Instructor(s): *Reitze/Kumar*

PHYSICS DEPARTMENT

PHY 2054 Final Exam April 23, 2011

Name (print, last first): ______________________ Signature: ______________________

On my honor, I have neither given nor received unauthorized aid on this examination.

YOUR TEST NUMBER IS THE 5-DIGIT NUMBER AT THE TOP OF EACH PAGE.

(1) **Code your test number on your answer sheet (use lines 76–80 on the answer sheet for the 5-digit number).** Code your name on your answer sheet. **DARKEN CIRCLES COMPLETELY**. Code your UFID number on your answer sheet.
(2) Print your name on this sheet and sign it also.
(3) Do all scratch work anywhere on this exam that you like. **Circle your answers on the test form.** At the end of the test, this exam printout is to be turned in. No credit will be given without both answer sheet and printout.
(4) **Blacken the circle of your intended answer completely, using a #2 pencil or blue or black ink**. Do not make any stray marks or some answers may be counted as incorrect.
(5) **The answers are rounded off. Choose the closest to exact. There is no penalty for guessing. If you believe that no listed answer is correct, leave the form blank.**
(6) Hand in the answer sheet separately.

Useful Constants:

$k_e = 8.99 \times 10^9 \text{Nm}^2/C^2$		$\epsilon_0 = 8.85 \times 10^{-12}\text{C}^2/(\text{Nm}^2)$		V=volt	N=newton
$\mu_0 = 4\pi \times 10^{-7}\text{Tm/A}$		$k_0 = \mu_0/(4\pi) = 10^{-7}\text{Tm/A}$		$c = 3 \times 10^8\text{m/s}$	
electron charge $= -1.6 \times 10^{-19}\text{C}$		electron mass $= 9.11 \times 10^{-31}\text{kg}$		J=joule	m=Meter
"milli"$=10^{-3}$	"micro"$=10^{-6}$	n="nano"$=10^{-9}$	"pico"$=10^{-12}$	C=coulomb	$g = 9.8 \text{ m/s}^2$

1. Two point particles, one with charge $+8.0 \times 10^{-9}$C and the other with charge $+2.0 \times 10^{-9}$C, are separated by 4 m. What is the magnitude of the electric field (in N/C) midway between them?

(1) 13.49 (2) 22.48 (3) 9.99 (4) 5.99 (5) 5.62

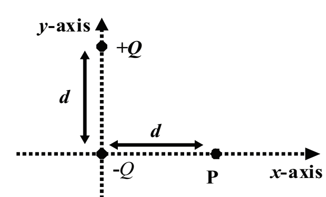
2. Two point particles, one with charge $+8.0 \times 10^{-9}$C and the other with charge $+2.0 \times 10^{-9}$C, are separated by 6 m. What is the magnitude of the electric field (in N/C) midway between them?

(1) 5.99 (2) 9.99 (3) 22.48 (4) 13.49 (5) 5.62

3. Two point particles, one with charge $+8.0 \times 10^{-9}$C and the other with charge $+2.0 \times 10^{-9}$C, are separated by 8 m. What is the magnitude of the electric field (in N/C) midway between them?

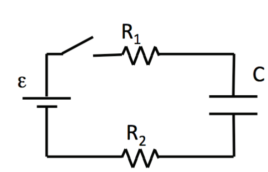
(1) 3.37 (2) 5.62 (3) 13.49 (4) 9.99 (5) 5.99

4. Two equal and opposite point charges $+Q$ and $-Q$ are located on the y-axis at $y = d$ and $y = 0$ as shown in the figure. What is the magnitude of the electric field at the point P on the x-axis a distance $x = d$ from the origin? Note $k_e = 1/(4\pi\epsilon_0)$.



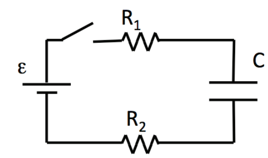
(1) $0.737 k_e Q/d^2$ (2) $2.83 k_e Q/d^2$ (3) $1.41 k_e Q/d^2$ (4) $0.71 k_e Q/d^2$ (5) $0.383 k_e Q/d^2$

5. If the switch shown in the figure is closed at $t = 0$, how much energy is stored in the capacitor C (in μJ) at $t = 10$ ms? Assume that $\epsilon = 10$V, $R_1 = 100\Omega$ $R_2 = 500\Omega$ and $C = 10\mu$F.



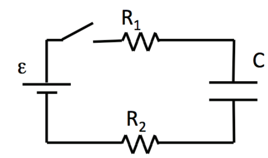
(1) 329.0 (2) 18.1 (3) 740.2 (4) 29.6 (5) 0.5

6. If the switch shown in the figure is closed at $t = 0$, how much energy is stored in the capacitor C (in μJ) at $t = 10$ ms? Assume that $\epsilon = 15$V, $R_1 = 100\Omega$ $R_2 = 500\Omega$ and $C = 10\mu$F.



(1) 740.2 (2) 329.2 (3) 18.1 (4) 29.6 (5) 0.5

7. If the switch shown in the figure is closed at $t = 0$, how much energy is stored in the capacitor C (in μJ) at $t = 10$ ms? Assume that $\epsilon = 3$V, $R_1 = 100\Omega$ $R_2 = 500\Omega$ and $C = 10\mu$F.



(1) 29.6 (2) 740.2 (3) 329.0 (4) 18.1 (5) 0.5

8. An electron (charge $q = -1.6 \times 10^{-19}$C) undergoing uniform circular motion with a radius $R = 2 \times 10^{-8}$m acts like a current loop. If the angular velocity of the electron is 1.0×10^{12} rad/s, what is the corresponding current flow around the circle (in Amps)?

(1) 2.5×10^{-8} (2) 5.0×10^{-8} (3) 1.2×10^{-8} (4) 2.5×10^{-7} (5) 5.0×10^{-7}

9. A NASA satellite traveling directly away from Earth at a speed of 1.0×10^8m/s is a distance of 6.0×10^9m from the Earth when a command is sent to the satellite from scientists on earth to send back telemetry data. Assuming the signal is sent by the scientists on Earth at $t = 0$ and the satellite instantly transmits the data when it receives the command, how much time (in s) would pass before the scientists receive the data?

(1) 60 (2) 30 (3) 5 (4) 40 (5) 4

10. A NASA satellite traveling directly away from Earth at a speed of 1.0×10^8m/s is a distance of 3.0×10^9m from the Earth when a command is sent to the satellite from scientists on earth to send back telemetry data. Assuming the signal is sent by the scientists on Earth at $t = 0$ and the satellite instantly transmits the data when it receives the command, how much time (in s) would pass before the scientists receive the data?

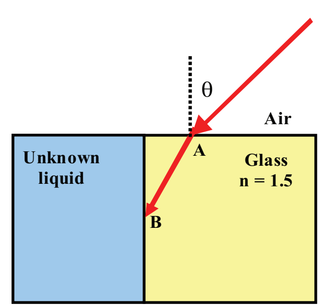
(1) 30 (2) 60 (3) 5 (4) 40 (5) 4

11. A NASA satellite traveling directly away from Earth at a speed of 1.0×10^8m/s is a distance of 6.0×10^8m from the Earth when a command is sent to the satellite from scientists on earth to send back telemetry data. Assuming the signal is sent by the scientists on Earth at $t = 0$ and the satellite instantly transmits the data when it receives the command, how much time (in s) would pass before the scientists receive the data?

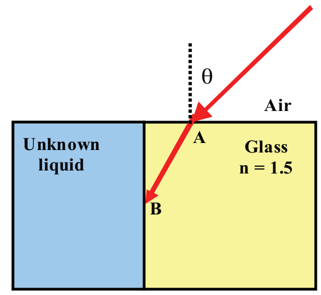
(1) 6 (2) 30 (3) 60 (4) 40 (5) 4

12. A light ray enters a rectangular glass slab (n = 1.5) at point A at an incident angle θ and then undergoes total internal reflection at point B at the interface between the glass and an unknown liquid as shown in figure. If the maximum incident angle θ for this to occur is 30°, what is the index of refraction of the unknown liquid?

(1) 1.41
(2) 1.32
(3) 1.22
(4) 1.15
(5) 1.5

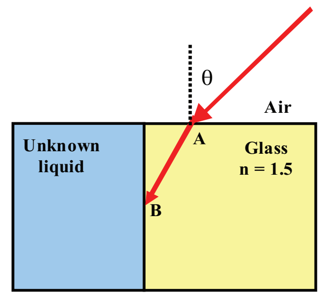


13. A light ray enters a rectangular glass slab (n = 1.5) at point A at an incident angle θ and then undergoes total internal reflection at point B at the interface between the glass and an unknown liquid as shown in figure. If the maximum incident angle θ for this to occur is 60°, what is the index of refraction of the unknown liquid?



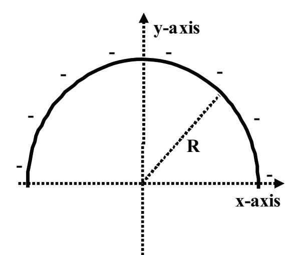
(1) 1.22
(2) 1.41
(3) 1.32
(4) 1.15
(5) 1.5

14. A light ray enters a rectangular glass slab (n = 1.5) at point A at an incident angle θ and then undergoes total internal reflection at point B at the interface between the glass and an unknown liquid as shown in figure. If the maximum incident angle θ for this to occur is 45°, what is the index of refraction of the unknown liquid?



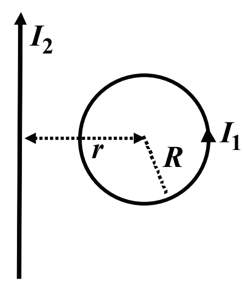
(1) 1.32
(2) 1.41
(3) 1.22
(4) 1.15
(5) 1.5

15. Negative charge is uniformly distributed on a thin insulating rod which forms a semicircle of radius R as shown in the figure. What is the direction of the electric field at the center of curvature of the semicircle (*i.e.*, at $x = y = 0$)?



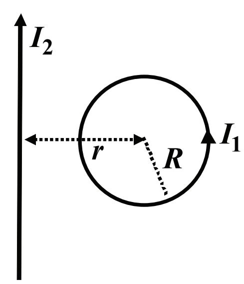
(1) positive y-direction
(2) negative y-direction
(3) positive x-direction
(4) negative x-direction
(5) E is zero at the center of curvature

16. A circular current loop with radius R carrying a current I_1 (*counter-clockwise*) is located a distance r from an infinite straight wire carrying current I_2 (*upward*) as shown in the figure. If $I_2 = 6.28 I_1$, what is the distance r such that the *net* magnetic field at the center of the circular loop is zero?



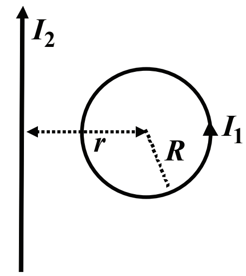
(1) $2R$
(2) $3R$
(3) R
(4) $4R$
(5) $R/2$

17. A circular current loop with radius R carrying a current I_1 (*counter-clockwise*) is located a distance r from an infinite straight wire carrying current I_2 (*upward*) as shown in the figure. If $I_2 = 9.42 I_1$, what is the distance r such that the *net* magnetic field at the center of the circular loop is zero?



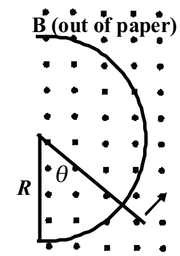
(1) $3R$
(2) $2R$
(3) R
(4) $4R$
(5) $R/2$

18. A circular current loop with radius R carrying a current I_1 (*counter-clockwise*) is located a distance r from an infinite straight wire carrying current I_2 (*upward*) as shown in the figure. If $I_2 = 12.56 I_1$, what is the distance r such that the *net* magnetic field at the center of the circular loop is zero?



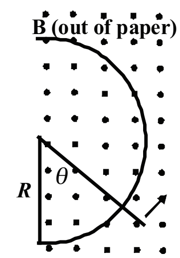
(1) $4R$
(2) $2R$
(3) R
(4) $3R$
(5) $R/2$

19. A conducting semicircle with radius $R = 2$ m lies in a uniform 0.5 T magnetic field which points out of the paper as shown in the figure. A pie shaped conducting circuit is formed by two straight wires which are connected at the center of curvature of the semicircle at an angle θ with respect to each other. If one of the straight wires is held fixed while the other is pulled around the semicircle with a constant angular velocity $\omega = 2$ rad/s, what is the induced EMF in the circuit (in Volts)?



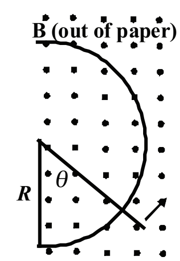
(1) 2 (2) 3 (3) 4 (4) 5 (5) 0.5

20. A conducting semicircle with radius $R = 2$ m lies in a uniform 0.5 T magnetic field which points out of the paper as shown in the figure. A pie shaped conducting circuit is formed by two straight wires which are connected at the center of curvature of the semicircle at an angle θ with respect to each other. If one of the straight wires is held fixed while the other is pulled around the semicircle with a constant angular velocity $\omega = 4$ rad/s, what is the induced EMF in the circuit (in Volts)?



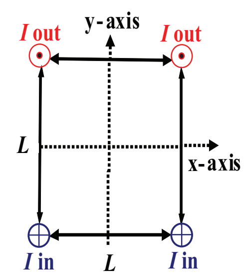
(1) 4 (2) 2 (3) 3 (4) 5 (5) 0.5

21. A conducting semicircle with radius $R = 2$ m lies in a uniform 0.5 T magnetic field which points out of the paper as shown in the figure. A pie shaped conducting circuit is formed by two straight wires which are connected at the center of curvature of the semicircle at an angle θ with respect to each other. If one of the straight wires is held fixed while the other is pulled around the semicircle with a constant angular velocity $\omega = 3$ rad/s, what is the induced EMF in the circuit (in Volts)?



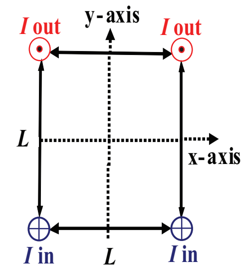
(1) 3 (2) 2 (3) 4 (4) 5 (5) 0.5

22. Four infinitely long parallel wires are normal to the xy-plane and form a square with sides of length L as shown in the figure. The top two wires each carry a current I (*out of the page*), while the bottom two wires each carry a current I (*into the page*). If $L = 0.2$ m and $I = 2$ A, what is the magnitude of the magnetic field (in μT) at the center of the square?



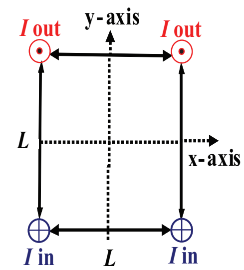
(1) 8
(2) 1
(3) 4
(4) 2
(5) 16

23. Four infinitely long parallel wires are normal to the xy-plane and form a square with sides of length L as shown in the figure. The top two wires each carry a current I (*out of the page*), while the bottom two wires each carry a current I (*into the page*). If $L = 0.2$ m and $I = 1$ A, what is the magnitude of the magnetic field (in μT) at the center of the square?



(1) 4
(2) 8
(3) 1
(4) 2
(5) 16

24. Four infinitely long parallel wires are normal to the xy-plane and form a square with sides of length L as shown in the figure. The top two wires each carry a current I (*out of the page*), while the bottom two wires each carry a current I (*into the page*). If $L = 0.1$ m and $I = 2$ A, what is the magnitude of the magnetic field (in μT) at the center of the square?



(1) 16
(2) 1
(3) 4
(4) 2
(5) 8

25. A charged particle with mass M and charge Q traveling in the x-direction with velocity v_0 enters a region of space that has a uniform 50 V/m electric field in the y-direction and a uniform 0.5 T magnetic field in the z-direction. If the particle experiences no *net* electromagnetic force and continues with the same speed and direction, what is its speed v_0 (in m/s)?

(1) 100 (2) 50 (3) 250 (4) 25 (5) 10

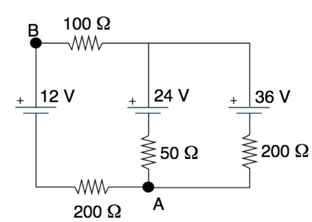
26. A charged particle with mass M and charge Q traveling in the x-direction with velocity v_0 enters a region of space that has a uniform 25 V/m electric field in the y-direction and a uniform 0.5 T magnetic field in the z-direction. If the particle experiences no *net* electromagnetic force and continues with the same speed and direction, what is its speed v_0 (in m/s)?

(1) 50 (2) 100 (3) 250 (4) 25 (5) 10

27. A charged particle with mass M and charge Q traveling in the x-direction with velocity v_0 enters a region of space that has a uniform 50 V/m electric field in the y-direction and a uniform 0.2 T magnetic field in the z-direction. If the particle experiences no *net* electromagnetic force and continues with the same speed and direction, what is its speed v_0 (in m/s)?

(1) 250 (2) 100 (3) 50 (4) 25 (5) 10

28. Find the magnitude of the current (in mA) going through the 100Ω resistor shown in the figure.



(1) 42.4
(2) 56.5
(3) 14.1
(4) 103
(5) 5.41

29. A capacitor is charged to an energy of 10.0 J. It is then disconnected from the battery and connected in parallel to a second identical capacitor. The total energy (in J) stored on both capacitors is now:

(1) 5.0 (2) 10.0 (3) 7.5 (4) 4.0 (5) 2.5

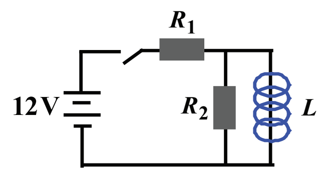
30. A capacitor is charged to an energy of 15.0 J. It is then disconnected from the battery and connected in parallel to a second identical capacitor. The total energy (in J) stored on both capacitors is now:

(1) 7.5 (2) 15.0 (3) 10.0 (4) 5.0 (5) 2.5

31. A capacitor is charged to an energy of 5.0 J. It is then disconnected from the battery and connected in parallel to a second identical capacitor. The total energy (in J) stored on both capacitors is now:

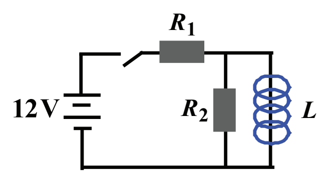
(1) 2.5 (2) 10.0 (3) 3.3 (4) 4.0 (5) 5.0

32. An RL circuit consists of an inductor L, two resistors R_1 and R_2, and a 12 V battery as shown in the figure. The switch is closed at time $t = 0$. If $R_1 = 4\Omega$, $R_2 = 2\Omega$, and $L = 10$ mH, how much energy (in mJ) is stored in the inductor after the switch has been closed for a long time?



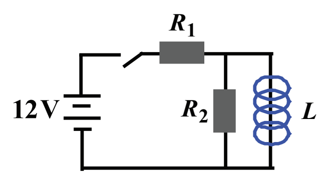
(1) 45 (2) 180 (3) 20 (4) 11.25 (5) 0.5

33. An RL circuit consists of an inductor L, two resistors R_1 and R_2, and a 12 V battery as shown in the figure. The switch is closed at time $t = 0$. If $R_1 = 2\Omega$, $R_2 = 2\Omega$, and $L = 10$ mH, how much energy (in mJ) is stored in the inductor after the switch has been closed for a long time?



(1) 180 (2) 45 (3) 20 (4) 11.25 (5) 0.5

34. An RL circuit consists of an inductor L, two resistors R_1 and R_2, and a 12 V battery as shown in the figure. The switch is closed at time $t = 0$. If $R_1 = 6\Omega$, $R_2 = 2\Omega$, and $L = 10$ mH, how much energy (in mJ) is stored in the inductor after the switch has been closed for a long time?



(1) 20 (2) 180 (3) 45 (4) 11.25 (5) 0.5

35. A man wishes to use a plane mirror on a wall to view both his head and feet as he stands in front of the mirror. The minimum required length of the mirror:

(1) is equal to one half the height of the man.
(2) is equal to the height of the man.
(3) depends on the distance the man stands from the mirror.
(4) depends on both the height of the man and the distance from the man to the mirror.
(5) must be greater than the height of the man.

36. A person holds an object 15 cm in front of a spherical mirror and finds the image to be upright and one third of its original size. Where is the image located from the mirror?

(1) 5.0 cm behind the mirror
(2) 5.0 cm in front of the mirror
(3) 10 cm in front of the mirror
(4) 10 cm behind the mirror
(5) 15 cm in front of the mirror

37. For the previous question, what is the focal length of the mirror (in cm)?

(1) -7.5 (2) -10.0 (3) $+10.0$ (4) -5.0 (5) $+15.0$

38. A person holds an object 10 cm in front of a spherical mirror and finds the image to be upright and one third of its original size. Where is the image located from the mirror?

(1) 3.3 cm behind the mirror
(2) 3.3 cm in front of the mirror
(3) 5.0 cm in front of the mirror
(4) 5.0 cm behind the mirror
(5) 10 cm in front of the mirror

39. For the previous question, what is the focal length of the mirror (in cm)?

(1) -5.0 (2) -10.0 (3) $+7.5$ (4) -7.5 (5) $+15.0$

40. A person holds an object 5 cm in front of a spherical mirror and finds the image to be upright and one third of its original size. Where is the image located from the mirror?

(1) 1.7 cm behind the mirror
(2) 1.7 cm in front of the mirror
(3) 3.3 cm in front of the mirror
(4) 3.3 cm behind the mirror
(5) 5 cm in front of the mirror

41. For the previous question, what is the focal length of the mirror (in cm)?

(1) -2.5 (2) -5.0 (3) $+5.0$ (4) $+3.3$ (5) $+7.5$

42. The near point of a farsighted person is located 60 cm from his eyes. If he wears glasses located 2 cm from his eyes, what focal length (in cm) must the glasses be in order for him to see clearly 25 cm from his eye?

(1) $+38.1$ (2) -30.0 (3) $+17.6$ (4) -15.5 (5) $+15.5$

43. The near point of a farsighted person is located 100 cm from his eyes. If he wears glasses located 2 cm from his eyes, what focal length (in cm) must the glasses be in order for him to see clearly 25 cm from his eye?

(1) $+30.0$ (2) -38.1 (3) $+17.6$ (4) -15.5 (5) $+15.5$

44. The near point of a farsighted person is located 40 cm from his eyes. If he wears glasses located 2 cm from his eyes, what focal length (in cm) must the glasses be in order for him to see clearly 25 cm from his eye?

(1) $+58.3$ (2) $+38.1$ (3) $+27.6$ (4) -58.3 (5) $+25.5$

45. A silicon monoxide ($n = 1.45$) film of 100 nm thickness is used to coat a glass camera lens ($n = 1.56$). What wavelength of light (in nm) in the visible region (390 to 710 nm) will be most efficiently transmitted by the lens?

(1) 580 (2) 464 (3) 624 (4) 400 (5) 696

46. A silicon monoxide ($n = 1.45$) film of 80 nm thickness is used to coat a glass camera lens ($n = 1.56$). What wavelength of light (in nm) in the visible region (390 to 710 nm) will be most efficiently transmitted by the lens?

(1) 464 (2) 492 (3) 624 (4) 580 (5) 696

47. A silicon monoxide ($n = 1.45$) film of 120 nm thickness is used to coat a glass camera lens ($n = 1.56$). What wavelength of light (in nm) in the visible region (390 to 710 nm) will be most efficiently transmitted by the lens?

(1) 696 (2) 492 (3) 624 (4) 580 (5) 464

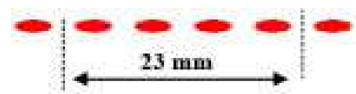
48. Light from a He-Ne laser ($\lambda = 633$ nm) strikes a pair of slits at normal incidence, forming a pattern on a screen located 1.4 m from the slits. The figure shows the interference pattern observed on the screen. What is the separation of slits (in μm)?

(1) 154 (2) 220 (3) 264 (4) 68 (5) 193

49. Light from a He-Ne laser ($\lambda = 633$ nm) strikes a pair of slits at normal incidence, forming a pattern on a screen located 2.0 m from the slits. The figure shows the interference pattern observed on the screen. What is the separation of slits (in μm)?

(1) 220 (2) 154 (3) 264 (4) 68 (5) 193

50. Light from a He-Ne laser ($\lambda = 633$ nm) strikes a pair of slits at normal incidence, forming a pattern on a screen located 2.4 m from the slits. The figure shows the interference pattern observed on the screen. What is the separation of slits (in μm)?



(1) 264 (2) 154 (3) 220 (4) 68 (5) 193

THE FOLLOWING QUESTIONS, NUMBERED IN THE ORDER OF THEIR APPEARANCE ON THE ABOVE LIST, HAVE BEEN FLAGGED AS CONTINUATION QUESTIONS: 37 39 41 FOLLOWING GROUPS OF QUESTIONS WILL BE SELECTED AS ONE GROUP FROM EACH TYPE

TYPE 1
Q# S 1
Q# S 2
Q# S 3
TYPE 2
Q# S 5
Q# S 6
Q# S 7
TYPE 3
Q# S 9
Q# S 10
Q# S 11
TYPE 4
Q# S 12
Q# S 13
Q# S 14
TYPE 5
Q# S 16
Q# S 17
Q# S 18
TYPE 6
Q# S 19
Q# S 20
Q# S 21
TYPE 7
Q# S 22
Q# S 23
Q# S 24
TYPE 8
Q# S 25
Q# S 26
Q# S 27
TYPE 9
Q# S 29
Q# S 30
Q# S 31

TYPE 10
Q# S 32
Q# S 33
Q# S 34
TYPE 11
Q# S 36 37
Q# S 38 39
Q# S 40 41
TYPE 12
Q# S 42
Q# S 43
Q# S 44
TYPE 13
Q# S 45
Q# S 46
Q# S 47
TYPE 14
Q# S 48
Q# S 49
Q# S 50