King Fahd University of Petroleum and Minerals
Physics Department

PHYS 101
Practice Final Exam

Term: 201
Saturday, 26 December 2020

Name: ________________

ID: ____________________

Code 1

1. A rod of length 1.26 m is pivoted at one end. It is allowed to swing with simple harmonic motion. What length must a simple pendulum have so that its period is equal to that of the rod? [The moment of inertia of a rod of length L and mass M about its center of mass is $I = (1/12)\ ML^2$].
   a. 84.0 cm
   b. 50.0 cm
   c. 25.3 cm
   d. 77.4 cm
   e. 98.1 cm

2. Water flows through a horizontal pipe of non-uniform cross section. The pressure is 5.0×10^4 Pa at a point where the speed of flow is 4.0 m/s and the cross sectional area is A. Find the pressure at a point where the area is $2A$.
   a. 5.9×10^3 Pa
   b. 5.0×10^4 Pa
   c. 5.6×10^4 Pa
   d. 6.2×10^4 Pa
   e. 4.5×10^3 Pa

3. A uniform beam whose weight is 1500 N and whose length is 10.00 m supports a mass of 100.0 kg, as shown in **figure 1**. The mass hangs from the center of the beam. The beam is attached to the wall by a pivot. What is the tension T in the supporting wire?
   a. 5207 N
   b. 1143 N
   c. 5300 N
   d. 1000 N
   e. 6941 N

4. A particle executes simple harmonic motion with an amplitude of 5.0 cm. At what displacement will the kinetic energy equal twice the potential energy?
   a. 1.6 cm
   b. 4.8 cm
   c. 3.7 cm
   d. 2.9 cm
   e. 3.3 cm

5. A projectile is fired into the air and its trajectory is a parabola. While the projectile is still in the air, it suddenly explodes into several fragments. What can be said about the motion of the center of mass (c.m.) of all the fragments?
   a. The c.m. remains at rest.
   b. The c.m. retraces its path back to the point from where it was fired.
   c. The c.m. moves in a horizontal direction with an acceleration of 9.8 m/s^2.
   d. The c.m. follows the same parabolic path which it would have followed in the absence of any explosion.
   e. The c.m. moves vertically downward.

6. A 100-kg spaceship is in a circular orbit of radius $2R_e$ about the earth. How much energy is required to transfer the spaceship to a circular orbit of radius $4R_e$? [R_e = radius of earth = 6.37 x 10^6 m, M_e = mass of earth = 5.98 x 10^{24} kg]
   a. 6.57 x 10^9 J
   b. 6.00 x 10^8 J
   c. 3.91 x 10^8 J
   d. 2.95 x 10^9 J
   e. 7.83 x 10^8 J

7. Two cars are at rest and 600 m apart. They start to move at the same time in the same direction along the same straight line. The one at the back moves with an acceleration of 4.00 m/s^2 and the one in the front with an acceleration of 1.00 m/s^2. How long does it take the faster car to overtake the slower one?
   a. 34.5 s
   b. 17.5 s
   c. 20.0 s
   d. 30.0 s
   e. 25.0 s

8. The density of oil in the left column of the U-tube shown in **figure 2** is:
   a. 0.20 g/cm^3
   b. 0.80 g/cm^3
   c. 1.0 g/cm^3
   d. 1.3 g/cm^3
   e. 5.0 g/cm^3

9. The equation of motion for the angular displacement of a certain simple pendulum (see **figure 12**) is: $\theta(t) = 0.35\cos[(3\pi)t + 0.60]$, where angles are in radians. Find the length of the pendulum.

   a. 25 cm
   b. 4.0 cm
   c. 8.1 cm
   d. 2.4 cm
   e. 11 cm

10. The planet Mars has a satellite which travels in a circular orbit of radius 9.40 x 10^6 m, with a period of 2.754 x 10^4 s. Calculate the mass of Mars from this information.

   a. 4.56 x 10^{26} kg
   b. 6.48 x 10^{23} kg
   c. 3.95 x 10^{23} kg
   d. 5.90 x 10^{26} kg
   e. Data incomplete. Mass of the satellite is not given.

11. Two particles of mass m are initially separated by a distance d. They are released from rest and accelerate toward each other through gravitational attraction. What is the kinetic energy of each particle when their separation is $d/3$?

   a. $3Gm^2/d$
   b. Gm^2/d
   c. $Gm/(2d^2)$
   d. $4Gm^2/d$
   e. $Gm^2/(2d)$

12. A 10.0-m long diving board has a support, **S**, that is 4.00 m from one end. It is also held down by a clamp at that end (see **figure 3**). The diving board is uniform and has a mass of 50.0 kg. A boy, weighing 700 N, stands on the other end of the diving board. What is the force which the support **S** exerts on the diving board?

   a. 1200 N
   b. 2360 N
   c. 2110 N
   d. 1550 N
   e. 7370 N

13. A load of 50 kg is hung on a steel wire of length 3.0 m and cross sectional area of 2.0 x 10^{-5} m^2. How much does the wire stretch? [Young's modulus of steel = 2.0 x 10^{11} N/m^2]

   a. 1.3 mm
   b. 0.28 mm
   c. 0.46 mm
   d. 1.5 mm
   e. 0.37 mm

14. A disk of moment of inertia 0.40 kg.m^2 and radius 0.40 m is pivoted about a horizontal axis through its center. A small body of mass 1.0 kg is fixed at the rim of the disk (see **figure 4**). If the disk is released from rest with the small body at the end of a horizontal radius (point **A**), find the angular velocity of the disk at the instant the small body is passing the lowest point (**B**). Neglect friction and treat the small body as a particle.

   a. 5.5 rad/s
   b. 4.1 rad/s
   c. 3.7 rad/s
   d. 3.2 rad/s
   e. 10 rad/s

15. The rate of flow of water through a horizontal pipe is 4.0 m^3/min. What is the speed of flow at a point where the radius of the pipe is 0.050 m?

   a. 8.5 m/s
   b. 9.4 m/s
   c. 7.6 m/s
   d. 6.5 m/s
   e. 5.5 m/s

16. A dive bomber, diving at an angle of 37.0° below the horizontal, releases a bomb at an altitude of 1000 m (see **figure 5**). The bomb strikes the ground 5.00 s later. What is the speed of the bomber at the instant the bomb was released?

   a. 292 m/s
   b. 516 m/s
   c. 324 m/s
   d. 350 m/s
   e. 406 m/s

17. A body moves with simple harmonic motion. At t = 0, it is released from rest at a displacement of x = 0.5 m. If the frequency of oscillation is 5 Hz, find the displacement x at t = 0.02 s.
    a. 0.3 m
    b. 0.5 m
    c. 0.4 m
    d. 0.1 m
    e. 0.2 m

18. A particle of mass m is scattered (deflected) through 90^o in an elastic collision with a body of mass $M = 4m$, initially at rest (see **figure 9**). What fraction of its original kinetic energy does the particle lose?
    a. 0.3
    b. 0.1
    c. 0.2
    d. 0.5
    e. 0.4

19. A 0.030-kg bullet initially travelling at 400 m/s penetrates 0.15 m into a vertical wall. What average force (magnitude only) does the bullet exert on the wall?
    a. 7.5 x 10^3 N
    b. 5.0 x 10^3 N
    c. 3.7 x 10^4 N
    d. 1.6 x 10^4 N
    e. 2.5 x 10^3 N

20. A ladder of negligible weight and of length 10 m leans against a smooth wall, making an angle of 60^o with the horizontal ground (see **figure 10**). How far up the ladder can a man weighing 150 N climb before the ladder slips if the coefficient of static friction between the ladder and the ground is 0.40?
    a. 9.2 m
    b. 7.5 m
    c. 3.3 m
    d. 6.9 m
    e. 8.2 m

21. A solid sphere has a weight of 10 N. When it is suspended from a spring scale and submerged in water, the scale reads 6.0 N. What is the radius of the sphere?
    a. 3.5 cm
    b. 9.5 cm
    c. 4.6 cm
    d. 5.9 cm
    e. 7.5 cm

22. A small object is placed 8.0 cm from the center of a rotating disk. It is observed to remain on the disk when it rotates at 45 rev/min but slides off if the disk is caused to rotate any faster than this. What is the coefficient of static friction between the object and the surface of the disk?
    a. 0.18
    b. 0.22
    c. 0.12
    d. 0.27
    e. 0.36

23. Three particles, each of mass 100 kg, are placed at the corners of an equilateral triangle of side length 50 m. Calculate the potential energy of the system.
    a. -1.5×10^{-7} J
    b. -4.0×10^{-8} J
    c. -4.5×10^{-8} J
    d. -3.5×10^{-8} J
    e. -2.5×10^{-7} J

24. Two blocks, each of mass 20 kg, rest on frictionless surfaces, as shown in **figure 6**. The inclination angle θ is 37^o. Assuming that the pulleys are light and frictionless, calculate the time required for block **A** to move 1.0 m down the plane, starting from rest.
    a. 1.6 s
    b. 0.45 s
    c. 0.58 s
    d. 0.90 s
    e. 0.82 s

25. A siphon is used to remove water from a container, as shown in **figure 7**. The cross-sectional area of the siphon is 1.00 cm^2. Assume that the cross sectional area of the container is much greater than that of the siphon. How much water is removed from the container in 10.0 s?

    a. 15.1 L
    b. 0.530 L
    c. 1.25 L
    d. 8.23 L
    e. 4.85 L

26. An airplane flies 20.0 km in a direction 60.0^{o} north of east. It then flies 30.0 km straight east, then 10.0 km straight north. How far and in what direction is the plane from the starting point?

    a. 27.3 km in a direction due north
    b. 67.3 km in a direction south of east
    c. 48.4 km in a direction 34.3^{o} north of east
    d. 10.0 km in a direction west of north
    e. 30.4 km in a direction 60.0^{o} south of east

27. Two spheres, each of mass 6.4 kg, are fixed at points **A** and **B** (see **figure 8**). Find the magnitude (in m/s^2) and direction of the initial acceleration of a sphere of mass 0.010 kg if released from rest at point **P** and acted on only by forces of gravitational attraction of spheres **A** and **B**.

    a. $-5.1 \times 10^{-8}\ \hat{\mathbf{j}}$
    b. $-3.2 \times 10^{-8}\ \hat{\mathbf{j}}$
    c. $-1.1 \times 10^{-7}\ \hat{\mathbf{j}}$
    d. $4.1 \times 10^{-7}\ (\hat{\mathbf{i}} - \hat{\mathbf{j}})$
    e. $2.3 \times 10^{-6}\ (\hat{\mathbf{i}} + \hat{\mathbf{j}})$

28. A horizontal platform, in the shape of a circular disk, rotates in a horizontal plane about a frictionless vertical axle. The platform has a mass of 100 kg and a radius of 2.0 m. A student, whose mass is 60 kg, walks slowly from the rim of the platform toward the center, as shown in **figure 11**. If the angular velocity of the system is 2.0 rad/s when the student is at the rim, calculate the angular velocity when the student has reached a point 0.50 m from the center.

   a. 11 rad/s
   b. 4.1 rad/s
   c. 8.2 rad/s
   d. 6.3 rad/s
   e. 12 rad/s

29. A 2-kg block moves up a 30^o rough incline with a constant speed of 4 m/s under the action of a force **F** applied parallel to the incline. If the coefficient of kinetic friction between the block and the incline is 0.2, calculate the power delivered by **F**.

   a. 78.54 W
   b. 52.78 W
   c. 27.16 W
   d. 66.36 W
   e. 39.20 W

30. Which of the following statements is TRUE?

   1) If the only forces acting on a system are conservative, the total mechanical energy of the system remains constant.
   2) The sliding frictional force is a conservative force.
   3) The gravitational force is a nonconservative force.
   4) The work done by a conservative force on a particle that moves through any round trip is zero.
   5) The work done by a conservative force acting on a particle moving between two points is independent of the path the particle takes between the points.

   a. 2), 3) and 4) only
   b. 1), 4) and 5) only
   c. 10, 2) and 3) only
   d. 2) and 5) only
   e. 1), 3) and 5) only

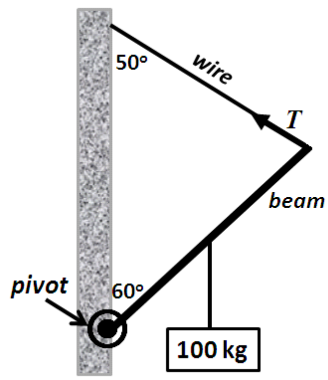


Figure 1

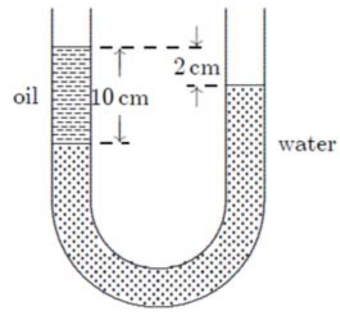


Figure 2

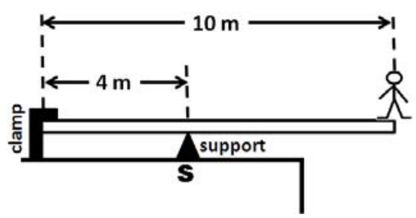


Figure 3

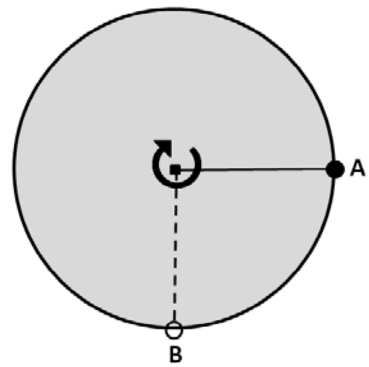


Figure 4

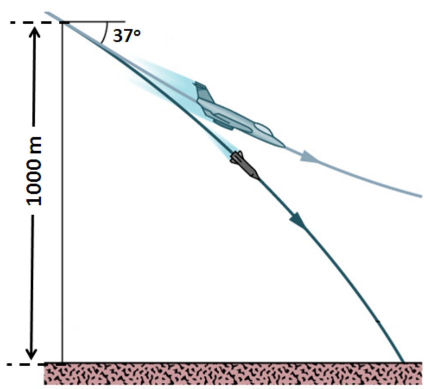


Figure 5

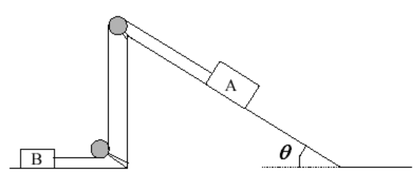
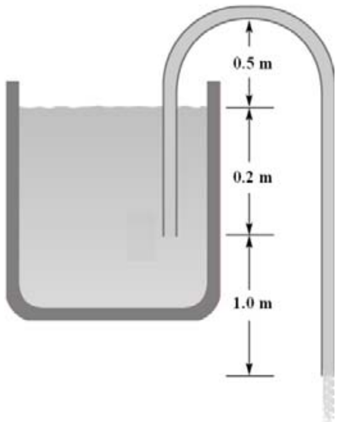
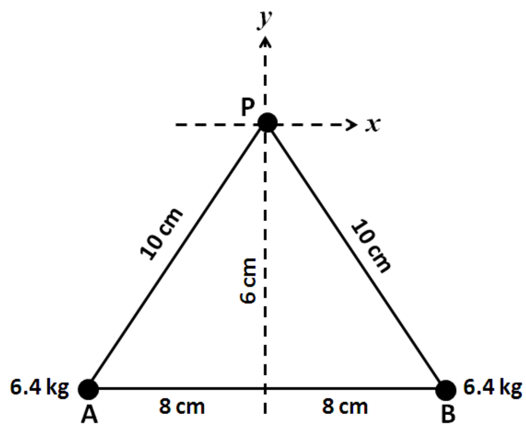
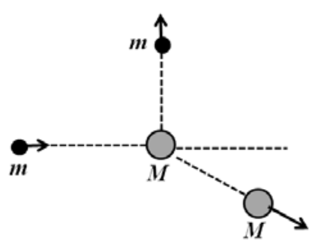
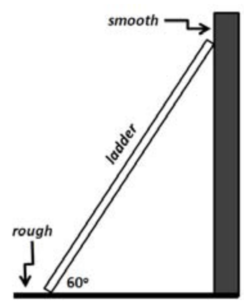
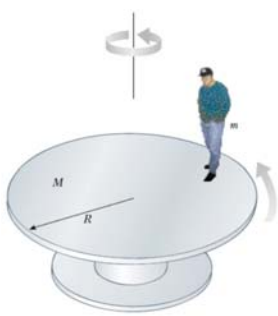
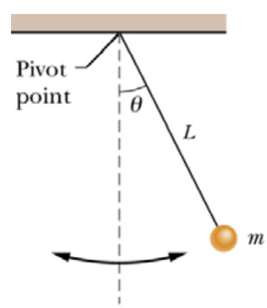


Figure 6

 **Figure 7**	 **Figure 8**
 **Figure 9**	 **Figure 10**
 **Figure 11**	 **Figure 12**

Physics 101 Unified Formula Sheet

$$v = \frac{dx}{dt} \qquad a = \frac{dv}{dt}$$

$$v_{avg} = \frac{\Delta x}{\Delta t} \qquad a_{avg} = \frac{\Delta v}{\Delta t}$$

$$v = v_0 + \mathrm{at}$$

$$v^2 = {v_0}^2 + 2a(x - x_0)$$

$$\mathrm{x} - \mathrm{x}_0 = v_0\mathrm{t} + \frac{1}{2}at^2$$

$$\vec{A} \cdot \vec{B} = ABcos\theta$$

$$\vec{A} \cdot \vec{B} = A_xB_x + A_yB_y + A_zB_z$$

$$\left|\vec{A} \times \vec{B}\right| = ABsin\theta$$

$$\vec{r} = x\hat{\imath} + y\hat{\jmath} + z\,\hat{k} \qquad \vec{v} = \vec{v}_0 + \vec{a}t$$

$$\vec{r} - \vec{r}_0 = \vec{v}_0 t + \frac{1}{2}\vec{a}t^2$$

$$H = \frac{v_0^2 sin^2\theta_0}{2g} \qquad R = \frac{v_0^2 sin2\theta_0}{g}$$

$$y = x\, tan\theta_0 - \frac{gx^2}{2(v_0 cos\theta_0)^2}$$

$$a_r = \frac{v^2}{r} \qquad \mathrm{T} = \frac{2\pi r}{v}$$

$$\vec{v}_{PA} = \vec{v}_{PB} + \vec{v}_{BA}$$

$$\vec{\mathrm{F}}_{\mathrm{net}} = m\vec{a}$$

$$f_k = \mu_k F_N \qquad f_s \le \mu_s F_N$$

$$W = \int \vec{F} \,.\, d\vec{s}$$

$$If\ \vec{F}\ is\ constant\!: W = \vec{F}.\vec{s}$$

$$P = \vec{F}.\vec{v} \qquad P_{avg} = \frac{W}{\Delta t}$$

$$W_{net} = \Delta K = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

$$F_s = -kx$$

$$W = -\Delta U$$

$$\Delta U_s = \frac{1}{2}kx_f^2 - \frac{1}{2}kx_i^2$$

$$\Delta U_g = mg\left(y_f - y_i\right)$$

$$W = \Delta K + \Delta U + \Delta E_{th}$$

$$\Delta E_{th} = f_k d$$

$$\vec{r}_{com} = \frac{\sum m_i \vec{r}_i}{\sum m_i} = \frac{1}{M}\int \vec{r}\, dm$$

$$\vec{v}_{com} = \frac{\sum m_i\, \vec{v}_i}{\sum m_i}$$

$$\vec{P}_{com} = \sum m_i\, \vec{v}_i$$

$$\vec{p} = m\vec{v};\ \vec{\mathrm{F}}_{\mathrm{net}} = \frac{d\vec{p}}{dt}$$

$$\vec{J} = \Delta\vec{p} = \int \vec{F}\ dt = \vec{F}_{avg}\,\Delta t$$

$$m_1\vec{v}_{1i} + m_2\vec{v}_{2i} = m_1\vec{v}_{1f} + m_2\vec{v}_{2f}$$

$$v_{1f} = \frac{m_1 - m_2}{m_1 + m_2}v_{1i} + \frac{2m_2}{m_1 + m_2}v_{2i}$$

$$v_{2f} = \frac{2m_1}{m_1 + m_2}v_{1i} + \frac{m_2 - m_1}{m_1 + m_2}v_{2i}$$

$$\omega = \frac{d\theta}{dt} \qquad \alpha = \frac{d\omega}{dt}$$

$$s = r\theta \qquad v = r\omega$$

$$a_t = r\alpha \qquad a_r = r\omega^2$$

$$\vec{a} = \vec{a}_t + \vec{a}_r$$

$$a = \sqrt{{a_r}^2 + {a_t}^2}$$

$$\omega = \omega_0 + \alpha t$$

$$\theta - \theta_0 = \omega_0 t + \frac{1}{2}\alpha t^2$$

$$\omega^2 = {\omega_0}^2 + 2\alpha(\theta - \theta_0)$$

$$I = \sum m_i {r_i}^2 = \int r^2\, dm$$

$$I = I_{com} + Mh^2$$

$$For\ cylinder\ I_{com} = \frac{1}{2}\,MR^2$$

$$For\ disk\ \ I_{com} = \frac{1}{2}\,MR^2$$

$$For\ thin\ rod\ I_{com} = \frac{1}{12}\,ML^2$$

$$For\ solid\ sphere\ \ I_{com} = \frac{2}{5}\,MR^2$$

$$For\ hoop\ I_{com} = \ MR^2$$

$$\vec{\tau} = \vec{r}\ \times \vec{F}$$

$$W = \int \tau d\theta$$

$$P = \frac{dW}{dt} = \tau\omega$$

$$K_{rot} = \frac{1}{2}I\omega^2$$

$$a_{com,x} = -\frac{gsin\theta}{1 + (I_{com}/MR^2)}$$

$$\vec{l} = \vec{r} \times \vec{p} = m(\vec{r} \times \vec{v})$$

$$L_z = I\omega$$

$$\vec{L}_i = \vec{L}_f$$

$$\vec{\tau} = \frac{d\vec{L}}{dt}$$

$$\sum \vec{\tau}_{ext} = \frac{d\vec{L}}{dt} = I\vec{\alpha}$$

$$\sum \vec{F} = 0\ and\ \sum \vec{\tau} = 0$$

$$E = \frac{F/A}{\Delta L/L_0} \qquad G = \frac{F/A}{\Delta x/L}$$

$$B = \frac{p}{|\Delta V|/V}$$

$$F = \frac{Gm_1m_2}{r^2} \qquad U = -\frac{Gm_1m_2}{r}$$

$$E = K + U = -\frac{GMm}{2r}$$

$$v_{esc} = \sqrt{\frac{2GM}{R}} \qquad T^2 = \frac{4\pi^2}{GM}r^3$$

$$\rho = \frac{m}{V} \qquad p = \frac{F}{A}$$

$$p = p_0 + \rho gh$$

$$F_b = m_f g = \rho_f V_f\, g$$

$$A_1v_1 = A_2v_2 = constant$$

$$p + \frac{1}{2}\rho v^2 + \rho gy = constant$$

$$x = x_m cos(\omega t + \phi)$$

$$T = \frac{1}{f} = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{m}{k}}$$

$$E = K + U = \frac{1}{2}mv^2 + \frac{1}{2}kx^2 = \frac{1}{2}kx_m^2$$

$$T = 2\pi\sqrt{\frac{L}{g}} \qquad T = 2\pi\sqrt{\frac{I}{mgh}}$$

Constants

$$g = 9.80\ m/s^2$$

$$G = 6.67 \times 10^{-11}\ Nm^2/kg^2$$

$$1\ Pa = 1N/m^2$$

$$p_{atm} = 1.01 \times 10^5 Pa = 1\ atm$$

$$\rho_{water} = 1000\ kg/m^3$$

$For\ Earth$:

$$M_E = 5.98 \times 10^{24}\ kg$$

$$R_E = 6.37 \times 10^6 m$$

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جامعة الملك فهد للبترول و المعادن
الظهران ٣١٢٦١ المملكة العربية السعودية

NAME ____________________

STUDENT No. ____________________

SECTION No. ____________________

TEST ANSWER FORM

MARKING INSTRUCTIONS

TESTING SERVICES SYSTEM

STUDENT NUMBER

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SECTION NUMBER

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TEST CODE No.

0 | 1 2 3 4 5 6 7 8 9
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1 | 0 2 3 4 5 6 7 8 9

DIRECTIONS:

Read each question and its numbered answers. When you have decided which answer is correct, blacken the corresponding oval on this form with a no. 2 pencil. Make no extra marks. They may be counted as incorrect answers. Erase incorrect answers fully before filling in correct answer.

DO NOT USE INK OR BALL POINT PEN

SAMPLE

1. RIYADH is:

A - a country
B - a mountain
C - an island
D - a city
E - a river

1 A B C ● E

1 A B C D E	26 A B C D E	51 A B C D E	76 A B C D E	101 A B C D E
2 A B C D E	27 A B C D E	52 A B C D E	77 A B C D E	102 A B C D E
3 A B C D E	28 A B C D E	53 A B C D E	78 A B C D E	103 A B C D E
4 A B C D E	29 A B C D E	54 A B C D E	79 A B C D E	104 A B C D E
5 A B C D E	30 A B C D E	55 A B C D E	80 A B C D E	105 A B C D E
6 A B C D E	31 A B C D E	56 A B C D E	81 A B C D E	106 A B C D E
7 A B C D E	32 A B C D E	57 A B C D E	82 A B C D E	107 A B C D E
8 A B C D E	33 A B C D E	58 A B C D E	83 A B C D E	108 A B C D E
9 A B C D E	34 A B C D E	59 A B C D E	84 A B C D E	109 A B C D E
10 A B C D E	35 A B C D E	60 A B C D E	85 A B C D E	110 A B C D E
11 A B C D E	36 A B C D E	61 A B C D E	86 A B C D E	111 A B C D E
12 A B C D E	37 A B C D E	62 A B C D E	87 A B C D E	112 A B C D E
13 A B C D E	38 A B C D E	63 A B C D E	88 A B C D E	113 A B C D E
14 A B C D E	39 A B C D E	64 A B C D E	89 A B C D E	114 A B C D E
15 A B C D E	40 A B C D E	65 A B C D E	90 A B C D E	115 A B C D E
16 A B C D E	41 A B C D E	66 A B C D E	91 A B C D E	116 A B C D E
17 A B C D E	42 A B C D E	67 A B C D E	92 A B C D E	117 A B C D E
18 A B C D E	43 A B C D E	68 A B C D E	93 A B C D E	118 A B C D E
19 A B C D E	44 A B C D E	69 A B C D E	94 A B C D E	119 A B C D E
20 A B C D E	45 A B C D E	70 A B C D E	95 A B C D E	120 A B C D E
21 A B C D E	46 A B C D E	71 A B C D E	96 A B C D E	121 A B C D E
22 A B C D E	47 A B C D E	72 A B C D E	97 A B C D E	122 A B C D E
23 A B C D E	48 A B C D E	73 A B C D E	98 A B C D E	123 A B C D E
24 A B C D E	49 A B C D E	74 A B C D E	99 A B C D E	124 A B C D E
25 A B C D E	50 A B C D E	75 A B C D E	100 A B C D E	125 A B C D E

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