2

Alternative explanation: i_{TH} is positive so positive carriers are moving top to bottom in the diagram. v_{TH} is negative, so potential is higher at the top. So positive carriers are moving toward the more negative potential. Therefore they are losing energy.

d) The sign of the charge carriers makes no difference, so electrons are also losing energy.

+2