

Instructor(s): *Field/Furic*PHYSICS DEPARTMENT
Exam 2

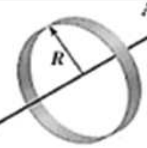
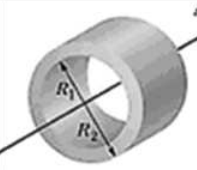
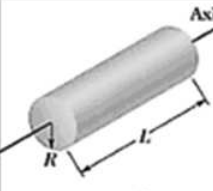
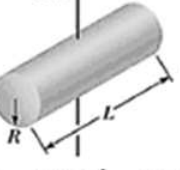

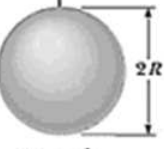
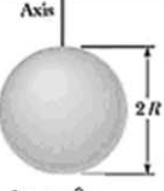


November 8, 2011

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.

Use $g = 9.80 \text{ m/s}^2$

 <p>Hoop about central axis</p> <p>$I = MR^2$ (a)</p>	 <p>Annular cylinder (or ring) about central axis</p> <p>$I = \frac{1}{2} M(R_1^2 + R_2^2)$ (b)</p>	 <p>Solid cylinder (or disk) about central axis</p> <p>$I = \frac{1}{2} MR^2$ (c)</p>
 <p>Solid cylinder (or disk) about central diameter</p> <p>$I = \frac{1}{4} MR^2 + \frac{1}{12} ML^2$ (d)</p>	 <p>Thin rod about axis through center perpendicular to length</p> <p>$I = \frac{1}{12} ML^2$ (e)</p>	 <p>Solid sphere about any diameter</p> <p>$I = \frac{2}{5} MR^2$ (f)</p>
 <p>Thin spherical shell about any diameter</p> <p>$I = \frac{2}{3} MR^2$ (g)</p>	 <p>Hoop about any diameter</p> <p>$I = \frac{1}{2} MR^2$ (h)</p>	 <p>Slab about perpendicular axis through center</p> <p>$I = \frac{1}{12} M(a^2 + b^2)$ (i)</p>

1. What is the mass (in kg) of a particle with a momentum of $2 \text{ kg}\cdot\text{m/s}$ and kinetic energy equal to 5 J ?
 (1) 0.4 (2) 0.9 (3) 1.6 (4) 3.2 (5) 0.2

2. What is the mass (in kg) of a particle with a momentum of $3 \text{ kg}\cdot\text{m/s}$ and kinetic energy equal to 5 J ?
 (1) 0.9 (2) 0.4 (3) 1.6 (4) 3.2 (5) 0.2

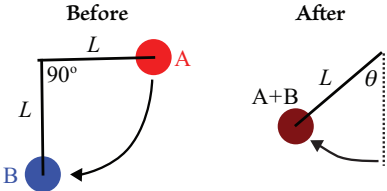
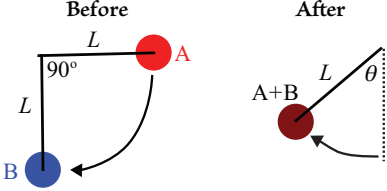
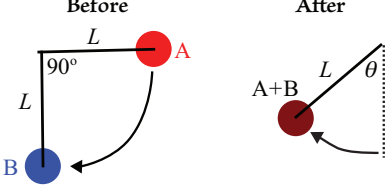
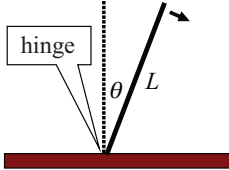
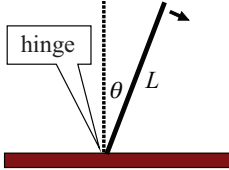
3. What is the mass (in kg) of a particle with a momentum of $4 \text{ kg}\cdot\text{m/s}$ and kinetic energy equal to 5 J ?
 (1) 1.6 (2) 0.9 (3) 0.4 (4) 3.2 (5) 0.2

4. At time $t = 0$, a 2 kg particle is located at $\vec{r} = (2m)\hat{x} + (4m)\hat{y}$, and its velocity is $\vec{v} = -(6m/s)\hat{y}$, and it is subject to the force $\vec{F} = (8N)\hat{x}$, where \hat{x} and \hat{y} are unit vectors in the x and y-direction, respectively. What are the magnitude of the angular momentum of the particle about the origin and the magnitude of the torque about the origin, respectively?
 (1) $24 \text{ kg}\cdot\text{m}^2/\text{s}$; $32 \text{ N}\cdot\text{m}$
 (2) $24 \text{ kg}\cdot\text{m}^2/\text{s}$; $24 \text{ N}\cdot\text{m}$
 (3) $24 \text{ kg}\cdot\text{m}^2/\text{s}$; $40 \text{ N}\cdot\text{m}$
 (4) $8 \text{ kg}\cdot\text{m}^2/\text{s}$; $32 \text{ N}\cdot\text{m}$
 (5) $16 \text{ kg}\cdot\text{m}^2/\text{s}$; $24 \text{ N}\cdot\text{m}$

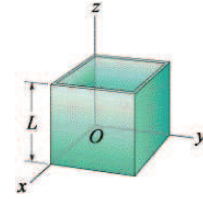
5. At time $t = 0$, a 2 kg particle is located at $\vec{r} = (2m)\hat{x} + (3m)\hat{y}$, and its velocity is $\vec{v} = -(6m/s)\hat{y}$, and it is subject to the force $\vec{F} = (8N)\hat{x}$, where \hat{x} and \hat{y} are unit vectors in the x and y-direction, respectively. What are the magnitude of the angular momentum of the particle about the origin and the magnitude of the torque about the origin, respectively?
 (1) $24 \text{ kg}\cdot\text{m}^2/\text{s}$; $24 \text{ N}\cdot\text{m}$
 (2) $24 \text{ kg}\cdot\text{m}^2/\text{s}$; $32 \text{ N}\cdot\text{m}$
 (3) $24 \text{ kg}\cdot\text{m}^2/\text{s}$; $40 \text{ N}\cdot\text{m}$
 (4) $8 \text{ kg}\cdot\text{m}^2/\text{s}$; $32 \text{ N}\cdot\text{m}$
 (5) $16 \text{ kg}\cdot\text{m}^2/\text{s}$; $24 \text{ N}\cdot\text{m}$

6. At time $t = 0$, a 2 kg particle is located at $\vec{r} = (2m)\hat{x} + (5m)\hat{y}$, and its velocity is $\vec{v} = -(6m/s)\hat{y}$, and it is subject to the force $\vec{F} = (8N)\hat{x}$, where \hat{x} and \hat{y} are unit vectors in the x and y-direction, respectively. What are the magnitude of the angular momentum of the particle about the origin and the magnitude of the torque about the origin, respectively?
 (1) $24 \text{ kg}\cdot\text{m}^2/\text{s}$; $40 \text{ N}\cdot\text{m}$
 (2) $24 \text{ kg}\cdot\text{m}^2/\text{s}$; $24 \text{ N}\cdot\text{m}$
 (3) $24 \text{ kg}\cdot\text{m}^2/\text{s}$; $32 \text{ N}\cdot\text{m}$
 (4) $8 \text{ kg}\cdot\text{m}^2/\text{s}$; $32 \text{ N}\cdot\text{m}$
 (5) $16 \text{ kg}\cdot\text{m}^2/\text{s}$; $24 \text{ N}\cdot\text{m}$

7. The coefficient of static friction between a certain cylinder with radius R and a horizontal floor is μ_s . If the rotational inertia of the cylinder about its symmetry axis is given by $I = MR^2/2$ and the magnitude of the maximum translational acceleration the cylinder can have without sliding is 7.84 m/s^2 , what is μ_s ?
 (1) 0.4 (2) 0.3 (3) 0.2 (4) 0.6 (5) 0.8

8. The coefficient of static friction between a certain cylinder with radius R and a horizontal floor is μ_s . If the rotational inertia of the cylinder about its symmetry axis is given by $I = MR^2/2$ and the magnitude of the maximum translational acceleration the cylinder can have without sliding is 5.88 m/s^2 , what is μ_s ?
- (1) 0.3 (2) 0.4 (3) 0.2 (4) 0.6 (5) 0.8
9. The coefficient of static friction between a certain cylinder with radius R and a horizontal floor is μ_s . If the rotational inertia of the cylinder about its symmetry axis is given by $I = MR^2/2$ and the magnitude of the maximum translational acceleration the cylinder can have without sliding is 3.92 m/s^2 , what is μ_s ?
- (1) 0.2 (2) 0.3 (3) 0.4 (4) 0.6 (5) 0.8
10. Two pendulum bobs have masses $M_A = 3 \text{ kg}$ and $M_B = 2 \text{ kg}$ and equal lengths L as shown in the figure. Bob A is initially held horizontally while bob B hangs vertically at rest. Bob A is released and collides with bob B. The two masses then stick together and swing upward to the right to a maximum angle θ . What is the maximum swing angle θ ?
- (1) 50.2° (2) 32.9° (3) 20.4° (4) 45.0° (5) 60.4°
- 
11. Two pendulum bobs have masses $M_A = 2 \text{ kg}$ and $M_B = 3 \text{ kg}$ and equal lengths L as shown in the figure. Bob A is initially held horizontally while bob B hangs vertically at rest. Bob A is released and collides with bob B. The two masses then stick together and swing upward to the right to a maximum angle θ . What is the maximum swing angle θ ?
- (1) 32.9° (2) 50.2° (3) 20.4° (4) 45.0° (5) 60.4°
- 
12. Two pendulum bobs have masses $M_A = 2 \text{ kg}$ and $M_B = 6 \text{ kg}$ and equal lengths L as shown in the figure. Bob A is initially held horizontally while bob B hangs vertically at rest. Bob A is released and collides with bob B. The two masses then stick together and swing upward to the right to a maximum angle θ . What is the maximum swing angle θ ?
- (1) 20.4° (2) 50.2° (3) 32.9° (4) 45.0° (5) 60.4°
- 
13. A thin stick with mass M , length L , and moment of inertia $ML^2/3$ is hinged at its lower end and allowed to fall freely as shown in the figure. If its length $L = 2 \text{ m}$ and it starts from rest at an angle $\theta = 60^\circ$, what is the speed (in m/s) of the free end of the stick when it hits the table?
- (1) 5.42 (2) 7.43 (3) 6.71 (4) 2.71 (5) 3.71
- 
14. A thin stick with mass M , length L , and moment of inertia $ML^2/3$ is hinged at its lower end and allowed to fall freely as shown in the figure. If its length $L = 2 \text{ m}$ and it starts from rest at an angle $\theta = 20^\circ$, what is the speed (in m/s) of the free end of the stick when it hits the table?
- (1) 7.43 (2) 5.42 (3) 6.71 (4) 2.71 (5) 3.71
- 

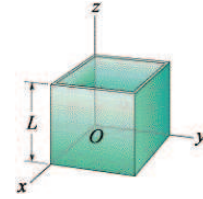
22. The figure shows a cubical box with each side consisting of a uniform metal plate of negligible thickness. Each of the four sides have mass, M , and the bottom has mass M_{bottom} . The box is open at the top (at $z = L$) and has edge length L . If the the z -coordinate of the center-of-mass is at $z_{CM} = L/3$, what is M_{bottom} ?



- (1) $2M$ (2) $4M$ (3) $6M$ (4) M

(5) $8M$

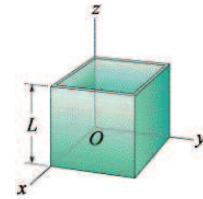
23. The figure shows a cubical box with each side consisting of a uniform metal plate of negligible thickness. Each of the four sides have mass, M , and the bottom has mass M_{bottom} . The box is open at the top (at $z = L$) and has edge length L . If the the z -coordinate of the center-of-mass is at $z_{CM} = L/4$, what is M_{bottom} ?



- (1) $4M$ (2) $2M$ (3) $6M$ (4) M

(5) $8M$

24. The figure shows a cubical box with each side consisting of a uniform metal plate of negligible thickness. Each of the four sides have mass, M , and the bottom has mass M_{bottom} . The box is open at the top (at $z = L$) and has edge length L . If the the z -coordinate of the center-of-mass is at $z_{CM} = L/5$, what is M_{bottom} ?



- (1) $6M$ (2) $4M$ (3) $2M$ (4) M

(5) $8M$

25. At the same instant that a 2.0-kg ball is dropped from 50 m above Earth, a second ball, with a mass of 1.0 kg, is thrown straight upward from Earth's surface with an initial speed of 20 m/s. They move along nearby lines and pass without colliding. What is the velocity of the center-of-mass of the two-ball system 0.5 seconds after the balls are released?

- (1) 1.8 m/s, upward (2) 8.0 m/s, downward (3) 4.7 m/s, upward (4) 1.8 m/s, downward (5) 8.0 m/s, upward

26. At the same instant that a 2.0-kg ball is dropped from 50 m above Earth, a second ball, with a mass of 1.0 kg, is thrown straight upward from Earth's surface with an initial speed of 20 m/s. They move along nearby lines and pass without colliding. What is the velocity of the center-of-mass of the two-ball system 1.5 seconds after the balls are released?

- (1) 8.0 m/s, downward (2) 1.8 m/s, upward (3) 4.7 m/s, upward (4) 1.8 m/s, downward (5) 8.0 m/s, upward

27. At the same instant that a 2.0-kg ball is dropped from 50 m above Earth, a second ball, with a mass of 1.0 kg, is thrown straight upward from Earth's surface with an initial speed of 20 m/s. They move along nearby lines and pass without colliding. What is the velocity of the center-of-mass of the two-ball system 0.2 seconds after the balls are released?

- (1) 4.7 m/s, upward (2) 8.0 m/s, downward (3) 1.8 m/s, upward (4) 4.7 m/s, downward (5) 8.0 m/s, upward

28. A man is riding in a cart with mass M at speed v along a frictionless horizontal surface. He jumps off in such a way as to land on the ground with no horizontal velocity. If the new speed of the cart is $3v$, what is the mass of the man?

- (1) $2M$ (2) $3M$ (3) $4M$ (4) $5M$ (5) M

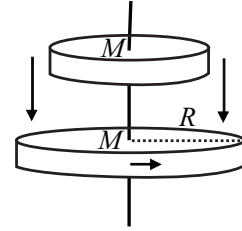
29. A man is riding in a cart with mass M at speed v along a frictionless horizontal surface. He jumps off in such a way as to land on the ground with no horizontal velocity. If the new speed of the cart is $4v$, what is the mass of the man?

- (1) $3M$ (2) $2M$ (3) $4M$ (4) $5M$ (5) M

30. A man is riding in a cart with mass M at speed v along a frictionless horizontal surface. He jumps off in such a way as to land on the ground with no horizontal velocity. If the new speed of the cart is $5v$, what is the mass of the man?

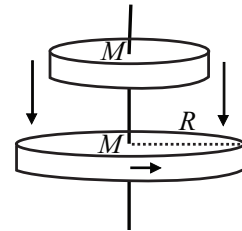
(1) $4M$ (2) $3M$ (3) $2M$ (4) $5M$ (5) M

31. A uniform solid disk with mass M and radius R is mounted on a vertical shaft with negligible rotational inertia and is initially rotating with angular speed ω . A non-rotating uniform solid disk with mass M and radius $R/2$ is suddenly dropped onto the same shaft as shown in the figure. The two disks stick together and rotate at the same angular speed. What is the new angular speed of the two disk system?



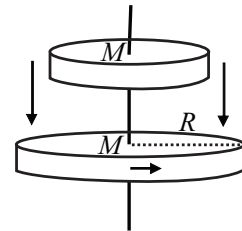
(1) $4\omega/5$ (2) $16\omega/25$ (3) $9\omega/13$ (4) $2\omega/3$ (5) $\omega/4$

32. A uniform solid disk with mass M and radius R is mounted on a vertical shaft with negligible rotational inertia and is initially rotating with angular speed ω . A non-rotating uniform solid disk with mass M and radius $3R/4$ is suddenly dropped onto the same shaft as shown in the figure. The two disks stick together and rotate at the same angular speed. What is the new angular speed of the two disk system?



(1) $16\omega/25$ (2) $4\omega/5$ (3) $9\omega/13$ (4) $2\omega/3$ (5) $\omega/4$

33. A uniform solid disk with mass M and radius R is mounted on a vertical shaft with negligible rotational inertia and is initially rotating with angular speed ω . A non-rotating uniform solid disk with mass M and radius $2R/3$ is suddenly dropped onto the same shaft as shown in the figure. The two disks stick together and rotate at the same angular speed. What is the new angular speed of the two disk system?



(1) $9\omega/13$ (2) $16\omega/25$ (3) $4\omega/5$ (4) $2\omega/3$ (5) $\omega/4$

34. Two small balls are simultaneously released from rest in a deep pool of water (with density ρ_{water}). The first ball is released from rest at the surface of the pool and has a density 1.5 times the density of water (*i.e.*, $\rho_1 = 1.5\rho_{\text{water}}$). A second ball of unknown density is released from rest at the bottom of the pool. If it takes the second ball the same amount of time to reach the surface of the pool as it takes for the first ball to reach the bottom of the pool, what is the density of the second ball? Neglect hydrodynamic drag forces.

(1) $\frac{3}{4}\rho_{\text{water}}$ (2) $\frac{2}{3}\rho_{\text{water}}$ (3) $\frac{3}{5}\rho_{\text{water}}$ (4) $\frac{1}{2}\rho_{\text{water}}$ (5) $\frac{1}{3}\rho_{\text{water}}$

35. Two small balls are simultaneously released from rest in a deep pool of water (with density ρ_{water}). The first ball is released from rest at the surface of the pool and has a density two times the density of water (*i.e.*, $\rho_1 = 2\rho_{\text{water}}$). A second ball of unknown density is released from rest at the bottom of the pool. If it takes the second ball the same amount of time to reach the surface of the pool as it takes for the first ball to reach the bottom of the pool, what is the density of the second ball? Neglect hydrodynamic drag forces.

(1) $\frac{2}{3}\rho_{\text{water}}$ (2) $\frac{3}{4}\rho_{\text{water}}$ (3) $\frac{3}{5}\rho_{\text{water}}$ (4) $\frac{1}{2}\rho_{\text{water}}$ (5) $\frac{1}{3}\rho_{\text{water}}$

36. Two small balls are simultaneously released from rest in a deep pool of water (with density ρ_{water}). The first ball is released from rest at the surface of the pool and has a density three times the density of water (*i.e.*, $\rho_1 = 3\rho_{\text{water}}$). A second ball of unknown density is released from rest at the bottom of the pool. If it takes the second ball the same amount of time to reach the surface of the pool as it takes for the first ball to reach the bottom of the pool, what is the density of the second ball? Neglect hydrodynamic drag forces.

- (1) $\frac{3}{5}\rho_{\text{water}}$ (2) $\frac{2}{3}\rho_{\text{water}}$ (3) $\frac{3}{4}\rho_{\text{water}}$ (4) $\frac{1}{2}\rho_{\text{water}}$ (5) $\frac{1}{3}\rho_{\text{water}}$

37. When a stone of weight W is suspended from a scale and submerged in water the scale reads 10 kg. When the same stone is suspended from a scale and submerged in oil the scale reads 12 kg. If the density of the oil is 0.8 the density of the water (*i.e.*, $\rho_{\text{oil}} = 0.8\rho_{\text{water}}$), what is the true weight W (in kg) of the stone?

- (1) 20 (2) 18 (3) 30 (4) 24 (5) 35

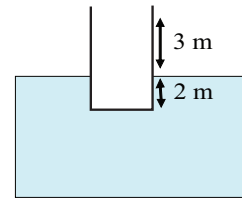
38. When a stone of weight W is suspended from a scale and submerged in water the scale reads 10 kg. When the same stone is suspended from a scale and submerged in oil the scale reads 12 kg. If the density of the oil is 0.75 the density of the water (*i.e.*, $\rho_{\text{oil}} = 0.75\rho_{\text{water}}$), what is the true weight W (in kg) of the stone?

- (1) 18 (2) 20 (3) 30 (4) 24 (5) 35

39. When a stone of weight W is suspended from a scale and submerged in water the scale reads 10 kg. When the same stone is suspended from a scale and submerged in oil the scale reads 12 kg. If the density of the oil is 0.9 the density of the water (*i.e.*, $\rho_{\text{oil}} = 0.9\rho_{\text{water}}$), what is the true weight W (in kg) of the stone?

- (1) 30 (2) 18 (3) 20 (4) 24 (5) 35

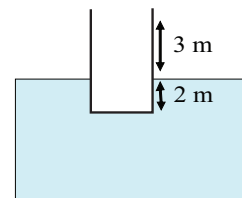
40. A large cargo container has a square base with an area of 4 m^2 and height $H = 5 \text{ m}$. When empty it floats on the water ($\rho_{\text{water}} = 1,000 \text{ kg/m}^3$) with 3 meters above the surface of the water and 2 m below the surface as shown in the figure. The cargo container is being loaded with small 50-kg boxes. What is the maximum number boxes the cargo container can hold without sinking?



- (1) 240 (2) 300 (3) 200 (4) 150

(5) 400

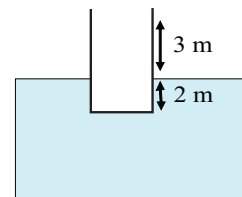
41. A large cargo container has a square base with an area of 4 m^2 and height $H = 5 \text{ m}$. When empty it floats on the water ($\rho_{\text{water}} = 1,000 \text{ kg/m}^3$) with 3 meters above the surface of the water and 2 m below the surface as shown in the figure. The cargo container is being loaded with small 40-kg boxes. What is the maximum number boxes the cargo container can hold without sinking?



- (1) 300 (2) 240 (3) 200 (4) 150

(5) 400

42. A large cargo container has a square base with an area of 4 m^2 and height $H = 5 \text{ m}$. When empty it floats on the water ($\rho_{\text{water}} = 1,000 \text{ kg/m}^3$) with 3 meters above the surface of the water and 2 m below the surface as shown in the figure. The cargo container is being loaded with small 60-kg boxes. What is the maximum number boxes the cargo container can hold without sinking?



- (1) 200 (2) 300 (3) 240 (4) 150

(5) 400

60. A 2,000 kg wrecking ball is to be lifted by a crane with a steel cable that has a diameter of 1.5 cm and an unstretched length of 31.4 m. The Young's modulus of steel is 2.0×10^{11} Pa. Ignoring the weight of the cable itself, when the ball is lifted and held at rest how much does the cable stretch (in cm)?
- (1) 1.74 (2) 3.92 (3) 0.98 (4) 0.24 (5) 4.25

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 4

Q# S 5

Q# S 6

TYPE 3

Q# S 7

Q# S 8

Q# S 9

TYPE 4

Q# S 10

Q# S 11

Q# S 12

TYPE 5

Q# S 13

Q# S 14

Q# S 15

TYPE 6

Q# S 16

Q# S 17

Q# S 18

TYPE 7

Q# S 19

Q# S 20

Q# S 21

TYPE 8

Q# S 22

Q# S 23

Q# S 24

TYPE 9

Q# S 25

Q# S 26

Q# S 27

TYPE 10

Q# S 28

Q# S 29

Q# S 30

TYPE 11

Q# S 31

Q# S 32

Q# S 33

TYPE 12

Q# S 34

Q# S 35

Q# S 36

TYPE 13

Q# S 37

Q# S 38

Q# S 39

TYPE 14

Q# S 40

Q# S 41

Q# S 42

TYPE 15

Q# S 43

Q# S 44

Q# S 45

TYPE 16

Q# S 46

Q# S 47
Q# S 48
TYPE 17
Q# S 49
Q# S 50
Q# S 51
TYPE 18
Q# S 52
Q# S 53
Q# S 54
TYPE 19
Q# S 55
Q# S 56
Q# S 57
TYPE 20
Q# S 58
Q# S 59
Q# S 60