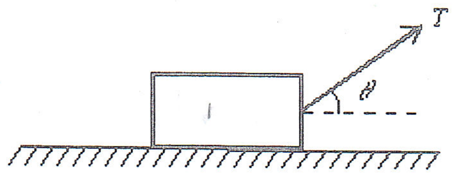
23. A block of mass m is pulled at constant velocity along a rough horizonatl floor by and applied force $\vec{T}$ as shown. The magnitude of frictional force is:



A) $T \cos \theta$
B) $T \sin \theta$
C) zero
D) mg
E) $mg \cos \theta$

$T \cos\theta + F_f = 0$

$F_f = -T\cos\theta$

24. For a block of mass m to slide without friction up the rise of height h shown, it must have a minimum initial speed of:

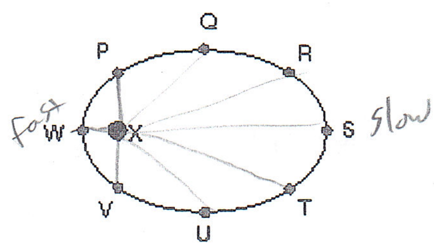
A) $1/2\sqrt{gh}$
B) $\sqrt{gh/2}$
C) $\sqrt{2gh}$
D) $2\sqrt{2gh}$
E) $2\sqrt{gh}$

$KE \rightarrow PE$

$\frac{1}{2} m v^2 = mgh$

$v = \sqrt{2gh}$

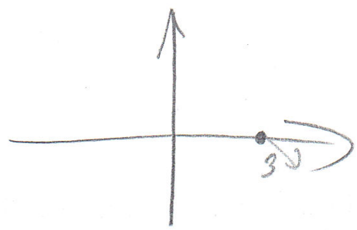
25. A planet travels in an elliptical orbit about a star X as shown. The magnitude of the acceleration of the planet is:



A) greatest at point Q
B) greatest at point S
C) greatest at point U
D) greatest at point W
E) the same at all points

29. A 2.0-kg block starts from rest on the positive x axis 3.0 m from the origin and thereafter has an acceleration given by $\vec{a} = 4.0\hat{i} - 3.0\hat{j}$ in m/s². The torque, relative to the origin, acting on it at the end of 2.0 s is:

A) 0
B) $(-18\ \mathrm{N \cdot m})\hat{k}$
C) $(+24\ \mathrm{N \cdot m})\hat{k}$
D) $(-144\ \mathrm{N \cdot m})\hat{k}$
E) $(+144\ \mathrm{N \cdot m})\hat{k}$

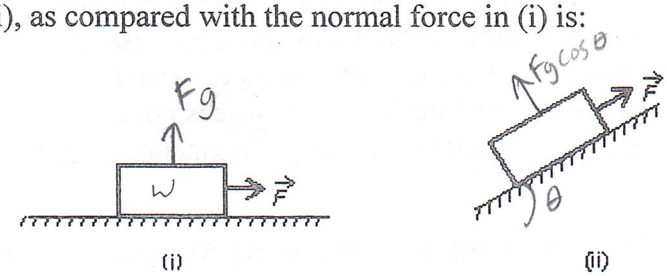


$\tau = F \times r$
$= m(a \times r)$
$= 2 \cdot -9 = (-18\ \mathrm{N \cdot m})\hat{k}$

30. For a planet in orbit around a star the perihelion distance is r_p and its speed at perihelion is v_p. The aphelion distance is r_a and its speed at aphelion is v_a. Which of following is true?

A) $v_a = v_p$
B) $v_a / r_a = v_p / r_p$
C) $v_a r_a = v_p r_p$
D) $v_a / r^2_a = v_p / r^2_p$
E) $v_a r^2_a = v_p / r^2_p$

31. A heavy wooden block is dragged by a force $\vec{F}$ along a rough steel plate, as shown below for two cases. The magnitude of the applied force $\vec{F}$ is the same for both cases. The normal force in (ii), as compared with the normal force in (i) is:



A) the same
B) greater
C) less
D) less for some angles of the incline and greater for others
E) less or greater, depending on the magnitude of the applied force $\vec{F}$.

32. A 2.0-kg block starts from rest on the positive x axis 3.0 m from the origin and thereafter has an acceleration given by $\vec{a} = 4.0\hat{i} - 3.0\hat{j}$ in m/s². At the end of 2.0 s its angular momentum about the origin is:

A) 0
B) $(-36\ \mathrm{kg \cdot m^2/s})\hat{k}$
C) $(+48\ \mathrm{kg \cdot m^2/s})\hat{k}$
D) $(-96\ \mathrm{kg \cdot m^2/s})\hat{k}$
E) $(+96\ \mathrm{kg \cdot m^2/s})\hat{k}$

$L =$

at $t = 2$

$a = \langle 4, -3 \rangle$

$v = \langle 4t, -3t \rangle \longrightarrow \langle 8, -6 \rangle$

$\cancel{d = \langle 3 + 2t^2, -\tfrac{3}{2}t^2 \rangle} \rightarrow \langle 11, -6 \rangle$

?

$L = I \cdot \omega = MRV$

$MR^2 \cdot \frac{V}{R}$

$= 2 \cdot \langle 8, -6 \rangle \times \langle 11, -6 \rangle$

$= -36\hat{k}$

37. Suitable units for the gravitational constant G are:
   A) kg·m/s^2
   B) m/s^2
   C) N·s/m
   D) kg·m/s
   E) m^3/(kg·s^2)

$G \rightsquigarrow N \frac{m^2}{kg^2} \rightarrow kg \cdot \frac{m}{s^2} \cdot \frac{m^2}{kg^2}$

$= \frac{m^3}{s^2 \cdot kg}$

38. When the brakes of an automobile are applied, the road exerts the greatest retarding force:
   A) while the wheels are sliding
   B) just before the wheels start to slide
   C) when the automobile is going fastest
   D) when the acceleration is least
   E) at the instant when the speed begins to change

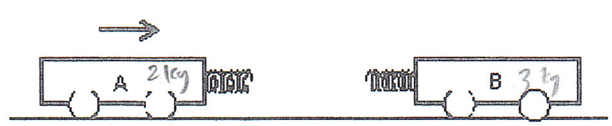
39. A sledge (including load) weighs 5000 N. It is pulled on level snow by a dog team exerting a horizontal force on it. The coefficient of kinetic friction between sledge and snow is 0.05. How much work is done by the dog team pulling the sledge 1000 m at constant speed?
   A) 2.5×10^4 J
   B) 2.5×10^5 J
   C) 5.0×10^5 J
   D) 2.5×10^6 J
   E) 5.0×10^6 J

$W = F \cdot d$

$= F_g \cdot \mu_k \cdot d$

$= 2.5 \times 10^5$

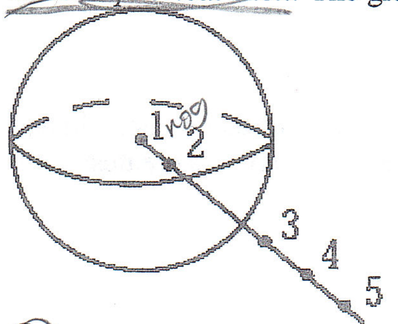
40. Two carts (A and B), having spring bumpers, collide as shown. Cart A has a mass of 2 kg and is initially moving to the right. Cart B has a mass of 3 kg and is initially stationary. When the separation between the carts is a minimum:



   A) cart B is still at rest
   B) cart A has come to rest
   C) the carts have the same momentum
   D) the carts have the same kinetic energy
   E) the kinetic energy of the system is at a minimum

Name: Cziu, ze Cain Date: ____________

4 1. Test masses are used to measure the gravitational field at various positions in and near a ~~*hollow spherical shell*~~. The gravitational field will have its greatest value at point(s)



A) 3
B) 4
C) 5
~~D)~~ 1, 2, and 5
~~E)~~ 1 and 2

4 2. The mass density of a planet varies with distance from the center as $\rho = \rho_o (1 - C\frac{r}{R_p})$ where C is a dimensionless constant, and R_P is the radius of the planet. The gravitational field of the planet for $r < R_P$ is

A) $\vec{g} = -\rho_o G(\frac{r}{2} - \frac{Cr^2}{3R_p})\hat{r}$ $* 4\pi$

B) $\vec{g} = -\rho_o G(\frac{r}{3} - \frac{Cr^2}{4R_p})\hat{r}$ $* 4\pi$

C) $\vec{g} = -\rho_o G(r - \frac{Cr^2}{R_p})\hat{r}$ $* 4\pi$

D) $\vec{g} = -\rho_o GC\frac{r^2}{R_p}\hat{r}$ $* 4\pi$

E) $\vec{g} = -\rho_o G\frac{r}{3}\hat{r}$ $* 4\pi$

$M_{enc} = \int_0^r \rho \, dr$

$= \int_0^r \rho_0 (1 - c\frac{r}{R_p})\, dr$

$= \rho_0 \int_0^r 1 - c\frac{r}{R_p}\, dr$

$= \rho_0 \left(r - c\frac{r^2}{2R_p}\right]_0^r$

$M_{enc} = \rho_0 \left(r - c\frac{r^2}{2R_p}\right)$

$g \cdot 4\pi r^2 = \frac{\rho_0 (r - c\frac{r^2}{2R_p}) \cdot -4\pi G}{r^2}$

$g = \rho_0 \left(\frac{1}{r} - c/2R_p\right)$