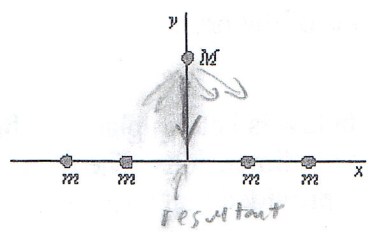
Period 1&2

Name: Qiu, ze Qin   Date: ____________   MP3 1st Exam

1. Four particles, each with mass m, are arranged symmetrically about the origin on the x axis. A fifth particle, with mass M, is on the y axis. The direction of the gravitational force on M is:



A) $\uparrow$
B) $\downarrow$
C) $\leftarrow$
D) $\rightarrow$
E) none of these directions

2. The coefficient of kinetic friction:
A) is in the direction of the frictional force
B) is in the direction of the normal force
C) is the ratio of force to ~~area~~ force
D) can have units of newtons
E) none of the above

$F = \mu_s F$

3. In planetary motion the line from the star to the planet sweeps out equal areas in equal times. This is a direct consequence of:
A) the conservation of energy
B) the conservation of momentum
C) the conservation of angular momentum
D) the conservation of mass
E) none of the above

4. Camping equipment weighing 6000 N is pulled across a frozen lake by means of a horizontal rope. The coefficient of kinetic friction is 0.05. The work done by the campers in pulling the equipment 1000 m at constant velocity is:
A) 3.1×10^4 J
B) 1.5×10^5 J
C) 3.0×10^5 J
D) 2.9×10^6 J
E) 6.0×10^6 J

3×10^5 J

$W = F \cdot d$

$F = F_g \cdot \mu_k$

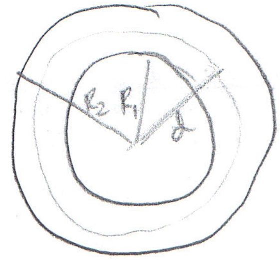
$= F_g \mu_k d$

8. 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 mass m a distance d from the center, inside the inner radius, is:

$M_{enc} = \frac{M(d^3 - r_1^3)}{(r_2^3 - r_1^3)}$

A) 0
B) GMm / R_1^2
C) GMm/d^2
D) $GMm / (R_2^2 - d^2)$
E) $GMm/(R_1 - d)^2$

$g = \frac{-4\pi G \cdot M_{enc}}{4\pi d^2}$



$V_{Total} = \frac{4}{3}\pi r_2^3 - \frac{4}{3}\pi r_1^3$

$\frac{\frac{4}{3}\pi r_2^3 - \frac{4}{3}\pi r_1^3}{M} = \frac{\frac{4}{3}\pi d^2 - \frac{4}{3}\pi r_1^3}{M_{enc}}$

9. An object is dropped from an altitude of one Earth radius above Earth's surface. If M is the mass of Earth and R is its radius the speed of the object just before it hits Earth is given by:

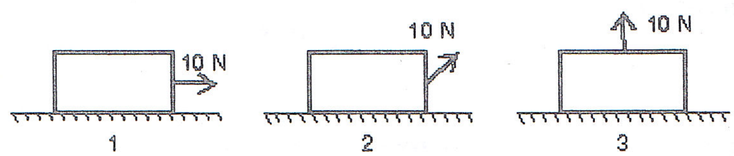
A) $\sqrt{GM / R}$
B) $\sqrt{GM / 2R}$
C) $\sqrt{2GM / R}$
D) $\sqrt{GM / R^2}$
E) $\sqrt{GM / 2R^2}$

$-\frac{GMm}{2R} = \frac{-2GMm}{2R} + \frac{1}{2} m v^2$

$= \frac{GM}{2R} = \frac{1}{2} v^2$

$v = \sqrt{\frac{GM}{R}}$

10. A crate moves 10 m to the right on a horizontal surface as a woman pulls on it with a 10-N force. Rank the situations shown below according to the work done by her force, least to greatest.



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

11. A 15-g paper clip is attached to the rim of a phonograph record with a radius of 30 cm, spinning at 3.5 rad/s. The magnitude of its angular momentum is:

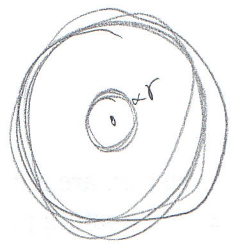
A) 1.4×10^{-3} kg · m²/s
B) 4.7×10^{-3} kg · m²/s
C) 1.6×10^{-2} kg · m²/s
D) 3.2×10^{-1} kg · m²/s
E) 1.1 kg · m²/s

$L = I\omega$

$= .015 \cdot (0.3)^2 \cdot 3.5$

$= 4.7 \times 10^{-3}$

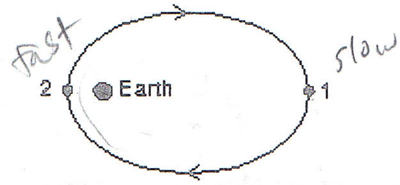
16. The mass density of a certain planet has spherical symmetry but varies in such a way that the mass inside every spherical surface with center at the center of the planet is proportional to the radius of the surface. If r is the distance from the center of the planet to a point mass inside the planet, the gravitational force on the mass is:
A) not dependent on r
B) proportional to r^2
C) proportional to r
D) proportional to $1/r$
E) proportional to $1/r^2$



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

$g \propto \frac{G}{r^4}$

17. A small satellite is in elliptical orbit around Earth as shown. If L denotes the magnitude of its angular momentum and K denotes kinetic energy:



A) $L_2 > L_1$ and $K_2 > K_1$
B) $L_2 > L_1$ and $K_2 = K_1$
C) $L_2 = L_1$ and $K_2 = K_1$
D) $L_2 < L_1$ and $K_2 = K_1$
E) $L_2 = L_1$ and $K_2 > K_1$

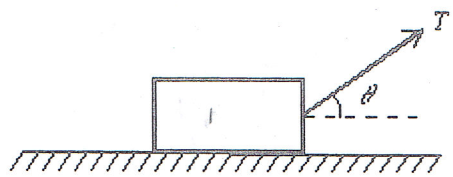
$K_1 < K_2$

18. Suppose you have a pendulum clock which keeps correct time on Earth (acceleration due to gravity = 9.8 m/s^2). Without changing the clock, you take it to the Moon (acceleration due to gravity = 1.6 m/s^2). For every hour interval (on Earth) the Moon clock will record:
A) (9.8/1.6) h
B) 1 h
C) $\sqrt{9.8/1.6}$ h
D) (1.6/9.8) h
E) $\sqrt{1.6/9.8}$ h

9.8 / 1.6 → 6.125 reduction

19. Acceleration is always in the direction:
A) of the displacement
B) of the initial velocity
C) of the final velocity
D) of the net force
E) opposite to the frictional force

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:

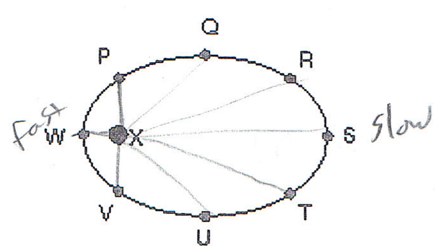
A) $1/2\sqrt{gh}$
B) $\sqrt{gh/2}$
C) $\sqrt{2gh}$
D) $2\sqrt{2gh}$
E) $2\sqrt{gh}$

KE → PE

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

$v = \sqrt{2gh}$

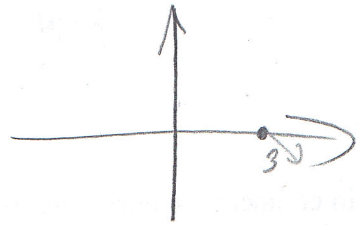
25. A planet travels in an elliptical orbit about a star X as shown. The magnitude of the acceleration of the planet is:



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 $\vec{a} = 4.0\hat{\imath} - 3.0\hat{\jmath}$ in m/s^2. 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) $(+144\ \mathrm{N \cdot m})\hat{k}$

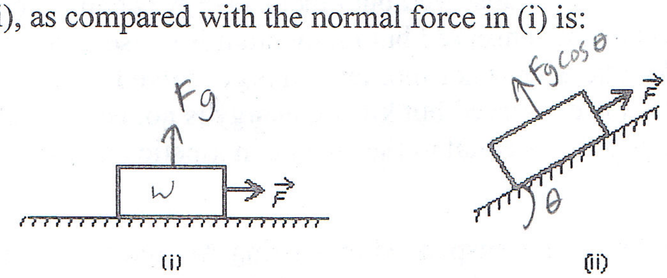


$\tau = F \times r$
$= m(a \times r)$
$= 2 \cdot -9 = (-18\ \mathrm{N \cdot m})\hat{k}$

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 $\vec{a} = 4.0\hat{\imath} - 3.0\hat{\jmath}$ in m/s^2. At the end of 2.0 s its angular momentum about the origin is:

$L=$

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) $(+96\ \mathrm{kg \cdot m^2/s})\hat{k}$

at $t=2$
$a = \langle 4, -3 \rangle$
$v = \langle 4t, -3t \rangle \longrightarrow \langle 8, -6 \rangle$
$\cancel{d = \langle 3 + 2t^2, -\tfrac{3}{2}t^2 \rangle} \Rightarrow \langle 11, -6 \rangle$

$L = I \cdot \omega$
$MR^2 \cdot \frac{V}{R}$
$= MRV$
$= 2 \cdot \langle 8, -6 \rangle \times \langle 11, -6 \rangle$
$= -36\hat{k}$

37. Suitable units for the gravitational constant G are:

A) $kg \cdot m/s^2$
B) m/s^2
C) $N \cdot s/m$
D) $kg \cdot m/s$
E) $m^3/(kg \cdot s^2)$

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

38. When the brakes of an automobile are applied, the road exerts the greatest retarding force:

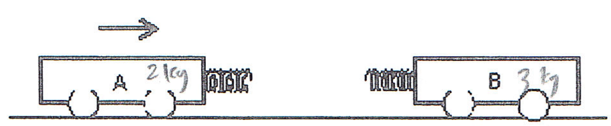
A) while the wheels are sliding
B) just before the wheels start to slide
C) when the automobile is going fastest
D) when the acceleration is least
E) at the instant when the speed begins to change

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

$W = F \cdot d$
$= F_g \cdot \mu_k \cdot d$
$= 2.5 \times 10^5$

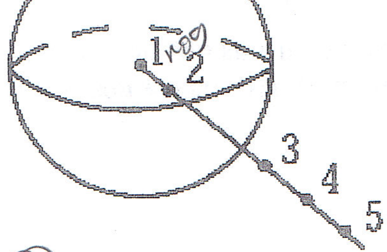
40. Two carts (A and B), having spring bumpers, collide as shown. Cart A has a mass of 2 kg and is initially moving to the right. Cart B has a mass of 3 kg and is initially stationary. When the separation between the carts is a minimum:



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: Qiu, ze Qin 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) $\vec{g} = -\rho_o G(\frac{r}{2} - \frac{Cr^2}{3R_P})\hat{r}$ $\ast 4\pi$

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

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

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

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

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

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

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

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

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

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

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