Conceptual Physics NAME:

Homework 5b Current: Homeworks are due usually a day after the corresponding textbook part/lecture is completed. Due dates will be announced in class. Multiple-choice problems will all be marked. **USE** the answer table for these problems. The rest of the homeworks will be marked for apparent completeness and some full-answer problems will/may be marked in detail. Make the full-answer solutions sufficiently detailed that the grader can follow your reasoning. Solutions will be posted eventually after the due dates. The solutions are intended to be (but not necessarily are) super-perfect and often go beyond full answers. For an argument or discussion problem, there really is no single right answer. The instructor's answer reflects his long experience in physics, but there could be objections to his arguments, assumptions, nuances, style, facts, etc.

NAME:

Answer Table for the Multiple-Choice Questions

	a	b	c	d	e		a	b	c	d	e
1.	O	O	O	O	O	26.	O	O	O	O	O
2.	O	O	O	O	O	27.	O	O	O	O	O
3.	O	O	O	O	O	28.	O	O	O	O	O
4.	O	O	O	O	O	29.	O	O	O	O	O
5.	O	O	O	O	O	30.	O	O	O	O	O
6.	O	O	O	O	O	31.	O	O	O	O	O
7.	O	O	O	O	O	32.	O	O	O	O	O
8.	O	O	O	O	O	33.	O	O	O	O	O
9.	O	O	O	O	O	34.	O	O	O	O	O
10.	O	O	O	O	O	35.	O	O	O	O	O
11.	O	O	O	O	O	36.	O	O	O	O	O
12.	O	O	O	O	O	37.	O	O	O	O	O
13.	O	O	O	O	O	38.	O	O	O	O	O
14.	O	O	O	O	O	39.	O	O	O	O	O
15.	O	O	O	O	O	40.	O	O	O	O	O
16.	O	O	O	O	O	41.	O	O	O	O	O
17.	O	O	O	O	O	42.	O	O	O	O	O
18.	O	O	O	O	O	43.	O	O	O	O	O
19.	O	O	O	O	O	44.	O	O	O	O	O
20.	O	O	O	O	O	45.	O	O	O	O	O
21.	O	O	O	O	O	46.	O	O	O	O	O
22.	O	O	O	O	O	47.	O	O	O	O	O
23.	O	O	O	O	O	48.	O	O	O	O	O
24.	O	O	O	O	O	49.	O	O	O	O	O
25.	O	O	O	O	O	50.	O	O	O	O	O

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015 qmult 00100 1 1 3 easy memory: short current definition 1

1. Current is the:

   a) flow of negative charge. b) flow of positive charge. c) flow of net charge.
   d) oscillation of charge. e) reflection of charge.

   SUGGESTED ANSWER: (c)

   Wrong answers:
   e) A nonsense answer.

   Redaction: Jeffery, 2012jan01

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015 qmult 00104 1 4 5 easy deducto-memory: long current definition 1

2. "Let's play *Jeopardy*! For \$100, the answer is: It is the rate of charge per unit time passing or flowing through a specified surface in a specified sense and we'll call this quantity flow for the nonce (i.e., for the rest of this answer). By 'charge' without qualification, one means the net charge (i.e., positive plus negative charge or positive charge minus the absolute value of negative charge). By 'specified sense', one means that one defines one side of the surface as the positive side where all charge flows to that side are added and all charge flows to the other side are subtracted. This means that added positive charge or subtracted negative charge both increase flow and added negative charge and positive subtracted charge both decrease flow. The above specifications for adding up the contributions to the flow make perfect sense if one considers the net charge in a box into which charge is flowing. For example, positive inflows and negative outflows increase charge in the box and positive outflows and negative inflows decrease charge in the box. Integrated flow as we have defined it gives the change in the box charge.

   Positive and negative flows can occur. Usually one chooses one's conventions so that the flows are positive, but obviously in cases where the flow can reverse or where you don't know the direction of flow initially, negative flows can arise."

   What is electrical _____, Alex?

   a) swarm b) tide c) flux d) tirade e) current

   SUGGESTED ANSWER: (e)

   Wrong answers:
   b) "There is an electrical tide in the affairs of men."

   Redaction: Jeffery, 2008jan01

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015 qmult 00110 1 1 2 easy memory: ampere defined

3. The SI unit of current is the:

   a) ampère: $1\,\mathrm{A} = 1\,\mathrm{C\,s}$. b) ampere: $1\,\mathrm{A} = 1\,\mathrm{C/s}$. c) ampere: $1\,\mathrm{A} = 1\,\mathrm{C/s^2}$.
   d) ampére: $1\,\mathrm{A} = 1\,\mathrm{C/s^2}$. e) volt: $1\,\mathrm{V} = 1\,\mathrm{C/s}$.

   SUGGESTED ANSWER: (b)

   Wrong answers:
   a) And we don't put the accent on the unit name even though the eponym was André-Marie Ampére.

   Redaction: Jeffery, 2012jan01

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015 qmult 00114 1 1 2 easy memory: ampere abbreviated to amp

4. In common parlance, the current unit ampere is often abbreviated to:

   a) ant. b) amp. c) aunt. d) aump. e) ahmp.

   SUGGESTED ANSWER: (b)

   Wrong answers:
   e) Oh, c'mon.

   Redaction: Jeffery, 2012jan01

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015 qmult 00116 1 1 4 easy memory: milliamp 1

5. One thousandth of an amp is a:

   a) kiloamp. b) hectoamp. c) deciamp. d) milliamp. e) microamp.

   SUGGESTED ANSWER: (d)

   Wrong answers:
   c) No one uses deciamps.

   Redaction: Jeffery, 2012jan01

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015 qmult 00120 1 1 1 easy memory: charge carrier charge

6. In general, the current charge carriers can be:

   a) positive or negative. b) positive only. c) negative only.
   d) neither positive nor negative. e) neutral.

   SUGGESTED ANSWER: (a)

   Wrong answers:
   d) A nonsense answer.

   Redaction: Jeffery, 2012jan01

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015 qmult 00122 1 1 1 easy memory: electron charge carriers in metals 1

7. In metals, the charge carriers are:

   a) electrons. b) protons. c) positrons. d) positive ions. e) negative ions.

   SUGGESTED ANSWER: (a)

   Wrong answers:
   c) A nonsense answer.

   Redaction: Jeffery, 2012jan01

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015 qmult 00126 1 4 1 easy deducto-memory: blame Ben Franklin

8. "Let's play *Jeopardy*! For \$100, the answer is: This person is to blame for naming positive positive and negative negative in the 18th century. If he/she had just done it the other way around, the most common charge carriers in technological application, electrons, would flow from 'positive' to 'negative'. This would have made our mental picture of conduction in metals simpler although it makes no difference in principle or practice as long as one sticks to the proper definition of current. Of course, there was not way in the 18th for him/her to have known the sign of the carriers. Still he/she could have been luckier."

   Who is _____, Alex?

   a) Ben Franklin (1706–1790) b) Benedict Arnold (1741–1801)
   c) Abigail Adams (1744–1818) d) John Paul Jones (1747–1792) e) Betsy Ross (1752–1836)

   SUGGESTED ANSWER: (a)

   Wrong answers:
   e) And she didn't sow the first flag either.

   Redaction: Jeffery, 2012jan01

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015 qmult 00150 2 3 3 moderate math: electrons in a current
Extra keywords: physci KB-173-9

9. A current of 2 A flows past a point in a wire. How many electrons flow past per second? (More exactly what is the net flow of electrons per second?)

   a) 3.2×10^{-19} electrons/s. b) 2 electrons/s. c) 1.25×10^{19} electrons/s.
   d) 2×10^{19} electrons/s. e) none.

   SUGGESTED ANSWER: (c)

Behold:

$$I_e = I \times \frac{1\,e}{1.602\ldots\times 10^{-19}\,\mathrm{C}} \approx 1.25\times 10^{19}\,e/\mathrm{s}\ .$$

The $1\,e/(1.602\ldots\times 10^{-19}\,\mathrm{C})$ is one of those factors of unity that are so convenient in conversions. Here we are finding out the current in e/second, but since each electron carries e of charge in absolute value, the current in e/second is the number of electrons flowing by per second. Note this is net flow of electrons. Actually electrons are bouncing around with partially random velocities flowing back and forth past the specified point. But there is a net flow and this is what constitutes the macroscopic current.

Wrong answers:
a) Dividing not multiplying was the right trick here.
e) As Lurch would say: "Aaaarh."

Redaction: Jeffery, 2001jan01

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015 qmult 00200 1 1 3 easy memory: current cause

10. Current is caused:

a) only by the electric field. b) only in force-free cases. c) in any number of ways.
d) conveyor belts. e) by pressure.

SUGGESTED ANSWER: (c)

Wrong answers:
a) This is usually the case in nature and technology, but it is not the only case.
d) This is the case in Van der Graaf generators.

Redaction: Jeffery, 2012jan01

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015 qmult 00210 1 1 2 easy memory: emf

11. In many current cases, the current is conceptualized as being ultimately caused by a/an _____ which is actually a work per unit charge. The _____ causes a potential difference which drives a current. The potential difference, of course, can be considered just a measure of the electric field effect that drives the current.

a) enf b) emf c) epf d) epa e) tva

SUGGESTED ANSWER: (b)

emf stands for electromotive force, but that name is a misnomer since an emf is not a force. It is a work per unit charge at one instant in time between two points in some system.

Wrong answers:
e) It built the power stations in the Tennessee Valley.

Redaction: Jeffery, 2012jan01

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015 qmult 00220 1 1 2 easy memory: battery voltage

12. The voltage difference between the terminals of a battery ideal equals the battery emf no matter what current flows through the battery. In reality, the voltage usually:

a) increases slowly with increasing current. b) decreases slowly with increasing current.
c) drops to zero with any current. d) doubles with any current.
e) oscillates with any current

SUGGESTED ANSWER: (b)

Wrong answers:
a) Exactly wrong.

Redaction: Jeffery, 2012jan01

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015 qmult 00230 1 1 5 easy memory: circuit defined

13. The electricity term circuit can be defined in somewhat different ways. But a common way is that it is closed loop or network of closed loops of:

a) wires. b) capacitors. c) magnets. d) resistors. e) conducting elements.

SUGGESTED ANSWER: (e)

Wrong answers:
a) Wires are only one common element in circuits.

Redaction: Jeffery, 2012jan01

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015 qmult 00240 1 4 1 easy deducto-memory: circuit diagrams

14. "Let's play *Jeopardy*! For $100, the answer is: They are conventionalized schematic diagrams of circuits. Common circuit elements are represented by conventionalized symbols. There are infinitely many ways of constructing a circuit represented by one of these diagrams—'do I put this wire here or there and do I lay it flat or do I make a cute curlicue of it or . . .'—but electrically the realizations should all behave the same to within some tolerance anyway."

What are _____, Alex?

a) circuit diagrams b) current diagrams c) wire diagrams d) circuit images e) wire images

SUGGESTED ANSWER: (a)

Wrong answers:
b) As Lurch would say AAAARGH.

Redaction: Jeffery, 2012jan01

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015 qmult 00300 1 1 5 easy memory: Ohm's law 1

15. The ratio of voltage drop across a device (caused by the electrical resistance of the device) to current flow through it is its resistance

$$R = \frac{V}{I} \ .$$

The SI unit of resistance is the ohm with symbol Ω:

$$1\,\Omega = \frac{1\,\mathrm{V}}{1\,\mathrm{A}} \ .$$

If R is independent of V or I (which is the same thing as being independent of V), then _____ is obeyed for the device. This law is usually written

$$V = IR \ .$$

a) Kirchhoff's voltage law b) Kirchhoff's current law c) Faraday's law d) Joe's law e) Ohm's law

SUGGESTED ANSWER: (e)

Wrong answers:
d) Doesn't seem likely does it.

Redaction: Jeffery, 2012jan01

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015 qmult 00320 1 1 4 easy math: current in toaster
Extra keywords: physci KB-171-32

16. What is the current in a toaster of 12 Ω with a DC potential (or voltage) drop across it of 120 V?

a) 0 A. b) 1440 A. c) 120 A. d) 10 A. e) 12 A.

SUGGESTED ANSWER: (d)

Wrong answers:
b) Don't multiply: divide.

Redaction: Jeffery, 2001jan01

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015 qmult 00330 1 1 3 easy memory: single loop circuit

17. A single loop circuit has emf $\mathcal{E}$ and resistor R. It's current is:

    a) $I = \mathcal{E}R$. b) $I = R/\mathcal{E}$. c) $I = \mathcal{E}/R$. d) $I = \mathcal{E}/R^2$. e) $I = \mathcal{E}R^2$.

    SUGGESTED ANSWER: (c)

    Wrong answers:
    b) Exactly wrong.

    Redaction: Jeffery, 2012jan01

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015 qmult 00400 1 4 1 easy deducto-memory: power defined

18. "Let's play *Jeopardy*! For \$100, the answer is: In physics, it is energy transferred per unit time."

    What is _____, Alex?

    a) power b) work c) force d) momentum e) density

    SUGGESTED ANSWER: (a)

    Wrong answers:
    e) As Lurch would say AAAARGH.

    Redaction: Jeffery, 2012jan01

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015 qmult 00410 1 1 3 easy memory: unit of power

19. The SI unit of power is the joule per second with special name:

    a) woo (W). b) wenn (W). c) watt (W). d) wye (W). e) woe (W).

    SUGGESTED ANSWER: (c)

    Wrong answers:
    a) A nonsense answer.

    Redaction: Jeffery, 2012jan01

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015 qmult 00428 1 1 4 easy memory: world commercial power use

20. The world commercial power usage is about:

    a) 10 kW. b) 15 MW. c) 15 GW. d) 15 TW. e) 10 PW.

    SUGGESTED ANSWER: (d)

    Wrong answers:
    e) PW stands for petawatt: $1\,\mathrm{PW} = 10^{15}\,\mathrm{W}$.

    Redaction: Jeffery, 2012jan01

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015 qmult 00430 1 1 2 easy memory: DC electric power formula 1

21. For a DC electrical element, the power input (voltage rises in current direction) or output (voltage drops in current direction) is given by the formula:

    a) $P = I/V$. b) $P = IV$. c) $P = V/I$. d) $P = IV^2$. e) $P = I^2V$.

    SUGGESTED ANSWER: (b)

    Wrong answers:
    a) A nonsense answer.

    Redaction: Jeffery, 2012jan01

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015 qmult 00440 1 1 2 easy memory: energy lost in resistance

Extra keywords: physci KB-170-13

22. The electrical energy lost in a resistance is converted into:

a) electric field energy. b) heat energy. c) magnetic field energy.
d) macroscopic mechanical energy. e) gravitational potential energy.

SUGGESTED ANSWER: (b)

Wrong answers:
e) As Lurch would say: "Aaaarh."

Redaction: Jeffery, 2001jan01

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015 qmult 00442 1 1 4 easy memory: power in resistance

23. The electrical power extracted in a resistance R with a potential drop V and a current I is:

a) $P = VIR = V/R = I/R.$ b) $P = VIR = VR^2 = I^2R.$ c) $P = VI = VR^2 = I^2/R.$
d) $P = VI = V^2/R = I^2R.$ e) $P = VI = V/R = IR.$

SUGGESTED ANSWER: (d)

Wrong answers:
a) A nonsense answer.

Redaction: Jeffery, 2008jan01

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015 qmult 00450 1 3 1 easy math: power calculation 1

Extra keywords: physci

24. A current of 10 A (an ampere is a coulomb per second) goes through a device with voltage difference of 10 V (a volt is joule per coulomb). What is the power (energy per unit time with MKS units of watts [symbol W]: i.e., joules per second) delivered to the device?

HINT: Do the units come out right from the math?

a) 100 W. b) 100 J. c) 10 W. d) 10 J. e) 1 W.

SUGGESTED ANSWER: (a)

Behold:

$$P = IV = 10 \times 10 = 100\,\mathrm{W}\ .$$

Wrong answers:
b) Wrong units.
d) Wrong units.

Redaction: Jeffery, 2001jan01

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015 qmult 00460 1 1 3 easy memory: power in X-ray tube

25. An X-ray tube operates at a current of 7.0 **mA** and a potential difference of 80 **kV** (note kilovolts). The energy is going out of electrical potential energy into electron kinetic energy and then into X-ray energy. What is the X-ray tube's power in watts?

a) 0.56 W. b) 5.6×10^5 W. c) 560 W. d) 11.4 W. e) 1.14×10^7 W.

SUGGESTED ANSWER: (c) Behold:

$$P = VI = 7.0 \times 10^{-3} \times 80 \times 10^3 = 560\,\mathrm{W}\ .$$

Wrong answers:
e) This is the resistance in ohms that would give the given current for given potential drop.

Redaction: Jeffery, 2008jan01

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015 qmult 00500 1 4 5 easy deducto-memory: in series

26. "Let's play *Jeopardy*! For $100, the answer is: It is an arrangement of circuit elements such that a single current flows consecutively through all of them."

What is _____, Alex?

a) in rough b) in sequence c) in perpendicular d) in parallel e) in series

SUGGESTED ANSWER: (e)

Wrong answers:
d) Exactly wrong.

Redaction: Jeffery, 2012jan01

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015 qmult 00600 1 1 4 easy memory: DC and AC

27. DC (direct current) has a current flow in a single direction. AC has current that alternates its direction in a periodic manner. The usual AC current function with time is a:

a) sawtooth wave. b) square wave. c) catenary. d) sinusoid. e) cycloid.

SUGGESTED ANSWER: (d)

Wrong answers:
a) This is another AC current with special uses.
b) This is another AC current with special uses.

Redaction: Jeffery, 2012jan01