BioE 1310 - Review 3 - Nonlinear and Sensors 1/16/2017

Instructions: On the Answer Sheet, enter your 2-digit ID number (with a leading 0 if needed) in the boxes of the ID section. *Fill in the corresponding numbered circles.* Answer each of the numbered questions by filling in the corresponding circles in the numbered question section. Print your name in the space at the bottom of the answer sheet. Sign here stating that you have neither given nor received help.

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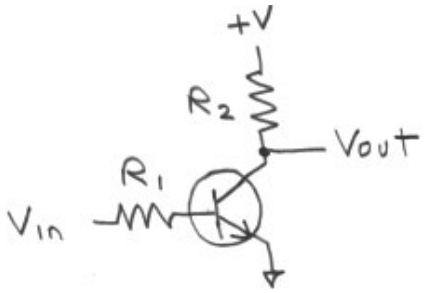
your signature

1. If $R_1 = 200\text{K}\Omega$, $R_2 = 1\text{K}\Omega$, $V_{in} = 5\text{V}$, $+V = 10\text{V}$, with a $\beta = 150$ for the transistor, and ignoring the base-emitter voltage drop, what voltage would you expect at V_{out}?



A. Cannot be determined.

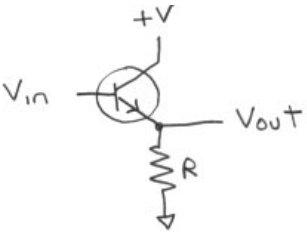
B. 6.25V

C. 3.75V

D. 2.75V

E. 5V

2. If $R = 1\text{K}\Omega$, $V_{in} = 2.5\text{V}$, $\beta = 150$, and the base-emitter voltage drop is 0.5V, what would you expect the current through R to be?



A. 0.3A

B. 375mA

C. 2mA

D. 0.2A

E. 2.5mA

3. Which of the following is (are) true about the photo-resistor used in our lab.

I - It is constructed of cadmium-sulfide.
II - Its resistance goes from very high in total darkness to much lower in bright light.
III - It is a polar device, and therefore must be inserted in the proper oreintation.

A. I

B. I and II

C. I and III

D. I, II and III

E. II and III

4. A thermistor differs from a standard resistor in that

A. A thermistor, unlike a standard resistor, has a non-linear relationship between current and voltage.

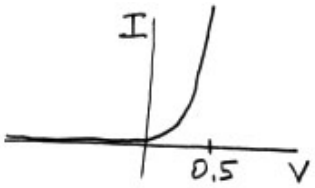
B. A thermistor has an imaginary impedance whereas the impedance of a standard resistance is real.

C. None of the other answers is true.

D. A thermistor demonstrates an intentionally poor constancy of resistance with change in temperature.

E. A thermistor's behavior depends on the direction of current through it.

5. Which of the following is (are) true about the graph below.



I - It shows that current flows when the diode if forward-biased but not when reverse-biased.
II - It shows that the diode can be safely attached to 1V in either orientation (forward- or reverse-biased).
III - It shows that the diode is a linear device.
IV - It shows that over a wide range of currents the voltage across the forward-biased diode is approximately 0.5V

A. I, II, and IV

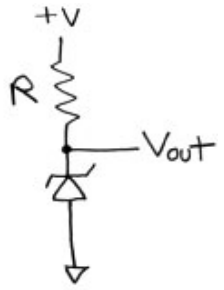
B. I, II and III

C. All of them.

D. I and III

E. I and IV

6. Which of the following is (are) true about the circuit below, given that $R = 1000\Omega$, $+V = 5$V, and the zener diode has a reverse breakdown voltage of 3V.



I - The current through the resistor is 3mA.
II - The zener diode is back-biased.
III - No current flows through the resistor.
IV - $V_{out} = 3V$

A. I, II and IV

B. II and IV

C. II and III

D. I, II, and III

E. II, III, and IV

7. A Zener diode can best be described as

A. a diode that has an extremely high reverse breakdown voltage, such that the breakdown voltage is never reached in practice.

B. a diode that exhibits completely linear behavior in both the forward and reverse biased condition, and thus obeys Ohm's law.

C. a component with three wires coming out of it.

D. a diode that is actually primarily used as an inductor.

E. a diode whose reverse breakdown voltage is used on purpose to provide a known and stable voltage, by maintaining that diode in the reverse-biased condition.

8. Which of the following are typical applications for diodes?

I - Peak Detector, to find the peak voltage over a time period.
II - Logical operations such as the Boolean OR operation.
III - Rectification (turning AC into DC).

A. I, II, and III

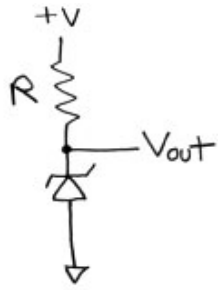
B. Only I

C. I and II

D. I and III

E. II and III

9. Which of the following is (are) true about the circuit below, given that R=10,000 Ω, $+V = 7$ V, and the zener diode has a reverse breakdown voltage of 4.2 V. Assume there is no current drawn from the output.



I - The voltage drop across the diode is about half a volt.
II - The current through the resistor is 280 μA.
III - The zener diode is back-biased.
IV - $V_{out} = 3.7V$

A. I, II, and IV

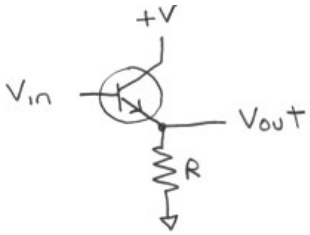
B. I, II and III

C. I, III and IV

D. II and III

E. II, III, and IV

10. If $R = 10\text{K}\Omega$, $V_{in} = 2.5\text{V}$, $\beta = 100$, and the base-emitter voltage drop is 0.5V, what would you expect the current through R to be?



A. 25 mA

B. No current will pass through the resistor.

C. 0.25mA

D. 0.2 mA

E. 20 mA

11. Which of the following is (are) linear components?

I - Capacitor.
II - Diode.
III - Resistor.

A. I and III

B. I and II

C. I, II, and III

D. III

E. II and III

12. The following are true about bipolar transistors *except*

A. They exhibit a voltage drop between the base and emitter, similar to that of a forward-biased diode, of about 0.5-0.7 volt.

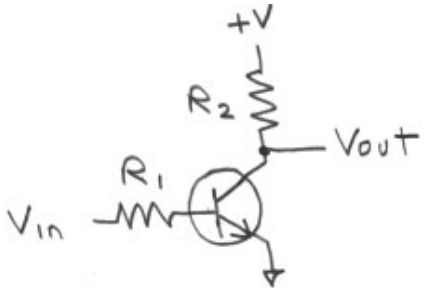
B. They consist of regions of semiconductor material (generally silicon), with some with some regions having extra electrons and some having extra "holes".

C. They can generally be modeled to have infinite input impedance and zero output impedance.

D. They are inherently nonlinear devices.

E. When properly biased, the collector current I_C and the base current I_B are related by an approximately constant proportion, β.

13. If $R_1 = 100\ K\Omega$, $R_2 = 2\ \mathrm{K}\Omega$, $V_{in} = 2.5$ V, $+V = 10$ V, with a $\beta = 100$ for the transistor, and a base-emitter voltage drop of 0.5 V, what voltage would you expect at V_{out}?



A. 2 V

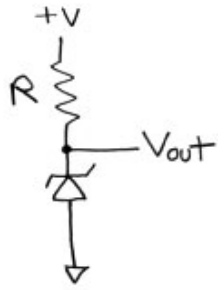
B. 4 V

C. 6 V

D. 0 V

E. 5 V

14. Which of the following is (are) true about the circuit below, given that R = 5000 Ω, $+V$ = 10 V, and the zener diode has a reverse breakdown voltage of 5 V.



I - The current through the resistor is 1 mA.
II - No current can flow through the zener diode.
III - V_{out} = 5 V.

A. I and III

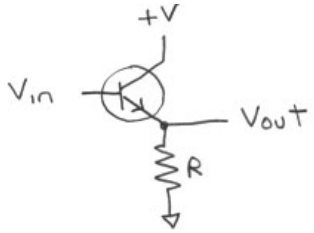
B. I and II

C. only III

D. II and III

E. I, II, and III

15. If $R = 10\Omega$, $\beta = 100$, the current through R is 50mA, and the base-emitter voltage drop is 0.5V, what would you expect V_{in} to be? (notice we are asking for the *input* voltage!)



A. 5 V

B. 5.5 V

C. 1 V

D. 0.5 V

E. 0 V

16. Which of the following is (are) true about the photo-resistor used in our lab.

I - It is constructed of cadmium-sulfide.
II - It stands out among types of photo detectors for being fast and extremely sensitive.
III - Its resistance goes from very high in total darkness to much lower in bright light.

A. I, II and III

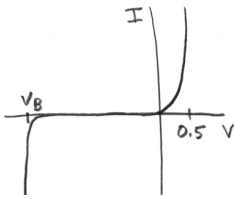
B. I and III

C. I and II

D. I

E. II and III

17. Which of the following is (are) true about the graph of the current vs. voltage for a diode, below.



I - It shows that the diode acts like a perfect switch that is closed when the diode is forward-biased but open when it is reverse-biased.
II - It shows that the diode could experience destructively large currents if attached to 1V in the forward-biased condition.
III - It shows that over a wide range of currents the voltage across the forward-biased diode is approximately 0.5V

A. II and III

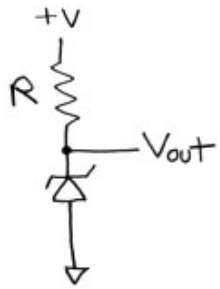
B. None of the other answers is correct.

C. I and III

D. I, II, and III

E. I and II

18. Which of the following is (are) true about the circuit below, given that $R = 100\Omega$, $+V = 6$V, and the zener diode has a reverse breakdown voltage of 2V.



I - The current through the resistor is 40mA.
II - The zener diode is forward-biased.
III - The voltage $V_{out} = 2V$

A. I and III

B. I, II, and III

C. only II

D. II and III

E. I and II

19. The following are true about bipolar transistors *except* (or all are true)

A. When properly biased, the collector current I_C and the base current I_B are related by an approximately constant proportion, β.

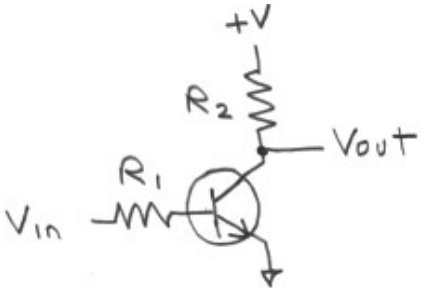
B. They consist of regions of semiconductor material (generally silicon), with some regions having extra electrons and some having extra "holes".

C. They exhibit a voltage drop between the base and emitter, similar to that of a forward-biased diode, of about 0.5-0.7 volt.

D. All are true.

E. When saturated, I_C no longer is $\beta \times I_B$, but can be much less.

20. If $R_1 = 100\ K\Omega$, $R_2 = 2\ \mathrm{K}\Omega$, $V_{in} = 2.5$ V, $+V = 11$ V, with a $\beta = 100$ for the transistor, and a base-emitter voltage drop of 0.5 V, what voltage would you expect at V_{out}?



A. 8 V

B. 5 V

C. 7 V

D. 6 V

E. 4 V

21. A thermistor differs from a standard resistor in that

A. A thermistor's behavior depends on the direction of current through it.

B. A thermistor demonstrates an intentional variation of resistance with temperature, and can be manufactured to have either a positive or a negative temperature coefficient.

C. A thermistor is a transistor that controls the flow of heat rather than electrical current.

D. A thermistor, unlike a standard resistor, is designed to generate heat when a current is passed through it.

E. A thermistor has an imaginary impedance whereas the impedance of a standard resistance is real.

22. A Zener diode can best be described as

A. a diode that has an extremely high reverse breakdown voltage, such that the breakdown voltage is never reached in practice.

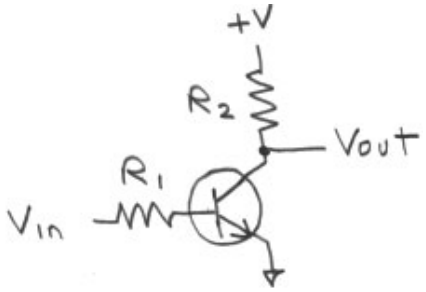
B. a transistor with extremely high input impedance.

C. a diode that is actually primarily used as an capacitor.

D. a diode that exhibits identical behavior in the forward and reverse biased condition.

E. a diode whose reverse breakdown voltage provides a known and stable reference voltage when reverse-biased.

23. If $R_1 = 100\ K\Omega$, $R_2 = 2$ KΩ, $V_{in} = 3$ V, $+V = 10$ V, with a $\beta = 100$ for the transistor, and a base-emitter voltage drop of 0.5 V, what voltage would you expect at V_{out}?



A. 0 V

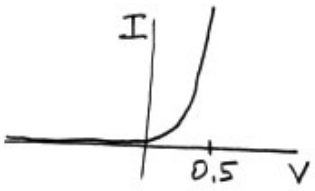
B. 6 V

C. 2 V

D. None of the other answers is correct.

E. 5 V

24. Which of the following is (are) true about the graph below.



I - It shows that current flows when the diode is forward-biased but not when reverse-biased.
II - It shows that the diode cannot be attached to 1V in the forward-biased direction without risking destroying it.
III - It shows that the diode is a non-linear device.

A. II and III

B. I

C. I and II

D. I, II and III

E. I and III

25. The following are true about bipolar transistors *except*

A. When properly biased, the collector current I_C and the base current I_B are related by an approximately constant proportion, β.

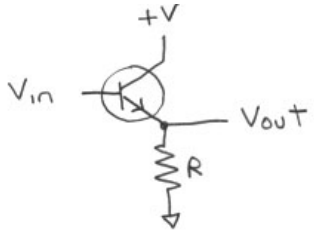
B. The base current I_B can pass in either direction in an NPN transistor.

C. They come in two varieties, NPN and PNP, depending on the arrangement of regions with either extra electrons or extra "holes".

D. The bipolar transistor we use in lab has three terminals, the Emitter, Base, and Collector.

E. When properly forward-biased, they exhibit a voltage drop between the base and emitter, similar to that of a diode, of about 0.5-0.7 volt.

26. If $+V = 5\text{V}$, $R = 1\text{K}\Omega$, $V_{in} = 2\text{V}$, $\beta = 150$, and the base-emitter voltage drop is 0.5V, what would you expect the current through R to be?



A. 300 mA

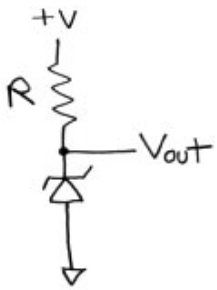
B. 2 mA

C. None of the other answers is correct.

D. 1.5 mA

E. 225 mA

27. Which of the following is *false* about the circuit below, given that $R = 1\text{K}\Omega$, $+V = 10\text{V}$, and the zener diode has a reverse breakdown voltage of 4V.



A. Current flows through the zener diode in a direction opposite to the voltage across it.

B. The voltage $V_{out} = 4V$.

C. The current through the resistor is 6mA.

D. The zener diode is used because, as opposed to most diodes, the reverse breakdown voltage is intentionally low at some known voltage.

E. The zener diode is back biased.

28. The following are true about thermistors *except*

A. Unlike standard resistors, the impedance of a thermistor is non-linear.

B. Like a standard resistor, the resistance of the thermistor constitutes a real (non-imaginary) impedance.

C. Like a standard resistor, a thermistor generates heat when a current is passed through it in the amount of I^2R.

D. Whereas most resistors show some variation in resistance with temperature, a thermistor demonstrates an intentional variation that is generally larger than that of an ordinary resistor.

E. A thermistor can be manufactured to have either a positive or a negative temperature coefficient.

29. Which of the following is *false* about the light sensor used in our lab.

A. It is constructed of cadmium-sulfide.

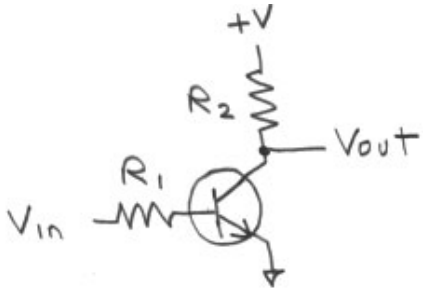
B. It is a photovoltaic device that generates a voltage from light (a small "solar cell").

C. Its resistance goes from very high in total darkness to much lower in bright light.

D. It is fairly slow and insensitive compared to other types of light sensors, but robust and easy to use.

E. It passes current in both directions equally.

30. If $R_1 = 200\ K\Omega$, $R_2 = 2$ KΩ, $V_{in} = 2.5$ V, $+V = 10$ V, with a $\beta = 200$ for the transistor, and a base-emitter voltage drop of 0.5 V, what voltage would you expect at V_{out}?



A. 4 V

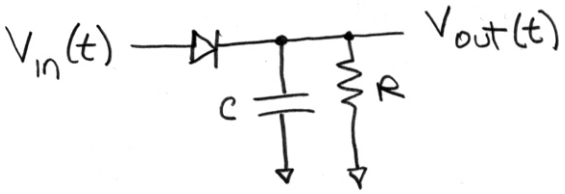
B. 6 V

C. 5 V

D. 8 V

E. 7 V

31. The following are true about the circuit below *except* (or all are true).



A. The resistor provides a way for the capacitor to eventually discharge.

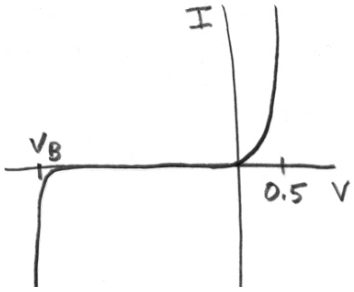
B. The capacitor acts as the voltage "memory".

C. All are true.

D. The circuit is known as a "peak detector".

E. When the diode is forward biased, $V_{out}(t)$ will follow the peak voltage in $V_{in}(t)$, minus the approximately 0.5V drop across the diode.

32. The following are true about the the graph below *except* (or all are true).



A. The forward-biased voltage asymptotes to approximately 0.5 V.

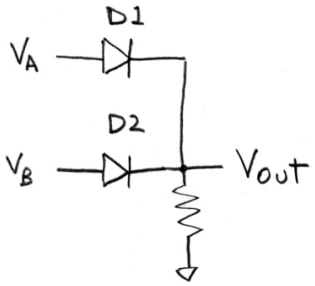
B. All are true.

C. When the component is back-biased, the current is in the opposite direction from the voltage.

D. When reversed-biased, the component demonstrates practically zero current up to a "breakdown voltage" at which it gives way.

E. It represents the current as a function of voltage for a diode.

33. The following are true about the the circuit below *except* (or all are true).



A. This represents a logical OR gate.

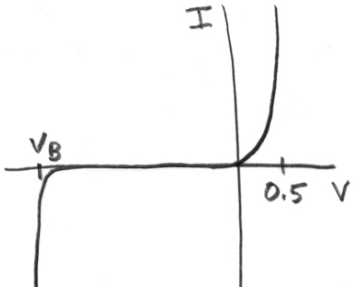
B. If V_A is at 5V and V_B is at ground, D1 will be forward-biased and D2 will be back-biased.

C. All are true.

D. If either V_A or V_B is high (e.g. near 5V), V_{out} is also high.

E. With actual diodes, V_{out} will always be a little bit ($\sim$ 0.5V) below *both* V_A and V_B.

34. The following are true about the the graph below *except* (or all are true).



A. This is a non-linear component.

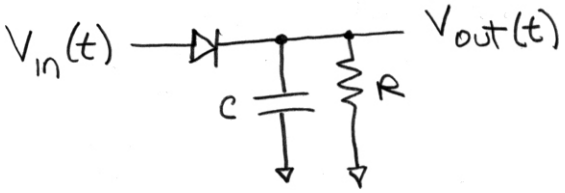
B. The forward-biased voltage asymptotes to approximately 0.5 V.

C. It could represent a regular diode, meant to be reversed-biased at voltages between 0 and V_B with practically zero current.

D. It could represents a zener diode whose intentional breakdown voltage is V_B.

E. All are true.

35. The following are true about the circuit below *except* (or all are true).



A. The capacitor acts as the voltage "memory."

B. The resistor prevents the capacitor from charging beyond $\frac{V_{in}}{2}$.

C. The circuit is known as a "peak detector".

D. When the diode is forward biased, $V_{out}(t)$ will follow the peak voltage in $V_{in}(t)$, minus the approximately 0.5V drop across the diode.

E. All are true.

36. Which of the following are true about the light sensor used in our lab *except* (or all are true).

A. It is fairly slow and insensitive compared to other types of light sensors, but robust and easy to use.

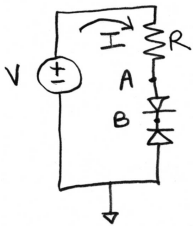
B. All are true.

C. Its resistance goes from very high in total darkness to much lower in bright light.

D. It is constructed of cadmium-sulfide.

E. It passes current in both directions equally.

37. Assuming $V = 5\text{V}$, $R = 100\Omega$, the forward biased voltage across the diodes is 0.5V, and the reverse breakdown voltage for the diodes is 200V, what is the voltage at points A and B?



A. A: 5V, B: 5V

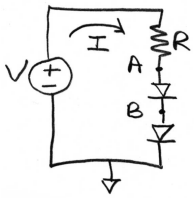
B. A: 4.5V, B: 4V

C. A: 0V, B: 0V

D. A: 5V, B: 4.5V

E. A: 5V, B: 0V

38. Assuming $V = 5\text{V}$, $R = 100\Omega$, the forward biased voltage across each diode is 0.5V, the reverse breakdown voltage for the diodes is 200V, and the diodes can handle 1A, what is the current I?



A. 45 mA

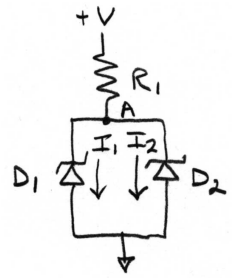
B. cannot be determined from the given information.

C. 0 mA

D. 50 mA

E. 40 mA

39. Assuming $+V = 10\text{V}$, $R = 1000\Omega$, the reverse breakdown voltage is 5V for D_1 and 7V for D_2, what is the voltage at A?



A. 5V

B. 10V

C. 0V

D. cannot be determined from the given information.

E. 7V

40. The following are true about bipolar transistors *except*

A. When properly forward-biased, they exhibit a voltage drop between the base and emitter, similar to that of a diode, of about 0.5-0.7 volt.

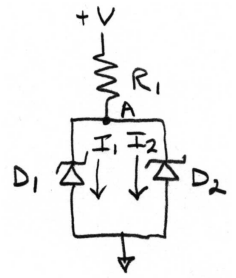
B. Because it is non-linear, the bipolar transistor is capable of generating a current when all three terminals are at the same voltage.

C. When properly biased, the collector current I_C and the base current I_B are related by an approximately constant proportion, β.

D. The bipolar transistor we use in lab has three terminals, the Emitter, Base, and Collector.

E. They come in two varieties, NPN and PNP, depending on the arrangement of regions with either extra electrons or extra "holes".

41. Assuming $+V = 10\text{V}$, $R = 1000\Omega$, the reverse breakdown voltage is 5V for D_1 and 7V for D_2, what is the current through R?



A. 5mA

B. 0mA

C. cannot be determined from the given information.

D. 7mA

E. 10mA

42. Which of the following are true about light emitting diodes (LEDs) *except* (or all are true).

A. They may emit visible or infrared light.

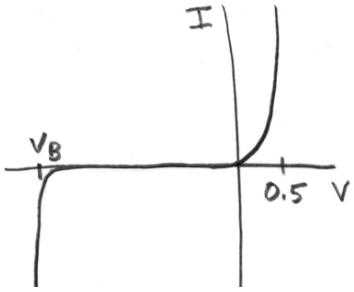
B. The forward biased voltage varies with color, increasing with the frequency of the light emitted, because the energy of individual photons is $E = h\nu$.

C. They are non-linear devices in terms of their current as a function of voltage.

D. All are true.

E. Like regular diodes, they conduct preferentially in one direction.

43. The following are true about the the graph below *except* (or all are true).



A. It represents the current as a function of voltage for a diode.

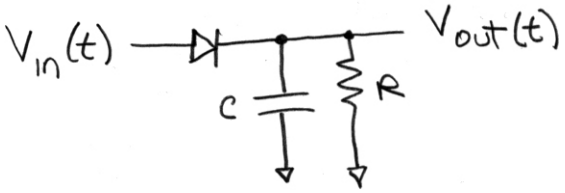
B. The forward-biased voltage asymptotes to approximately 0.5 V.

C. All are true.

D. As in the relationship between current and voltage for all passive components, the curve passes through the origin.

E. When reversed-biased, the component demonstrates practically zero current up to a "breakdown voltage" at which it gives way.

44. The following are true about the circuit below *except* (or all are true).



A. The circuit can act as an Amplitude Modulation (AM) radio receiver.

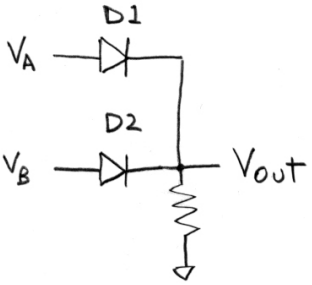
B. All are true.

C. When the diode is forward biased, $V_{out}(t)$ will follow the peak voltage in $V_{in}(t)$, minus the approximately 0.5V drop across the diode.

D. The resistor provides a way for the capacitor to eventually discharge.

E. The circuit is known as a "peak detector".

45. The following are true about the the circuit below *except* (or all are true).



A. All are true.

B. If either V_A or V_B is high (e.g. near 5V), V_{out} is also high.

C. If V_A is at 5V and V_B is at ground, D1 will be forward-biased and D2 will be reverse-biased.

D. The non-linear behavior of the circuit results from the diodes.

E. This represents a logical OR gate.

46. Which of the following is *false* about the light sensor used in our lab.

A. It is fairly slow and insensitive compared to other types of light sensors, but robust and easy to use.

B. It is constructed of cadmium-sulfide.

C. It is a polar device, meaning that there are specific plus and minus terminals.

D. It passes current in both directions equally.

E. Its resistance goes from very high in total darkness to much lower in bright light.

47. The following are true about thermistors *except*, or all are true.

A. Like a standard resistor, a thermistor generates heat when a current is passed through it in the amount of I^2R.

B. A thermistor can be manufactured to have either a positive or a negative temperature coefficient.

C. Like a standard resistor, the resistance of the thermistor constitutes a real (non-imaginary) impedance.

D. All are true.

E. Whereas most resistors show some variation in resistance with temperature, a thermistor demonstrates an intentional variation that is generally larger than that of an ordinary resistor.

48. The following are true about silicon diodes *except*, or all are true

A. All are true.

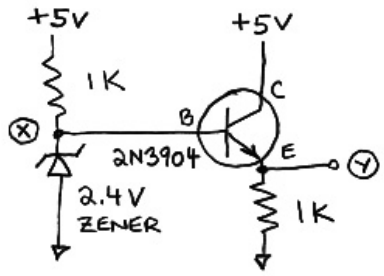
B. When forward biased, the *holes* are adjacent to the *carriers*, permitting current to flow through the P-N junction.

C. The N region is doped with an element with 5 valence electrons, constituting *carriers*.

D. The P region is doped with an element with only 3 valence electrons, constituting *holes*.

E. The substrate has 4 valence electrons.

49. Assuming a base-emitter drop of 0.5 V, what is the current through the 1K resistor *between the emitter and ground*?



A. 5 mA.

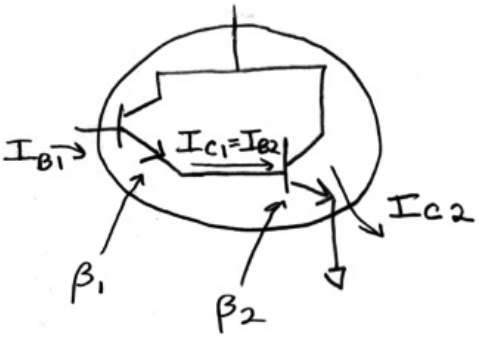
B. 0 mA.

C. 2.6 mA.

D. 2.4 mA.

E. 1.9 mA.

50. The effective β for the Darlington transistor shown below is.



A. $\beta_1 \times \beta_2$

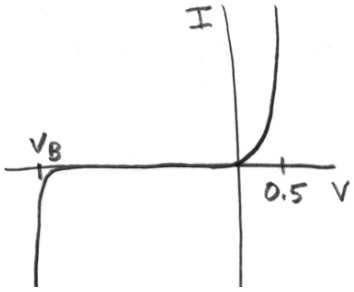
B. $\frac{\beta_2}{\beta_1}$.

C. $\frac{\beta_1}{\beta_2}$.

D. None of the others is correct.

E. $\beta_1 + \beta_2$.

51. The following are true about the the graph below *except* (or all are true).



A. As in the relationship between current and voltage for all passive components, the curve passes through the origin.

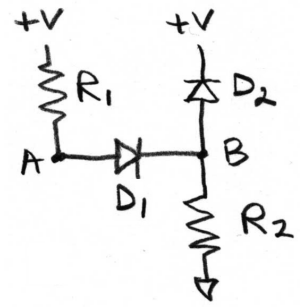
B. All are true.

C. The forward-biased voltage asymptotes to approximately 0.5 V.

D. V_B is the "base" voltage of the forward biased base-emitter junction, for the transistor within the diode.

E. It represents the current as a function of voltage for a diode.

52. In the circuit below, +V = 5V, $R_1 = 3$ KΩ, $R_2 = 6$ KΩ, and the forward bias voltage drop across the diodes can be assumed to be 0.5 V. The following are true *except* (or all are true).



A. The voltage at node B is 3.0 V.

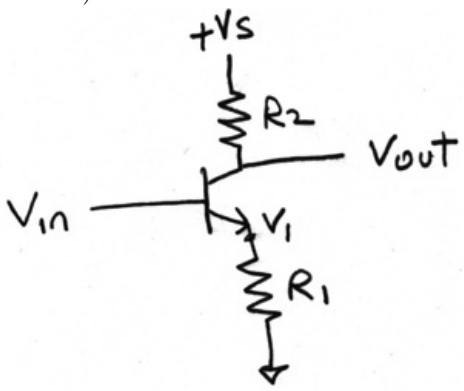
B. The voltage at node A is 3.5 V.

C. All are true.

D. The voltage across D_2 is 0.5 V.

E. The current through D_1 is 0.5 mA.

53. In the following circuit, the forward biased voltage drop across the Base-Emitter junction of the transistor is 0.5 V. Assume $\beta = 200$, $R_1 = 2$ KΩ, $R_2 = 6$ KΩ, $+V_S = 20$ V, and $V_{in} = 1.5$ V. The following are true *except* (or all are true).



A. All are true.

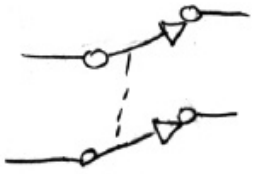
B. $V_1 = 1$ V.

C. The current through R_1 is 0.5 mA.

D. The current through R_2 is approximately 0.5 mA (though a little less, because of the base current I_B).

E. The voltage across R_2 is approximately 3 V.

54. Identify the following component.



A. None of the above.

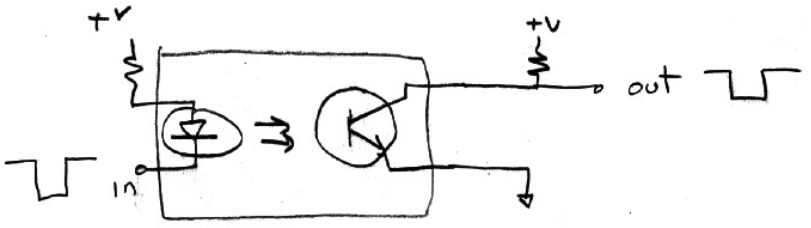
B. single-pole, double-throw switch.

C. double-pole, double-throw switch.

D. single-pole, single-throw switch.

E. double-pole, single-throw switch.

55. Regarding this device, the following are true *except* (or all are true).



A. The device contains an LED.

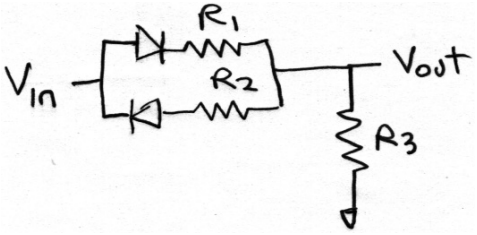
B. The device contains a photo-transistor, essentially a transistor whose base current I_B results from incoming photons.

C. This is an optical isolator, which is often used in medical electronics to avoid any electrical connection between the patient and potentially dangerous voltages.

D. Information entering the input as a voltage is converted to light and then back to a voltage again at the output.

E. All are true.

56. In the circuit below, $V_{in} = 6.5$ V, $R_1 = 3$ KΩ, $R_2 = 6$ KΩ, $R_3 = 6$ KΩ, the forward bias voltage drop across the diodes is 0.5 V, and the reverse breakdown voltage across the diodes is 200 V. What is V_{out}?



A. 3 V.

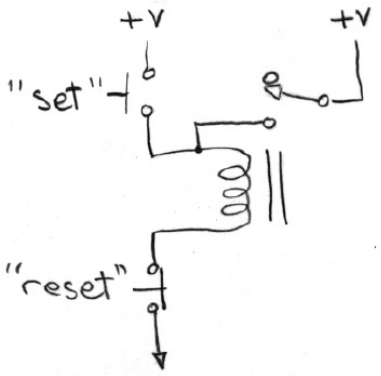
B. 4.33 V.

C. None of the other answers is correct.

D. 4 V.

E. 4.5 V

57. Regarding this device, the following are true *except* (or all are true).



A. The "reset" switch is a momentary pushbutton that is normally open (NO).

B. The relay includes a single-pole, double-throw switch.

C. It has two stable states, made possible by positive feedback.

D. This is latch.

E. All are true.

58. The following are true about strain gages *except*

A. They are often mounted on a cantilever, such that bending the cantilever changes the length of the strain gage.

B. They are often used in a Wheatstone bridge circuit, in which strain effects multiple gages differentially, to compensate for temperature

C. They contain a very thin wire printed on a non-rigid surface such that the length of the wire changes length preferentially with strain in a particular direction.

D. They depend on the piezo effect.

E. They measure applied force only through the resulting change in the length of the strain gage.

59. Regarding this diagram, the following are true *except* (or all are true).

5 B	6 C	7 N
13 Al	14 Si	15 P
31 Ga	32 Ge	33 As

A. Most semiconductors today consist of silicon with trace amounts of elements from neighboring columns used to "dope" the lattice with extra electrons (carriers) or missing electrons (holes).

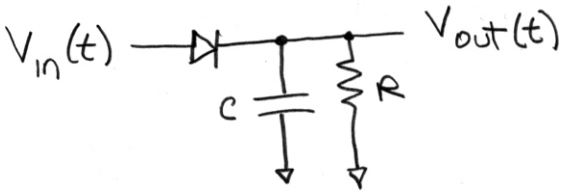
B. Diodes are made up of two layers of silicon, one with carriers and one with holes, such that when forward-biased, the holes are adjacent to the carriers permitting current to flow.

C. It represents a piece of the Periodic Table of Elements.

D. The central column contains Carbon, Silicon and Germanium, each of which have 4 valance electrons.

E. All are true.

60. The following are true about the circuit below *except* (or all are true).



A. When the diode is forward biased, $V_{out}(t)$ will follow the peak voltage in $V_{in}(t)$, minus the approximately 0.5V drop across the diode.

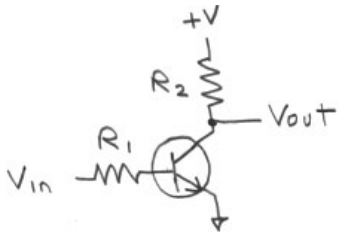
B. When $V_{in}(t) < V_{out}(t)$, the capacitor will discharge through the diode, assuming a perfect diode.

C. The circuit is known as a "peak detector".

D. All are true.

E. The capacitor acts as the voltage "memory"

61. If $R_1 = 10\text{K}\Omega$, $R_2 = 1\text{K}\Omega$, $V_{in} = 10\text{V}$, $+V = 10\text{V}$, and $\beta = 100$ for the transistor, ignoring the base-emitter voltage drop, which of the following is *false* (or all are true)?



A. Ignoring the base-emitter voltage drop, the base current I_B will be 1 mA.

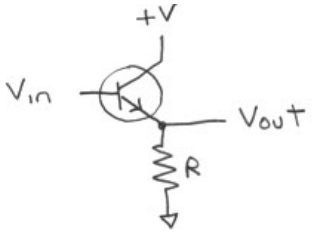
B. The current through R_2 will be approximately 10 mA.

C. $I_C = \beta I_B$ will hold for this circuit, since it is always true.

D. V_{out} will be approximately 0, since the transistor will be in saturation mode, letting through as much collector current I_C as it can.

E. All are true.

62. If $R = 1\text{K}\Omega$, $V_{in} = 2.5\text{V}$, $\beta = 150$, and the base-emitter voltage drop is 0.5V, which of the following is *false* (or all are true)?



A. All are true

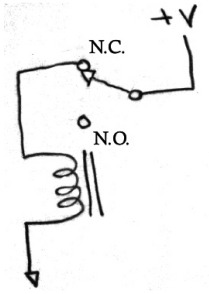
B. V_{out} will be about 0.5V below V_{in}

C. V_{out} does not significantly depend on β.

D. $I_C = \beta I_B$, since the transistor is not in saturation mode.

E. This circuit exhibits stable *negative* feedback.

63. Regarding this device, the following are true *except* (or all are true).



A. All are true.

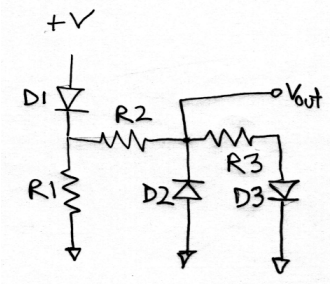
B. This is an unstable circuit, using *negative* feedback to continually cause a change in state.

C. This circuit oscillates because of a 90 degree phase shift in the inductor and a -90 degree phase shift in the capacitance of the switch.

D. When the coil of the relay is receiving current, the relay pulls its switch into the *normally open* position, disconnecting that current.

E. The coil in the relay controls a switch, which when in the *normally closed* position permits current to flow to that coil.

64. Regarding this circuit, assuming a forward bias voltage drop of 0.5 V and an infinite reverse bias breakdown voltage across all diodes, and assuming all resistors are 1 KΩ and $+V = 10$ V, what is V_{out}?



A. 0.5 V

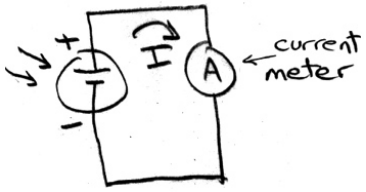
B. 9.5 V

C. 10 V

D. 0 V

E. 5 V

65. Regarding this circuit, the following are true *except*



A. The current I is generated by the energy in the incoming light.

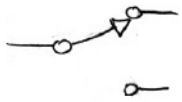
B. The two parallel arrows on the left represent incoming light.

C. The circuit exhibits a photodiode being used in *photoconductive* mode.

D. Kirchhoff's law applies to this circuit.

E. The device on the left is a type of photodiode known as a solar cell.

66. Identify the following component.



A. single-pole, single-throw switch.

B. single-pole, double-throw switch.

C. None of the above.

D. double-pole, single-throw switch.

E. double-pole, double-throw switch.

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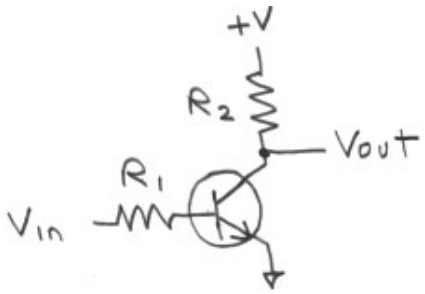
BioE 1310 - Review 3 - Nonlinear and Sensors 1/16/2017
Answer Sheet - Correct answer is A for all questions

1. If $R_1 = 200\text{K}\Omega$, $R_2 = 1\text{K}\Omega$, $V_{in} = 5\text{V}$, $+V = 10\text{V}$, with a $\beta = 150$ for the transistor, and ignoring the base-emitter voltage drop, what voltage would you expect at V_{out}?



A. 6.25V

B. 5V

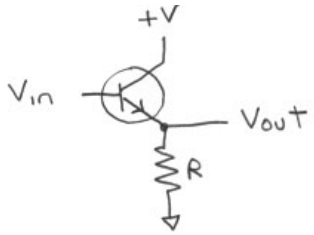
C. 2.75V

D. 3.75V

E. Cannot be determined.

Explanation: $V_{out} = (10 - 150 \times 1000\Omega(5\text{V}/200\text{K}\Omega))$
[*circuits0030.mcq*]

2. If $R = 1\text{K}\Omega$, $V_{in} = 2.5\text{V}$, $\beta = 150$, and the base-emitter voltage drop is 0.5V, what would you expect the current through R to be?



A. 2mA

B. 2.5mA

C. 0.3A

D. 375mA

E. 0.2A

Explanation: Current = $\frac{V_{in} - 0.5\text{V}}{R}$; β is not needed.
[*circuits0032.mcq*]

3. Which of the following is (are) true about the photo-resistor used in our lab.

I - It is constructed of cadmium-sulfide.
II - Its resistance goes from very high in total darkness to much lower in bright light.
III - It is a polar device, and therefore must be inserted in the proper oreintation.

A. I and II

B. I, II and III

C. II and III

D. I

E. I and III

Explanation: It is generally the (-) input of the op amp. III is nonsense.
[*circuits0033.mcq*]

4. A thermistor differs from a standard resistor in that

A. A thermistor demonstrates an intentionally poor constancy of resistance with change in temperature.

B. A thermistor, unlike a standard resistor, has a non-linear relationship between current and voltage.

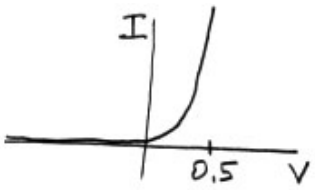
C. A thermistor's behavior depends on the direction of current through it.

D. A thermistor has an imaginary impedance whereas the impedance of a standard resistance is real.

E. None of the other answers is true.

Explanation: Thermistors change resistance intentionally with temperature.
[*circuits0034.mcq*]

5. Which of the following is (are) true about the graph below.



I - It shows that current flows when the diode if forward-biased but not when reverse-biased.
II - It shows that the diode can be safely attached to 1V in either orientation (forward- or reverse-biased).
III - It shows that the diode is a linear device.
IV - It shows that over a wide range of currents the voltage across the forward-biased diode is approximately 0.5V

A. I and IV

B. I, II and III

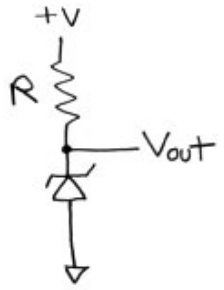
C. I, II, and IV

D. I and III

E. All of them.

Explanation: The diode is clearly not linear (like a resistor is), and the current approaches ∞ mathematically as the voltage goes over 0.5V.
[*circuits0035.mcq*]

6. Which of the following is (are) true about the circuit below, given that $R = 1000\Omega$, $+V = 5$V, and the zener diode has a reverse breakdown voltage of 3V.



I - The current through the resistor is 3mA.
II - The zener diode is back-biased.
III - No current flows through the resistor.
IV - $V_{out} = 3V$

A. II and IV

B. I, II and IV

C. II, III, and IV

D. II and III

E. I, II, and III

Explanation: The voltage across the back-biased diode is 3V. The voltage across the resistor is 5V - 3V = 2V; The current through the resistor is 2 mA.
[*circuits0038.mcq*]

7. A Zener diode can best be described as

A. a diode whose reverse breakdown voltage is used on purpose to provide a known and stable voltage, by maintaining that diode in the reverse-biased condition.

B. a component with three wires coming out of it.

C. a diode that is actually primarily used as an inductor.

D. a diode that exhibits completely linear behavior in both the forward and reverse biased condition, and thus obeys Ohm's law.

E. a diode that has an extremely high reverse breakdown voltage, such that the breakdown voltage is never reached in practice.

Explanation: A zener diode is one that intentionally has a known, and usually relatively low, breakdown voltage, which is used by reverse-biasing the diode.
[*circuits0092.mcq*]

8. Which of the following are typical applications for diodes?

I - Peak Detector, to find the peak voltage over a time period.
II - Logical operations such as the Boolean OR operation.
III - Rectification (turning AC into DC).

A. I, II, and III

B. I and III

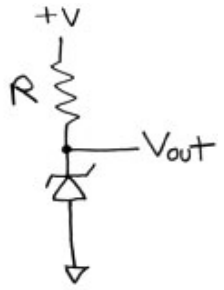
C. II and III

D. I and II

E. Only I

Explanation: All three are uses for diodes.
[*circuits0094.mcq*]

9. Which of the following is (are) true about the circuit below, given that R=10,000 Ω, $+V$ = 7 V, and the zener diode has a reverse breakdown voltage of 4.2 V. Assume there is no current drawn from the output.



I - The voltage drop across the diode is about half a volt.
II - The current through the resistor is 280 μA.
III - The zener diode is back-biased.
IV - $V_{out} = 3.7V$

A. II and III

B. I, III and IV

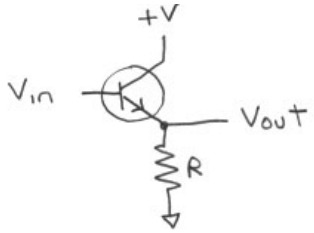
C. II, III, and IV

D. I, II and III

E. I, II, and IV

Explanation: The voltage across the back-biased diode is 4.2V. The voltage across the resistor is 7 V - 4.2 V = 2.8 V; The current through the resistor is 2.8 280 μA.
[*circuits0104.mcq*]

10. If $R = 10\text{K}\Omega$, $V_{in} = 2.5\text{V}$, $\beta = 100$, and the base-emitter voltage drop is 0.5V, what would you expect the current through R to be?



A. 0.2 mA

B. 0.25mA

C. 20 mA

D. 25 mA

E. No current will pass through the resistor.

Explanation: Current = $\frac{V_{in}-0.5\text{V}}{R}$; β is not needed.
[*circuits0106.mcq*]

11. Which of the following is (are) linear components?

I - Capacitor.
II - Diode.
III - Resistor.

A. I and III

B. I and II

C. II and III

D. I, II, and III

E. III

Explanation: Resistors are linear. Capacitors are linear for A.C. and are thus considered linear devices. Diodes are not linear.
[*circuits0108.mcq*]

12. The following are true about bipolar transistors *except*

A. They can generally be modeled to have infinite input impedance and zero output impedance.

B. They consist of regions of semiconductor material (generally silicon), with some with some regions having extra electrons and some having extra "holes".

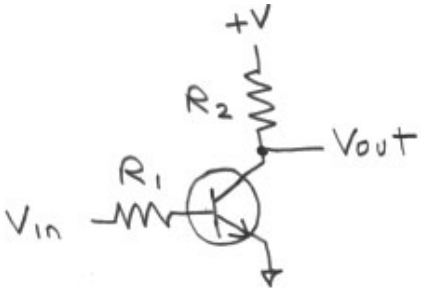
C. When properly biased, the collector current I_C and the base current I_B are related by an approximately constant proportion, β.

D. They are inherently nonlinear devices.

E. They exhibit a voltage drop between the base and emitter, similar to that of a forward-biased diode, of about 0.5-0.7 volt.

Explanation: There is a definite base current, so the input impedance is not infinite. Also, since the collector current is relatively insensitive to voltage, they have a high, not low, output impedance (i.e., they act like a current source.
[*circuits0109.mcq*]

13. If $R_1 = 100\ K\Omega$, $R_2 = 2$ KΩ, $V_{in} = 2.5$ V, $+V = 10$ V, with a $\beta = 100$ for the transistor, and a base-emitter voltage drop of 0.5 V, what voltage would you expect at V_{out}?



A. 6 V

B. 5 V

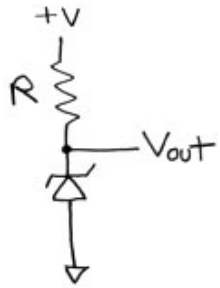
C. 4 V

D. 2 V

E. 0 V

Explanation: The Voltage across R_1 is 2.5 V − 0.5 V, so the base current is 2V/100 $K\Omega = 20\ \mu$A. Collector current is thus 20 μA × 100 = 2 mA. Voltage across $R_2 = 2$ mA × 2 K$\Omega = 4$V. $V_{out} = 10$ V − 4 V = 6 V
[*circuits0117.mcq*]

14. Which of the following is (are) true about the circuit below, given that R = 5000 Ω, $+V = 10$ V, and the zener diode has a reverse breakdown voltage of 5 V.



I - The current through the resistor is 1 mA.
II - No current can flow through the zener diode.
III - $V_{out} = 5$ V.

A. I and III

B. I and II

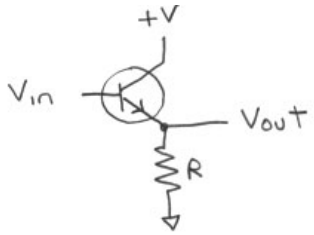
C. II and III

D. only III

E. I, II, and III

Explanation: The voltage across the back-biased zener diode is 5 V. The voltage across the resistor is 10 V − 5 V = 5 V; The current through the resistor is 1 mA, and that same current must be running through the zener (at least it will when there is no current flowing to the output).
[*circuits0121.mcq*]

15. If $R = 10\Omega$, $\beta = 100$, the current through R is 50mA, and the base-emitter voltage drop is 0.5V, what would you expect V_{in} to be? (notice we are asking for the *input* voltage!)



A. 1 V

B. 0.5 V

C. 5.5 V

D. 0 V

E. 5 V

Explanation: This is an emitter follower. $V_{out} = V_{in} - 0.5\text{V}$; β is not needed.
[*circuits0154.mcq*]

16. Which of the following is (are) true about the photo-resistor used in our lab.

I - It is constructed of cadmium-sulfide.
II - It stands out among types of photo detectors for being fast and extremely sensitive.
III - Its resistance goes from very high in total darkness to much lower in bright light.

A. I and III

B. I, II and III

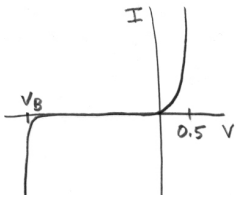
C. II and III

D. I

E. I and II

Explanation: II is not true. Photodiodes and phototransistors are faster and more sensitive.
[*circuits0155.mcq*]

17. Which of the following is (are) true about the graph of the current vs. voltage for a diode, below.



I - It shows that the diode acts like a perfect switch that is closed when the diode is forward-biased but open when it is reverse-biased.
II - It shows that the diode could experience destructively large currents if attached to 1V in the forward-biased condition.
III - It shows that over a wide range of currents the voltage across the forward-biased diode is approximately 0.5V

A. II and III

B. I and III

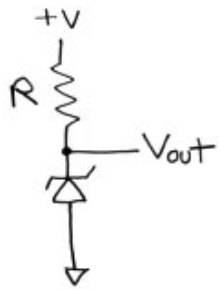
C. I and II

D. I, II, and III

E. None of the other answers is correct.

Explanation: The diode does not act as a perfect switch, because of the 0.5V forward biased drop, as well as the reverse breakdown voltage, neither of which would occur in a perfect switch.
[*circuits0156.mcq*]

18. Which of the following is (are) true about the circuit below, given that $R = 100\Omega$, $+V = 6$V, and the zener diode has a reverse breakdown voltage of 2V.



I - The current through the resistor is 40mA.
II - The zener diode is forward-biased.
III - The voltage $V_{out} = 2V$

A. I and III

B. I and II

C. I, II, and III

D. II and III

E. only II

Explanation: The voltage across the back-biased diode is 2V. The voltage across the resistor is 6V - 2V = 4V; The current through the resistor therefore is 40 mA.
[*circuits0161.mcq*]

19. The following are true about bipolar transistors *except* (or all are true)

A. All are true.

B. They consist of regions of semiconductor material (generally silicon), with some regions having extra electrons and some having extra "holes".

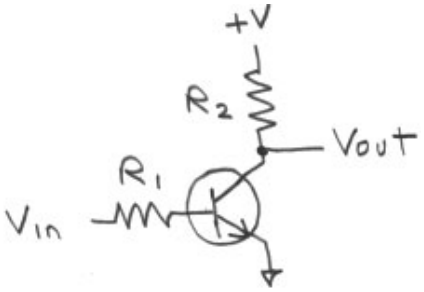
C. When properly biased, the collector current I_C and the base current I_B are related by an approximately constant proportion, β.

D. When saturated, I_C no longer is $\beta \times I_B$, but can be much less.

E. They exhibit a voltage drop between the base and emitter, similar to that of a forward-biased diode, of about 0.5-0.7 volt.

Explanation: All are true.
[*circuits0162.mcq*]

20. If $R_1 = 100\ K\Omega$, $R_2 = 2$ KΩ, $V_{in} = 2.5$ V, $+V = 11$ V, with a $\beta = 100$ for the transistor, and a base-emitter voltage drop of 0.5 V, what voltage would you expect at V_{out}?



A. 7 V

B. 5 V

C. 8 V

D. 6 V

E. 4 V

Explanation: The Voltage across R_1 is 2 V $-$ 0.5 V, so the base current is 2V/100 $K\Omega = 20\ \mu$A. Collector current is thus 20 μA $\times$ 100 = 2 mA. Voltage across $R_2 = 2$ mA $\times$ 2 K$\Omega = 4$V. $V_{out} = 11$ V $-$ 4 V = 7 V
[*circuits0163.mcq*]

21. A thermistor differs from a standard resistor in that

A. A thermistor demonstrates an intentional variation of resistance with temperature, and can be manufactured to have either a positive or a negative temperature coefficient.

B. A thermistor, unlike a standard resistor, is designed to generate heat when a current is passed through it.

C. A thermistor's behavior depends on the direction of current through it.

D. A thermistor has an imaginary impedance whereas the impedance of a standard resistance is real.

E. A thermistor is a transistor that controls the flow of heat rather than electrical current.

Explanation: Thermistors change resistance intentionally with temperature. The one we used in the lab had a negative temperature coefficient. All resistors heat up when a current is passed through them, including thermistors, though that is not the purpose of a thermistor. The impedance of a thermistor is still real, it just varies. Answer E is silly.
[*circuits0164.mcq*]

22. A Zener diode can best be described as

A. a diode whose reverse breakdown voltage provides a known and stable reference voltage when reverse-biased.

B. a transistor with extremely high input impedance.

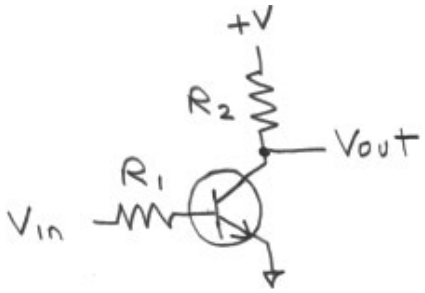
C. a diode that is actually primarily used as an capacitor.

D. a diode that exhibits identical behavior in the forward and reverse biased condition.

E. a diode that has an extremely high reverse breakdown voltage, such that the breakdown voltage is never reached in practice.

Explanation: A zener diode is one that intentionally has a known, and usually relatively low, breakdown voltage, which is used by reverse-biasing the diode.
[*circuits0165.mcq*]

23. If $R_1 = 100\ K\Omega$, $R_2 = 2$ KΩ, $V_{in} = 3$ V, $+V = 10$ V, with a $\beta = 100$ for the transistor, and a base-emitter voltage drop of 0.5 V, what voltage would you expect at V_{out}?



A. 5 V

B. 6 V

C. None of the other answers is correct.

D. 2 V

E. 0 V

Explanation: The Voltage across R_1 is 3 V $-$ 0.5 V, so the base current is 2.5V/100 $K\Omega = 25\ \mu$A. Collector current is thus 25 μA $\times$ 100 = 2.5 mA. Voltage across $R_2 = 2.5$ mA $\times$ 2 K$\Omega = 5$V. $V_{out} = 10$ V $-$ 5 V = 5 V
[*circuits0184.mcq*]

24. Which of the following is (are) true about the graph below.

I - It shows that current flows when the diode is forward-biased but not when reverse-biased.
II - It shows that the diode cannot be attached to 1V in the forward-biased direction without risking destroying it.
III - It shows that the diode is a non-linear device.

A. I, II and III

B. II and III

C. I and II

D. I and III

E. I

Explanation: The diode is clearly not linear (like a resistor is), and the current approaches ∞ mathematically as the voltage goes over 0.5V. The current wouldn't go to ∞, of course, but be limited by whatever current the power source could deliver, but that current times the 0.5 V across the diode would yield a power likely to burn up the diode.
[*circuits0195.mcq*]

25. The following are true about bipolar transistors *except*

A. The base current I_B can pass in either direction in an NPN transistor.

B. The bipolar transistor we use in lab has three terminals, the Emitter, Base, and Collector.

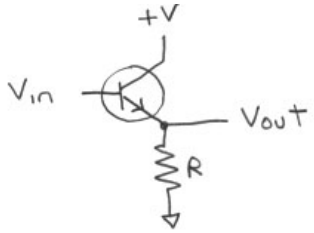
C. When properly biased, the collector current I_C and the base current I_B are related by an approximately constant proportion, β.

D. They come in two varieties, NPN and PNP, depending on the arrangement of regions with either extra electrons or extra "holes".

E. When properly forward-biased, they exhibit a voltage drop between the base and emitter, similar to that of a diode, of about 0.5-0.7 volt.

Explanation: The base current I_B can only pass in one direction, from the Base to the Emitter (in an NPN transistor), since the Base-Emitter junction behaves as a diode.
[*circuits0215.mcq*]

26. If $+V = 5\text{V}$, $R = 1\text{K}\Omega$, $V_{in} = 2\text{V}$, $\beta = 150$, and the base-emitter voltage drop is 0.5V, what would you expect the current through R to be?



A. 1.5 mA

B. 2 mA

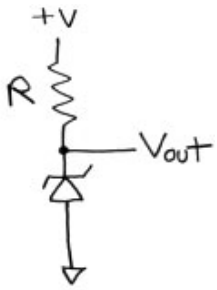
C. 300 mA

D. 225 mA

E. None of the other answers is correct.

Explanation: Current $= \frac{V_{in} - 0.5\text{V}}{R}$; β is not needed.
[*circuits0216.mcq*]

27. Which of the following is *false* about the circuit below, given that $R = 1\text{K}\Omega$, $+V = 10\text{V}$, and the zener diode has a reverse breakdown voltage of 4V.



A. Current flows through the zener diode in a direction opposite to the voltage across it.

B. The voltage $V_{out} = 4V$.

C. The current through the resistor is 6mA.

D. The zener diode is back biased.

E. The zener diode is used because, as opposed to most diodes, the reverse breakdown voltage is intentionally low at some known voltage.

Explanation: Current through a passive device cannot flow opposite to the voltage across it, or you would have an infinite source of energy.
[*circuits0217.mcq*]

28. The following are true about thermistors *except*

A. Unlike standard resistors, the impedance of a thermistor is non-linear.

B. Like a standard resistor, a thermistor generates heat when a current is passed through it in the amount of I^2R.

C. A thermistor can be manufactured to have either a positive or a negative temperature coefficient.

D. Like a standard resistor, the resistance of the thermistor constitutes a real (non-imaginary) impedance.

E. Whereas most resistors show some variation in resistance with temperature, a thermistor demonstrates an intentional variation that is generally larger than that of an ordinary resistor.

Explanation: Thermistors change resistance intentionally with temperature. The one we used in the lab had a negative temperature coefficient. All resistors heat up when a current is passed through them, including thermistors, though that is not the purpose of a thermistor. The impedance of a thermistor is still real, it just varies. Like a standard resistor, the impedance is linear.
[*circuits0218.mcq*]

29. Which of the following is *false* about the light sensor used in our lab.

A. It is a photovoltaic device that generates a voltage from light (a small "solar cell").

B. It is constructed of cadmium-sulfide.

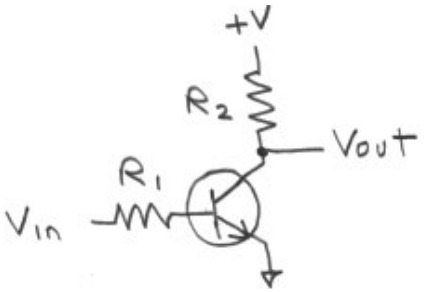
C. It passes current in both directions equally.

D. Its resistance goes from very high in total darkness to much lower in bright light.

E. It is fairly slow and insensitive compared to other types of light sensors, but robust and easy to use.

Explanation: Solar cells are photodiodes, whereas this is a photoresistor.
[*circuits0219.mcq*]

30. If $R_1 = 200\ K\Omega$, $R_2 = 2$ KΩ, $V_{in} = 2.5$ V, $+V = 10$ V, with a $\beta = 200$ for the transistor, and a base-emitter voltage drop of 0.5 V, what voltage would you expect at V_{out}?



A. 6 V

B. 5 V

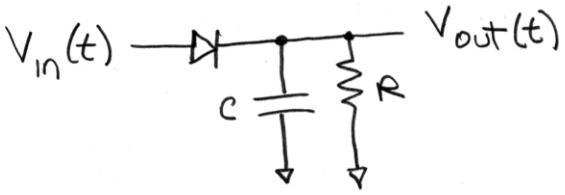
C. 8 V

D. 7 V

E. 4 V

Explanation: The Voltage across R_1 is 2.5 V − 0.5 V, so the base current is 2V/200 $K\Omega = 10\ \mu$A. Collector current is thus 10 μA × 200 = 2 mA. Voltage across $R_2 = 2$ mA × 2 K$\Omega = 4$V. $V_{out} = 10$ V − 4 V = 6 V.
[*circuits0220.mcq*]

31. The following are true about the circuit below *except* (or all are true).



A. All are true.

B. The circuit is known as a "peak detector".

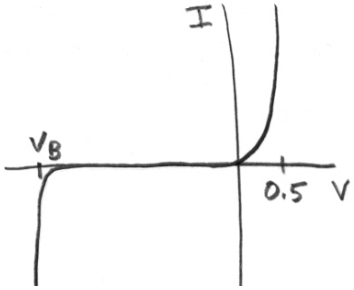
C. When the diode is forward biased, $V_{out}(t)$ will follow the peak voltage in $V_{in}(t)$, minus the approximately 0.5V drop across the diode.

D. The capacitor acts as the voltage "memory".

E. The resistor provides a way for the capacitor to eventually discharge.

Explanation: To a first approximation, $V_{out}(t)$ will follow the peak voltage in $V_{in}(t)$, although approximately 0.5 V below it. The resistor provides a way to discharge the capacitor and thereby limit the time period over which the peak is remembered by the voltage on the capacitor.
[*circuits0221.mcq*]

32. The following are true about the the graph below *except* (or all are true).



A. When the component is back-biased, the current is in the opposite direction from the voltage.

B. It represents the current as a function of voltage for a diode.

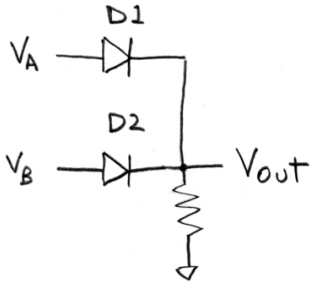
C. The forward-biased voltage asymptotes to approximately 0.5 V.

D. When reversed-biased, the component demonstrates practically zero current up to a "breakdown voltage" at which it gives way.

E. All are true.

Explanation: When the component is back-biased (or forward-biased), the current is in the same direction as the voltage. This is always true for a passive component; otherwise it would be generating energy on its own.
[*circuits0222.mcq*]

33. The following are true about the the circuit below *except* (or all are true).



A. With actual diodes, V_{out} will always be a little bit ($\sim$ 0.5V) below *both* V_A and V_B.

B. If either V_A or V_B is high (e.g. near 5V), V_{out} is also high.

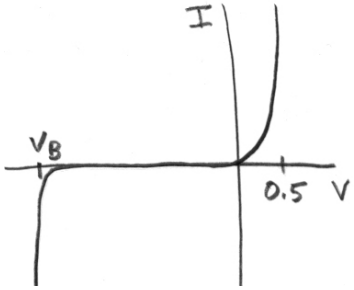
C. If V_A is at 5V and V_B is at ground, D1 will be forward-biased and D2 will be back-biased.

D. This represents a logical OR gate.

E. All are true.

Explanation: With actual diodes, V_{out} will always be a little bit ($\sim$ 0.5V) below *the higher of* V_A and V_B.
[*circuits0223.mcq*]

34. The following are true about the the graph below *except* (or all are true).



A. All are true.

B. It could represents a zener diode whose intentional breakdown voltage is V_B.

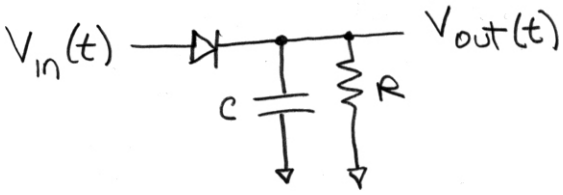
C. The forward-biased voltage asymptotes to approximately 0.5 V.

D. It could represent a regular diode, meant to be reversed-biased at voltages between 0 and V_B with practically zero current.

E. This is a non-linear component.

Explanation: The same graph applies to both regular and zener diodes; the only difference is whether the reverse bias voltage is meant to exceed V_B.
[*circuits0269.mcq*]

35. The following are true about the circuit below *except* (or all are true).



A. The resistor prevents the capacitor from charging beyond $\frac{V_{in}}{2}$.

B. The circuit is known as a "peak detector".

C. When the diode is forward biased, $V_{out}(t)$ will follow the peak voltage in $V_{in}(t)$, minus the approximately 0.5V drop across the diode.

D. The capacitor acts as the voltage "memory."

E. All are true.

Explanation: Answer A is nonsense.
[*circuits0270.mcq*]

36. Which of the following are true about the light sensor used in our lab *except* (or all are true).

A. All are true.

B. It is constructed of cadmium-sulfide.

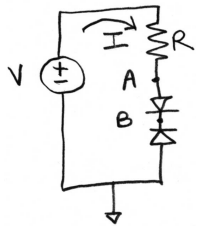
C. It passes current in both directions equally.

D. Its resistance goes from very high in total darkness to much lower in bright light.

E. It is fairly slow and insensitive compared to other types of light sensors, but robust and easy to use.

Explanation:
[*circuits0271.mcq*]

37. Assuming $V = 5\text{V}$, $R = 100\Omega$, the forward biased voltage across the diodes is 0.5V, and the reverse breakdown voltage for the diodes is 200V, what is the voltage at points A and B?



A. A: 5V, B: 5V

B. A: 5V, B: 4.5V

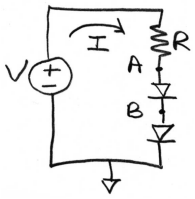
C. A: 4.5V, B: 4V

D. A: 5V, B: 0V

E. A: 0V, B: 0V

Explanation: Since one of the diodes is reversed biased, current will be zero. Thus the voltage drop across the resistor and the top diode will be zero, and all 5V will be across the bottom (reverse biased) diode.
[*circuits0289.mcq*]

38. Assuming $V = 5\text{V}$, $R = 100\Omega$, the forward biased voltage across each diode is 0.5V, the reverse breakdown voltage for the diodes is 200V, and the diodes can handle 1A, what is the current I?



A. 40 mA

B. 50 mA

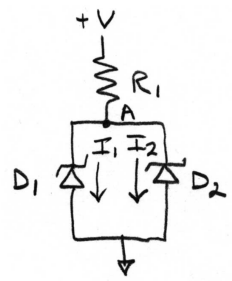
C. 0 mA

D. 45 mA

E. cannot be determined from the given information.

Explanation: Since both diodes are forward biased, each will have a 0.5V drop. That leaves 4V across $R = 100\Omega$ or 40 mA.
[*circuits0290.mcq*]

39. Assuming $+V = 10\text{V}$, $R = 1000\Omega$, the reverse breakdown voltage is 5V for D_1 and 7V for D_2, what is the voltage at A?



A. 5V

B. 7V

C. 10V

D. 0V

E. cannot be determined from the given information.

Explanation: The zener diode with the lesser reverse breakdown voltage will be breaking down at that voltage. $I_2 = 0$.
[*circuits0291.mcq*]

40. The following are true about bipolar transistors *except*

A. Because it is non-linear, the bipolar transistor is capable of generating a current when all three terminals are at the same voltage.

B. The bipolar transistor we use in lab has three terminals, the Emitter, Base, and Collector.

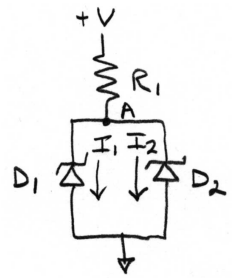
C. When properly biased, the collector current I_C and the base current I_B are related by an approximately constant proportion, β.

D. They come in two varieties, NPN and PNP, depending on the arrangement of regions with either extra electrons or extra "holes".

E. When properly forward-biased, they exhibit a voltage drop between the base and emitter, similar to that of a diode, of about 0.5-0.7 volt.

Explanation: No passive device (linear or non-linear) is capable of generating a current without a voltage. Energy cannot be created or destroyed.
[*circuits0293.mcq*]

41. Assuming $+V = 10\text{V}$, $R = 1000\Omega$, the reverse breakdown voltage is 5V for D_1 and 7V for D_2, what is the current through R?



A. 5mA

B. 7mA

C. 10mA

D. 0mA

E. cannot be determined from the given information.

Explanation: The zener diode with the lesser reverse breakdown voltage will be breaking down at that voltage. $I_2 = 0$. Thus the voltage across the resistor is 10V - 5V = 5V.
[*circuits0327.mcq*]

42. Which of the following are true about light emitting diodes (LEDs) *except* (or all are true).

A. All are true.

B. The forward biased voltage varies with color, increasing with the frequency of the light emitted, because the energy of individual photons is $E = h\nu$.

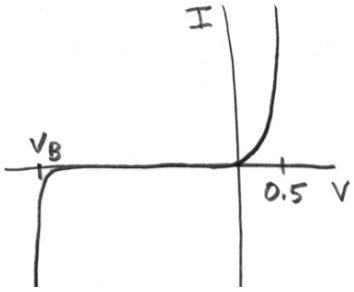
C. They may emit visible or infrared light.

D. They are non-linear devices in terms of their current as a function of voltage.

E. Like regular diodes, they conduct preferentially in one direction.

Explanation:
All are true.
[*circuits0360.mcq*]

43. The following are true about the the graph below *except* (or all are true).



A. All are true.

B. It represents the current as a function of voltage for a diode.

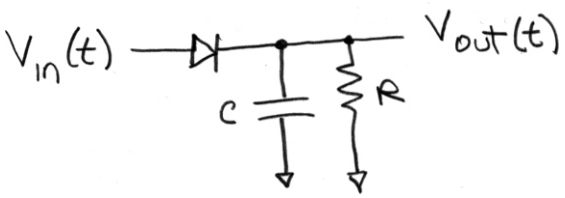
C. The forward-biased voltage asymptotes to approximately 0.5 V.

D. When reversed-biased, the component demonstrates practically zero current up to a "breakdown voltage" at which it gives way.

E. As in the relationship between current and voltage for all passive components, the curve passes through the origin.

Explanation: All are true.
[*circuits0328.mcq*]

44. The following are true about the circuit below *except* (or all are true).



A. All are true.

B. The circuit is known as a "peak detector".

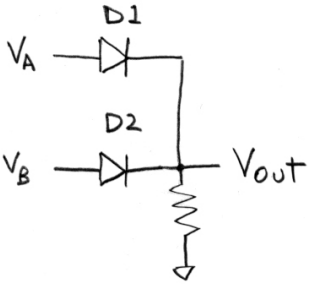
C. When the diode is forward biased, $V_{out}(t)$ will follow the peak voltage in $V_{in}(t)$, minus the approximately 0.5V drop across the diode.

D. The circuit can act as an Amplitude Modulation (AM) radio receiver.

E. The resistor provides a way for the capacitor to eventually discharge.

Explanation: To a first approximation, $V_{out}(t)$ will follow the peak voltage in $V_{in}(t)$, although approximately 0.5 V below it. The resistor provides a way to discharge the capacitor and thereby limit the time period over which the peak is remembered by the voltage on the capacitor.
[*circuits0329.mcq*]

45. The following are true about the the circuit below *except* (or all are true).



A. All are true.

B. If either V_A or V_B is high (e.g. near 5V), V_{out} is also high.

C. If V_A is at 5V and V_B is at ground, D1 will be forward-biased and D2 will be reverse-biased.

D. This represents a logical OR gate.

E. The non-linear behavior of the circuit results from the diodes.

Explanation: All are true. The circuit is non-linear, since when V_A is high the output is not affected by V_B, whereas when V_A is low, it is. In linear systems, one input cannot change the effect of the other input on the output, i.e., superposition.
[*circuits0330.mcq*]

46. Which of the following is *false* about the light sensor used in our lab.

A. It is a polar device, meaning that there are specific plus and minus terminals.

B. It is constructed of cadmium-sulfide.

C. It passes current in both directions equally.

D. Its resistance goes from very high in total darkness to much lower in bright light.

E. It is fairly slow and insensitive compared to other types of light sensors, but robust and easy to use.

Explanation: Photoresistors, like other resistors, are not polar devices. Current passes exactly the same in both directions as a function of voltage.
[*circuits0331.mcq*]

47. The following are true about thermistors *except*, or all are true.

A. All are true.

B. Like a standard resistor, a thermistor generates heat when a current is passed through it in the amount of I^2R.

C. A thermistor can be manufactured to have either a positive or a negative temperature coefficient.

D. Like a standard resistor, the resistance of the thermistor constitutes a real (non-imaginary) impedance.

E. Whereas most resistors show some variation in resistance with temperature, a thermistor demonstrates an intentional variation that is generally larger than that of an ordinary resistor.

Explanation: Thermistors change resistance intentionally with temperature. The one we used in the lab had a negative temperature coefficient. All resistors heat up when a current is passed through them, including thermistors, though that is not the purpose of a thermistor. The impedance of a thermistor is still real, it just varies. Like a standard resistor, the impedance is linear.

Alternate acceptable answer: B

Errata: Answer B should technically say at a rate of I^2R, since heat per time is generated by power.
[*circuits0332.mcq*]

48. The following are true about silicon diodes *except*, or all are true

A. All are true.

B. The substrate has 4 valence electrons.

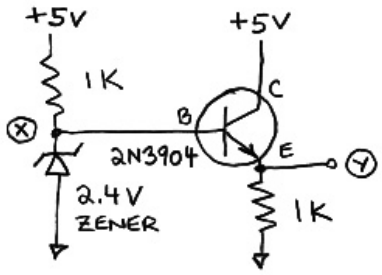
C. The P region is doped with an element with only 3 valence electrons, constituting *holes*.

D. When forward biased, the *holes* are adjacent to the *carriers*, permitting current to flow through the P-N junction.

E. The N region is doped with an element with 5 valence electrons, constituting *carriers*.

Explanation: All are true.
[*circuits0333.mcq*]

49. Assuming a base-emitter drop of 0.5 V, what is the current through the 1K resistor *between the emitter and ground*?



A. 1.9 mA.

B. 2.4 mA.

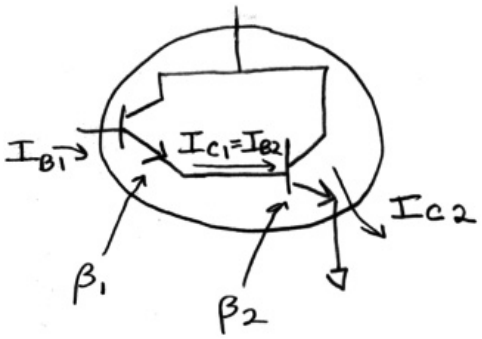
C. 5 mA.

D. 2.6 mA.

E. 0 mA.

Explanation: The base of the transistor will be at 2.4V, so the emitter will be at 1.9V, and the current will be 1.9mA.
[*circuits0334.mcq*]

50. The effective β for the Darlington transistor shown below is.



A. $\beta_1 \times \beta_2$

B. $\frac{\beta_1}{\beta_2}$.

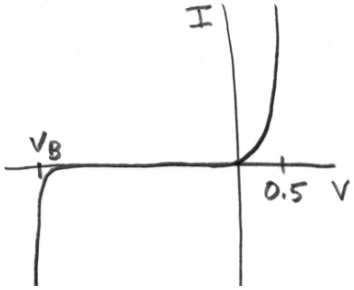
C. $\frac{\beta_2}{\beta_1}$.

D. $\beta_1 + \beta_2$.

E. None of the others is correct.

Explanation: Since $I_{C1} = I_{B2}$, $\beta_{total} = \beta_1 \times \beta_2$
[*circuits0336.mcq*]

51. The following are true about the the graph below *except* (or all are true).



A. V_B is the "base" voltage of the forward biased base-emitter junction, for the transistor within the diode.

B. It represents the current as a function of voltage for a diode.

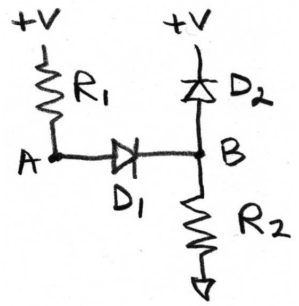
C. The forward-biased voltage asymptotes to approximately 0.5 V.

D. All are true.

E. As in the relationship between current and voltage for all passive components, the curve passes through the origin.

Explanation: When reversed-biased, the component demonstrates practically zero current up to a "breakdown voltage" V_B at which it gives way. Answer A is garbage.
[*circuits0361.mcq*]

52. In the circuit below, +V = 5V, R_1 = 3 KΩ, R_2 = 6 KΩ, and the forward bias voltage drop across the diodes can be assumed to be 0.5 V. The following are true *except* (or all are true).



A. The voltage across D_2 is 0.5 V.

B. The voltage at node A is 3.5 V.

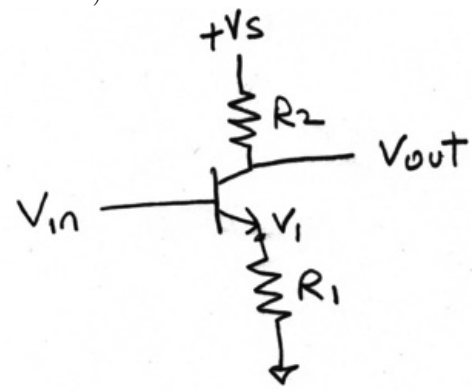
C. The voltage at node B is 3.0 V.

D. The current through D_1 is 0.5 mA.

E. All are true.

Explanation: Since D_2 is reverse biased, the voltage across it does not have to be 0.5 V. It is, in fact 5 V - 3 V = 2 V.
[*circuits0388.mcq*]

53. In the following circuit, the forward biased voltage drop across the Base-Emitter junction of the transistor is 0.5 V. Assume β = 200, R_1 = 2 KΩ, R_2 = 6 KΩ, $+V_S$ = 20 V, and V_{in} = 1.5 V. The following are true *except* (or all are true).



A. All are true.

B. V_1 = 1 V.

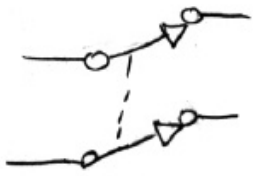
C. The current through R_1 is 0.5 mA.

D. The current through R_2 is approximately 0.5 mA (though a little less, because of the base current I_B).

E. The voltage across R_2 is approximately 3 V.

Explanation: All are true.
[*circuits0389.mcq*]

54. Identify the following component.



A. double-pole, single-throw switch.

B. double-pole, double-throw switch.

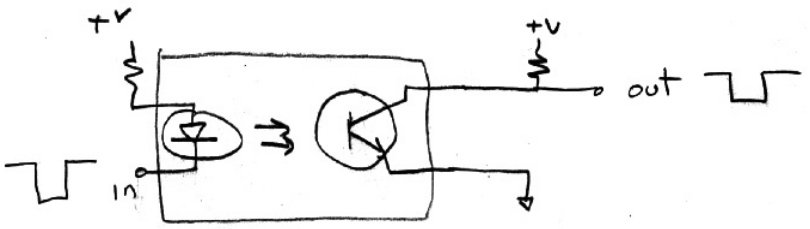
C. single-pole, single-throw switch.

D. single-pole, double-throw switch.

E. None of the above.

Explanation: This is essentially two single-pole switches mechanically linked, hence two "poles".
[*circuits0392.mcq*]

55. Regarding this device, the following are true *except* (or all are true).



A. All are true.

B. This is an optical isolator, which is often used in medical electronics to avoid any electrical connection between the patient and potentially dangerous voltages.

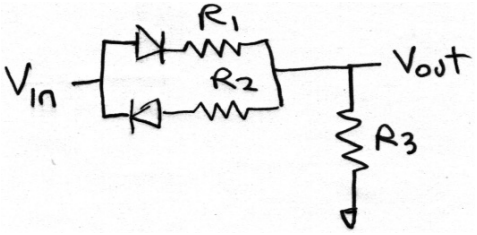
C. The device contains an LED.

D. The device contains a photo-transistor, essentially a transistor whose base current I_B results from incoming photons.

E. Information entering the input as a voltage is converted to light and then back to a voltage again at the output.

Explanation: All are true.
[*circuits0393.mcq*]

56. In the circuit below, $V_{in} = 6.5$ V, $R_1 = 3$ KΩ, $R_2 = 6$ KΩ, $R_3 = 6$ KΩ, the forward bias voltage drop across the diodes is 0.5 V, and the reverse breakdown voltage across the diodes is 200 V. What is V_{out}?



A. 4 V.

B. 4.5 V

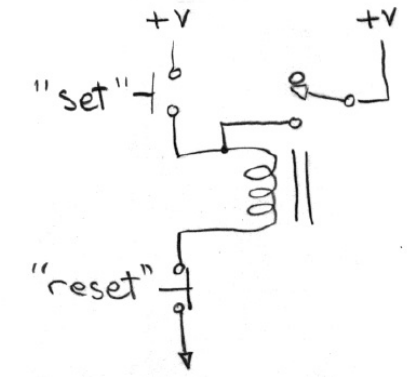
C. 3 V.

D. 4.33 V.

E. None of the other answers is correct.

Explanation: Only one of the diodes is forward biased, depending on whether V_{in} is positive or negative. Once its forward bias voltage is subtracted, this becomes a simple voltage divider.
[*circuits0395.mcq*]

57. Regarding this device, the following are true *except* (or all are true).



A. The "reset" switch is a momentary pushbutton that is normally open (NO).

B. This is latch.

C. It has two stable states, made possible by positive feedback.

D. The relay includes a single-pole, double-throw switch.

E. All are true.

Explanation: The "reset" switch is a momentary pushbutton that is normally closed (NC).
[*circuits0440.mcq*]

58. The following are true about strain gages *except*

A. They depend on the piezo effect.

B. They contain a very thin wire printed on a non-rigid surface such that the length of the wire changes length preferentially with strain in a particular direction.

C. They are often used in a Wheatstone bridge circuit, in which strain effects multiple gages differentially, to compensate for temperature

D. They are often mounted on a cantilever, such that bending the cantilever changes the length of the strain gage.

E. They measure applied force only through the resulting change in the length of the strain gage.

Explanation: Strain gages do not depend on the piezo effect, in which a material generates a voltage from a displacement of charges in a latice.
[*circuits0441.mcq*]

59. Regarding this diagram, the following are true *except* (or all are true).

A. All are true.

B. It represents a piece of the Periodic Table of Elements.

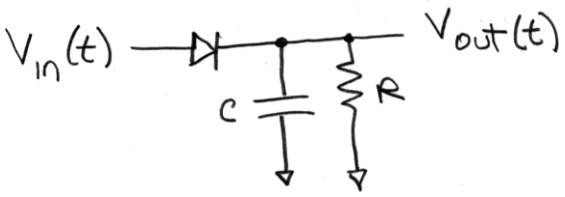
C. The central column contains Carbon, Silicon and Germanium, each of which have 4 valance electrons.

D. Most semiconductors today consist of silicon with trace amounts of elements from neighboring columns used to "dope" the lattice with extra electrons (carriers) or missing electrons (holes).

E. Diodes are made up of two layers of silicon, one with carriers and one with holes, such that when forward-biased, the holes are adjacent to the carriers permitting current to flow.

Explanation: All are true.
[*circuits0442.mcq*]

60. The following are true about the circuit below *except* (or all are true).



A. When $V_{in}(t) < V_{out}(t)$, the capacitor will discharge through the diode, assuming a perfect diode.

B. The circuit is known as a "peak detector".

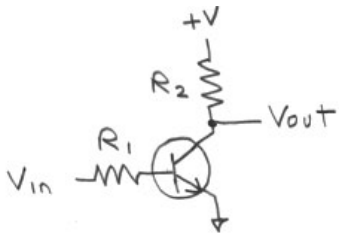
C. When the diode is forward biased, $V_{out}(t)$ will follow the peak voltage in $V_{in}(t)$, minus the approximately 0.5V drop across the diode.

D. The capacitor acts as the voltage "memory"

E. All are true.

Explanation: When $V_{in}(t) < V_{out}(t)$, the diode will be back-biased and not conduct at all, assuming a perfect diode.
[*circuits0443.mcq*]

61. If $R_1 = 10\text{K}\Omega$, $R_2 = 1\text{K}\Omega$, $V_{in} = 10\text{V}$, $+V = 10\text{V}$, and $\beta = 100$ for the transistor, ignoring the base-emitter voltage drop, which of the following is *false* (or all are true)?



A. $I_C = \beta I_B$ will hold for this circuit, since it is always true.

B. V_{out} will be approximately 0, since the transistor will be in saturation mode, letting through as much collector current I_C as it can.

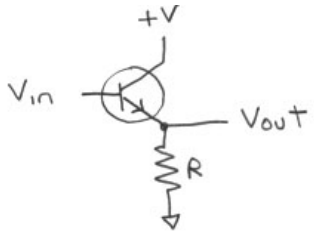
C. Ignoring the base-emitter voltage drop, the base current I_B will be 1 mA.

D. The current through R_2 will be approximately 10 mA.

E. All are true.

Explanation: $I_C = \beta I_B$ will not hold in this case, because the transistor cannot actively produce a collector voltage below 0 V.
[*circuits0470.mcq*]

62. If $R = 1\text{K}\Omega$, $V_{in} = 2.5\text{V}$, $\beta = 150$, and the base-emitter voltage drop is 0.5V, which of the following is *false* (or all are true)?



A. All are true

B. $I_C = \beta I_B$, since the transistor is not in saturation mode.

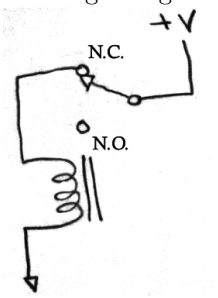
C. V_{out} does not significantly depend on β.

D. This circuit exhibits stable *negative* feedback.

E. V_{out} will be about 0.5V below V_{in}

Explanation:
[*circuits0471.mcq*]

63. Regarding this device, the following are true *except* (or all are true).



A. This circuit oscillates because of a 90 degree phase shift in the inductor and a -90 degree phase shift in the capacitance of the switch.

B. This is an unstable circuit, using *negative* feedback to continually cause a change in state.

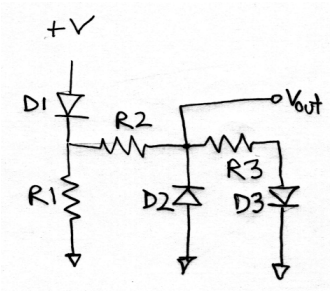
C. When the coil of the relay is receiving current, the relay pulls its switch into the *normally open* position, disconnecting that current.

D. The coil in the relay controls a switch, which when in the *normally closed* position permits current to flow to that coil.

E. All are true.

Explanation: Answer A is nonsense.
[*circuits0472.mcq*]

64. Regarding this circuit, assuming a forward bias voltage drop of 0.5 V and an infinite reverse bias breakdown voltage across all diodes, and assuming all resistors are 1 KΩ and $+V = 10$ V, what is V_{out}?



A. 5 V

B. 0 V

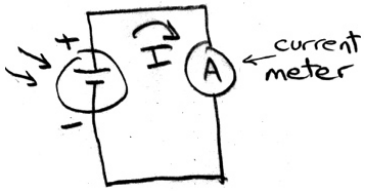
C. 10 V

D. 9.5 V

E. 0.5 V

Explanation: D2 is reversed biased and thus of no consequence. D1 and D3 are forward biased, bringing the voltages at the top of R2-in-series-with-R3 to 9.5 V, and at the bottom to 0.5 V. V_{out} is half way between them, or 5 V. R1 has no effect since D1 is forward-biased at its defined voltage.
[*circuits0473.mcq*]

65. Regarding this circuit, the following are true *except*



A. The circuit exhibits a photodiode being used in *photoconductive* mode.

B. The device on the left is a type of photodiode known as a solar cell.

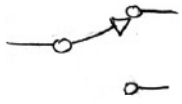
C. The two parallel arrows on the left represent incoming light.

D. The current I is generated by the energy in the incoming light.

E. Kirchhoff's law applies to this circuit.

Explanation: The circuit exhibits a photodiode being used in *photovoltaic* mode.
[*circuits0474.mcq*]

66. Identify the following component.



A. single-pole, double-throw switch.

B. double-pole, double-throw switch.

C. single-pole, single-throw switch.

D. double-pole, single-throw switch.

E. None of the above.

Explanation: This switch has a single "pole" or contact acting as a fulcrum whose lever can "throw" between two different contacts.
[*circuits0475.mcq*]