Group Number		Name		Type
List Number		Surname		A
Student ID		Signature		
e-mail				

ATTENTION: There is normally only one correct answer for each question and each correct answer is equal to 1 point. Only the answers on your answer sheet form will be evaluated. Please be sure that you have marked all of your answers on the answer sheet form by using a pencil (*not* pen).

Questions 1-5

1. If ρ has a units of kg/m^3, and P has units of N/m^2, what are the units of c if $c = \sqrt{5P/3\rho}$?

(a) m^3/s (b) m/s (c) $m^2/s^{1/2}$ (d) kgm^2/s^2 (e) $s^{1/2}$

2. Drag force of the air is given by the equation $D = bv^2$ where $b = 4.0Ns^2/m^2$ and v is the speed of the object. An object of mass $m = 10.0kg$ is falling under the effect of constant gravity and this drag force to the ground. What is the terminal speed (the constant speed) of the object? ($g = 10\,m/s^2$)

(a) $3.0m/s$ (b) $4.0m/s$ (c) $6.0m/s$ (d) $5.0m/s$ (e) $5.5m/s$

3. Vector $\vec{a} = 2\hat{i} + 3\hat{j} - 5\hat{k}$ and vector $\vec{b} = \hat{i} - 2\hat{j} - 3\hat{k}$ are given. Find a vector $\vec{c}$ that is perpendicular to both $\vec{a}$ and $\vec{b}$.

(a) $\vec{c} = -19\hat{i} + \hat{j} + 7\hat{k}$ (b) $\vec{c} = +19\hat{i} + \hat{j} - 7\hat{k}$ (c) $\vec{c} = -19\hat{i} + \hat{j} - 7\hat{k}$ (d) $\vec{c} = 19\hat{i} + \hat{j} + 7\hat{k}$ (e) $\vec{c} = -19\hat{i} - \hat{j} - 7\hat{k}$

4. Vectors $\vec{A} = 4\hat{i} + a\hat{j} + 2\hat{k}$ and $\vec{B} = -3\hat{i} + 2\hat{j} + b\hat{k}$ are given. Find the value of $a + b$ if the angle between these two vectors is 90^o.

(a) 12 (b) 8 (c) 6 (d) 7 (e) 5

5. The period of an object making uniform circular motion on a circular trajectory of radius R is T. What is the magnitude of the centripetal acceleration?

(a) $\dfrac{4\pi^2 R^2}{T^3}$ (b) $\dfrac{4\pi^2 R}{T}$ (c) $\dfrac{2\pi^2 R^2}{T^3}$ (d) $\dfrac{\pi^2 R}{T^2}$ (e) $\dfrac{4\pi^2 R}{T^2}$

Questions 6-7

While driving along a highway at 40 m/s you see a police car 50 m ahead traveling at a constant speed of 30 m/s which is the speed limit. You apply the brakes and begin decelareting at 1.0 m/s^2.

6. After applying to the brakes, when will you reach to the police car?

(a) $10s$ (b) $14s$ (c) $8.0s$ (d) $12s$ (e) $9.0s$

7. After applying to the brakes, what is the distance covered by the car to reach the police car?

(a) $300m$ (b) $450m$ (c) $250m$ (d) $350m$ (e) $400m$

Questions 8-10

A particle starts from the origin at $t = 0$ with a velocity of $4.0\hat{j}$ and moves in the xy plane with a constant acceleration of $(2.0\hat{i} - 3.0\hat{j})m/s^2$.

8. At $t = 2.0s$, what is the distance of the particle to the origin?

(a) $2\sqrt{5}m$ (b) $4.0m$ (c) $4\sqrt{5}$ (d) $3\sqrt{3}$ (e) $5.0m$

9. Find the velocity of the particle at $t = 2.0s$ in units of m/s.

(a) $3.0\hat{i} - 2.0\hat{j}$ (b) $-4.0\hat{i} - 2.0\hat{j}$ (c) $4.0\hat{i} - 2.0\hat{j}$ (d) $4.0\hat{i} + 2.0\hat{j}$ (e) $-3.0\hat{i} + 2.0\hat{j}$

10. A second object is moving with a velocity $\vec{v} = -2\hat{i} + \hat{j}$ m/s in this coordinate system. What is the velocity of this object with respect to the first at $t = 2$ s in units of m/s?

(a) $-4.0\hat{i} + 3.0\hat{j}$ (b) $-4.0\hat{i} + 5.0\hat{j}$ (c) $6.0\hat{i} - 3.0\hat{j}$ (d) $-6.0\hat{i} + 3.0\hat{j}$ (e) $4.0\hat{i} - 3.0\hat{j}$

11. A 5.0 kg mass is suspended by a string from the ceiling of an elevator that is moving upward with a speed which is decreasing at a constant rate of 2.0 m/s in each second. What is the tension in the string supporting the mass assuming that $g = 10m/s^2$?

(a) 40 N (b) 60 N (c) 15 N (d) 45 N (e) 50 N

12. Consider a horizontal block-spring system such that the block is released from rest when the spring is stretched a distance d. The spring obeys the Hooke's Law. If the spring constant $k = 50$ N/m, the mass of the block is $m = 0.50$ kg, $d = 10$ cm, and the coefficient of kinetic friction $\mu_k = 0.25$, what is the speed of the block when it first passes through the position for which the spring is unstretched ? ($g = 10m/s^2$)

(a) $\frac{\sqrt{3}}{2}$ m/s (b) $\sqrt{\frac{3}{2}}$ m/s (c) $\frac{1}{\sqrt{3}}$ m/s (d) $\frac{\sqrt{2}}{2}$ m/s (e) $\frac{1}{2}$ m/s

Questions 13-15

A box of mass m is sitting on top of another box of mass M, which sits on a frictionless layer of ice. There is friction between the two boxes. A horizontal force of magnitude F is applied to the lower box

13. Assume that the static friction is such that the two boxes will move together. What is the acceleration of the system?

(a) $\frac{Fm}{M^2}$ (b) $\frac{F}{m}$ (c) $\frac{F}{M}$ (d) $\frac{F(m+M)}{mM}$ (e) $\frac{F}{m+M}$

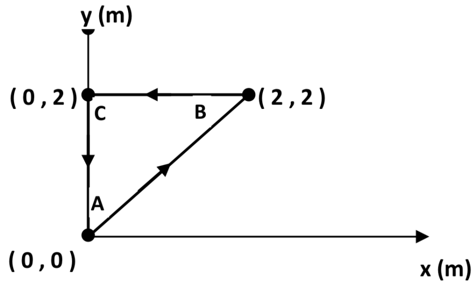
14. What is the minimum coefficient of static friction μ_s between the two boxes such that they move together?

(a) $\frac{F}{g(m+M)}$ (b) $\frac{F}{gM}$ (c) $\frac{F(m+M)}{gmM}$ (d) $\frac{F}{gm}$ (e) $\frac{Fm}{gM^2}$

15. Now, assume that something is exerting an additional vertical downwards force F_2 on the upper box. What would the minimum μ_s now be such that the two boxes still move together?

(a) $\frac{MF_2}{m(m+M)(mg+F_2)}$ (b) $\frac{mF}{M(m+M)(mg+F)}$ (c) $\frac{mF}{M(m+M)(mg+F_2)}$ (d) $\frac{MF_2}{(m+M)(mg+F)}$ (e) $\frac{mF}{(m+M)(mg+F_2)}$

Questions 16-18



A force acting on a particle is given by $F = (3\hat{i} + 4x\hat{j})N$.

16. Calculate W_{AB}, the work done by the force to take the particle from $(0,0)$ to $(2,2)$.

(a) 16J (b) 10J (c) 14J (d) 8J (e) 12J

17. Calculate W_{BC}, the work done by the force to take the particle from $(2,2)$ to $(0,2)$.

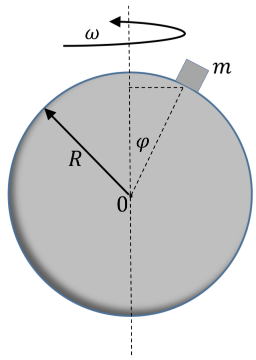
(a) 0J (b) -6J (c) 6J (d) 4J (e) -4J

18. Calculate W_{TOT}, the total work done for the complete loop.

(a) 6J (b) 8J (c) 4J (d) 2J (e) 0J

Questions 19-20

A small mass m is put on the surface of the sphere of radius R, as shown in the figure. The coefficient of static friction between the mass and the surface is μ_s. Answer the following questions, expressing your answers in terms of $\{R, m, \varphi, g, \mu_s\}$.



19. Initially the sphere and the mass are at rest. Find the minimum value of μ_s so that the mass does not slide on the sphere because of friction?

(a) φ (b) $\tan\varphi$ (c) $\cos\varphi$ (d) $\sin\varphi$ (e) $\cot\varphi$

20. If the sphere is rotating about its axis with a constant angular speed ω, as shown in the figure, what is the maximum value of ω such that the mass m is at rest? ($v = \omega r$)

(a) $\omega = \sqrt{\frac{g}{R}}$

(b) $\omega = \sqrt{\frac{g}{R}\left(\frac{\cos\varphi - \mu_s\sin\varphi}{\mu_s\sin^2\varphi}\right)}$

(c) $\omega = \sqrt{\frac{g}{R}\left(\frac{\mu_s\sin\varphi}{\mu_s\sin^2\varphi + \cos^2\varphi\sin\varphi}\right)}$

(d) $\omega = \sqrt{\frac{g}{R}\left(\frac{\cos\varphi}{\mu_s\sin^2\varphi}\right)}$

(e) $\omega = \sqrt{\frac{g}{R}\left(\frac{\mu_s\cos\varphi - \sin\varphi}{\mu_s\sin^2\varphi + \cos\varphi\sin\varphi}\right)}$