Final on MAY 04 2010 - Physics 105 – R. Schad

YOUR NAME	A solution
your clicker #	

name & student number on the answer sheet, please

1. A

This is to identify the exam version you have – IMPORTANT
Mark the A

2. B

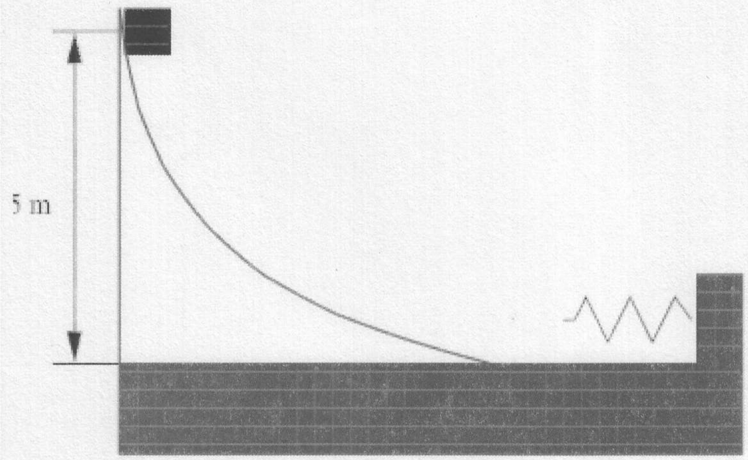
This is to identify the exam version you have – IMPORTANT
Mark the B

3. C

A small block with a mass of 100 g is released from a height of 5 m as shown in the figure. The block following a curved path transitions to a linear horizontal path and hits the spring fixed to a wedge. No friction is involved.
The maximum compression of the spring will be 0.5 m
The spring constant is:

$mgh = \frac{1}{2}Kx^2$

$K = \frac{2mgh}{x^2}$



1. 19.6 N/m
2. 3,920 N/m
3. 39.2 N/m
4. 1,960 N/m
5. none of these

4. E

A bowling ball of mass 2 kg rolls down the alley with speed 3 m/s. What is the kinetic energy of the bowling ball?
(The moment of inertia of a sphere is 2/5 M R^2)

A) 9 J
B) 6 J
C) 18 J
D) 3 J
E) none of these

$K = K_{LIN} + K_{ROT}$ $\qquad \omega = \frac{v}{R}$

$= \frac{1}{2}Mv^2 + \frac{1}{2}I\omega^2$

$= \frac{1}{2}Mv^2 + \frac{1}{2}(\frac{2}{5}MR^2)\frac{v^2}{R^2}$

$= \frac{1}{2}Mv^2[1 + \frac{2}{5}] = 0.7\,Mv^2$

$= 12.6\ J$

5\. D

A 50 gram bullet hits and embeds itself in a 950 gram wooden block that is initially standing still. After the impact the block–bullet combination moves at a speed of 5 meters/s. What was the speed of the bullet just before it hit the block?

A) 70.7 m/s

B) 22.4 m/s

C) 95 m/s

D) 100 m/s

E) 250 m/s

$m_1 v_1 + 0 = (m_1 + m_2) v_2$

$v_1 = \frac{m_1 + m_2}{m_1} v_2 = 100$ m/s

6\. C

An electromagnetic wave travels in vacuum at a speed of 3×10^8 meters/sec. If the wave has a wavelength of 300 nm what is its frequency?

One nm is 10^{-9} meter.

A) 4×10^{12} Hz

B) 3.6×10^{20} Hz

C) 10^{15} Hz

D) 360 Hz

E) none of these

$v = f \cdot \lambda$

$f = \frac{v}{\lambda} = 1 \times 10^{15}$ Hz

7\. D

How fast would you have to throw a snowball at a wall in order for it to have enough kinetic energy for it to melt when it hits the wall? Assume that all of the kinetic energy is transformed into heat and that all of the heat goes into the snowball. Further assume that the process takes place at 0°C. It takes 3.33×10^5 J to melt one kilogram of ice.

A) 12.6 m/s

B) 126 m/s

C) 40.5 m/s

D) 816 m/s

E) none of these

$\frac{1}{2} m v^2 = m \cdot L$

$v = \sqrt{2L}$

8\. A

The moon's nearly circular orbit around the earth has a radius of 385,000 km and it takes 27.3 days for the moon to orbit the earth once. What is the acceleration of the moon toward the earth?

1. 2.73×10^{-3} m/s^2
2. 5.21×10^{-2} m/s^2
3. 0.417 m/s^2
4. 9.8 m/s^2
5. 10.52 m/s^2

$F = m_M a = G \frac{m_E m_M}{R^2}$

$a = G \frac{m_E}{R^2} = 2.7 \times 10^{-3}$ m/s^2

9. C

An object undergoes un-damped simple harmonic oscillation.
Which of the following statements is correct?

a. The total mechanical energy is always equally divided between kinetic energy and potential energy.

b. The total mechanical energy of the oscillator is proportional to the amplitude of the oscillation.

c. The restoring force of the oscillatory system is strongest when the kinetic energy is zero.

d. The maximal value of the potential energy is larger than the maximal value of the kinetic energy.

10. C

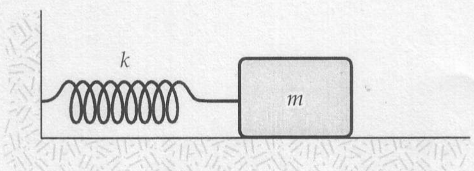
You are on a merry-go-round (MGR) which spins without friction.
Originally located at the perimeter, you now move closer to the center.
Which of the following statements is correct about
angular velocity ω, angular momentum (L)

1. ω increases, L increases
2. ω remains constant, L remains constant
3. ω increases, L remains constant
4. ω remains constant, L increases
5. none of these

11. B

A mass m = 2.0 kg is attached to a spring as in the figure and oscillating with a frequency of 10 Hz. The total energy in the system is 50 J.

The maximum velocity during the oscillation is:



$E_{TOT} = \frac{1}{2} m v_{MAX}^2$

$v_{MAX} = \sqrt{\frac{2E}{m}}$

a. 5.0 m/s
b. 7.1 m/s
c. 50 m/s
d. 1000 m/s
e. none of these

12. A	Tommy_1 and his skateboard have a combined mass of 50 kg. Tommy_2 and his skateboard total 100 kg. You push each of them with the same force F, but you push Tommy_1 for a 2 m distance and Tommy_2 for 1 m. After you finish pushing them, (a) Tommy_1 is moving faster than Tommy_2 (b) Tommy_2 is moving faster than Tommy_1 (c) They are both moving the same speed (d) There is not enough information to decide about their speeds. — $F \times 2m \Rightarrow 2W$; $F \times 1m \Rightarrow 1W$
13. C	Two identical containers, *A* and *B*, hold equal amounts of the same ideal gas at the same P_o, V_o and T_o. The pressure of *A* then decreases by a half while its volume doubles. The pressure of *B* doubles while its volume decreases by a half. Which statement correctly describes the temperatures of the gases after the changes? **a.** $T_A = 0.5T_B = T_o$. **b.** $T_B = 0.5T_A = T_o$. **c.** $T_B = T_A = T_o$. **d.** $T_A = 2T_B = T_o$. **e.** $T_B = 2T_A = T_o$. — 1) $P_1 = \frac{1}{2}P_0$; $V_1 = 2V_0$ $p \cdot V = const \Rightarrow T_1 = T_0$ 2) $P_2 = 2P_0$; $V_2 = \frac{1}{2}V_0$ $pV = const \Rightarrow T_2 = T_0$
14. D	A dentist's drill starts from rest. Then, with a constant angular acceleration, it turns through 100,000 rev reaching its final angular speed within a period of 1 s. The value of this ~~final~~ angular acceleration is: 1. 100,000 rad/s^2 2. 200,000 rad/s^2 3. 628,000 rad/s^2 4. 1,250,000 rad/s^2 5. none of these — $\theta_f = \theta_i + \omega t + \frac{\alpha}{2}t^2$; $\alpha = \frac{2\theta_f}{t^2} = \frac{2 \cdot 2 \cdot \pi \text{ Rev}}{t^2}$

15.

B

The position of a particle is given in the graph below as a function of time.

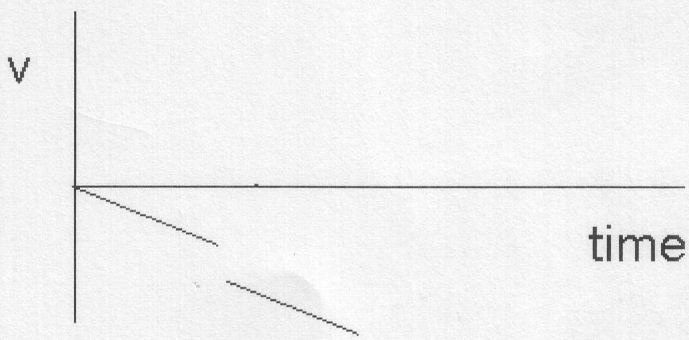
At which time (interval) is the acceleration negative?

1. 3 - 12 sec
2. 0 - 8 sec
3. 8 sec
4. 12 sec
5. never

16.

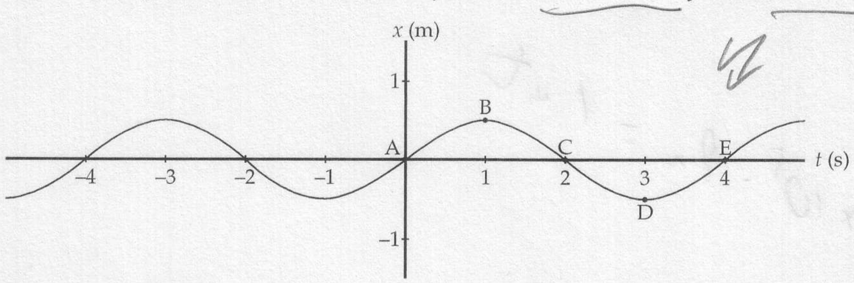
B

The graph below shows the velocity versus time graph for a ball. Which explanation best fits the motion of the ball as shown by the graph?



a. The ball is rising, hits the ceiling, and falls down.
b. The ball is falling, is caught, and is thrown down with greater speed.
c. The ball is rolling, stops, and then continues rolling.
d. The ball is falling, hits the floor, and bounces up.
e. The ball is rising, is caught, and then is allowed to fall.

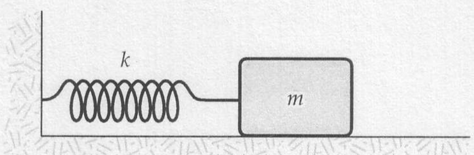
17. A graph of position versus time for an object oscillating at the free end of a horizontal spring is shown below.
A point or points at which the object has zero velocity and zero acceleration is(are)



- a. B
- b. C
- c. D
- d. B or D
- e. never

18. A mass $m = 2.0$ kg is attached to a spring as in the figure and oscillating with a frequency of 10 Hz.

The force constant of the spring k is:



- a. 790 N/m
- b. 1257 N/m
- c. 7896 N/m
- d. 15790 N/m
- e. none of these

19. 3 mole of an ideal gas at a pressure of 1×10^5 Pa and a temperature of 25°C are heated to 50°C.
If the volume is held constant and the final pressure will be

- a. 1×10^5 Pa
- b. 2×10^5 Pa
- c. 1.08×10^5 Pa
- d. 75×10^5 Pa
- e. none of these

20. D

A bubble with a volume of $1.00\ cm^3$ is released from the bottom of a swimming pool where the depth is 10 m.
(The density of water is $1.00 \times 10^3\ kg/m^3$. air pressure is 98×10^3 Pa)

The value of the buoyant force at a depth of 10 m and just before reaching the surface are, respectively:

	at a depth of 10 m	just before reaching the surface
a	zero	9.8 mN
b	9.8 mN	9.8 mN
c	9.8 N	9.8 N
(d)	9.8 mN	19.6 mN
e	none of these	

21. C

Five moles of an ideal gas expand isothermally at 300 Kelvin while 8,600 J of heat flow into the system.
By which factor did the volume of the gas expand?

- a. volume remained constant
- b. factor 1.1
- (c.) factor 2
- d. factor 10
- e. none of these

isothermal
$E_{INT,i} = E_{INT,f} \Rightarrow$
$W = -Q$
$= nRT \ln \frac{V_i}{V_f}$
$\ln \frac{V_f}{V_i} = \frac{Q}{nRT}$

22. B

An 100 kg aluminum flagpole, originally 50 m long, is heated by the sun receiving 6 MJ of heat.
The length of the flag pole after being heated is:
[The specific heat of aluminum is 900 J/kg K.]
[The linear coefficient of expansion is 24x 10^{-6}]

- a. 49.00 m
- (b.) 50.08 m
- c. 53.22 m
- d. 50.00 m
- e. none of these

$Q = cm\Delta T$
$\Delta L = \alpha L \Delta T$
$= \alpha L \frac{Q}{cm}$
$= 0.08\ m$

20) $F_B @10m = \rho_{H_2O}\, g \cdot V_{bub,10} = 9.8\ mN$

$F_B @ surface = \rho_{H_2O} \cdot g \cdot V_{bub,surf.} = 19.6\ mN$

$V_{bub,surf} = \frac{P_{10m}}{P_{surf}} V_{10m} = \frac{[98 \times 10^3 + 10^3 \times 9.8 \cdot 10]\ Pa}{98 \times 10^3\ Pa} 1cc$

$= 2\ cc$

velocity acceleration gravitational acceleration	$\mathbf{v} = d\mathbf{x}/dt$ $\mathbf{a} = d\mathbf{v}/dt$ $\lvert\mathbf{a}\rvert = g = 9.8\ m/s^2$ downwards	
Kinematics (1-dimensional)	$\mathbf{v}_f = \mathbf{v}_i + \mathbf{a}\cdot t$ $\mathbf{x}_f = \mathbf{x}_i + \mathbf{v}_i\cdot t + \frac{1}{2}\cdot\mathbf{a}\cdot t^2$ $\mathbf{v}_f^2 = \mathbf{v}_i^2 + 2\mathbf{a}\cdot(\mathbf{x}_f - \mathbf{x}_i)$	
Projectile Motion (2-dimensional)	$v_{xf} = v_{xi}$ $x_f = x_i + v_{xi}\cdot t$	$v_{yf} = v_{yi} + a\cdot t$ $y_f = y_i + v_{yi}\cdot t + \frac{1}{2}\cdot a\cdot t^2$

Newton's Law	$\mathbf{F} = m\cdot\mathbf{a}$
Friction	$F_{friction} = F_N\ \mu$
Circular Motion - Radial Force	$F_{radial} = mv^2/r$
Conservation of Energy	$K_i + U_i + W_{in/out} = K_f + U_f$
Energy	Kinetik (linear): $K_{lin} = \frac{1}{2}mv^2$ Kinetik (rotation): $K_{rot} = \frac{1}{2}I\omega^2$ Potential (gravity): $U_g = m\ g\ h$ Pot. (univ. gravity): $U_{Gr} = -\ G\ (m_1\cdot m_2)\ /\ r$ Potential (spring): $U_s = \frac{1}{2}k\ x^2$
Work	$W = \int \vec{F} d\vec{x}$
Power	$P = W/t = E/t$
momentum	$\mathbf{p} = m\ \mathbf{v}$
conservation of momentum	$\mathbf{p}_{1i} + \mathbf{p}_{2i} = \mathbf{p}_{1f} + \mathbf{p}_{2f}$
impulse (change of momentum)	$\Delta\mathbf{p} = \int \vec{F} dt$
Radial Force	$F_{radial} = mv^2/r = \omega^2\ r$
Frequency, Period	f = revolutions/s $= 1/T = \omega/2\pi$
Angle in radians	2π rad = 360° = 1 revolution
Hooke's Law (spring force)	$F_{spring} = -k\ x$
oscillation	$x = A\cos(\omega t + \phi)$ $v = -A\omega\sin(\omega t + \phi)$ $a = -A\omega^2\cos(\omega t + \phi)$
Oscillation frequency spring pendulum	$f = \frac{1}{2\pi}\sqrt{k/m}$ $f = \frac{1}{2\pi}\sqrt{g/L}$

Wave Wave velocity	$y(x,t) = A \sin(kx - \omega t)$ $k = 2\pi / \lambda$ $\omega = 2\pi / T$ $v = f\lambda = \omega / k$
Standing wave	$y = 2A \sin(kx) \cos(\omega t)$
Density	$\rho = m/V$
Pressure	$P = F / A$
Buoyant force	$F_b = \rho_{fluid} \cdot V_{object} \cdot g$
Law of Gravitation	$F_{Gr} = G (m_1 \cdot m_2) / r^2$ $G = 6.673 \cdot 10^{-11}$ Nm^2/kg^2 $U_{Gr} = - G (m_1 \cdot m_2) / r$ r measured from center
Temperature	T [Kelvin] = T [ºC) + 273
Thermal Expansion	$\Delta L = \alpha L \Delta T$
Universal gas law	$P \cdot V = n \cdot R \cdot T$; R = 8.3 J/(K·mol)
Heat	$Q = m \cdot c \cdot \Delta T$ $Q = m \cdot L$
1st Law of Thermodynamics [conservation of energy]	$E_{int,initial} \forall W \forall Q = E_{int,final}$ [for ideal gas: **E_{int} is proportional to the temperature**]
Work done on a gas: for isothermal process:	$W = \int P dV$ $W = nRT \ln(V_i/V_f)$
quadratic equation $x^2 + px + q = 0$	$x_{1,2} = -p/2 \pm (p^2/4 - q)^{1/2}$
Mass of the Earth	6×10^{24} kg