

# PHYSICS

NEET

CRASH COURSE

ROTATIONAL MOTION

**SMART ACHIEVERS**  
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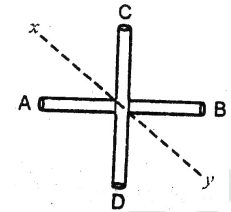
A Unit of SMARTACHIEVERS LEARNING Pvt. Ltd., Delhi

**ROTATIONAL MOTION**

Q.1 In an arrangement four particles, each of mass 2 kilogram are situated at the coordinate points (3, 2, 0), (1, -1, 0), (0, 0, 0) and (-1, 1, 0). The moment of inertia of this arrangement about the Z-axis will be  
 (1) 8 units                      (2) 16 units                      (3) 43 units                      (4) 34 units

Q.2 AB and CD are two identical rods each of length  $2\sqrt{2}l$  and mass m joined to form a cross. The moment of inertia of these two rods about a bisector (XY) of angle between the rods is :

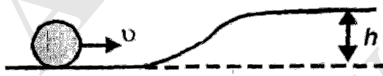
- (1)  $\frac{ml^2}{12}$                                       (2)  $\frac{ml^2}{3}$   
 (3)  $\frac{2ml^2}{3}$                                       (4)  $\frac{ml^2}{6}$



Q.3 A circular ring of wire of mass M and radius R is making n revolutions/sec about an axis passing through a point on its rim and perpendicular to its plane. The kinetic energy of rotation of the ring is given by-

- (1)  $4\pi^2MR^2n^2$                       (2)  $2\pi^2MR^2n^2$                       (3)  $\frac{1}{2}\pi^2MR^2n^2$                       (4)  $8\pi^2MR^2n^2$

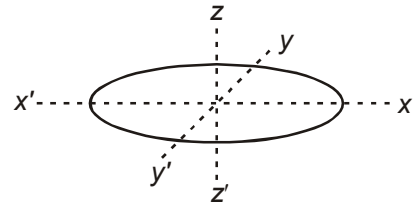
Q.4 A solid sphere is rolling on a frictionless surface as shown in Fig. with a translational velocity v m/s. If it is to climb the inclined surface, then v should be :



- (1)  $\geq \sqrt{\frac{10}{7}gh}$                       (2)  $> \sqrt{2gh}$                       (3)  $2gh$                       (4)  $\frac{10}{7}gh$

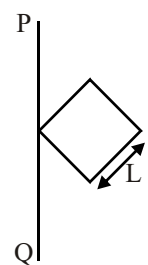
Q.5 An elliptical disc shown in the figure is rotated in turn about  $x-x'$ ,  $y-y'$  and  $z-z'$  axes passing through the centre of mass of the disc. Moment of inertia of the disc is (The disc lies in x-y plane)

- (1) Same about all the three axes  
 (2) Maximum about  $z-z'$  axes  
 (3) Maximum about  $y-y'$  axis  
 (4) Same about  $x-x'$  and  $y-y'$  axis



Q.6 A square is made by joining four rods, each of mass M and length L. Its moment of inertia, about an axis PQ, in its plane and is passing through one of its end, is (as shown in the figure)

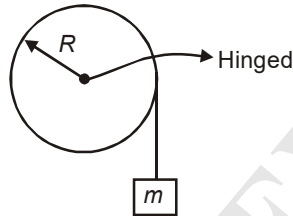
- (1)  $6ML^2$   
 (2)  $\frac{4}{3}ML^2$   
 (3)  $\frac{8}{3}ML^2$   
 (4)  $\frac{10}{3}ML^2$



Q.7 Let  $\vec{F}$  be a force acting on a particle having position vector  $\vec{r}$ . Let  $\vec{\tau}$  be the torque of this force about the origin, then :

- (1)  $\vec{F} \cdot \vec{\tau} = 0$  and  $\vec{r} \cdot \vec{\tau} = 0$                       (2)  $\vec{F} \cdot \vec{\tau} = 0$  but  $\vec{r} \cdot \vec{\tau} \neq 0$   
 (3)  $\vec{F} \cdot \vec{\tau} \neq 0$  but  $\vec{r} \cdot \vec{\tau} = 0$                       (4)  $\vec{F} \cdot \vec{\tau} \neq 0$  and  $\vec{r} \cdot \vec{\tau} \neq 0$

Q.8 Calculate the torque acting on the disc in the given arrangement (Radius of disc 1m and mass  $m$ )

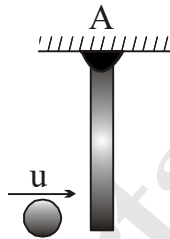


- (1)  $2 mg/3$                       (2)  $mg/3$                       (3)  $mg$                       (4)  $4 mg/5$

Q.9 A solid iron sphere A rolls down an inclined plane, while another hollow sphere B with the same mass and external radius also rolls down the inclined plane. If  $V_A$  and  $V_B$  are their velocities at the bottom of the inclined plane, then

- (1)  $V_A > V_B$                       (2)  $V_A = V_B$                       (3)  $V_A < V_B$                       (4)  $V_A > = < V_B$

Q.10 In the given figure a ball strikes a uniform rod of same mass elastically and rod is hinged at point A. Then which of the statement is correct?



- (1) linear momentum of system (ball + rod) is conserved.  
 (2) angular momentum of system (ball + rod) about any point except the hinged point A is conserved.  
 (3) kinetic energy of system (ball + rod) before the collision is equal to kinetic energy of system just after the collision  
 (4) linear momentum of ball is conserved.

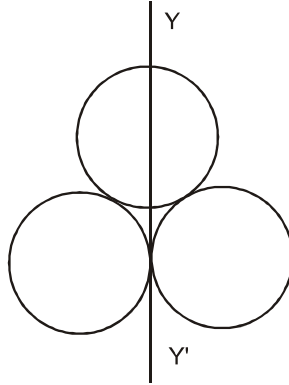
Q.11 From the theorem of perpendicular axes. If the lamina is in X- Y plane

- (1)  $I_x - I_y = I_z$                       (2)  $I_x + I_z = I_y$                       (3)  $I_x + I_y = I_z$                       (4)  $I_y + I_z = I_x$

Q.12 The moment of inertia of a uniform ring of mass M and radius r about a tangent lying in its own plane is

- (1)  $2Mr^2$                       (2)  $\frac{3}{2} Mr^2$                       (3)  $Mr^2$                       (4)  $\frac{1}{2} Mr^2$

Q.13 Three rings each of mass  $M$  and radius  $R$  are arranged as shown in the figure. The moment of inertia of the system about  $YY'$  will be

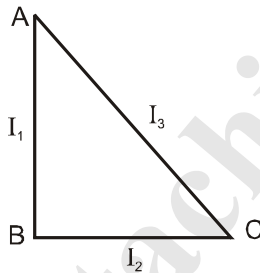


- (1)  $3 MR^2$                       (2)  $\frac{3}{2} MR^2$                       (3)  $5 MR^2$                       (4)  $\frac{7}{2} MR^2$

Q.14 Three rods each of length  $L$  and mass  $M$  are placed along  $X$ ,  $Y$  and  $Z$  axes in such a way that one end of each of the rod is at the origin. The moment of inertia of this system about  $Z$  axis is

- (1)  $\frac{2ML^2}{3}$                       (2)  $\frac{4ML^2}{3}$                       (3)  $\frac{5ML^2}{3}$                       (4)  $\frac{ML^2}{3}$

Q.15  $ABC$  is a right angled triangular plate of uniform thickness. The sides are such that  $AB > BC$  as shown in figure.  $I_1, I_2, I_3$  are moments of inertia about  $AB, BC$  and  $AC$  respectively. Then which of the following relations is correct ?



- (1)  $I_1 = I_2 = I_3$                       (2)  $I_2 > I_1 > I_3$                       (3)  $I_3 < I_2 < I_1$                       (4)  $I_3 > I_1 > I_2$

Q.16 The moment of inertia of a sphere of mass  $M$  and radius  $R$  about an axis passing through its centre is  $\frac{2}{5}MR^2$ . The radius of gyration of the sphere about a parallel axis to the above and tangent to the sphere is

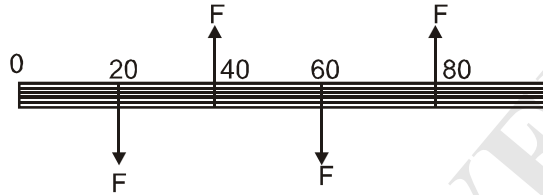
- (1)  $\frac{7}{5}R$                       (2)  $\frac{3}{5}R$                       (3)  $\left(\frac{7}{5}\right)R$                       (4)  $\left(\frac{3}{5}\right)R$

Q.17 Rotational power in rotational motion is

- (1)  $\tau \cdot \omega$                       (2)  $\omega \times \tau$                       (3)  $\tau \cdot \alpha$                       (4)  $\tau \times \alpha$

- Q.18 A constant torque of 31.4 N-m is exerted on a pivoted wheel. If angular acceleration of wheel is  $4\pi \text{ rad/sec}^2$ , then the moment of inertia of the wheel is  
 (1)  $2.5 \text{ kg-m}^2$       (2)  $3.5 \text{ kg-m}^2$       (3)  $4.5 \text{ kg-m}^2$       (4)  $5.5 \text{ kg-m}^2$

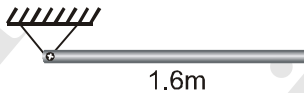
- Q.19 Four equal and parallel forces are acting on a rod (as shown in figure) at distances of 20 cm, 40 cm, 60 cm and 80 cm respectively from one end of the rod. Under the influence of these forces the rod :



- (1) Is at rest      (2) Experiences a torque  
 (3) Experiences a linear motion      (4) Experiences a torque and also a linear motion
- Q.20 One end of a uniform rod of mass  $m$  and length  $2\sqrt{2}l$  is clamped. The rod lies on a smooth horizontal surface and rotates on it about the clamped end at a uniform angular velocity  $\omega$ . The force exerted by the clamp on the rod has a horizontal component

- (1)  $m\omega^2 2\sqrt{2}l$       (2) zero      (3)  $mg$       (4)  $\frac{1}{2}m\omega^2 2\sqrt{2}l$

- Q.21 The uniform rod of mass 20 kg and length of 1.6 m is pivoted at its end and swings freely in the vertical plane. Angular acceleration of rod just after the rod is released from rest in the horizontal position.



- (1)  $\frac{15g}{16}$       (2)  $\frac{17g}{16}$       (3)  $\frac{16g}{15}$       (4)  $\frac{g}{15}$

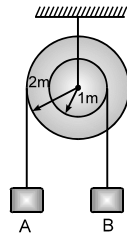
- Q.22 The rotational kinetic energy is:

- (1)  $\frac{1}{2}m\omega^2$       (2)  $\frac{1}{2}I\alpha^2$       (3)  $\frac{1}{2}I\omega^2$       (4)  $\frac{1}{2}mv^2$

- Q.23 A uniform rod of length  $2L$  is placed with one end in contact with the horizontal and is then inclined at an angle  $\alpha$  to the horizontal and allowed to fall without slipping at contact point. When it becomes horizontal. its angular velocity Will be

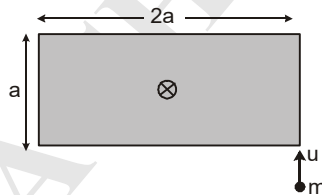
- (1)  $\omega = \sqrt{\frac{3g\sin\alpha}{L}}$       (2)  $\omega = \sqrt{\frac{2L}{3g\sin\alpha}}$       (3)  $\omega = \sqrt{\frac{6g\sin\alpha}{L}}$       (4)  $\omega = \sqrt{\frac{L}{g\sin\alpha}}$

- Q.24 In the pulley system (stick to each other) shown, if radii of the bigger and smaller pulley are 2 m and 1 m respectively and the acceleration of block A is  $5 \text{ m/s}^2$  in the downward direction, then the acceleration of block B will be:



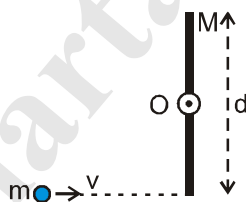
- (1)  $0 \text{ m/s}^2$                       (2)  $5 \text{ m/s}^2$                       (3)  $10 \text{ m/s}^2$                       (4)  $5/2 \text{ m/s}^2$

- Q.25 A uniform rectangular plate of mass  $m$  which is free to rotate about the smooth vertical hinge passing through the centre and perpendicular to the plate, is lying on a smooth horizontal surface. A particle of mass  $m$  moving with speed ' $u$ ' collides with the plate and sticks to it as shown in figure. The angular velocity of the plate after collision will be :



- (1)  $\frac{12 u}{5 a}$                       (2)  $\frac{12 u}{19 a}$                       (3)  $\frac{3 u}{2 a}$                       (4)  $\frac{3 u}{5 a}$

- Q.26 A particle of mass  $m$  is moving horizontally at speed  $v$  perpendicular to a uniform rod of length  $d$  and mass  $M = 6m$ . The rod is hinged at centre  $O$  and can freely rotate in horizontal plane about a fixed vertical axis passing through its centre  $O$ . The hinge is frictionless. The particle strikes and sticks to the end of the rod. The angular speed of the system just after the collision :



- (1)  $2v/3d$                       (2)  $3v/2d$                       (3)  $v/3d$                       (4)  $2v/d$

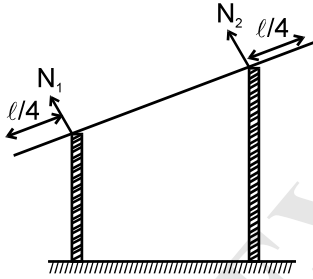
- Q.27 A wheel having moment of inertia  $2 \text{ kg-m}^2$  about its vertical axis, rotates at the rate of 60 rpm about this axis. The torque which can stop the wheel's rotation in one minute would be :

- (1)  $\frac{2\pi}{15} \text{ N-m}$                       (2)  $\frac{\pi}{12} \text{ N-m}$                       (3)  $\frac{\pi}{15} \text{ N-m}$                       (4)  $\frac{\pi}{18} \text{ N-m}$

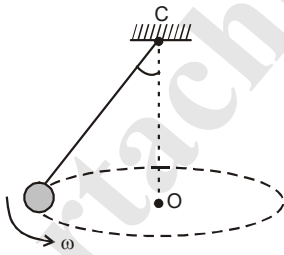
- Q.28 Two rigid bodies A and B rotate with rotational kinetic energies  $E_A$  and  $E_B$  respectively. The moments of inertia of A and B about the axis of rotation are  $I_A$  and  $I_B$  respectively. If  $I_A = I_B/4$  and  $E_A = 100 E_B$  the ratio of angular momentum ( $L_A$ ) of A to the angular momentum ( $L_B$ ) of B is  
 (1) 25 (2) 5/4 (3) 5 (4) 1/4
- Q.29 The torque applied to a ring revolving about its own axis so as to change its angular momentum by 2 J-s. in 5 s, is  
 (1) 10N-m (2) 2.5 N-m (3) 0.1N-m (4) 0.4 N-m
- Q.30 A ring of mass 1 kg and diameter 1m is rolling on a plane road with a speed 2m/s. Its kinetic energy would be  
 (1) 1 joule (2) 4 joule (3) 2 joule (4) 0.5 joule
- Q.31 A solid cylinder starts rolling from a height h on an inclined plane. At some instant t, the ratio of its rotational K.E. and the total K.E. would be  
 (1) 1 : 2 (2) 1 : 3 (3) 2 : 3 (4) 1 : 1
- Q.32 A solid cylinder 30 cm in diameter at the top of an inclined plane 2.0 m high is released and rolls down the incline without loss of energy due to friction. Its linear speed at the bottom is  
 (1) 5.29 m/sec (2)  $4.1 \times 10^3$  m/sec (3) 51 m/sec (4) 51 cm/sec
- Q.33 A solid sphere and a solid cylinder having the same mass and radius, roll down the same incline. The ratio of their acceleration will be  
 (1) 15 : 14 (2) 14 : 15 (3) 5 : 3 (4) 3 : 5
- Q.34 A uniform sphere is released on a smooth inclined plane from the top. When it moves down its angular momentum is:  
 (1) conserved about every point  
 (2) conserved about the point of contact only  
 (3) conserved about the centre of the sphere only  
 (4) conserved about any point on a fixed line parallel to the inclined plane and passing through the centre of the ball.
- Q.35 A uniform cube of side a and mass m rests on a rough horizontal table. A horizontal force 'F' is applied normal to one of the faces at a point that is directly above the centre of the face, at a height  $\frac{3a}{4}$  above the base. The minimum value of 'F' for which the cube begins to tilt about the edge is .....(assume that the cube does not slide).  
 (1)  $\frac{2}{3}mg$  (2)  $\frac{4}{3}mg$  (3)  $\frac{5}{4}mg$  (4)  $\frac{1}{2}mg$
- Q.36 Find moment of inertia of a semi circular disc about axis passing through center of mass and perpendicular to its plane.  
 (1)  $MR^2 \left( \frac{1}{2} - \frac{16}{9\pi^2} \right)$  (2)  $MR^2 \left( \frac{1}{2} + \frac{16}{9\pi^2} \right)$  (3)  $MR^2 \left( \frac{1}{2} - \frac{9\pi^2}{16} \right)$  (4)  $MR^2 \left( \frac{1}{2} + \frac{9\pi^2}{16} \right)$

- Q.37 The beam and pans of a balance have negligible mass. An object weighs  $W_1$  when placed in one pan and  $W_2$  when placed in the other pan. The weight  $W$  of the object is :
- (1)  $\sqrt{W_1 W_2}$                       (2)  $\sqrt{(W_1 + W_2)}$                       (3)  $W_1^2 + W_2^2$                       (4)  $(W_1^{-1} + W_2^{-1})/2$

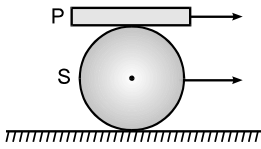
- Q.38 A uniform rod of length  $2\sqrt{2}l$  is placed symmetrically on two walls as shown in figure. The rod is in equilibrium. If  $N_1$  and  $N_2$  are the normal forces exerted by the walls on the rod then



- (1)  $N_1 > N_2$                       (2)  $N_1 < N_2$                       (3)  $N_1 = N_2$   
 (4)  $N_1$  and  $N_2$  would be in the vertical directions.
- Q.39 If  $\tau^P \times \vec{L} = 0$  for a rigid body, where  $\tau^P$  = resultant torque &  $\vec{L}$  = angular momentum about a point and both are non-zero. Then :
- (1)  $\vec{L} = \text{constant}$                       (2)  $|\vec{L}| = \text{constant}$                       (3)  $|\vec{L}|$  will increase                      (4)  $|\vec{L}|$  may increase
- Q.40 A conical pendulum consists of a simple pendulum moving in a horizontal circle as shown. C is the pivot, O the centre of the circle in which the pendulum bob moves and  $\omega$  the constant angular velocity of the bob. If  $\vec{L}^P$  is the angular momentum about point C, then

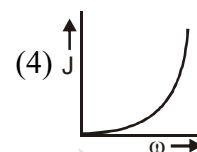
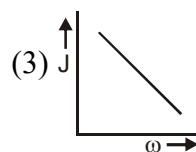
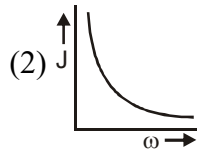
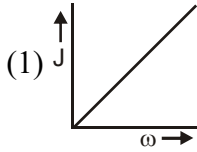


- (1)  $\vec{L}^P$  is constant                      (2) only direction of  $\vec{L}^P$  is constant  
 (3) only magnitude of  $\vec{L}^P$  is constant                      (4) none of the above.
- Q.41 A plank P is placed on a solid cylinder S, which rolls on a horizontal surface. The two are of equal mass. There is no slipping at any of the surfaces in contact. The ratio of the kinetic energy of P to the kinetic energy of S is:



- (1) 1:1                      (2) 2:1                      (3) 8:3                      (4) 1:4

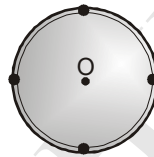
Q.42 The graph between the angular momentum  $J$  and angular velocity  $\omega$  will be :-



Q.43 For rotational motion, the Newton's second law of motion is indicated by :-

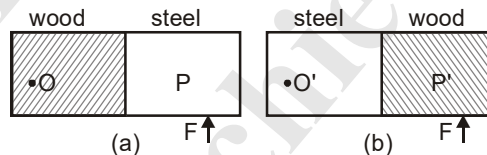
(1)  $\omega_2^2 = \omega_1^2 + 2\alpha\theta$       (2)  $\vec{F} = \frac{d\vec{p}}{dt}$       (3)  $\vec{\tau} = \frac{d\vec{J}}{dt}$       (4)  $\vec{F}_{12} = \vec{F}_{21}$

Q.44 Four similar point masses (each of mass  $m$ ) are placed on the circumference of a disc of mass  $M$  and radius  $R$ . The M.I. of the system about the normal axis through the centre  $O$  will be:



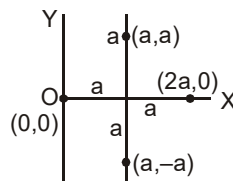
(1)  $MR^2 + 4mR^2$       (2)  $\frac{1}{2} MR^2 + 4mR^2$       (3)  $MR^2 + \frac{8}{5} mR^2$       (4) none of these

Q.45 In the fig. (a) half of the meter scale is made of wood while the other half of steel. The wooden part is pivoted at  $O$ . A force  $F$  is applied at the end of steel part. In figure (b) the steel part is pivoted at  $O'$  and the same force is applied at the wooden end:-



- (1) more angular acceleration will be produced in (a)
- (2) more angular acceleration will be produced in (b)
- (3) same angular acceleration will be produced in both conditions
- (4) information is incomplete

Q.46 Four point masses (each of mass  $m$ ) are arranged in the  $X$ - $Y$  plane the moment of inertia of this array of masses about  $Y$ -axis is



(1)  $ma^2$       (2)  $2ma^2$       (3)  $4ma^2$       (4)  $6ma^2$

Q.47 A particle of mass  $m$  and radius of gyration  $K$  is rotating with an angular acceleration  $\alpha$ . The torque acting on the particle is

- (1)  $\frac{1}{2}mK^2\alpha$                       (2)  $mK^2\alpha$                       (3)  $mK^2/\alpha$                       (4)  $\frac{1}{4}mK^2\alpha^2$

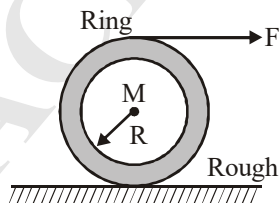
Q.48 A body of mass  $m$  slides down on incline and reaches the bottom with velocity  $V$ . If the same mass were in form of a ring which rolls down this incline, the velocity of ring at the bottom would have been :-

- (1)  $V$                       (2)  $(\sqrt{2})V$                       (3)  $\frac{V}{\sqrt{2}}$                       (4)  $\left(\sqrt{\frac{2}{5}}\right)V$

**Direction for following questions :**

- A. Both Assertion and Reason are true, and Reason is the correct explanation of Assertion.
- B. Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
- C. Assertion is true but Reason is false.
- D. Assertion and Reason both are false.

Q.49 **Assertion :** In shown situation ring is performing pure rolling motion on rough horizontal ground. The value of friction force in this case is zero.



**Reason :** In pure rolling work done by friction is always zero.

- (1) A                      (2) B                      (3) C                      (4) D

Q.50 **Assertion :** Many great rivers flow towards the equator. The sediments that they carry increases the time of rotation of the earth about its own axis.

**Reason :** The angular momentum of the earth about its rotation axis is conserved.

- (1) A                      (2) B                      (3) C                      (4) D

Q.51 **Assertion :** The hard boiled egg and raw egg can be distinguished on the basis of spinning of both.

**Reason :** The moment of inertia of hard boiled egg is more as compared to raw egg.

- (1) A                      (2) B                      (3) C                      (4) D

**ANSWER KEY**

Q.1	4	Q.2	1	Q.3	1	Q.4	2	Q.5	2
Q.6	3	Q.7	1	Q.8	2	Q.9	1	Q.10	3
Q.11	3	Q.12	2	Q.13	4	Q.14	1	Q.15	2
Q.16	3	Q.17	1	Q.18	1	Q.19	2	Q.20	4
Q.21	1	Q.22	3	Q.23	1	Q.24	4	Q.25	4
Q.26	1	Q.27	3	Q.28	3	Q.29	4	Q.30	2
Q.31	2	Q.32	1	Q.33	1	Q.34	4	Q.35	1
Q.36	1	Q.37	1	Q.38	3	Q.39	4	Q.40	3
Q.41	3	Q.42	1	Q.43	3	Q.44	2	Q.45	2
Q.46	4	Q.47	2	Q.48	3	Q.49	2	Q.50	1
Q.51	3								

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