: < 60% OF CLASS GOT CORRECT

(1) Which type of memory in a flash PIC allow programs (software) to be stored and over-written via a PC?
- (a) RAM
- (b) ROM
- (c) EPROM
- (d) EEPROM
- (e) HD

(2) If a PWM signal is high for 5 ms and low for 10 ms during a single period, what is the duty cycle of the signal?
- (a) (1/4) * 100%
- (b) (1/3) * 100%
- (c) (1/2) * 100%
- (d) 200%
- (e) 300%

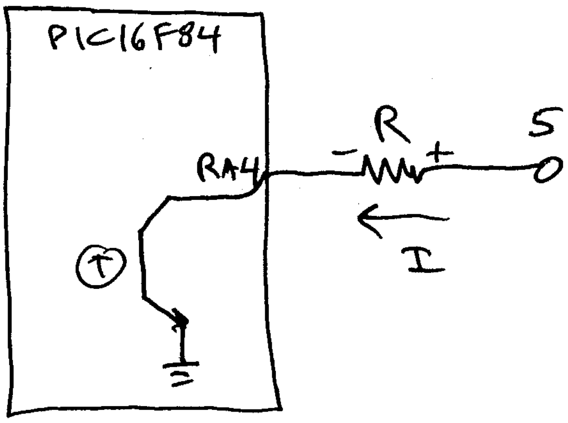
(3) The PicBasic POT command is typically used to measure
- (a) voltage
- (b) current
- (c) capacitance
- (d) inductance
- (e) resistance

(4) Given that PORTA.4 on a PIC16F84 is an open-drain output, if a resistor (of resistance R) is attached from a 5 V supply to pin RA4, what could you say about the current through the resistor after the following statement is executed?

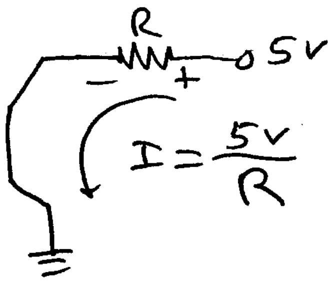
High PORTA.4

- (a) it would increase gradually (over a few tenths of a second)
- (b) it would decrease gradually (over a few tenths of a second)
- (c) it would be approximately 5V/R practically immediately
- (d) it would be approximately R/5V practically immediately
- (e) it would be 0

HIGH ⇒ (T): ON



⇒



(IMMEDIATELY SINCE NO CAPACIT[...] IN CIRCU[...]

(8) In PicBasic, to what value would the following expression evaluate:

$$2 + 2*2 / 3*3$$

(a) 2
(b) 3
(c) 4
(d) 5
(e) 6

(9) In PicBasic, what's the largest positive integer that can be represented with a WORD variable?

(a) 2^{16}
(b) $2^{16} - 1$
(c) 2^{8}
(d) $2^{8} - 1$
(e) none of the above

Questions 10 and 11 assume the following PicBasic assignment statement has been made:

TRISB = $A3

(10) What is TRISB.4?

(a) 0
(b) 1
(c) uncertain

(11) What is TRISB.5?

(a) 0
(b) 1
(c) uncertain

(12) A negative phase angle shifts a wave in the which direction?

(a) to the right along the time axis
(b) to the left along the time axis
(c) up along the vertical axis
(d) down along the vertical axis
(e) phase angle changes do not shift a wave left/right or up/down

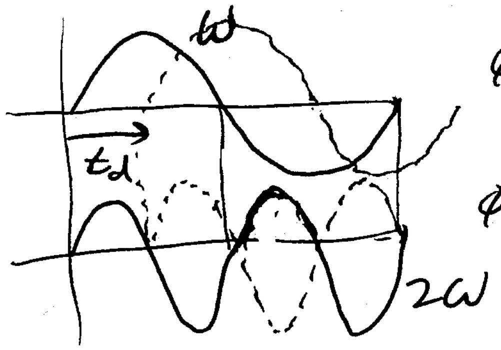
$\sin(\omega t + \phi)$
$\equiv \sin[\omega(t + t_d)]$

(13) A measurement system exhibiting phase linearity shifts all frequency components by the same amount of

(a) phase angle
(b) amplitude
(c) ~~frequency~~
(d) time
(e) ~~resonance~~

FOR NO DISTORTION
IN OUTPUT

$\phi = -k\omega \Rightarrow t_d = \frac{\phi}{\omega}$: CONSTANT



$\phi_\omega = \frac{\pi}{2}$

$\phi_{2\omega} = 2\phi_\omega$

(14) The cutoff frequency for a frequency response is defined to be at the point where
(a) the output amplitude is half the input amplitude
(b) the output power is half the input power
(c) the output power is 0.707 times the input power
(d) the frequency is 0.707 times the fundamental
(e) the frequency is half of the fundamental

$\frac{P_{out}}{P_{in}} = \frac{1}{2}$

$P \propto A^2 \Rightarrow \frac{A_{out}}{A_{in}} = \sqrt{\frac{P_{out}}{P_{in}}} = \sqrt{\frac{1}{2}} = .7$

(15) What happens to the magnitude of the impedance of a capacitor when the input frequency increases?
(a) it decreases
(b) it increases
(c) it stays the same

(16) In a typical measurement system, with a single cut-off frequency, what can you say about the attenuation in the output amplitudes for frequencies just above (but close to) the cut-off frequency?
(a) there is full attentuation
(b) there is partial attentuation
(c) there is no attenuation

(17) If the transfer function of a measurement system (with s replaced by jω) is given by:

$$G(j\omega) = \frac{1}{1-j}$$

What is the output-to-input amplitude ratio?
(a) 0
(b) 1
(c) 1/2
(d) $1/\sqrt{2}$
(e) $\sqrt{2}$

(18) If the transfer function of a measurement system (with s replaced by jω) is given by:

$$\frac{X_{out}}{X_{in}} = G(j\omega) = \frac{1}{1+j}$$

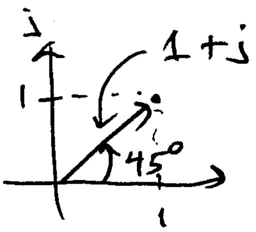
$\frac{A_{out}}{A_{in}} = |G(j\omega)|$

What is the phase relationship between the input and the output?
(a) the output lags the input by 45°
(b) the output leads the input by 45°
(c) the output lags the input by 90°
(d) the output leads the input by 90°
(e) the output is in phase with the input

$\phi = \angle G(j\omega)$

$\phi = \angle 1 - \angle(1+j)$
$= 0° - 45°$

LAG



(25) When you increase the gain magnitude of a 741 op amp circuit (e.g., a noninverting amplifier), the bandwidth of the circuit

(a) increases
(b) decreases
(c) remains unchanged
(d) becomes negative
(e) becomes infinite

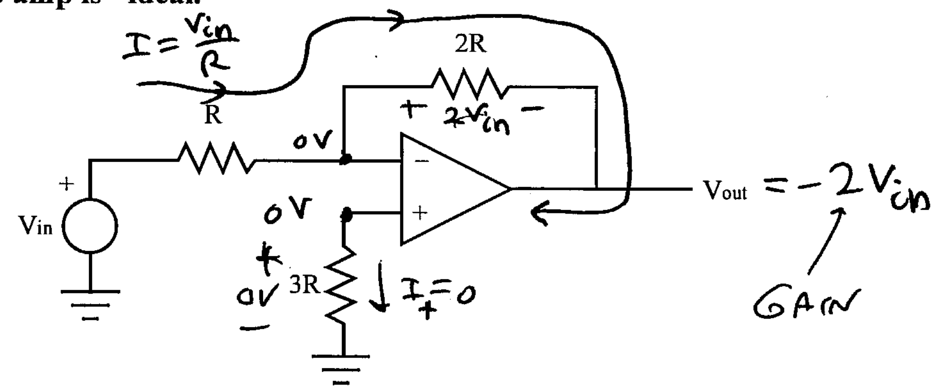
SEE NEXT PAGE

(26) An op amp follower circuit is useful because

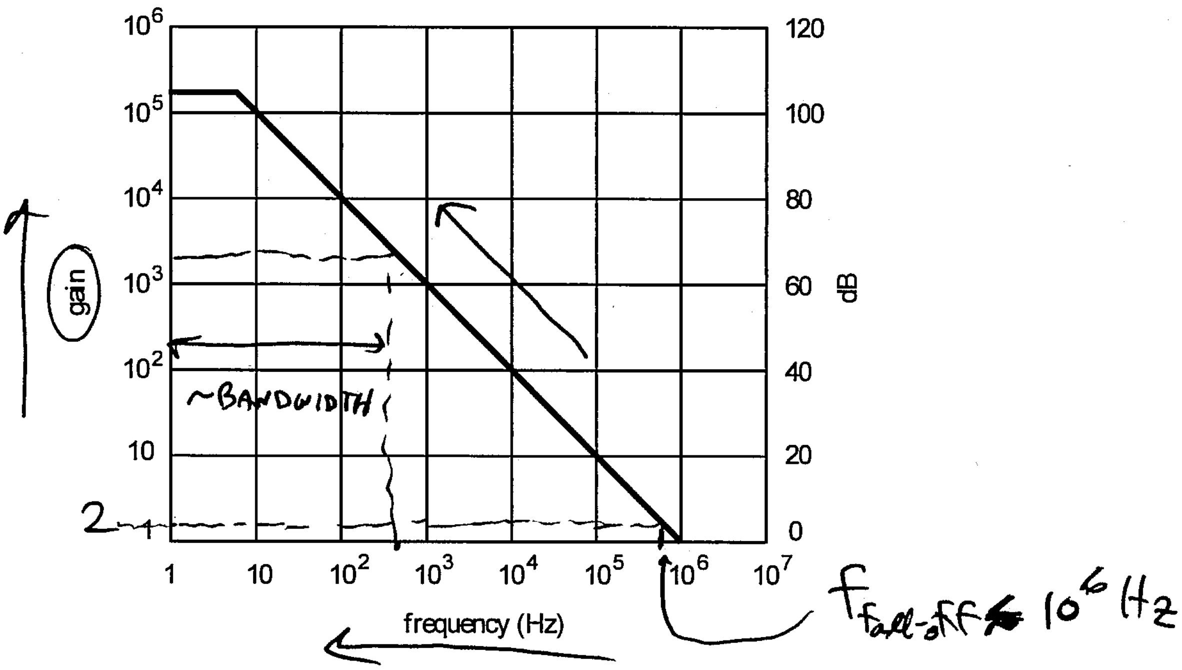
(a) the output is fixed (i.e., doesn't change) even when the input changes
(b) the output voltage is equal to the input voltage and the input current is almost zero
(c) the output voltage is equal to the input voltage and the input current is very large
(d) the output voltage is the negative of the input voltage and the input current is almost zero
(e) the output voltage is the negative of the input voltage and the input current is very large

Questions 27 through 30 deal with the circuit below, where the op amp is an LM741 with an output short circuit current of 25 mA, and a maximum output voltage swing of +/- 13.6 V. **NOTE: do not assume the op amp is "ideal."**

$I_{max} = I_{osc} = 25mA$



The open-loop frequency response curve for the op amp, as provided by the manufacturer is:



(27) If V_{in}=10V, and R=1kΩ, what would you expect for V_{out} for the real (not ideal) op amp?
(a) 5V
(b) -20V
(c) 20V
(d) -13.6V
(e) 13.6V

(28) If V_{in}=5V, and R=1kΩ, what is the magnitude of the current the op amp is sourcing or sinking at the output?
(a) 0mA
(b) 2.5mA
(c) 5mA
(d) 10mA
(e) 20mA

e

(29) If $V_{in} = 2\sin(2\pi ft)$ V, and R=1kΩ, which of the below frequencies is the highest input frequency (f) that will result in the expected amplified output voltage amplitude (without attenuation)?

$|GAIN| = 2$ SEE PREV. PAGE

(a) 100 Hz
(b) 1,000 Hz
(c) 10,000 Hz
(d) 100,000 Hz — HIGHEST f BELOW $f_{FALL-OFF}$
(e) ~~1,000,000 Hz~~

(30) If V_{in}=5V, What is the smallest R can be and still have the op amp circuit work properly (i.e., the output voltage will be as expected)?
(a) 100Ω
(b) 200Ω
(c) ~~500Ω~~
(d) 1kΩ
(e) 2kΩ

$$I = \frac{V_{in}}{R} \le I_{max}$$
$$\Rightarrow R \geq \frac{V_{in}}{I_{max}} = \frac{5V}{25mA} = \frac{1}{5}k\Omega = .2k\Omega = \boxed{200\Omega}$$

(31) Because the highest frequency a typical human (with good hearing) can hear is approximately 20 kHz, the sampling rate for standard audio CD technology is closest to
(a) 4 kHz
(b) 9 kHz
(c) 11 kHz
(d) 40 kHz
(e) 44 kHz

(32) How many different output states can a 4-bit A/D converter represent?
(a) 16
(b) 15
(c) 8
(d) 7
(e) 3

(33) If using a 4-bit A/D converter with an input voltage range of –5 V to 5 V, what is the minimum change in input voltage that would guarantee a change in the digital output for any starting value of input voltage?
(a) 5 V / 2
(b) 5 V / 4
(c) 5 V / 8
(d) 5 V / 16
(e) 5 V / 32

DISCUSS LAB PRACTICAL

- SEE COURSE POLICIES

- MENTION CIRCUIT CHECKS

  GET CREDIT ONLY IF CIRCUIT CORRECT WHEN CHECKED] TAs CAN'T TELL YOU WHAT IS WRONG (YOU MUST FIGURE OUT)

- DO WHICHEVER PART 1st THAT WILL ~~TAKE~~ YOU THE LEAST TIME

  ex: IF CIRCUIT NOT CORRECT AFTER 1st CHECK, DO OTHER PART FIRST

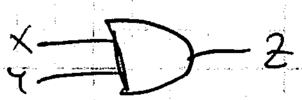
  OR PART 2 1st EASIER

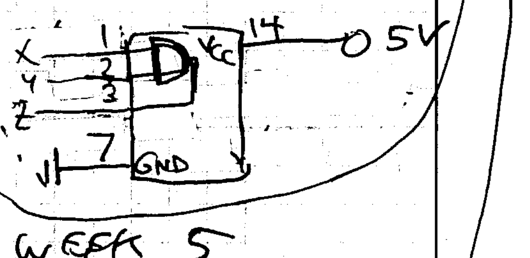
(IN POLICIES)

- GOOD FOR PRACTICE: LABS 2, 3 (BASIC STUFF), 7
- IF COLORBLIND, ASK TA TO IDENTIFY RESISTOR COLOR BAND COLORS

- KNOW DIFFERENCE BETWEEN DETAILED WIRING DIAGRAM & CIRCUIT SCHEMATIC

  ex:

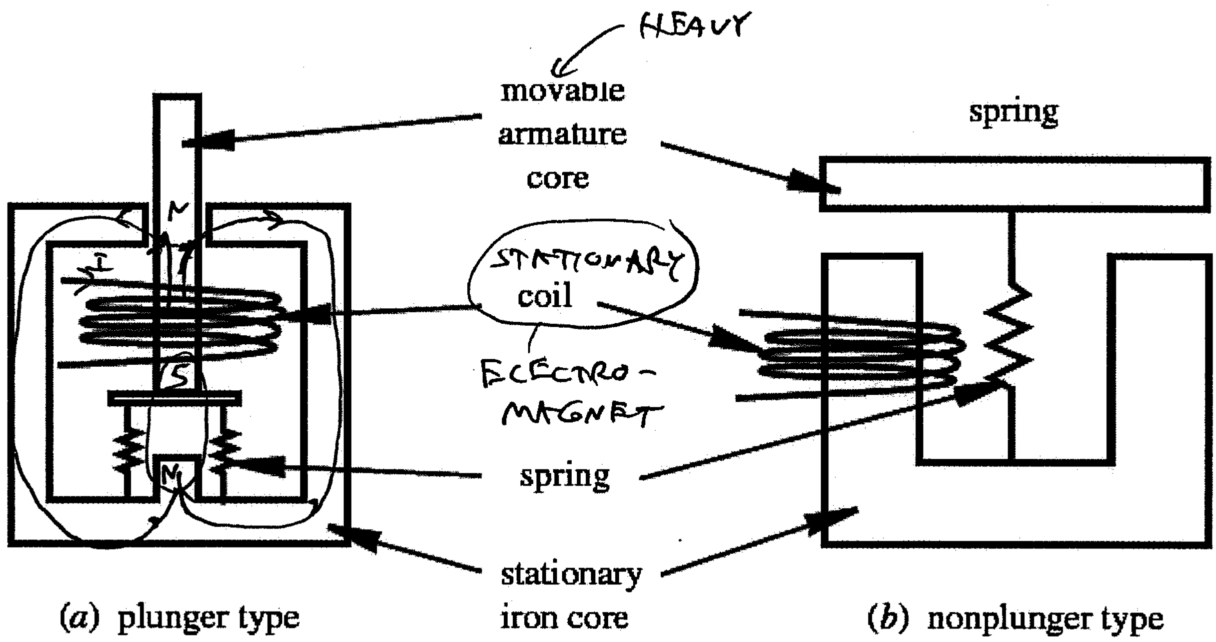




SEE CDI 6.7 SOLUTION IN WEEK 5 FOR GOOD EXAMPLE

ACTUATORS : DEVICES THAT CREATE MOTION

- SOLENOID, VOICE COIL
- ELECTRIC MOTOR
  - dc, ac, STEPPER, SERVO → (MOTOR + SENSOR)
- ENGINES
  - IC, GAS TURBINES, STEAM
- HYDRAULIC (~~FLUID~~ LIQUID POWERED)
  - CYLINDERS, MOTOR
- PNEUMATIC (AIR POWERED)
  - CYLINDER, MOTOR



ex: RELAY

Figure 10.2 (p. 434)

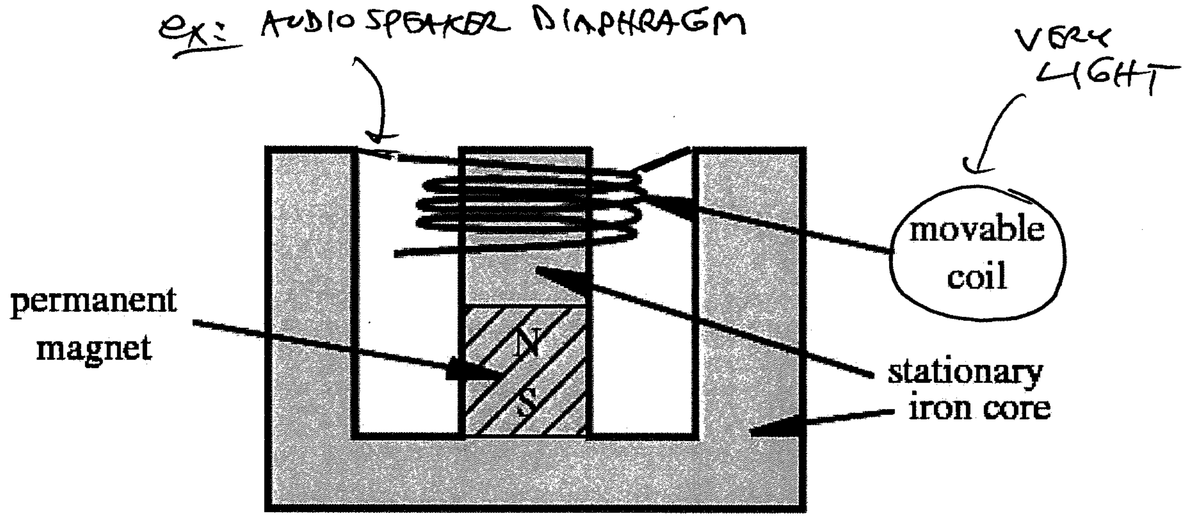
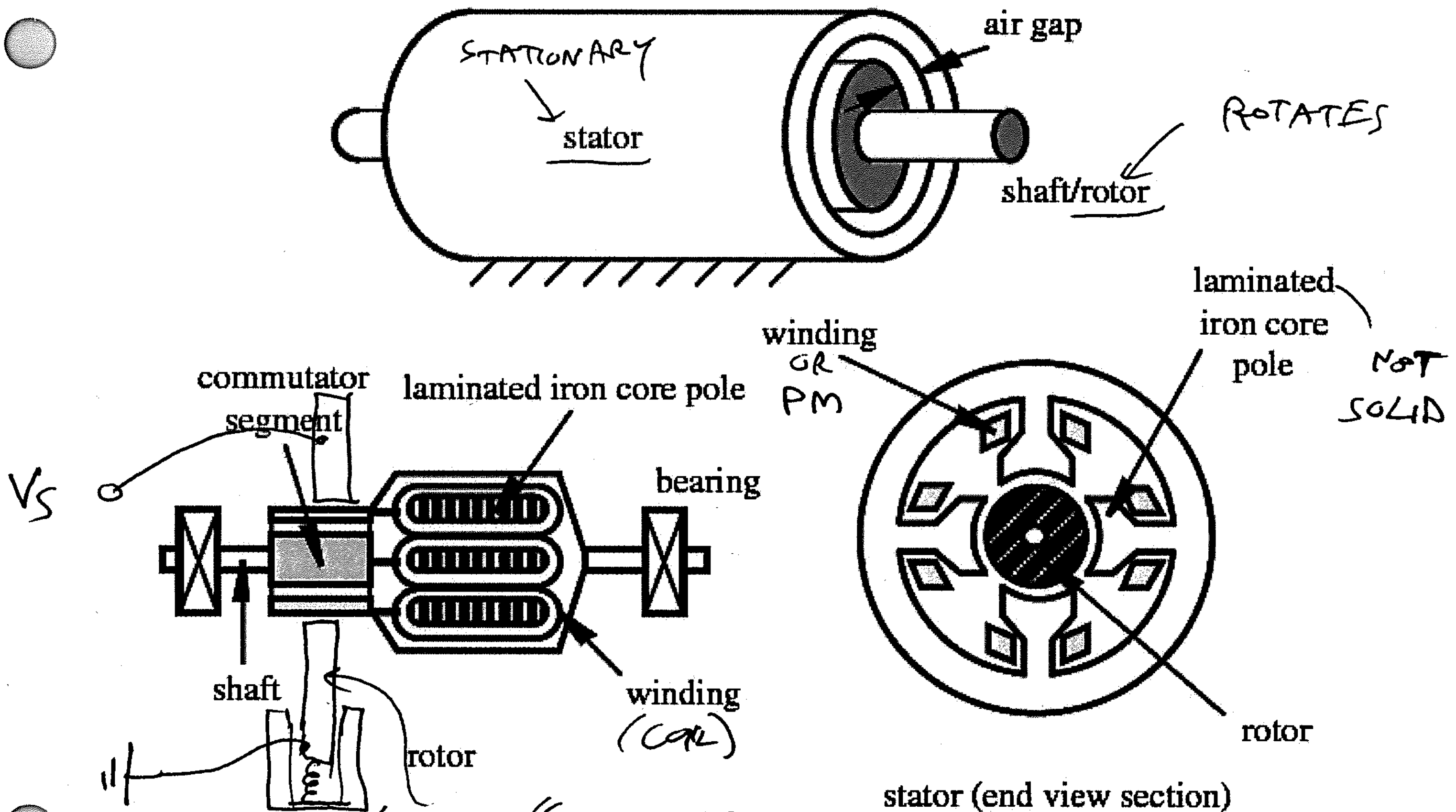


Figure 10.3 (p. 434)

CDI 10.1

CAR: STARTER MOTOR, "SOLENOID" RELAY, DOOR LOCKS,
GEAR-TO-FLYWHEEL
ENGAGE
SOLENOID

HOUSE: DISHWASHER/WASHING MACH. SOLENOID VALVES
SPRINKLER SYSTEM
SPEAKER VOICE COILS



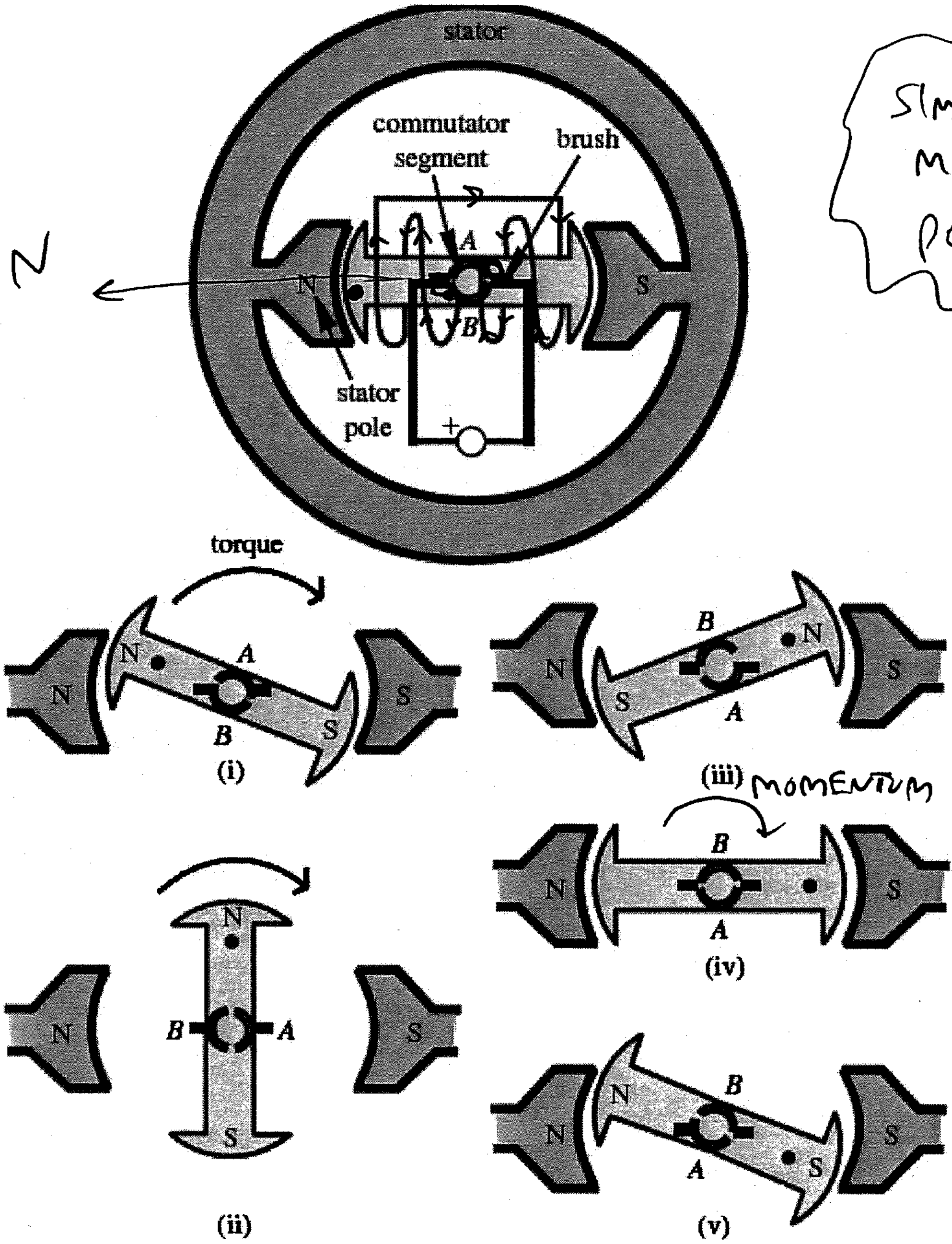
"BRUSHES" — MAKE ELECTRICAL CONTACT w/ COMMUTATOR SEGMENTS

Figure 10.6 (p. 436)

USU. GRAPHITE FOR

SELF-LUBRICATING

GOOD CONDUCTOR

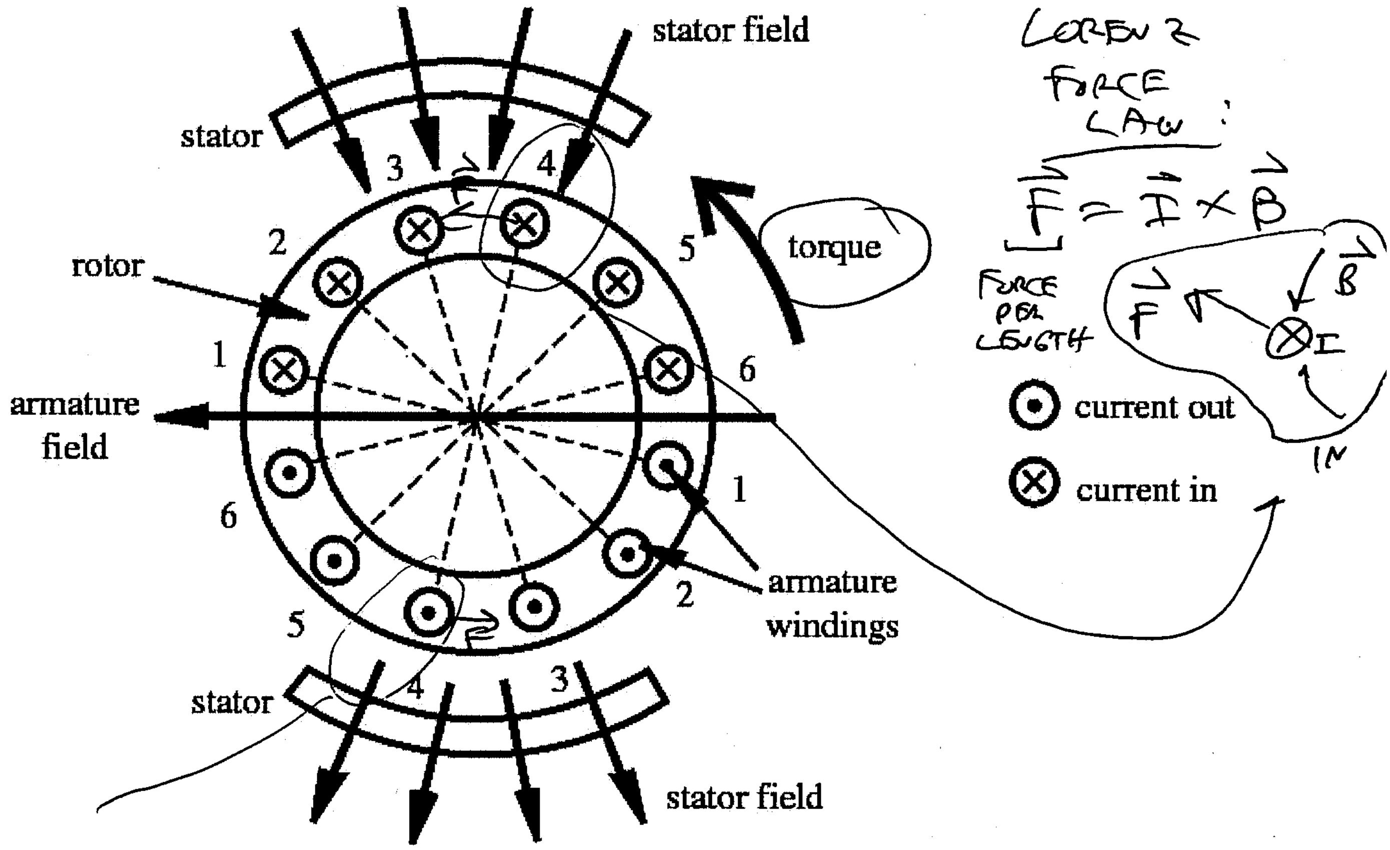


SIMPLEST DC MOTOR POSSIBLE

BUT NOT SELF-STARTING IN THIS POSITION

Figure 10.10 (p. 440)

FIELD - FIELD



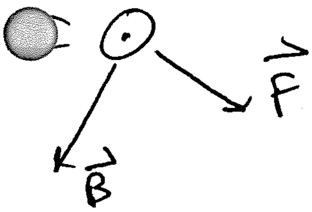


Figure 10.8 (p. 438)

SEE RADIO SHACK dc MOTOR VIDEO

CDI 10.2 WHY LAMINATE POLES

↓ B: STATOR PM FIELD

SOLID IRON POLE

EDDY CURRENTS

ROTOR WINDING

MOTOR ROTATION

FARADAY'S LAW OF INDUCTION:

$$V \propto A \cdot \underbrace{\dot{B}}$$

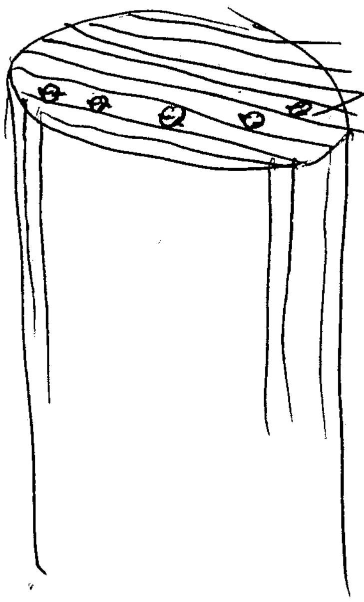
INDUCED VOLTAGE (OPPOSES CHANGE)

FROM MOTION PAST STATOR FIELDS + CHANGING CURRENTS IN ROTOR WINDINGS

BAD!

- HEAT
- POWER LOSS
- LESS TORQUE (DUE TO FIELD OPPOSITION)

LAMINATED POLE



TINY AREAS ⇒ EDDY CURRENTS VERY SMALL

⇓

SMALL V+I

⇓

BAD EFFECTS MINIMISED