YOUR NAME
CWID

Answers to be submitted on webassign [Exam 3]

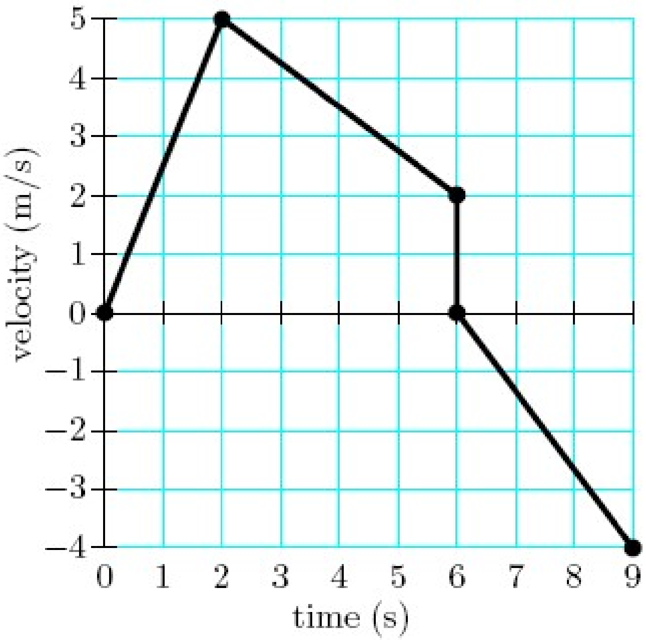
Show your work required for those problems which require calculations. Work to be uploaded on Blackboard

1. 4

This is to identify the exam version you have.
You have exam version 4.
Mark as your answer to Question 1: 4

2. 4

A something moves according to the shown velocity profile.
[it started moving from $x_i = 0$]
What is the acceleration at 4 seconds?



$\frac{2-5}{4}$ $\frac{m}{s^2}$

1. 3.5 m/s^2
2. 0.875 m/s^2
3. – 3.5 m/s^2
4. – 0.75 m/s^2
5. – 4.0 m/s^2
6. – 0.875 m/s^2
7. none of these

3.

2

A solid disc, radius R = 2 m and moment of inertia I = 20 kg m^2
is driven by a motor accelerating it from zero to 5 rad/s and corresponding rotational kinetic energy in 10 seconds.
If the same disc were to be accelerated by the same motor from zero to 4x the rotational kinetic energy -
How long would this take?

1. 10 s
2. 20 s
3. 30 s
4. 40 s
5. 80 s
6. none of these

$KE = \frac{1}{2} I \omega^2$

×4 SAME $(\times 2)^2$

same α $\Rightarrow$ $\Delta\omega = \alpha \Delta t$

time ×2

4.

4

The asteroid Eros, one of the many minor planets that orbit the sun in the region between Mars and Jupiter, has a radius of 7.0 km and a mass of 2.0 x 10^{15} kg and no atmosphere.

A projectile were to be firedstraightup such that it would fly VERY FAR away,
with which speed would it have to start?

$KE + U = 0 + 0$

1. Infinite velocity would be needed.
2. 195 m/s (✓)
3. 4.4 m/s
4. 6.2 m/s ✓
5. 12.4 km/s (✓)
6. None of these.

$\frac{1}{2} m v_1^2 - G \frac{m_1 m_1}{r} = 0$

$v_1 = \sqrt{\frac{2Gm}{r}} = 6.2 \, m/s$

I HAD IN MIND: WHAT WOULD B THE MINIMUM SPEED TO GET VERY FAR AWAY, WITHOUT SAYING THIS – I JUST GAVE EVERYONE A POINT.

5. 4	A figure skater spins around her vertical axis, doing a pirouette, initially with her arms and the other leg stretched out. Then she pulls arms and leg closer to her. Her original spinning speed was $\omega = 5$ rad/s and moment of inertia was $I = 20$ kgm^2. After pulling arms and leg closer her moment of inertia now is $I_n = 10$ kgm^2. Her spinning speed now is: $L = I \omega$ = conserved $I \times \frac{1}{2}$ $\omega \times 2$ 1) None of these 2) 40 rad/s 3) 20 rad/s 4) 10 rad/s 5) 5 rad/s 6) 2.5 rad/s 7) 1.25 rad/s
6. 5	A wooden block floats on oil such that ½ of its volume is below the oil surface and the other half sticks out. taking this to the moon, where the gravity strength is 1/6 of the value on earth, this would change to: weight = mg 1) 1/6 of the volume below the oil surface 2) 1/6 of the volume above the oil surface 3) 1/12 of the volume below the oil surface 4) 1/12 of the volume above the oil surface 5) 1/2 of the volume below the oil surface [unchanged] $F_{buoy} = \rho g h$ 6) None of these both scale with "g" → unchanged

7.

7

For an oscillation with x = (2.00 m) cos(π rad/s * t),
The period and maximum velocity are:

1. T = 3.14 s; v_{max} = 12.6 m/s
2. T = 0.5 s; v_{max} = 8.0 m/s
3. T = 2.0 s; v_{max} = 4.0 m/s
4. T = 3.14 s; v_{max} = 4.0 m/s
5. T = 2.0 s; v_{max} = 8.0 m/s
6. T = 3.14 s; v_{max} = 1.0 m/s
7. None of these

$A = 2\ m$

$\omega = \pi\ rad/s$

$T = 2\ s$

$V_{MAX} = 2\pi\ m/s$

8.

1

Two communications satellites are on circular orbits around earth, one closer to earth, the other farther away.
The closer will circle the earth more frequently [shorter period to complete one orbit], but which one has the larger speed?

1) The closer satellite.
2) The farther away satellite.
3) They must have the same speed.
4) none of these

$$G\frac{m_1 m_2}{r^2} = \frac{m_1 v^2}{r}$$

$$v^2 = \frac{G m_2}{r}$$

9.

3

A mass on a spring undergoes un-damped simple harmonic oscillation.
Which of the following statements is **IN**correct?

1. The total energy is always the sum of kinetic energy and potential energy.

2. The acceleration is largest when the kinetic energy is zero.

3. The spring force is zero when the kinetic energy is minimum.

4. The maximal value of the potential energy is equal to the maximal value of the kinetic energy.

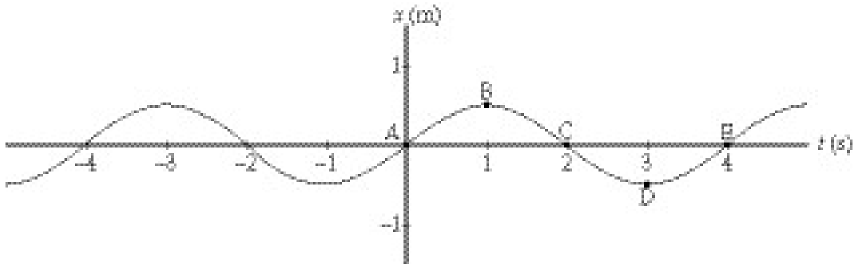
5. At the equilibrium kinetic energy is maximum while potential energy is minimum.

10.

5

Ok

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 **maximum negative velocity** and **negative acceleration** is(are)



1. B
2. C
3. D
4. B and D
5. never

11.

2

Two objects are separated by 20 cm. They attract each other with a gravitational force of magnitude 2×10^{-8} N.

If mass_1 is 5.0 kg, what is the mass_2 of the other object?

1. mass_2 = 1.2 kg
2. mass_2 = 2.4 kg
3. mass_2 = 12.0 kg
4. mass_2 = 5.0 kg
5. mass_2 = 7.0 kg
6. none of these

$$F_G = G \frac{m_1 m_2}{r^2}$$

$$m_2 = \frac{F_G r^2}{G m_1} = 2\ 4 \text{ Kg}$$

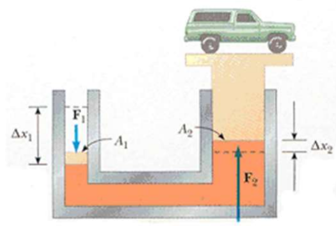
<table>
<tr>
<td>12.

3</td>
<td>The pressure inside a hydraulic system is $p = 3 \times 10^7$ N/m^2. The cross sectional area of the right piston is 10 cm^2.

The hydraulic fluid exerts a force onto the right piston of

1) 3×10^8 N
2) 3×10^6 N
3) 3×10^4 N
4) 3×10^{10} N
5) 3×10^3 N
6) None of these

1)



$F = pA \quad A = 10 \times 10^{-4}\ m^2$</td>
</tr>
<tr>
<td>13.

5</td>
<td>In an engine, a piston oscillates with simple harmonic motion so that its position varies according to the following expression, where t is in seconds.

$x = (7.00 \text{ cm}) \cos(2 \text{ rad/s } t)$

At $t = 0$, the position and velocity of the piston are:

1) x(t=0) = 0.07 m ; v(t=0) = 0.14 m/s
2) x(t=0) = 7 m ; v(t=0) = 14 m/s
3) x(t=0) = 0 m ; v(t=0) = 0.14 m/s
4) x(t=0) = 0 m ; v(t=0) = 0 m/s
5) x(t=0) = 0.07 m ; v(t=0) = 0 m/s
6) none of these

$x(0) = 7\text{cm}$
$V(t)\ -A\omega \sin(\omega t)$
$v(0) = 0$</td>
</tr>
<tr>
<td>14.

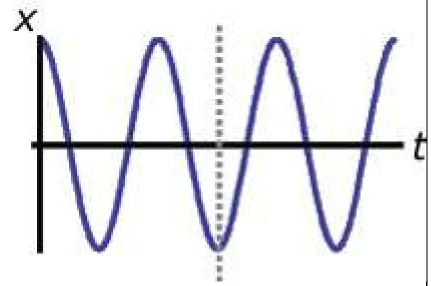
4</td>
<td>An object undergoes a simple harmonic motion on a friction-free table.
If the maximum velocity is doubled, the maximum force on the object is

$v_{MAX} \times 2 \Rightarrow A \times 2$
$F_{MAX} \times 2$

1. quartered
2. halved
3. quadrupled
4. doubled
5. unchanged</td>
</tr>
</table>

15. 5

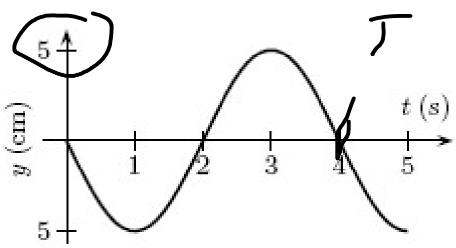
This is the position vs. time graph of a mass on a spring. What can you say about the acceleration and the velocity at the instant indicated by the dotted line?



1. v = positive and max; a = positive and max
2. v = negative and max; a = positive and max
3. v = positive and max; a = negative and max
4. v = negative and max; a = negative and max
5. v = zero; a = positive and max
6. v = zero; a = negative and max
7. none of these

16. 4

A particle oscillates in simple harmonic motion. Its height y as a function of time t is shown in the diagram.



$A = 5\text{ cm}$

$f = \frac{1}{T} = \frac{1}{4}\ s^{-1}$

The amplitude and frequency of the oscillation are:

1. **A = 10 cm; f = 4 s^{-1}**
2. **A = 5 cm; f = 4 s^{-1}**
3. **A = 10 cm; f = 0.25 s^{-1}**
4. **A = 5 cm; f = 0.25 s^{-1}**
5. **None of these**

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)	$\mathbf{v}_f = \mathbf{v}_i + \mathbf{a} \cdot t$ $\mathbf{x}_f = \mathbf{x}_i + \mathbf{v}_i \cdot t + ½ \cdot \mathbf{a} \cdot t^2$ $\mathbf{v}_f^2 = \mathbf{v}_i^2 + 2\mathbf{a} \cdot (\mathbf{x}_f - \mathbf{x}_i)$	
Projectile Motion (2-dimensional)	$v_{xf} = v_{xi}$ $x_f = x_i + v_{xi} \cdot t$	$v_{yf} = v_{yi} + a \cdot t$ $y_f = y_i + v_{yi} \cdot t + ½ \cdot a \cdot t^2$

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): $K_{lin} = ½\ mv^2$ Kinetik (rotation): $K_{rot} = ½\ I\omega^2$ Potential (gravity): $U_g = m\ g\ h$ Pot. (univ. gravity): $U_{Gr} = -\ G\ (m_1 \cdot m_2)\ /\ r$ Potential (spring): $U_s = ½\ k\ x^2$
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	$F_{radial} = mv^2/r = m\ \omega^2\ r$
Frequency, Period	f = revolutions/s $= 1/T = \omega/2\pi$
Angle in radians	2π rad = 360° = 1 revolution
Torque	$\tau = \mathbf{F}\ x\ \mathbf{r} = F\ r\ \sin\theta$
Newton's Law of Rotation	$\tau = I\ \alpha$
Angular momentum	$\mathbf{L} = I\ \omega$ is conserved unless a net torque is applied
Momentum of Inertia ('mass' for rotation)	$I = \int r^2 dm$ or $\sum_i r_i^2 m_i$
Rotational Kinematics	$\omega_f = \omega_i + \alpha \cdot t$ $\theta_f = \theta_i + \omega_i \cdot t + ½ \cdot \alpha \cdot t^2$ $\omega_f^2 = \omega_i^2 + 2\alpha \cdot (\theta_f - \theta_i)$
Angle in radians	2π rad = 360° = 1 revolution
Hooke's Law (spring force)	$F_{spring} = -k\ x$

oscillation	$x = A\cos(\omega t + \phi)$ $v = -A\omega\sin(\omega t + \phi)$ $a = -A\omega^2\cos(\omega t + \phi)$ $\omega = 2\pi f$; $f = 1/T$
Oscillation frequency spring pendulum	$f = \frac{1}{2\pi}\sqrt{k/m}$ $f = \frac{1}{2\pi}\sqrt{g/L}$
Density	$\rho = m/V$
Pressure	$p = F / A$
Buoyant force	$F_b = \rho_{fluid} \cdot V_{object\text{-}submersed} \cdot g$
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 U_{Gr} = zero: very (infinitely) far away
quadratic equation $x^2 + px + q = 0$	$x_{1,2} = -p/2 \pm (p^2/4 - q)^{1/2}$
Radius, Mass of the Earth	$R_E = 6.37 \times 10^6$ m; $M_E = 6 \times 10^{24}$ kg