Phys 106 Final Exam Practice Questions Spring 2003
NJIT

Situation **A**
A 4.0–kg body is freely pivoted about a point 0.15 m from the center of mass. The period of small–amplitude oscillations of this physical pendulum is 1.2 s.

1) In Situation **A**, the centroidal moment of inertia of the body is closest to:
A) 0.12 kg · m^2 C) 0.18 kg · m^2 E) 0.09 kg · m^2
B) 0.15 kg · m^2 D) 0.21 kg · m^2

2) In Situation **A**, the length of a simple pendulum that has the same frequency of oscillation and the same amplitude as the physical pendulum is closest to:
A) 0.34 m B) 0.32 m C) 0.36 m D) 0.38 m E) 0.40 m

3) A meter stick is freely pivoted about the 20 cm mark. The frequency of small amplitude oscillations is closest to:
A) 0.7 Hz B) 0.5 Hz C) 1.5 Hz D) 1.2 Hz E) 0.9 Hz

4) If both the mass of a simple pendulum and its length are doubled, the period will
A) be unchanged. C) increase by a factor of 2. E) increase by a factor of 1.4
B) increase by a factor of 4. D) increase by a factor of 0.71.

Situation **B**
A particle is in simple harmonic motion along the x–axis with a period of 1.5 s and an amplitude of 0.60 m. The equilibrium position of the particle is at x = 0. At time t = 0, the particle is at x = +0.30 m and it is moving in the negative x–direction.

5) In Situation **B**, the magnitude of the velocity of the particle, at time t = 0 s is closest to:
A) 2.1 m/s B) 2.2 m/s C) 2.3 m/s D) 1.9 m/s E) 2.0 m/s

6) In Situation **B**, the x–component of the acceleration at time t = 0 is closest to:
A) –8.4 m/ s^2 B) zero C) +8.4 m/ s^2 D) –5.3 m/ s^2 E) +5.3 m/ s^2

7) In Situation **B**, the time interval required for the particle to reach x = –0.60 m from its initial position at t = 0 s is closest to:
A) 0.62 s B) 0.50 s C) 0.75 s D) 0.88 s E) 1.00 s

8) In Situation **B**, at time t = 0, the ratio of the potential energy to the total mechanical energy is closest to:
A) 0.75 B) 0.38 C) 0.50 D) 0.62 E) 0.25

Table **I**

	Mass	Radius	orbital radius	orbital period
Moon A	4×10^{20} kg		2×10^{8} m	4×10^{6} s
Moon B	1.5×10^{20} kg	2×10^{5} m	3×10^{8} m	

Ekapluto is an unknown planet that has two moons in circular orbits. The table summarizes the hypothetical data about the moons.

9) In Table **I**, the mass of Ekapluto is closest to:
A) 1×10^{24} kg C) 3×10^{23} kg E) 3×10^{22} kg
B) 1×10^{22} kg D) 1×10^{23} kg

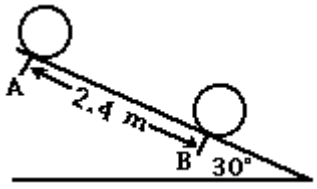
10) In Table **I**, the orbital period of Moon B is closest to:
A) 6.4×10^{6} s B) 6.0×10^{6} s C) 5.6×10^{6} s D) 7.4×10^{6} s E) 6.9×10^{6} s

11) In Table **I**, the maximum gravitational force between the two moons is closest to:
A) 2.0×10^{14} N C) 4.4×10^{13} N E) 4.0×10^{14} N
B) 1.6×10^{13} N D) 1.0×10^{14} N

12) In Table **I**, a meteoroidal fragment is in circular orbit around Moon B, at a small altitude above the surface. The speed of this body is closest to:
A) 640 m/s B) 320 m/s C) 220 m/s D) 440 m/s E) 880 m/s

13) In Table **I**, the gravitational acceleration at the surface of Moon B is closest to:
A) 0.30 m/ s^2 B) 0.10 m/ s^2 C) 0.25 m/ s^2 D) 0.15 m/ s^2 E) 0.20 m/ s^2

Figure **1**



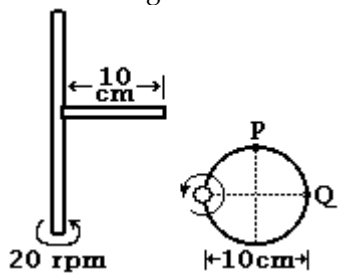
The radius of a 3.0 kg wheel is 6.0 cm. The wheel is released from rest at point A on a 30° incline. The wheel rolls without slipping and moves 2.4 m to point B in 1.20s.

14) In Figure **1**, the moment of inertia of the wheel is closest to:
A) 0.0060 kg.m^2 C) 0.0054 kg.m^2 E) 0.0057 kg.m^2
B) 0.0048 kg.m^2 D) 0.0051 kg.m^2

15) In Figure **1**, the angular acceleration of the wheel is closest to:
A) 65 rad/ s^2 B) 48 rad/ s^2 C) 73 rad/ s^2 D) 82 rad/ s^2 E) 56 rad/ s^2

16) A hoop is released from rest at the top of a plane inclined at 20° above horizontal. How long does it take the hoop to roll 12.0 m down the plane?
A) 2.24 s B) 2.86 s C) 3.78 s D) 2.44 s E) 1.76 s

Figure **2**



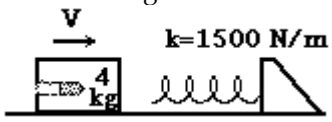
A uniform disk is attached at the rim to a vertical shaft and is used as a cam. Two views of the disk and shaft are shown. The disk has a diameter of 10 cm. The moment of inertia of the disk about the axis of the shaft is 4.5×10^{-3} kg.m^2. The shaft rotates uniformly about its axis at 20 rpm.

17) In Figure **2**, the mass of the disk is closest to:
A) 1.4 kg B) 0.8 kg C) 1.0 kg D) 1.2 kg E) 1.6 kg

18) In Figure **2**, the kinetic energy of the disk, in mJ, is closest to:
A) 29 B) 6 C) 3 D) 17 E) 10

19) In Figure **2**, the linear velocity of point P is closest to:
A) 0.12 m/s B) 0.20 m/s C) 0.15 m/s D) 0.17 m/s E) 0.10 m/s

Figure **3**

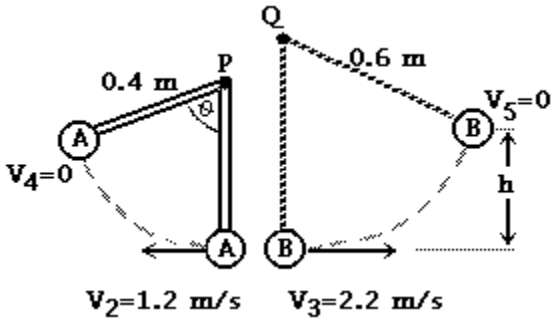


An 8–g bullet is shot into a 4.0–kg block, at rest on a frictionless horizontal surface. The bullet remains lodged in the block. The block moves into a spring and compresses it by 3.0 cm. The force constant of the spring is 1500 N/m.

20) In Figure **3**, the initial velocity of the bullet is closest to:
A) 280 m/s B) 290 m/s C) 320 m/s D) 300 m/s E) 310 m/s

21) In Figure **3**, the impulse of the block (including the bullet), due to the spring, during the entire time interval in which block and spring are in contact is closest to:
A) 3.5 N · s B) 2.3 N · s C) 4.7 N · s D) 4.1 N · s E) 2.9 N · s

Figure **4**



Ball A, of mass 3.0 kg, is attached to a 0.4 m light rod, freely pivoted at P. Ball B is suspended from Q by a 0.6–m rope and is at rest. Ball A is raised to a certain level and is released. Ball A descends, and has a speed $\mathbf{v}_1$ = 3.6 m/s at the bottom, prior to striking ball B. The speed of balls A and B after the collision are $\mathbf{v}_1$ = 1.2 m/s and $\mathbf{v}_2$ = 2.2 m/s, as shown.

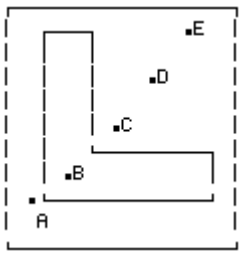
22) In Figure **4**, the mass of ball B is closest to:
A) 3.3 kg B) 6.6 kg C) 4.9 kg D) 5.7 kg E) 4.1 kg

23) In Figure **4**, the magnitude of the impulse on ball A is closest to:
A) 3.6 N · s B) 18.0 N · s C) 7.2 N · s D) 10.8 N · s E) 14.4 N · s

24) In Figure **4**, ball A rebounds and swings through an angle θ, where the speed of $\mathbf{v}_4$ is zero. The rebound angle θ is closest to:
A) 35° B) 39° C) 37° D) 33° E) 31°

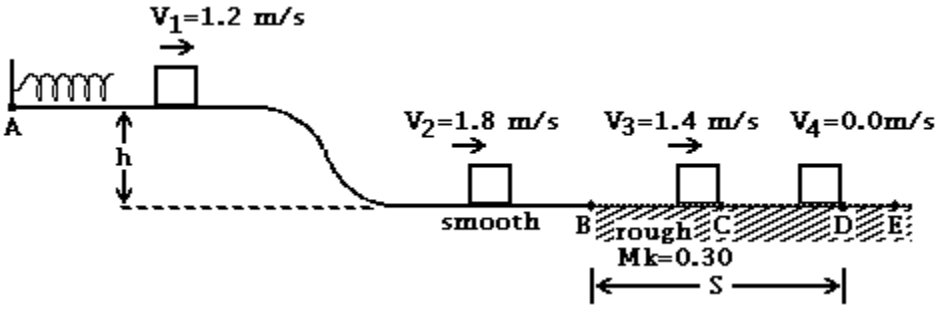
25) In Figure **4**, ball B rises through a height h, where the speed $\mathbf{v}_5$ is zero. The height h is closest to:
A) 0.33 m B) 0.25 m C) 0.21 m D) 0.37 m E) 0.29 m

Figure **5**



26) In Figure **5**, an L–shaped piece is cut from a uniform sheet of metal. Which of the points indicated is closest to the center of mass of the object?
A) B B) D C) C D) A E) E

Figure **6**



A 0.50–kg block is held in place against the spring by a 36–N horizontal external force. The external force is removed, and the block is projected with a velocity v_1 = 1.2 m/s upon separation from the spring. The block descends a ramp and has a velocity v_2 = 1.8 m/s at the bottom. The track is frictionless between points A and B. The block enters a rough section at B, extending to E. The coefficient of kinetic friction is 0.30. The velocity of the block is v_3 = 1.4 m/s at C. The block moves on to D, where it stops.

27) In Figure **6**, the force constant of the spring is closest to:
A) 900 N/m B) 1300 N/m C) 640 N/m D) 1800 N/m E) 450 N/m

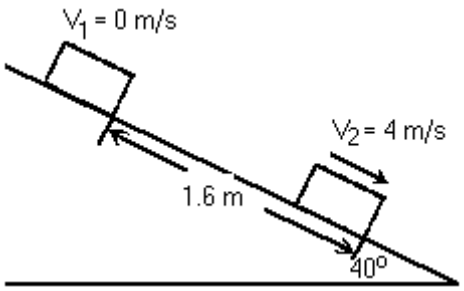
28) In Figure **6**, the initial compression of the spring, in cm, is closest to:
A) 2.8 B) 1.0 C) 2.0 D) 4.0 E) 1.4

29) In Figure **6**, the height of the ramp h, in cm, is closest to:
A) 13 B) 11 C) 9 D) 7 E) 15

30) In Figure **6**, the work done by friction between points B and C is closest to:
A) –0.40 J B) –0.64 J C) –0.56 J D) –0.32 J E) –0.48 J

31) In Figure **6**, the distance s that the block travels between points B and D is closest to:
A) 0.65 m B) 0.25 m C) 0.35 m D) 0.55 m E) 0.45 m

Figure **7**



An 8.0–kg block is released from rest, $\mathbf{v}_1 = 0$ m/s, on a rough incline. The block moves a distance of 1.6 m down the incline, in a time interval of 0.80 s, and acquires a velocity of $\mathbf{v}_2 = 4.0$ m/s.

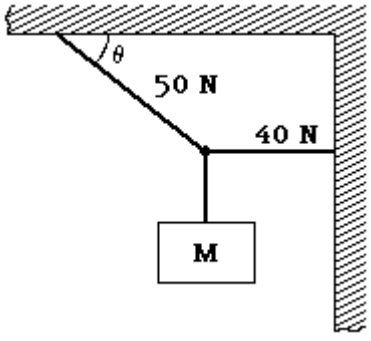
32) In Figure **7**, the work done by the weight is closest to:
A) –80 J B) +100 J C) –100 J D) +80 J E) +120 J

33) In Figure **7**, the average rate at which the friction force does work during the 0.80 s time interval is closest to:
A) +20 W B) –40 W C) +40 W D) –20 W E) zero

34) In Figure **7**, the average rate at which the normal force does work during the 0.80 s time interval is closest to:
A) +100 W B) +120 W C) zero D) –120 W E) –100 W

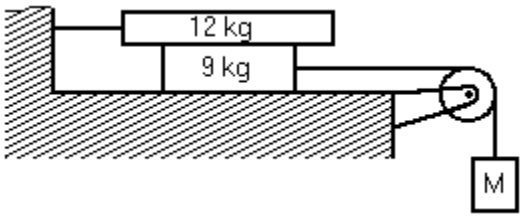
35) In Figure **7**, the average rate at which the block gains kinetic energy during the 0.80 s time interval is closest to:
A) 80 W B) 89 W C) 83 W D) 77 W E) 86 W

Figure **8**



36) In Figure **8**, a block of mass M hangs in equilibrium. The rope which is fastened to the wall is horizontal and has a tension of 40 N. The rope which is fastened to the ceiling has a tension of 50 N, and makes an angle Θ with the ceiling. The angle Θ is
A) 37 ° B) 45 ° C) 60 ° D) 53 ° E) 39 °

Figure **9**

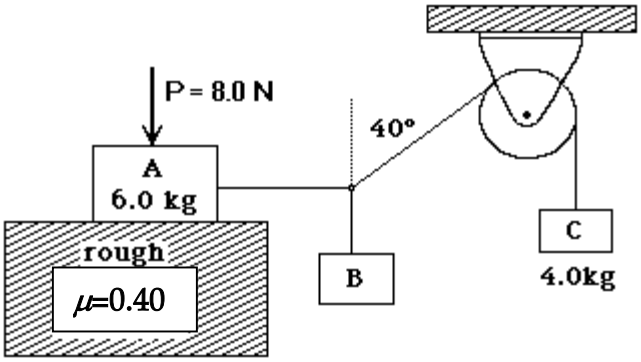


A system comprising blocks, a light frictionless pulley, and connecting ropes is shown. The 9–kg block is on a smooth horizontal table ($\mu = 0$). The surfaces of the 12–kg block are rough, with $\mu = 0.30$.

37) In Figure **9**, the mass M is set so that it descends at constant velocity when released. The mass M is closest to:
A) 3.0 kg B) 3.3 kg C) 2.7 kg D) 3.6 kg E) 2.4 kg

38) In Figure **9**, mass M is set at 5.0 kg. It accelerates downward when it is released. The acceleration of mass M is closest to:
A) 1.8 m/ s^2 B) 1.2 m/ s^2 C) 1.0 m/ s^2 D) 1.4 m/ s^2 E) 1.6 m/ s^2

Figure **10**



A system of blocks and a frictionless pulley is given. Block A has a mass of 6.0 kg and is on a rou gh surface (μ= 0.40). Block C has a mass of 4.0 kg. An external force P = 8.0 N, applied vertically to block A, maintains the system in static equilibrium as shown.

39) In Figure **10**, the mass of block B is closest to:
A) 2.5 kg B) 2.3 kg C) 2.7 kg D) 3.1 kg E) 2.9 kg

40) In Figure **10**, the frictional force on block A is closest to:
A) 24.4 N B) 23.5 N C) 25.2 N D) 26.7 N E) 25.9 N

41) In Figure **10**, the external 8.0 N is removed. The masses of blocks B and C are adjusted, so that the system remains at rest as shown, but is on the verge of moving. The mass of block A is unchanged. The tensions in the two vertical ropes are closest to:
A) 28 N and 37 N C) 34 N and 44 N E) 28 N and 44 N
B) 24 N and 31 N D) 24 N and 37 N

42) The value of $\hat{\imath} \cdot (\hat{\jmath} \times \hat{k})$ is:
A) zero
B) +1
C) –1
D) 3
E) $\sqrt{3}$

43) The value of $\hat{k} \cdot (\hat{k} \times \hat{\imath})$ is:
A) zero
B) +1
C) –1
D) 3
E) $\sqrt{3}$

44) If $\vec{A} = (6\text{ m})\hat{\imath} - (8\text{ m})\hat{\jmath}$ then $4\vec{A}$ has magnitude:
A) 10 m
B) 20 m
C) 30 m
D) 40 m
E) 50 m

45) The angle between $\vec{A} = (25\text{ m})\hat{\imath} + (45\text{ m})\hat{\jmath}$ and the positive *x*-axis is:
A) 29°
B) 61°
C) 151°
D) 209°
E) 241°

Answer Key

1) Answer: D
2) Answer: C
3) Answer: A
4) Answer: E
5) Answer: B
6) Answer: D
7) Answer: B
8) Answer: E
9) Answer: C
10) Answer: D
11) Answer: E
12) Answer: C
13) Answer: C
14) Answer: D
15) Answer: E
16) Answer: C
17) Answer: D
18) Answer: E
19) Answer: C
20) Answer: B
21) Answer: C
22) Answer: B
23) Answer: E
24) Answer: A
25) Answer: B
26) Answer: C
27) Answer: D
28) Answer: C
29) Answer: C
30) Answer: D
31) Answer: D
32) Answer: D
33) Answer: D
34) Answer: C
35) Answer: A
36) Answer: A
37) Answer: D
38) Answer: C
39) Answer: D
40) Answer: C
41) Answer: A

Answer Key -- Vectors

42) B
43) A
44) D
45) B