PH 105 Exam 2 VERSION A

Name________________________________

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

1) Is it possible for a system to have negative potential energy? 1) ______
- A) Yes, since the choice of the zero of potential energy is arbitrary.
- B) No, because this would have no physical meaning.
- C) Yes, as long as the kinetic energy is positive.
- D) No, because the kinetic energy of a system must equal its potential energy.
- E) Yes, as long as the total energy is positive.

2) Consider the motion of a 1.00-kg particle that moves with potential energy given by $U(x) = (-2.00\ \text{J}\cdot\text{m})/x + (4.00\ \text{J}\cdot\text{m}^2)/x^2$. Suppose the particle is moving with a speed of 3.00 m/s when it is located at $x = 1.00$ m. What is the speed of the object when it is located at $x = 5.00$ m? 2) ______

A) 2.13 m/s B) 3.67 m/s C) 4.68 m/s D) 3.00 m/s

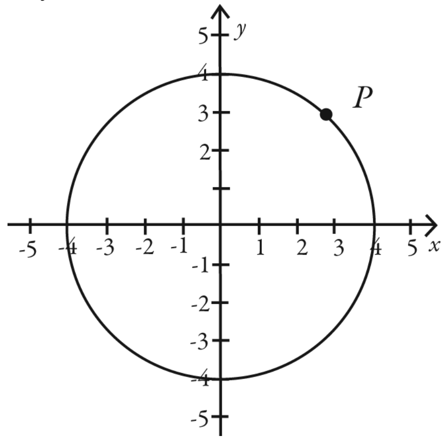
3) A 2.00-kg object traveling east at 20.0 m/s collides with a 3.00-kg object traveling west at 10.0 m/s. After the collision, the 2.00-kg object has a velocity 5.00 m/s to the west. How much kinetic energy was lost during the collision? 3) ______

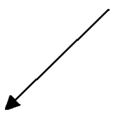
A) 91.7 J B) 0.000 J C) 516 J D) 175 J E) 458 J

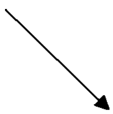
4) You swing a bat and hit a heavy box with a force of 1500 N. The force the box exerts on the bat is 4) ______
- A) less than 1500 N if the box moves.
- B) exactly 1500 N whether or not the box moves.
- C) greater than 1500 N if the bat bounces back.
- D) greater than 1500 N if the box moves.
- E) exactly 1500 N only if the box does not move.

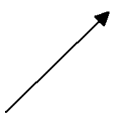
5) A 7.0-kg object is acted on by two forces. One of the forces is 10.0 N acting toward the east. Which of the following forces is the other force if the acceleration of the object is 1.0 m/s^2 toward the east? 5) ______
- A) 3.0 N west
- B) 7.0 N west
- C) 6.0 N east
- D) 9.0 N west
- E) 12 N east

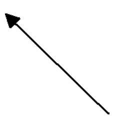
6) Point P in the figure indicates the position of an object traveling at constant speed clockwise around the circle. Which arrow best represent the direction the object would travel if the net external force on it were suddenly reduced to zero? 6) _______

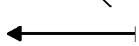


A) 

B) 

C) 

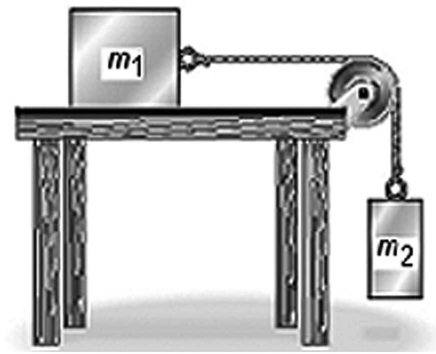
D) 

E) 

7) Consider what happens when you jump up in the air. Which of the following is the most accurate statement? 7) _______

A) Since the ground is stationary, it cannot exert the upward force necessary to propel you into the air. Instead, it is the internal forces of your muscles acting on your body itself that propels your body into the air.
B) When you push down on the earth with a force greater than your weight, the earth will push back with the same magnitude force and thus propel you into the air.
C) When you jump up the earth exerts a force F_1 on you and you exert a force F_2 on the earth. You go up because $F_1 > F_2$.
D) It is the upward force exerted by the ground that pushes you up, but this force cannot exceed your weight.
E) You are able to spring up because the earth exerts a force upward on you that is greater than the downward force you exert on the earth.

8) Two objects having masses m_1 and m_2 are connected to each other as shown in the figure and are released from rest. There is no friction on the table surface or in the pulley. The masses of the pulley and the string connecting the objects are completely negligible. What must be true about the tension T in the string just after the objects are released? 8) _______



A) $T < m_2g$ B) $T > m_2g$ C) $T = m_1g$ D) $T = m_2g$ E) $T > m_1g$

9) Consider two less-than-desirable options. In the first you are driving 30 mph and crash head-on into an identical car also going 30 mph. In the second option you are driving 30 mph and crash head-on into a stationary brick wall. In neither case does your car bounce off the thing it hits, and the collision time is the same in both cases. Which of these two situations would result in the greatest impact force? 9) _______

A) hitting the brick wall
B) hitting the other car
C) The force would be the same in both cases.
D) We cannot answer this question without more information.
E) None of these is true.

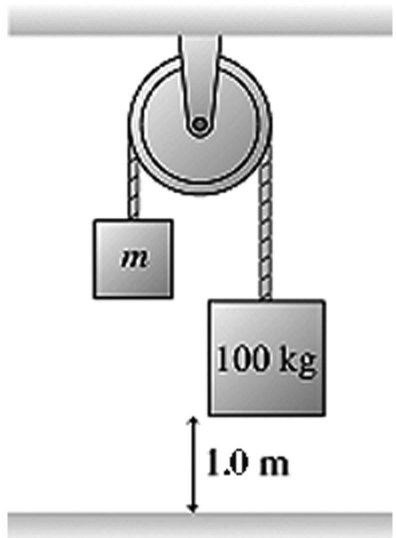
10) A 50.0-N box is sliding on a rough horizontal floor, and the only horizontal force acting on it is friction. You observe that at one instant the box is sliding to the right at 1.75 m/s and that it stops in 2.25 s with uniform acceleration. What magnitude force does friction exert on this box? 10) _______

A) 490 N B) 38.9 N C) 3.97 N D) 8.93 N E) 50.0 N

11) On its own, a certain tow-truck has a maximum acceleration of 3.0 m/s^2. What would be the maximum acceleration when this truck was towing a bus of twice its own mass? 11) _______

A) 1.0 m/s^2 B) 2.5 m/s^2 C) 1.5 m/s^2 D) 2.0 m/s^2

12) The figure shows a 100-kg block being released from rest from a height of 1.0 m. It then takes it 0.90 s to reach the floor. What is the mass m of the other block? The pulley has no appreciable mass or friction. 12) ______



A) 42 kg B) 48 kg C) 54 kg D) 60 kg

13) An object attached to an ideal massless spring is pulled across a frictionless surface. If the spring constant is 45 N/m and the spring is stretched by 0.88 m when the object is accelerating at 2.0 m/s^2, what is the mass of the object? 13) ______

A) 22 kg B) 20 kg C) 17 kg D) 26 kg

14) Two identical balls are thrown directly upward, ball A at speed v and ball B at speed $2v$, and they feel no air resistance. Which statement about these balls is correct? 14) ______

A) The balls will reach the same height because they have the same mass and the same acceleration.
B) At its highest point, ball B will have twice as much gravitational potential energy as ball A because it started out moving twice as fast.
C) Ball B will go twice as high as ball A because it had twice the initial speed.
D) At their highest point, the acceleration of each ball is instantaneously equal to zero because they stop for an instant.
E) Ball B will go four times as high as ball A because it had four times the initial kinetic energy.

15) Which, if any, of the following statements concerning the work done by a conservative force is NOT true? 15) ______

A) It is independent of the path of the body and depends only on the starting and ending points.
B) It can always be expressed as the difference between the initial and final values of a potential energy function.
C) When the starting and ending points are the same, the total work is zero.
D) All of the above statements are true.
E) None of the above statements are true.

16) It requires 49 J of work to stretch an ideal very light spring from a length of 1.4 m to a length of 2.9 m. What is the value of the spring constant of this spring? 16) ______

A) 22 N/m B) 44 N/m C) 15 N/m D) 29 N/m

17) A force $F = bx^3$ acts in the x direction, where the value of b is 3.7 N/m^3. How much work is done by this force in moving an object from $x = 0.00$ m to $x = 2.6$ m? 17) ______

A) 13 J B) 57 J C) 50 J D) 42 J

18) A constant horizontal pull acts on a sled on a horizontal frictionless ice pond. The sled starts from rest. When the pull acts over a distance x, the sled acquires a speed v and a kinetic energy K. If the same pull instead acts over twice this distance: 18) ______

A) The sled's speed will be $v\sqrt{2}$ and its kinetic energy will be $K\sqrt{2}$.
B) The sled's speed will be $2v$ and its kinetic energy will be $K\sqrt{2}$.
C) The sled's speed will be $2v$ and its kinetic energy will be $2K$.
D) The sled's speed will be $4v$ and its kinetic energy will be $2K$.
E) The sled's speed will be $v\sqrt{2}$ and its kinetic energy will be $2K$.

19) An object is attached to a hanging unstretched ideal and massless spring and slowly lowered to its equilibrium position, a distance of 6.4 cm below the starting point. If instead of having been lowered slowly the object was dropped from rest, how far then would it then stretch the spring at maximum elongation? 19) ______

A) 6.4 cm B) 9.1 cm C) 26 cm D) 18 cm E) 13 cm

20) For general projectile motion, when the projectile is at the highest point of its trajectory 20) ______

A) the horizontal component of its velocity is zero.
B) its velocity is perpendicular to the acceleration.
C) its velocity and acceleration are both zero.
D) the horizontal and vertical components of its velocity are zero.
E) its acceleration is zero.

21) What is the maximum distance we can shoot a dart, from ground level, provided our toy dart gun gives a maximum initial velocity of 2.78 m/s and air resistance is negligible? 21) ______

A) 1.39 m B) 1.58 m C) 0.394 m D) 0.789 m

22) A hobby rocket reaches a height of 72.3 m and lands 111 m from the launch point with no air resistance. What was the angle of launch? 22) ______

A) 67.4° B) 44.8° C) 22.6° D) 69.0°

23) A boy throws a rock with an initial velocity of 2.15 m/s at 30.0° above the horizontal. If air resistance is negligible, how long does it take for the rock to reach the maximum height of its trajectory? 23) ______

A) 0.215 s B) 0.110 s C) 0.303 s D) 0.194 s

24) An object has a position given by $\vec{r} = [2.0\ \text{m} + (3.00\ \text{m/s})t]\hat{i} + [3.0\ \text{m} - (2.00\ \text{m/s}^2)t^2]\hat{j}$, where all quantities are in SI units. What is the magnitude of the acceleration of the object at time t = 2.00 s? 24) ______

A) 0.522 m/s^2
B) 2.00 m/s^2
C) 1.00 m/s^2
D) 4.00 m/s^2
E) 0.00 m/s^2

25) A 60.0-kg person rides in an elevator while standing on a scale. The scale reads 400 N. The acceleration of the elevator is closest to 25) ______

A) 6.67 m/s^2 upward.
B) zero.
C) 9.80 m/s^2 downward.
D) 3.13 m/s^2 downward.
E) 6.67 m/s^2 downward.

Formula sheet

basics

$$g = |\vec{a}_{\text{free fall}}| = 9.81\,\text{m/s}^2 \quad \text{near earth's surface}$$

$$\text{sphere} \quad V = \frac{4}{3}\pi r^3$$

$$ax^2 + bx^2 + c = 0 \Longrightarrow x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$\frac{d}{dx}\sin ax = a\cos ax \qquad \frac{d}{dx}\cos ax = -a\sin ax$$

$$\int \cos ax\,\text{dx} = \frac{1}{a}\sin ax \qquad \int \sin ax\,\text{dx} = -\frac{1}{a}\cos ax$$

$$\vec{A} = \vec{A}_x + \vec{A}_y = A_x\,\hat{\imath} + A_y\,\hat{\jmath}$$

$$\vec{A}\cdot\vec{B} = AB\cos\phi = A_xB_x + A_yB_y$$

$$|\vec{F}| = \sqrt{F_x^2 + F_y^2} \quad \text{magnitude}$$

$$\theta = \tan^{-1}\left[\frac{F_y}{F_x}\right] \quad \text{direction}$$

1D & 2D motion

$$\Delta\vec{r} = \vec{r}_f - \vec{r}_i$$

$$\text{speed} = v = |\vec{v}| \quad \vec{v}_{av} \equiv \frac{\Delta\vec{r}}{\Delta t} \quad \vec{v} = \lim_{\Delta t\to 0}\frac{\Delta\vec{r}}{\Delta t} \equiv \frac{d\vec{r}}{dt}$$

$$a_{x,av} \equiv \frac{\Delta v_x}{dt} \quad a_x = \lim_{\Delta t\to 0}\frac{\Delta v_x}{\Delta t} \equiv \frac{dv_x}{dt} = \frac{d}{dt}\left(\frac{dx}{dt}\right) = \frac{d^2x}{dt^2}$$

$$x_f = x_i + v_{x,i}\Delta t + \frac{1}{2}a_x(\Delta t)^2$$

$$v_{x,f} = v_{x,i} + a_x\Delta t$$

$$x(t) = x_i + v_{x,i}t + \frac{1}{2}a_xt^2$$

$$v_x(t) = v_{x,i} + a_xt$$

$$v_{x,f}^2 = v_{x,i}^2 + 2a_x\Delta x$$

↓ launched from origin, level ground

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

$$\text{max height} \;= H = \frac{v_i^2\sin^2\theta_i}{2g}$$

$$\text{Range} \;= R = \frac{v_i^2\sin 2\theta_i}{g}$$

momentum

$$\Delta\vec{p} = \vec{0} \quad \vec{p}_f = \vec{p}_i \quad \text{isolated system} \qquad \vec{p} = m\vec{v} \qquad \vec{J} = \Delta\vec{p}$$

$$v_{1f} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)v_{i1} + \left(\frac{2m_2}{m_1 + m_2}\right)v_{2i} \quad \text{1D elastic}$$

$$v_{2f} = \left(\frac{2m_1}{m_1 + m_2}\right)v_{1i} + \left(\frac{m_2 - m_1}{m_1 + m_2}\right)v_{2i} \quad \text{1D elastic}$$

$$\vec{v}_{12} = \vec{v}_2 - \vec{v}_1 \quad \text{relative velocity}$$

$$v_{12} = |\vec{v}_2 - \vec{v}_1| \quad \text{relative speed}$$

interactions

$$\Delta U^G = mg\Delta x \qquad \frac{a_{1x}}{a_{2x}} = -\frac{m_2}{m_1}$$

$$E_{\text{mech}} = K + U \quad K = \frac{1}{2}mv^2$$

$$\Delta E_{\text{mech}} = \Delta K + \Delta U = 0 \quad \text{non-dissipative, closed}$$

force

$$\vec{a} = \frac{\sum\vec{F}}{m} \qquad a_{\vec{cm}} = \frac{\sum\vec{F}_{\text{ext}}}{m} \qquad \sum\vec{F} \equiv \frac{d\vec{p}}{dt} \quad \vec{F}_{12} \quad = -\vec{F}_{21}$$

$$\vec{J} = \left(\sum\vec{F}\right)\Delta t \quad \text{constant force}$$

$$\vec{J} = \int_{t_i}^{t_f}\sum\vec{F}(t)\,dt \quad \text{time-varying force}$$

$$F_{\text{so},x} = -k(x - x_o) \quad \text{small displacement}$$

work

$$\Delta E_{\text{mech}} = \Delta K + \Delta U = W \quad \leftarrow \text{not closed} \qquad \Delta U_{\text{spring}} = \frac{1}{2}k\,(x - x_o)^2$$

$$P = \frac{dE}{dt} \quad P = F_{\text{ext,x}}\,v_x \quad \text{one dimension}$$

$$W = \left(\sum\vec{F}\right)\Delta x_F \quad \text{constant foce 1D}$$

$$W = \sum_n\left(F_{\text{ext,x}}\,\Delta x_{Fn}\right) \quad \text{const nondiss., many particles, 1D}$$

$$W = \int_{x_i}^{x_f}F_x(x)\,dx \quad \text{nondiss. force, 1D}$$

$$(F_{12}^s)_{\max} = \mu_sF_{12}^n \quad \text{static} \qquad F_{12}^k = \mu_kF_{12}^n \quad \text{kinetic}$$

$$W = \vec{F}\cdot\Delta\vec{r}_F \quad \text{const non-diss force}$$

$$W = \int_{\vec{r}_i}^{\vec{r}_f}\vec{F}(\vec{r})\cdot d\vec{r} \quad \text{variable nondiss force}$$

sundry bits

Power	Prefix	Abbreviation
10^{-9}	nano	n
10^{-6}	micro	µ
10^{-3}	milli	m
10^{-2}	centi	c
10^{3}	kilo	k
10^{6}	mega	M
10^{9}	giga	G

Derived unit	Symbol	equivalent to
newton	N	$\text{kg}\cdot\text{m/s}^2$
joule	J	$\text{kg}\cdot\text{m}^2/\text{s}^2 = \text{N}\cdot\text{m}$
watt	W	$\text{J/s} = \text{m}^2\cdot\text{kg/s}^3$