PHYS 1111, Section 5, Fall 2014
Test no. 2, version 1
October 14, 2014
2:00pm – 3:15pm

KEY

NOTE: This test consists of 20 multiple choice problems. 18 of the problems are required, while the extra 2 are for bonus points. Fill in your name, Student ID, Version number, and answers on the scantron sheet. You may keep the problem sheet when you are finished. An equation sheet appears on the last page.

TRUE/FALSE. Choose 'True' if the statement is true and 'False' if the statement is false.

1) The mass of the Moon is about 1/80th of the mass of Earth. The force exerted by Earth on the Moon is about 80 times that exerted by the Moon on Earth. 1) B

A) True (B) False

Newton's 3rd Law $\vec{F}_{12} = -\vec{F}_{21}$

2) Kinetic energy is proportional to speed. 2) B

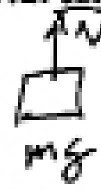
A) True (B) False

$K = \frac{1}{2}mv^2$

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

3) You ride on an elevator that is moving downward with constant speed while standing on a bathroom scale. The reading on the scale is 3) A

(A) equal to your true weight, *mg*.
B) less than your true weight, *mg*.
C) more than your true weight, *mg*.
D) could be more or less than your true weight, *mg*, depending on the value of the speed.



$N - mg = 0$

$N = mg$ = true weight

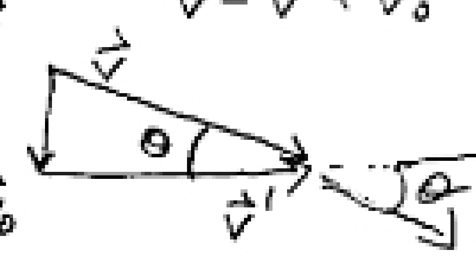
4) A plane is headed eastward at a speed of 156 m/s. A 20.0 m/s wind is blowing southward at the same time as the plane is flying. The velocity of the plane relative to the ground is 4) C

A) 157 m/s at an angle 7.31° east of south.
B) 155 m/s at an angle 7.36° south of east.
(C) 157 m/s at an angle 7.31° south of east.
D) 155 m/s at an angle 7.36° east of south.
E) 157 m/s at an angle 7.36° south of east.

$\vec{V} = \vec{V}' + \vec{V}_0$

$V = \sqrt{V'^2 + V_0^2} = \sqrt{156^2 + 20^2} = 157\ m/s$

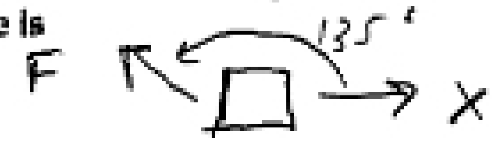
see page 2



5) A constant force is applied to an object that causes a certain displacement. If the angle between the force and the displacement is 135°, the work done by this force is 5) C

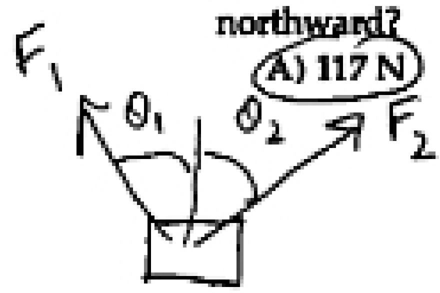
A) 0 J.
B) positive.
(C) negative.
D) Cannot be determined without knowing the magnitude of the displacement.
E) Cannot be determined without knowing the magnitude of the applied force.

$W = F\cos\phi\ x$



6) A 1000-kg barge is being towed by means of two horizontal cables. One cable is pulling with a force of 80.0 N in a direction 30.0° west of north. The second cable pulls in a direction 20.0° east of north. What should the magnitude of its pulling force be so that the barge will accelerate northward? 6) A

(A) 117 N B) 58.5 N C) 120 N D) 127 N E) 73.7 N



$\Sigma F_x = 0$ to go North

$-F_1 \sin\theta_1 + F_2 \sin\theta_2 = 0$

$F_2 = F_1 \frac{\sin\theta_1}{\sin\theta_2} = 80 \frac{\sin 30^\circ}{\sin 20^\circ} = 117N$

Problem 4 (cont'd)

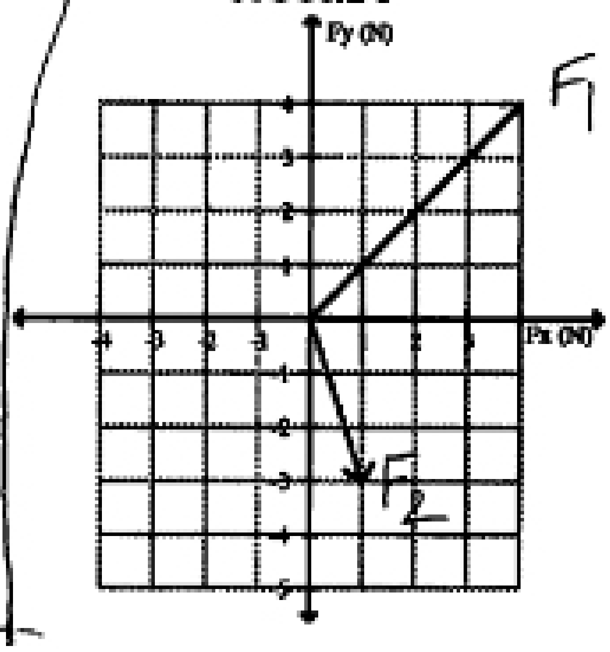
$\tan\theta = \frac{V_0}{V'}$

$\theta = \tan^{-1}\left(\frac{V_0}{V'}\right)$

$= \tan^{-1}\left(\frac{20}{156}\right)$

$\theta = 7.31°$ S of E

FIGURE 1



7) The two forces indicated in **Figure 1** act on a 3.00-kg object. What is the acceleration of the object? 7) D

A) $(5.00\ m/s^2)\hat{i} + (1.00\ m/s^2)\hat{j}$

B) $(1.67\ m/s^2)\hat{i} - (0.333\ m/s^2)\hat{j}$

C) $(1.67\ m/s^2)\hat{i} + (2.333\ m/s^2)\hat{j}$

D) $(1.67\ m/s^2)\hat{i} + (0.333\ m/s^2)\hat{j}$

E) $(15.0\ m/s^2)\hat{i} + (3.00\ m/s^2)\hat{j}$

$\vec{F}_1 = 4\hat{x} + 4\hat{y}$ N

$\vec{F}_2 = 1\hat{x} - 3\hat{y}$ N

$\Sigma\vec{F} = 5\hat{x} + 1\hat{y}$ N

$\vec{a} = \frac{\Sigma\vec{F}}{m} = \left(\frac{5}{3}\hat{x} + \frac{1}{3}\hat{y}\right)\frac{m}{s^2}$

8) The total mechanical energy of a system 8) B

A) is equally divided between kinetic energy and potential energy. — maybe

B) is constant, only if conservative forces act. ← best answer

C) is either all kinetic energy or all potential energy, at any one instant. — maybe

D) is not uniquely determined for most naturally occurring systems. — No

E) can never be negative. — No

9) The hydrogen atom consists of a proton of mass 1.67×10^{-27} kg and an orbiting electron of mass 9.11×10^{-31} kg. In one of its orbits, the electron is 5.3×10^{-11} m from the proton. What is the mutual attractive gravitational force between the electron and proton? 9) B

A) 9.3×10^{-47} N

B) 3.6×10^{-47} N

C) 5.4×10^{-47} N

D) 1.8×10^{-47} N

E) 7.0×10^{-47} N

$F = G\frac{m_1 m_2}{r^2} = \frac{(6.67\times10^{-11})(1.67\times10^{-27})(9.11\times10^{-31})}{(5.3\times10^{-11})^2} = 3.6\times10^{-47}\,N$

10) An object of mass m moving with a certain speed has a kinetic energy of 0.0124 J. The object collides with a horizontal spring and compresses it by 0.800 m before it is brought to rest. What is the spring constant of this spring? 10) D

A) 0.194 N/m

B) 0.315 N/m

C) 0.0235 N/m

D) 0.0388 N/m

E) 0.150 N/m

Use conservation of energy

$E = K + U_s$, $E_i = K_i$, $E_f = U_s = \frac{1}{2}kx^2$

$K_i = \frac{1}{2}kx^2$

$k = \frac{2K_i}{x^2} = \frac{2(0.0124)}{(.8)^2} = 0.0388\frac{N}{m}$

V_i $|\Delta x|$ $V_f = 0$

A → T $\Sigma F_x = m_A a_A$

$T = m_A a_A$ —(1)

B: ↑T, ↓ $m_B g$

$\Sigma F_y = m_B a_B$

$T - m_B g = m_B a_B$

$T = m_B(g + a_B)$ —(2)

$a_A = -a_B = a$

$T = m_A a$ —(1)

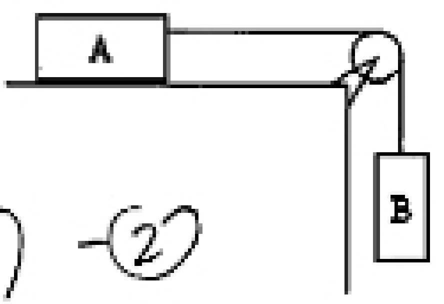
$T = m_B(g - a)$ —(2)

or $m_A a = m_B(g - a)$

$(m_A + m_B)a = m_B g$

$a = \frac{m_B g}{m_A + m_B} = \frac{2(9.8)}{3+2} = 3.92 m/s^2$ (see p. 5)

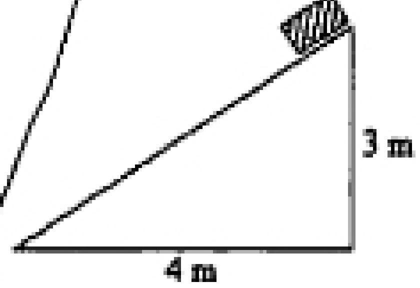
FIGURE 2



11) Refer to Figure 2. Block A has a mass of 3.00 kg and rests on a smooth table and is connected to block B, which has a mass of 2.00 kg, after passing over an ideal pulley, as shown. Block B is released from rest. How long does it take block B to travel 80.0 cm? 11) D

A) 0.785 s B) 0.935 s C) 0.404 s D) 0.639 s E) 0.494 s

FIGURE 3



Use conservation of Energy

$E = \frac{1}{2}mv^2 + mgy$

$E_i = E_f$

$mgy_i = \frac{1}{2}mv_f^2$

$v_f = \sqrt{2gh} = \sqrt{2(10)(3)} = 7.75 m/s$

An object of mass 2 kg is held at the top of a triangular wedge as shown in Figure 3, and then released. The reference level for potential energy is at the base of the triangle. Neglect friction and use $g = 10\ m/s^2$.

12) Refer to Figure 3. What is the speed of the object just before it reaches the bottom of the wedge? 12) C

A) 6 m/s B) 2 m/s C) 8 m/s D) 10 m/s E) 0 m/s

13) A 5.00-kg box slides 4.00 m across the floor before coming to rest. What is the coefficient of kinetic friction between the floor and the box if the box had an initial speed of 3.00 m/s? 13) E

A) 0.587 B) 0.267 C) 1.13 D) 0.229 E) 0.115

Use p. 5 use work-energy theorem

14) A spaceship with a mass of 2.8×10^6 kg is traveling toward two asteroids, each with a mass of 5.0×10^{16} kg, which are 40 km apart. Its path is perpendicular to the line joining the asteroids and aimed at the midpoint of that line. What is the net gravitational force exerted by the asteroids on the spaceship when the spaceship is 30 km away from that midpoint? 14) B

$G = 6.67 \times 10^{-11}\ N \cdot m^2/kg^2$

A) 8000 N B) 12,000 N C) 6200 N D) 18,000 N E) 16,000 N

15) An object of mass 4 kg is thrown vertically upwards from ground level with an initial speed of 20 m/s. Ignore friction and use $g = 10\ m/s^2$. What is the kinetic energy of the object just before it hits the ground? 15) D

A) 100 J B) 400 J C) 0 J D) 800 J E) 200 J

By conservation of energy

$E_0 = E_1 = E_2$

$E_0 = \frac{1}{2}mv_0^2$

$E_2 = \frac{1}{2}mv_2^2$

$E_2 = E_0 = \frac{1}{2}mv_0^2 = \frac{1}{2}(4)(20)^2 = 800 J$