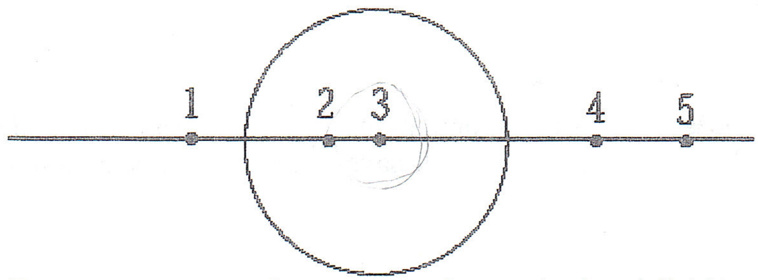
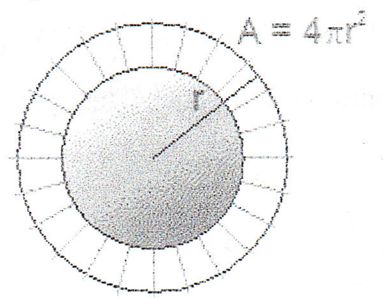
4 3.



Test masses are used to measure the gravitational field at various positions in and near a *solid sphere of uniform density.* The gravitational field will have its greatest value at point

A) 1
B) 2
C) 3
D) 4
E) 5

4 4. Earth's gravitational field is given by $\vec{g} = -\frac{GM_E}{r^2}\hat{r}$. The total flux (field times area) for a spherical surface area A that encloses all the field lines is



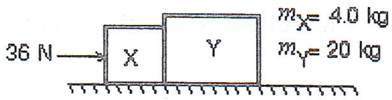
A) $-4\pi GM_E$
B) $-GM_E$
C) $-GM_E/4\pi$
D) $-2\pi GM_E$
E) $-4GM_E$

33. An object at the surface of Earth (at a distance R from the center of Earth) weighs 90 N. Its weight at a distance $3R$ from the center of Earth is:

A) 10 N
B) 30 N
C) 90 N
D) 270 N
E) 810 N

$F \propto \frac{1}{r^2}$

34. Two blocks (X and Y) are in contact on a horizontal frictionless surface. A 36-N constant force is applied to X as shown. The magnitude of the force of X on Y is:



$4+20=24$

$36=24 \cdot a$

$a=1.5$

A) 1.5 N
B) 6.0 N
C) 29 N
D) 30 N
E) 36 N

$F_Y = m \cdot a$

$F_Y = 1.5 \cdot 20$

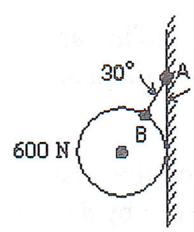
$F_Y = 30$

35. An inelastic collision is one in which:

A) momentum is not conserved but kinetic energy is conserved
B) total mass is not conserved but momentum is conserved
C) neither kinetic energy nor momentum is conserved
D) momentum is conserved but kinetic energy is not conserved
E) the total impulse is equal to the change in kinetic energy

36. The 600-N ball shown is suspended on a string AB and rests against the frictionless vertical wall. The string makes an angle of 30° with the wall. The magnitude of the tension for of string is:

ce

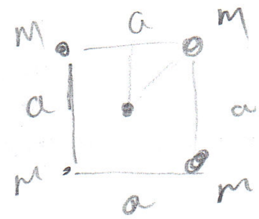


A) 690 N
B) 1200 N
C) 2100 N
D) 2400 N
E) none of these

$T\cos 30 = 600$ N

$= 692.8$

26. Each of the four corners of a square with edge a is occupied by a point mass m. There is a fifth mass, also m, at the center of the square. To remove the mass from the center to a point far away the work that must be done be an external agent is given by:
A) $4Gm^2/a$
B) $-4Gm^2/a$
C) $4\sqrt{2}Gm^2/a$
D) $-4\sqrt{2}Gm^2/a$
E) $4Gm^2/a^2$



$PE = -\frac{GMm}{R} = \frac{-4\sqrt{2}GMm}{a}$

$R = \frac{a^2}{4} + \frac{a^2}{4} = \sqrt{\frac{a^2}{2}} = \frac{a}{\sqrt{2}}$

at ∞ $PE = 0$

need $\frac{4\sqrt{2}GMm}{a}$

27. A spaceship is returning to Earth with its engine turned off. Consider only the gravitational field of Earth and let M be the mass of Earth, m be the mass of the spaceship, and R be the distance from the center of Earth. In moving from position 1 to position 2 the kinetic energy of the spaceship increases by:

A) $GM\,m\left[\frac{1}{R_2}-\frac{1}{R_1}\right]GM\,m/R_2$

B) $GM\,m\left[\frac{1}{R_1}+\frac{1}{R_2}\right]$

C) $GM\,m\frac{R_1-R_2}{R_1}$

D) $GM\,m\frac{R_2-R_1}{R_1R_2}$

E) $GM\,m\frac{R_1-R_2}{R_1R_2}$

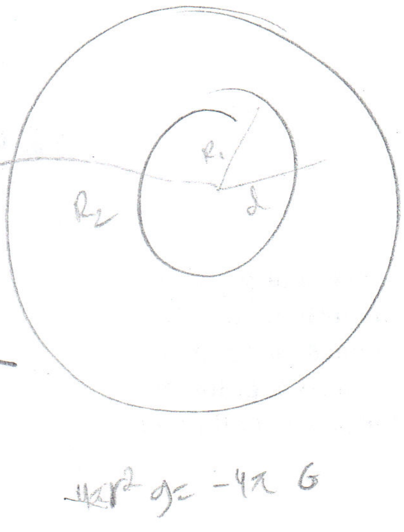
potential $= \frac{-GMm}{R}$

to go from r_f to r_i

$\Delta PE = -\frac{GMm}{r_f} - \frac{-GMm}{r_i}$

$\Delta KE = \frac{GMm}{r_f} - \frac{GMm}{r_i} = \frac{r_i - r_f}{r_f r_i} \cdot GMm$

28. A spherical shell has inner radius R_1, outer radius R_2, and mass M, distributed uniformly throughout the shell. The magnitude of the gravitational force exerted on the shell by a point particle of mass m, located a distance d from the center, outside the inner radius and inside the outer radius, is:
A) 0
B) GMm/d^2
C) $GMm/\left(R_2^3-d^3\right)$
D) $GMm\left(d^3-R_1^3\right)/d^2\left(R_2^3-R_1^3\right)$
E) $GMm/\left(d^3-R_1^3\right)$



Continued from page 3

$g = \frac{G\,M_{enc}}{d^2}$ $\quad M_{enc} = M\frac{(d^3 - r_1^3)}{(r_2^3 - r_1^3)}$

$F_g = \frac{GmM(d^3 - r_1^3)}{d^2(r_2^3 - r_1^3)}$

$4\pi r^2 g = -4\pi G$

$U = \int F \cdot dx$ $\quad F = \frac{-dw}{dx}$

20. The potential energy of a body of mass m is given by $U = -mgx + 1/2kx^2$. The corresponding force is:
    A) $-mgx^2/2 + kx^3/6$
    B) $mgx^2/2 - kx^3/6$
    C) $-mg + kx/2$
    D) $-mg + kx$
    E) $mg - kx$

$F = \frac{-dw}{dx}$

$F = mg - Kx^2$

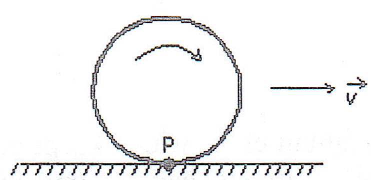
21. Two particles, each of mass m, are a distance d apart. To bring a third particle, with mass $2m$, from far away to a resting point midway between the two particles the work done by an external agent does work given by:
    A) $4Gm^2/d$
    B) $-4Gm^2/d$
    C) $8Gm^2/d$
    D) $-8Gm^2/d$
    E) zero

$U_{me} = \frac{-2G\,m^2}{d/2} \rightarrow \frac{-4G\,m^2}{d}$

(M) • (M) $\quad W_f = -\frac{8Gm^2}{d}$

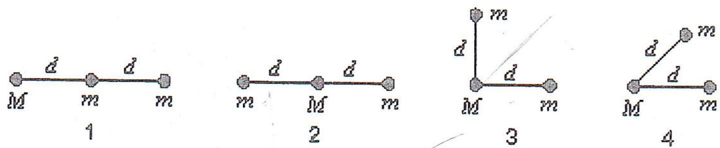
$d/2$ Final state

22. A wheel rolls without slipping along a horizontal road as shown. The velocity of the center of the wheel is represented by →. Point P is painted on the rim of the wheel. The instantaneous velocity of point P is:



A) →
B) ←
C) ↑
D) ↗
E) zero

12. Three particles, two with mass m and one mass M, might be arranged in any of the four configurations known below. Rank the configurations according to the magnitude of the gravitational force on M, least to greatest.



A) 1, 2, 3, 4
B) 2, 1, 3, 4
C) 2, 1, 4, 3
D) 2, 3, 4, 1
E) 2, 3, 2, 4

$(2\sqrt{2}, 2\sqrt{2})$ $(\sqrt{2}+1, \sqrt{2})$

Magnitude $\Rightarrow 4$ $\sqrt{2+(\sqrt{2}+1)^2} = 2.79 < 4$

13. A 3.0-kg and a 2.0-kg cart approach each other on a horizontal air track. They collide and stick together. After the collision their total kinetic energy is 40 J. The speed of their center of mass is:

A) zero
B) 2.8 m/s
C) 4.0 m/s
D) 5.2 m/s
E) 6.3 m/s

$V_{cm} = \frac{\Sigma m \cdot V}{M_T}$

$40 = \frac{1}{2} m v^2$

$16 = v^2$

$v = 4$

14. A particle moving along the x axis is acted upon by a single force $F = F_0e^{-kx}$, where F_0 and k are constants. The particle is released from rest at $x = 0$. It will attain a maximum kinetic energy of:

$\frac{1}{2}mv^2$

$F = F_0 e^{-kx}$ $W = F \cdot d$

A) F_0/k
B) F_0/e^k
C) kF_0
D) $1/2(kF_0)^2$
E) ke^kF_0

$\cancel{\frac{1}{2} \cdot m\left(-\frac{F_0}{mk} e^{-kx}\right)^2}$

$a = \int_0^\infty \frac{F_0}{m} e^{-kx}$

$\frac{1}{2}\frac{F_0^2}{mk^2}$ $= \frac{1}{2} m \left(\frac{F_0}{mk}\right)^2$

$V = -\frac{F_0}{mk} e^{-kx} + \frac{F_0}{mk} e^{0}$

15. A force on a particle is conservative if:

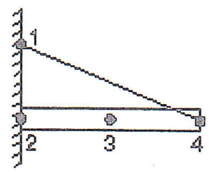
A) its work equals the change in the kinetic energy of the particle
B) it obeys Newton's second law
C) it obeys Newton's third law
D) its work depends on the end points of the motion, not this the path between
E) it is not a frictional force

5. Assume that Earth is in circular orbit around the Sun with kinetic energy K and potential energy U, taken to be zero for infinite separation. Then, the relationship between K and U:

A) is $K = U$
B) is $K = -U$
C) is $K = U/2$
D) is $K = -U/2$
E) depends on the radius of the orbit

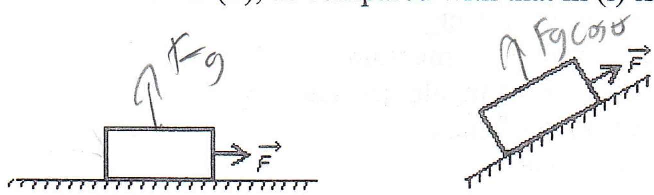
as objects get closer to the Sun they get faster

6. The uniform rod shown below is held in place by the rope and wall. Suppose you know the weight of the rod and all dimensions. Then you can solve a single equation for the force exerted by the rope, provided you write expressions for the torques about the point:



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

7. A heavy wooden block is dragged by a force $\vec{F}$ along a rough steel plate, as shown below for two possible situations. The magnitude of $\vec{F}$ is the same for the two situations. The magnitude of the frictional force in (ii), as compared with that in (i) is:



(i) (ii)

A) the same
B) greater
C) less
D) less for some angles and greater for others
E) can be less or greater, depending on the magnitude of the applied force.