King Fahd University of Petroleum and Minerals

Department of Physics

PHYS101-052
FINAL EXAM
Test Code: **100**

Tuesday, 29 May 2006
Exam Duration: 3 hrs (from 12:30pm to 3:30pm)

Name:	
Student Number:	
Section Number:	

1. The graph of Fig 1 represents the straight line motion of a car that starts at $t = 0$, $x = 0$. What is the position of the car at $t = 4$ s?
   A) 30 m
   B) 0
   C) -40 m
   D) 20 m
   E) -20 m

2. As shown in Fig 2, vector $\vec{A}$ has magnitude of 12 m and vector $\vec{B}$ has magnitude of 8 m. $\vec{A} - \vec{B}$ in vector notation is:
   A) (10.3m) **i** + (1.90m) **j**
   B) (8.40m) **i** + (2.90m) **j**
   C) (4.49m) **i** + (15.4m) **j**
   D) 0 **i** + 0 **j**
   E) (14.4m) **i** + (2.50m) **j**

3. A boy on the edge of a vertical building 19.6 m high throws a stone horizontally outward with a speed of 20.0 m/s. It strikes the ground at a horizontal distance (x) from the foot of the building. Find the value of x.
   A) 10.0 m
   B) 9.80 m
   C) 50.0 m
   D) 19.6 m
   E) 40.0 m

4. A stone is tied to a 0.50-m string and moves in a vertical circle at a constant speed of 4.0 m/s. Its acceleration at the top of the circle is:
   A) 9.8 m/s^2, up
   B) 9.8 m/s^2, down
   C) 0.0 m/s^2
   D) 32 m/s^2, up
   E) 32 m/s^2, down

5. A 2.0-kg block slides on a horizontal surface. Part of the surface is smooth and the other part is rough. A horizontal force is applied to the block. On the smooth part, the acceleration of the block is 3.0 m/s^2, while it is 2.0 m/s^2 on the rough part. What is the magnitude of the frictional force on the rough part?
   A) 8.0 N
   B) 6.0 N
   C) 4.0 N
   D) 2.0 N
   E) 10 N

6. A mass is suspended by a string from the ceiling of a train accelerating horizontally at 2.5 m/s^2. The angle that the string makes with the vertical is:
   A) 10^o
   B) 16^o
   C) 14^o
   D) 12^o
   E) 30^o

7. At time t = 0, a 2.0-kg particle has a velocity of $\vec{v}_i = (8.0 m/s)\hat{i} - (6.0 m/s)\hat{j}$. At time t = 3.0 s its velocity is $\vec{v}_f = (3.0 m/s)\hat{i} + (4.0 m/s)\hat{j}$. During this time interval the net work done on it is:
A) 100 J
B) –25 J
C) –75 J
D) –50 J
E) (-5.0 J) i + (10 J) j

8. A 6.0-kg block is released from rest 80 m above the ground. When it reaches the ground its kinetic energy is:
A) 3500 J
B) 4700 J
C) 1200 J
D) 120 J
E) 640 J

9. A 0.50-kg block attached to an ideal spring with a spring constant of 80 N/m oscillates on a horizontal frictionless surface. The total mechanical energy is 0.12 J. The greatest extension of the spring from its equilibrium length is:
A) 0.015 m
B) 0.030 m
C) 0.039 m
D) 0.055 m
E) 18 m

10. A 2.2-kg block starts from rest on a rough inclined plane (μ_k = 0.25) that makes an angle of 25° with the horizontal. As the block goes 2.0 m down the plane, the change in mechanical energy of the block is:
A) 0
B) –9.8 J
C) 9.8 J
D) –18 J
E) 18 J

11. A 0.20-kg rubber ball is dropped from the window of a building. It strikes the sidewalk below at 30 m/s and rebounds up at 20 m/s. The impulse on the ball during collision is:
A) 9.8 N·s upward
B) 10 N·s downward
C) 2 N·s upward
D) 2 N·s downward
E) 10 N·s upward

12. Blocks *A* and *B* are moving toward each other. Block *A* has a mass of 2.00 kg and a velocity of 50.0 m/s, while block *B* has a mass of 4.00 kg and a velocity of -25.0 m/s. They suffer a completely inelastic collision. The kinetic energy lost during the collision is:
A) 0
B) 1250 J
C) 3750 J
D) 5000 J
E) 5600 J

13. A solid ball of mass M = 400 g and radius R = 5.0 cm is rotating about its fixed central axis with angular speed of 3.0 rad/s. It was brought to a stop in 6.0 s. The work done to stop the ball is:
    A) -1.8×10^{-3} J
    B) -3.0×10^{-4} J
    C) -4.8×10^{-4} J
    D) -3.6×10^{-3} J
    E) -9.0×10^{-3} J

14. Two identical thin (negligible radius) rods are joined together to form the shape shown in Fig 3. Each rod has a mass M and length L. The rotational inertia of the assembly about the *y* axis is:
    A) (1/12) ML^2
    B) (1/6) ML^2
    C) ML^2
    D) (1/2) ML^2
    E) (1/3) ML^2

15. A projectile of mass m=0.50 kg moves to the right with speed v_0 =8.0 m/s (see Fig 4). The projectile strikes and sticks to the end of a stationary thin rod of mass M=6.0 kg and length L=1.0 m that is pivoted about a frictionless vertical axle through its center (O). The final angular velocity (ω) of the (projectile + rod) after collision is:
    A) 1.2 rad/s clockwise
    B) 1.0 rad/s clockwise
    C) 3.2 rad/s clockwise
    D) 4.0 rad/s counterclockwise
    E) 2.4 rad/s clockwise

16. A 5.0-m weightless rod (AC), hinged to a wall at A, is used to support an 800-N block as shown in Fig 5. The horizontal and vertical components of the force (F_H, F_V) of the hinge on the rod are:
    A) F_H = 800 N, F_V = 800N
    B) F_H = 800 N, F_V = 600N
    C) F_H = 0, F_V = 800N
    D) F_H = 1200 N, F_V = 800N
    E) F_H = 600 N, F_V = 800N

17. A shearing force F = 50 N is applied to an aluminum rod with a length of L =10 m, a cross-sectional area A=1.0 × 10^{-5} m^2, and a shear modulus G = 2.5 × 10^{10} N/m^2. As a result the rod is sheared through a distance (Δx) of:
    A) 0.10 cm
    B) 0.30 cm
    C) 0.20 cm
    D) 0.40 cm
    E) 0.50 cm

18. A man holds a rod AB of length = 6.0 m and weight = 30 N in equilibrium, by exerting an upward force F_1, with one hand, and a downward force F_2, with the other hand as shown in Fig 6. What are the magnitude of the forces F_1 and F_2?
    A) F_1 = 90 N, F_2 = 60 N
    B) F_1 = 30 N, F_2 = 30 N
    C) F_1 = 60 N, F_2 = 40 N
    D) F_1 = 40 N, F_2 = 50 N
    E) F_1 = 20 N, F_2 = 60 N

19. Three identical particles each of mass m are distributed along the circumference of a circle of radius R as shown in Fig 7. The gravitational force of m_2 on m_1 is 1.0 x 10^{-6} N. The magnitude of the net gravitational force on m_1 due to m_2, m_3 is:
    A) 3.0 x 10^{-6} N
    B) 1.4 x 10^{-6} N
    C) 2.0 x 10^{-6} N
    D) 0
    E) 2.5 x 10^{-6} N

20. Calculate the mass of the Sun using the fact that Earth is rotating around the Sun in a circular orbit of radius 1.496 x 10^{11}m with a period of one year (1 year =3.156 x 10^{7}s).
    A) 1.99 x 10^{30} kg
    B) 6.42 x 10^{32} kg
    C) 4.88 x 10^{28} kg
    D) 3.18 x 10^{26} kg
    E) 5.98 x 10^{24} kg

21. Calculate the work require to move an Earth satellite of mass m from a circular orbit of radius $2R_E$ to one of radius $3R_E$. (Consider M_E = mass of Earth, R_E = radius of Earth, G = universal Gravitational constant)
    A) G M_E m /(6 R_E)
    B) G M_E m /(8 R_E)
    C) G M_E m /(4 R_E)
    D) G M_E m /(12 R_E)
    E) G M_E m /(3 R_E)

22. A 100-kg rock from outer space is heading directly toward Earth. When the rock is at a distance of ($9R_E$) from the Earth's surface, its speed is 12 km/s. Neglecting the effects of the Earth's atmosphere on the rock, find the speed of the rock just before it hits the surface of Earth.
    A) 12 km/s
    B) 16 km/s
    C) 0
    D) 20 km/s
    E) 18 km/s

23. A uniform U-tube is partially filled with water. Oil, of density 0.75 g/cm^3, is poured into the right arm until the water level in the left arm rises 3.0 cm (see Fig 8). The length of the oil column (h) is then:
    A) 2.2 cm
    B) 8.0 cm
    C) 3.0 cm
    D) 4.0 cm
    E) 10 cm

24. The dimensions of a boat (ρ_{boat}= 150 kg/m^3) is 3.00 m x 3.00 m x 1.00 m. What maximum load can it carry in sea water ($\rho_{sea\ water}$= 1020 kg/m^3) without sinking?
    A) 1350 kg
    B) 7830 kg
    C) 9200 kg
    D) 19500 kg
    E) 24300 kg

25. A water line enters a house 2.0 m below ground. A smaller diameter pipe carries water to a faucet 5.0 m above ground, on the second floor. Water flows at 2.0 m/s in the main line and at 7.0 m/s on the second floor. If the pressure in the main line is 3.0×10^5 Pa, then the pressure on the second floor is: (Take the density of water to be 1.0×10^3 kg/m^3)
A) 5.3×10^4 Pa
B) 4.5×10^5 Pa
C) 1.1×10^5 Pa
D) 2.1×10^5 Pa
E) 3.4×10^5 Pa

26. The rate of flow of water through a horizontal pipe is 2.00 m^3/min. Calculate the speed of flow at a point where the diameter of the pipe is 10.0 cm.
A) 4.24 m/s
B) 2.00 m/s
C) 0.20 m/s
D) 20.0 m/s
E) 2.12 m/s

27. A mass m_1 = 1.0 kg is connected to a spring (with spring constant equal to k) and oscillates on a horizontal frictionless table with a period of 1.0 s. When m_1 is replaced with another unknown mass m_2, the period changes to 2.0 s. Find the value of m_2.
A) 4.0 kg
B) 2.0 kg
C) 1.0 kg
D) 0.5 kg
E) 0.25 kg

28. A 0.500 kg block is connected to a spring (k = 20.0 N/m) and oscillates on a horizontal frictionless table. Calculate the maximum kinetic energy of the block if the amplitude of the simple harmonic motion is 3.00 cm.
A) 4.00×10^{-4} J
B) 8.00×10^{-2} J
C) 3.00×10^{-1} J
D) 9.00×10^{-3} J
E) 5.00×10^{-5} J

29. If the displacement of a block-spring system is described by the following equation $x(t) = 0.2\cos(10t)$ where x is in m, and t is in s. What is the speed of the block when its displacement is x = 0.1 m?
A) 10.0 m/s
B) 1.73 m/s
C) 0.30 m/s
D) 2.00 m/s
E) 1.00 m/s

30. A simple pendulum has a period of 10.0 s if the free fall acceleration is g. What would its period be if the free fall acceleration is g/2?
A) 14.1 s
B) 20.0 s
C) 5.00 s
D) 10.0 s
E) 7.07 s

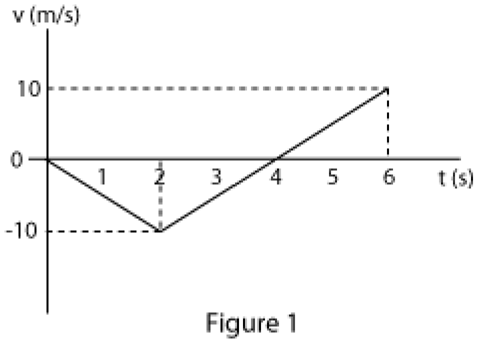

Figure 1

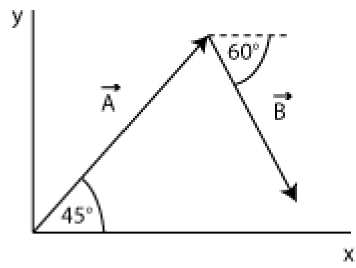

Figure 2

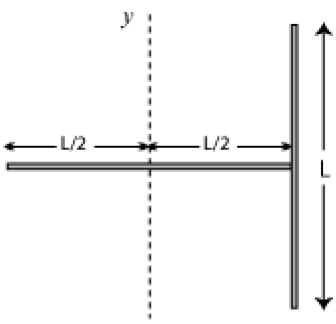

Figure 3

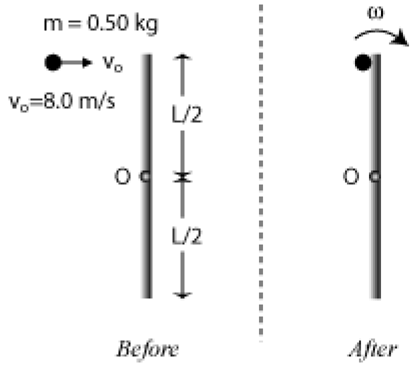

Figure 4

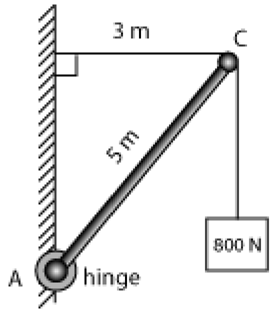

Figure 5

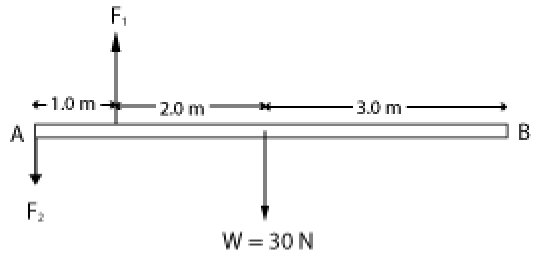

Figure 6

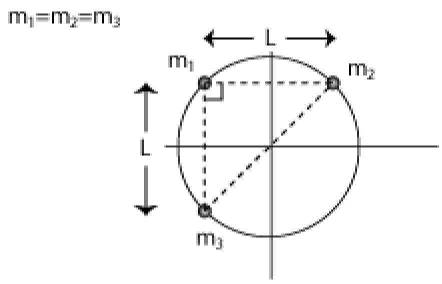

Figure 7

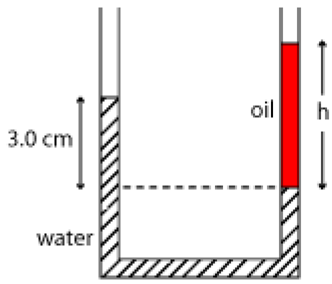

Figure 8

Answer Key

1. E
2. C
3. E
4. E
5. D
6. C
7. C
8. B
9. D
10. B
11. E
12. C
13. A
14. E
15. C
16. E
17. C
18. A
19. B
20. A
21. D
22. B
23. D
24. B
25. D
26. A
27. A
28. D
29. B
30. A