Physics 1135 Version A

Spring 2024

Rec Sec______

Answer Sheet

EM Mini-Test

& Final Exam

Print LAST Name: Solution

First Name: ______________

Remove this page from your exam when you begin. Write clearly in the space provided on this *Answer Sheet* the *letter* which you believe to be the *best* answer to each question.

ONLY THIS ANSWER SHEET will be looked at for scoring. Make sure your chosen answers are on it and do not leave any answer space blank.

Neither calculators nor notes can be used during the test.

EM Mini-Test Score = 50

Final-Exam Score = 200

Mini-Test Responses (10 pts each)

Em - 1) B

Em - 2) A

Em - 3) A

Em - 4) C

Em - 5) B

Final-Exam Responses (10 pts each)

1)	C	11)	B
2)	C	12)	B
3)	D	13)	B
4)	C	14)	A
5)	B	15)	B
6)	B	16)	C
7)	A	17)	B
8)	C	18)	A
9)	C	19)	C
10)	A	20)	D

End-Material Mini Test

Em-1. A wave on a string has a fundamental frequency of 300 Hz. The frequency of the second harmonic is:

A) 150 Hz B) 600 Hz C) 300 Hz D) 900 Hz

$\lambda_1 = 2L \quad f_1 = \frac{v}{2L} \qquad \lambda_2 = L \quad f_2 = \frac{v}{L} = 2f_1$

Em-2. You drop your phone, which is ringing with frequency f, from the top of a cliff. What is the frequency you will last hear just before the phone meets its untimely demise when it hits the ground with speed V? The speed of sound is v.

A) $f/(1 + V/v)$ B) $f/(1 - V/v)$ C) $f(1 + V/v)$ D) $f(1 - V/v)$

$v_0 = 0 \quad \downarrow v_s \quad \uparrow x \qquad f' = f \frac{v - v_{0x}}{v - v_{sx}} = f \frac{v}{v-(-V)} = f \frac{1}{1 + V/v}$

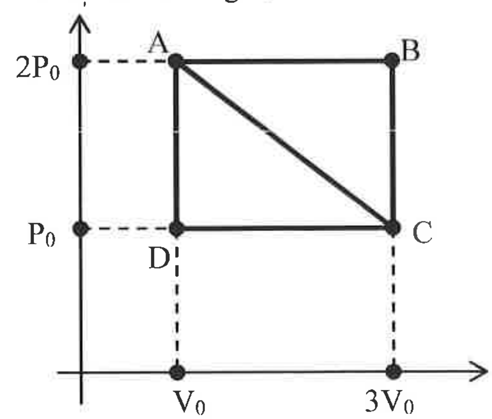
Em-3. When an ideal gas undergoes an isothermal expansion, we know that

A) heat flows into the gas B) no heat flows into the gas
C) the internal energy increases D) the pressure increases

Questions **4** and **5** both refer to the processes shown in the diagram for an ideal monatomic gas.

Em-4. Considering only the points A, B, C, D in the p-V diagram at the right, the ratio between the highest and the lowest temperatures is

A) 2 B) 3 C) 6 D) 3/2



$T = \frac{pV}{nR}$

Em-5. The work done in the cycle A-C-D-A is:

A) $3p_0V_0$ B) p_0V_0 C) 0 D) $4p_0V_0$

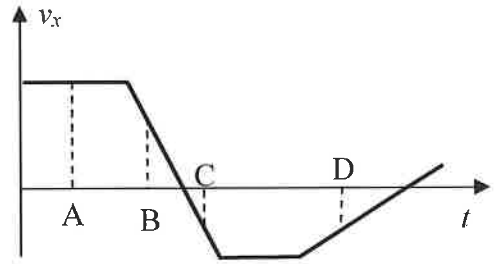
Area enclosed $= \frac{1}{2}(2V_0)(p_0) = p_0V_0$

_____ / 50 for this page

Final Exam

1. The graph on the right shows the x- component of velocity of an object moving along the x-axis. Which of the following is correct?

A) The object is at rest at A.
B) The object is moving in the negative x-direction at B.
C) The object is speeding up at C.
D) The object is moving in the positive x-direction at D.



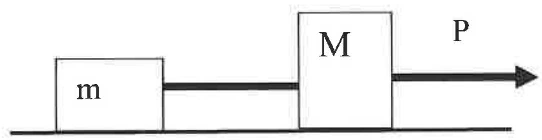
2. A child kicks a ball from the ground level with an initial speed V_0 at an angle θ with respect to the horizontal. The ball strikes a wall which is a horizontal distance D away. The time it takes the ball to reach the wall equals

A) $D/(2V_0 \sin\theta))$ B) $D/(V_0 \sin\theta)$ C) $D/(V_0 \cos\theta)$ D) D/V_0

3. If the net force that acts on a moving object is zero, then the object

A) accelerates.
B) changes its direction of motion.
C) slows down and stops.
D) continues moving with constant velocity .

4. Two blocks of mass M and m are on a frictionless horizontal surface. The blocks are connected by a massless rope. A horizontal pulling force of magnitude P acts on mass M, as shown in the figure. The acceleration of the blocks is a. The magnitude of the pulling force equals

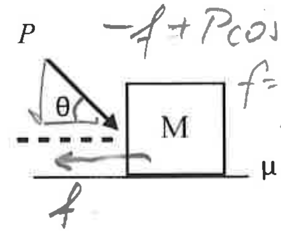


A) Ma B) $2ma$ C) $(M+m)a$ D) $(M+m)a/2$

5. A truck of mass M collides head-on with a small car of mass m=M/10. During the collision,

A) The truck exerts a force on the car but the car does not exert a force on the truck
B) The car exerts the same force magnitude on the truck as the truck exerts on the car
C) The truck exerts a greater in magnitude force on the car than the car exerts on the truck
D) The car exerts a force [redacted] on the truck but the truck does not exert a force on the car

6. A box of mass M rests on a rough horizontal surface with a coefficient of static friction μ between the surface and the box. An external force of magnitude P directed at an angle θ >0 with respect to the horizontal acts on the box as shown. If the box does not move, then the magnitude f of the frictional force satisfies



A) $f = \mu Mg$ B) $f < P$ C) $f > P$ D) $f = P$

7. A particle with mass M moves in a vertical circle at the end of a taut string of length L. The speed of the mass at its highest point is V. At this point, the tension in the rope has magnitude _____ and is directed _____.

A) $MV^2/L - Mg$, downward
B) MV^2/L, downward
C) $MV^2/L + Mg$, downward
D) MV^2/L, upward

8. A constant force pushes a block of mass M up a rough incline whose coefficient of kinetic friction with the box is μ. The block moves at a constant speed. The work done by friction on the block is

A) μMg B) μN C) negative D) zero

9. The potential energy of a force is given as $U(x) = \frac{4}{x^2}$. The x-component of the respective force is

A) $\frac{8}{x^2}$ B) $\frac{4}{x}$ C) $\frac{8}{x^3}$ D) $-\frac{8}{x^3}$

10. Force $\vec{F_1}$ has a potential energy $U_1(x) = ax^2 + bx^3$ and force $\vec{F_2}$ has a potential energy $U_2(x) = ax^2 + bx^3 + c$ where a, b, and c are positive constants. Which of the following is true:

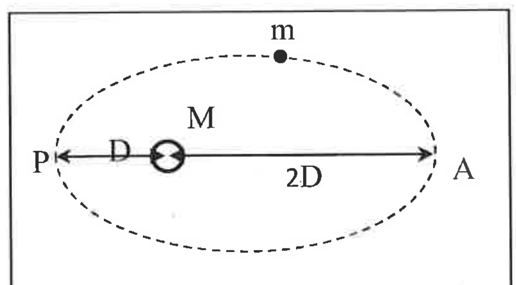
A) The forces $\vec{F_1}$ and $\vec{F_2}$ are identical. B) F_1 is smaller than F_2.

C) The forces $\vec{F_1}$ and $\vec{F_2}$ are in opposite directions. D) F_1 is larger than F_2.

11. A Satellite with speed V is orbiting a planet a distance h above its surface. The planet has radius R. The mass of the planet equals

A) $\frac{RV^2}{G}$ B) $\frac{(R+h)V^2}{G}$ C) $\frac{(R+h)V^2}{2G}$ D) $\frac{hV^2}{G}$

12. A comet of mass m performs an elliptical orbit around a star of mass M. At the closest point P of its orbit the comet is a distance D from the center of the star, and at the farthest point A the distance is $2D$. The presence of any other celestial bodies can be neglected. The change in the comet's kinetic energy when it moves from point P to A is



A) $-\frac{GMm}{4D}$ B) $-\frac{GMm}{2D}$ C) $-\frac{2GMm}{D}$ D) $-\frac{2GMm}{3D}$

13. A ball of mass m is moving in the positive x-direction with velocity V and collides with a small ball of mass ½m that is initially at rest. After the collision, the ball of mass m continues in the positive x-direction with half of its initial speed. The velocity of the small ball after the collision is

A) $2V$ B) V C) $3V$ D) 0

14. A plastic ball floats in water, with half of it exposed above the water level. The buoyancy force magnitude is ___ the ball's weight magnitude.

A) equal to B) greater than C) less than D) half of

15. A circular platform in a playground is rotating with a constant angular velocity ω. A boy is standing halfway from the center of the platform, and a girl is standing near the edge. Which of the following is true?

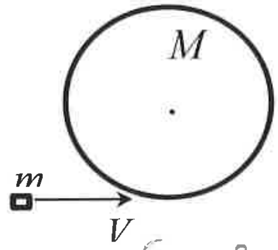
A) The boy has a greater linear velocity than the girl.
B) The girl has a greater linear velocity than the boy.
C) Both the boy and the girl have the same linear velocity.
D) The girl has a larger angular velocity than the boy.

16. A solid ball with mass M and radius R (moment of inertia $\frac{2}{5}MR^2$) is rolling without slipping on a horizontal surface at a constant linear speed V. It collides with a spring of spring constant k that is fixed to a wall. The maximum compression of the spring just before the ball momentarily comes to rest equals

A) $V\sqrt{\frac{M}{k}}$ B) $V\sqrt{\frac{3M}{2k}}$ C) $V\sqrt{\frac{7M}{5k}}$ D) $V\sqrt{\frac{9M}{7k}}$

$\frac{1}{2}Mv^2 + \frac{1}{2}\frac{2}{5}MR^2\frac{v^2}{R^2} = \frac{1}{2}kx^2 \Rightarrow \frac{7}{5}Mv^2 = kx^2$

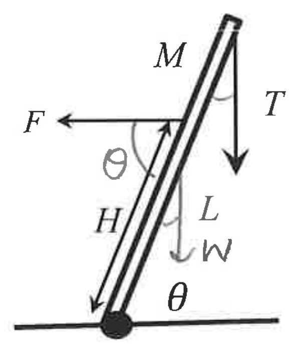
17. A bullet with a mass m is traveling horizontally at a constant speed V. It strikes and becomes embedded in the edge of a solid disk of mass M and radius R and moment of inertia ½ MR^2. Prior to the collision, the disk is at rest and mounted such that it can freely rotate around its central axis. The angular speed of the disk immediately after the bullet embedded is



A) $\frac{MV}{\left(\frac{1}{2}M+m\right)R}$ B) $\frac{mV}{\left(\frac{1}{2}M+m\right)R}$ C) $\frac{mV}{(M+m)R}$ D) $\frac{MV}{(M+m)R}$

$mVR = \left(\frac{1}{2}MR^2 + mR^2\right)\omega$

18. A uniform beam of length L and mass M is set in static equilibrium on a pivot attached to the floor, making an angle θ with the horizontal. A constant horizontal pulling force to the left of unknown magnitude F is applied to the beam at H distance from the pivot. A vertical rope with tension T is attached to the top end of the beam. The magnitude of the force F is



A) $\left(\frac{Mg}{2}+T\right)\frac{L\cot\theta}{H}$ B) $\left(\frac{Mg}{2}+T\right)\frac{L\tan\theta}{H}$ C) $\frac{TL\cot\theta}{H}$ D) $\frac{TL\tan\theta}{H}$

Torques about foot: $FH\sin\theta - Mg\frac{L}{2}\cos\theta - TL\cos\theta = 0$

19. A ball attached to a spring is undergoing simple harmonic motion. When the ball is two-thirds of the way to the maximum distance from its equilibrium position, what fraction of its total mechanical energy is potential energy?

A) 1/3 B) 2/3 C) 4/9 D) 1/9

$U = \frac{1}{2}kx^2 = \frac{1}{2}k\left(\frac{2}{3}A\right)^2$
$E = \frac{1}{2}kA^2$

20. A mass-spring oscillator and a simple pendulum have the same period of small oscillations on the earth. If they are placed on the moon, what is now true for their periods of small oscillations?

A) Their periods have changed but remain equal to each other.
B) Both their periods remain unchanged.
C) The period of the pendulum remains unchanged. D) The period of the mass-spring oscillator remains unchanged.