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

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) $mg - kx$

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

$F = mg - Kx^2$

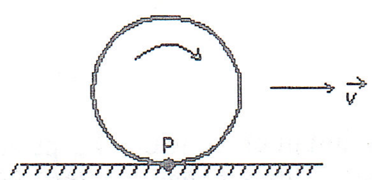
21. Two particles, each of mass *m*, are a distance *d* apart. To bring a third particle, with mass 2*m*, from far away to a resting point midway between the two particles the work done by an external agent does work given by:
    A) $4Gm^2/d$
    B) $-4Gm^2/d$
    C) $8Gm^2/d$
    D) $-8Gm^2/d$
   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

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

M • M $W_f = -\frac{8 G m^2}{d}$

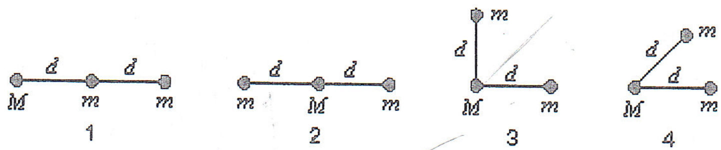
$d/2$ Final State

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 $F = F_0 e^{-kx}$, where F_0 and k are constants. The particle is released from rest at $x = 0$. It will attain a maximum kinetic energy of:
~~A)~~ F_0/k
~~B)~~ F_0/e^k
~~C)~~ kF_0
D) $1/2(kF_0)^2$
~~E)~~ ke^kF_0

$\frac{1}{2} m v^2$ $F = F_0 e^{-kx}$ $v = F \cdot d$

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

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

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

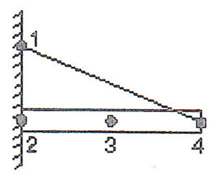
15. A force on a particle is conservative if:
A) its work equals the change in the kinetic energy of the particle
B) it obeys Newton's second law
C) it obeys Newton's third law
D) its work depends on the end points of the motion, not this the path between
E) it is not a frictional force

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

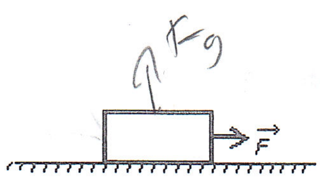
as objects get closer to the Sun they get faster

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:

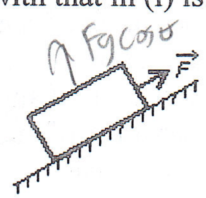


~~A)~~ 1
B) 2
C) 3
~~D)~~ 4
E) 1, 2, or 3

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.