ISP209 Fall 2012

Exam #1

Name:_____

Student #:_____

Please write down your name and student # on both the exam and the scoring sheet. After you are finished with the exam, please place the scoring sheet inside the exam and turn in at the front of the lecture room.

No form number is necessary. No section # is necessary. Please write last your last name and first names in the locations provided. Mixing last and first names has caused a lot of problems in the past.

Do not begin working on the exam before permission is given. Keep your eyes on your own exam and no conversations. You will be given one verbal warning. The second violation will result in the exam being taken away and a grade of 0 assigned. **No cell phones visible.**

Some useful constants:

$g=9.83\ m/s^2$

$G=6.67X10^{-11}\ Nm^2/kg^2$

$M_{Earth}=6X10^{24}\ kg$

$R_{Earth}=6.37X10^{6}\ m$

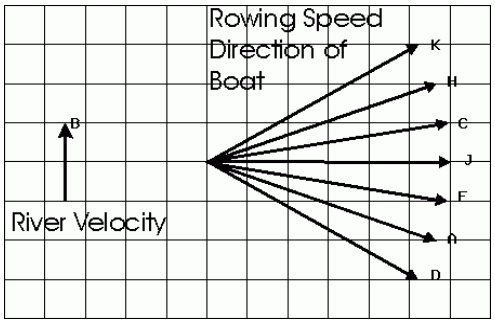
$M_{Sun}=1.99X10^{30}\ kg$

$R_{Sun}=6.98X10^{8}\ m$

Distance from Earth to Sun$=1.50X10^{11}\ m$

1)0.00325X10^{-7} cm can also be expressed as

a) 3.25X10^{-12} mm
b) 3.25X10^{-11} mm
c) 3.25X10^{-10} mm
d) 3.25X10^{-9} mm
e) 3.25X10^{-8} mm



2) A student is rowing a boat across a river, with the river current directed from the bottom of the page towards the top of the page. Which vector describes the motion that allows the student to cross the river in the shortest time? The vectors represent the possible velocities of the student with respect to the river.

a) H

b) J

c) A

d) K

e) D

3) A student is rowing a boat across a river, with the river current directed from the bottom of the page towards the top of the page. Which vector describes the motion that allows the sudent to end up on other side of the river directly across from where he started? The vectors represent the possible velocities of the student with respect to the river.

a) H

b) J

c) A

d) K

e) D

4) An elevator is able to raise 200 kg to a height of 40 m in 15 s. How much work does the elevator do?

a) 2613 J
b) 39,320 J
c) 78,640 J
d) 10,500 J
e) 246,000 J

W=Fd=mgd=(200kg)(9.83N/kg)(40m)

=78,640J

5) What is the increase in potential energy of the 200 kg mass in the problem above?

a) 2613 J
b) 39,320 J
c) 78,640 J
d) 10,500 J
e) 246,000 J

6) What is power output of the elevator in problem 4?

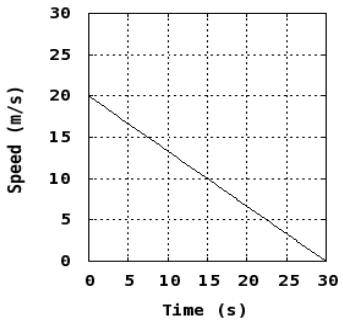
a) 5240 W
b) 39,320 W
c) 25,342 W
d) 2620 W
e) 31,990 W

P=W/t=(78,640J/15s)=5240W

7) Which viewpoint did Emilie du Chatelet have that most other scientists of her day disagreed with?

a) that the kinetic energy of an object was proportional to the square of the object's speed
b) that the momentum of an object depended linearly on the velocity
c) that the potential energy of a system always equalled the kinetic energy
d) that Newton's 3 laws of motion were correct

8) A car of mass 2165 kg slows down as the brakes are applied, as shown in the figure below. What (magnitude of) acceleration is the car experiencing?



a) 0 m/s^2
b) 0.67 m/s^2
c) 2.3 m/s^2
d) 15m/s^2
e) 20 m/s^2

$a=\Delta v/\Delta t=(0\ m/s - 20\ m/s)/(30s)=-0.67\ m/s^2$

Since we're asking only for the magnitude, we don't worry about the negative sign.

9) What magnitude of force is the car experiencing?

a) 1450 N
b) 20 N
c) 898 N
d) 2180 N
e) 791 N

$F=ma=(2165kg)(0.67\ N/kg)=1450N$

Note how we switched the units for a.

10) Which of the scientists below first proposed the atomic hypothesis

a) Johannes Kepler
b) Democritus
c) Galileo Galilei
d) Emilie du Chatelet
e) Aristotle

11) As it orbits around the Earth, the Hubble Space Telescope (mass of 11,110 kg) travels at a speed of 7900 m/s and is 560 km above the Earth's surface. What is its kinetic energy?

a) 9.42E12 J
b) 8.78E7 J
c) 6.67E9 J
d) 3.47E11 J
e) 1.57E6 J

$KE=1/2mv^2=0.5(11110kg)(7900m/s)^2=3.47X10^{11}$ J (note that the altitude does not enter into the calculation)

12) A bullet is shot horizontally from a rifle at a speed of 1292 m/s from a height of 2.48 m above the ground. How long after it has been fired does the bullet hit the ground?

a) 0.35 s

b) 0.59 s

c) 0.65 s

d) 0.71 s

e) 0.79 s

$y=1/2gt^2$

$t=(2y/g)^{1/2}=(4.96m/9.8m/s^2)^{1/2}=0.71s$

13) How far has the bullet in the problem above travelled horizontally when it hits the ground?

a) 452 m

b) 762 m

c) 840 m

d) 917 m

e) 1021 m

$x=vt=(1292m/s)(0.71s)=917m$

14) A boy is pulling a cart with a mass of 15.2 kg using a force of 1160 N. Neglecting friction, what is the acceleration of the cart?

a) 37.9 m/s^2

b) $35.5X10^3$ m/s^2

c) 76.2 m/s^2

d) 0.59 m/s^2

e) 5.54 m/s^2

$a=F/m=1160N/15.2kg=76.2m/s^2$

Note again we have switched units for a.

15) A police car starting from rest reaches a speed of 90 km/hr in 5.5 seconds. What is its average acceleration?

a) 5.55 m/s^2

b) 25.0 m/s^2

c) 4.5 m/s^2

d) 7.92 m/s^2

e) 9.83 m/s^2

*v_{final}=90 km/hr * (1000 m/km) * (1 hr/3600 s) = 25 m/s*

Note how the units cancel to get m/s.

$a=\Delta v/\Delta t=(25\ m/s-0\ m/s)/5.5s=4.5\ m/s^2$

16) You throw a ball straight up. Air resistance is negligible. After the ball leaves your hand, which of the following statements is true?

a) the ball experiences an upward force at first, which gradually diminishes as gravity takes over
b) the ball experiences no forces in its motion
c) the ball experiences an upward force as it rises and then a downward force as it falls
d) the ball experiences only the downward force of its own weight
e) the ball experiences the upward force of the throw and the downward force of its weight while it rises ,but only the downward force of the throw as it falls

17) What is the mass of a man who is running with a speed of 5.56 m/s if he has a kinetic energy of 932 J?

a) 57.2 kg

b) 66.1 kg

c) 60.3 kg

d) 70.4 kg

e) 87.5 kg

KE=1/2mv2

$m=2KE/v^2=2(932J)/(5.56m/s)^2=60.3kg$

18) What is the height above the ground where a woman with a mass of 56.6 kg would have a gravitational potential energy of 5898 J. (Her potential energy is zero J at a height of 0 m.)

a) 4.32 m

b) 9.91 m

c) 7.51 m

d) 10.6 m

e) 15.9 m

PE=mgh

*h=PE/mg=(5898J)/(56.6kg*9.83N/kg)=10.6m*

19) If she were to drop to the ground from the height determined in the problem above, how much kinetic energy would she have when she hit the ground?

a) 2088 J

b) 3091 J

c) 4176 J

d) 4912 J

e) 5898 J

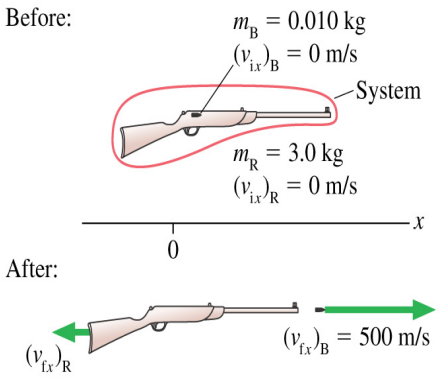
20) What would happen to your weight if the radius of the Earth were increased by a factor of 3,but its mass remained the same?

a) it would remain the same
b) it would increase by a factor of 3
c) it would decrease by a factor of 3
d) it would decrease by a factor of 9
e) it would increase by a factor of 9

Since the force is proportional to the square of the radius, it would decrease by a factor of 9.

21) A rifle fires a bullet, as shown below. Given the relative masses of the rifle and the bullet, and the speed of the bullet, what is the speed of the rifle after the bullet leaves the rifle?

a) 0 m/s
b) 1.67 m/s
c) 23.5 m/s
d) 0.01 m/s
e) 500 m/s



Since the initial momentum is zero, so is the final momentum.

$m_B v_B = m_R v_R$

$v_R = m_B v_B / m_R = (0.01kg)(500m/s)/3kg = 1.67m/s$

22) In the absence of any external force, a moving object will

a) stop immediately

b) slow down and eventually come to a stop

c) move with constant velocity

d) move faster

e) move more slowly

23) Two moons orbit a planet with circular orbits. Moon A has an orbital radius of r, and Moon B has an orbital radius of 4r. If Moon A takes 20 days to complete 1 orbit, how long does it take Moon B to complete 1 orbit?

a) 320 days

b) 160 days

c) 80 days

d) 40 days

e) 20 days

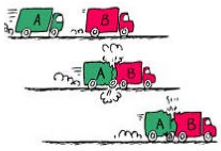
Kepler's 3rd law states that the square of the period is inversely proportional to the cube of the radius. If the radius is 4 times as big, then $4^3=64$. The square root of 64 is 8, so the period is 8 times as long, or 160 days.

24) Two people are standing on ice skates facing each other. Person A, with a mass of 60 kg, pushes on person B, who has a mass of 90 kg, with a force of 60 N. What is the acceleration of person A? (Assume the ice is frictionless.)

a) 60 m/s^2
b) 90 m/s^2
c) 1 m/s^2
d) 2.5 m/s^2
e) 0.67 m/s^2

$a = F/m = 60N/60kg = 1m/s^2$

The forces on A and B are equal and opposite.



25) Suppose truck A above has a mass of 1500 kg and truck B has a mass of 2000 kg. Truck A is travelling at a speed of 50 m/s while truck B is travelling in the same direction at a speed of 30 m/s. The two stick together after the collision. How fast are they moving?

a) 50 m/s

b) 38.6 m/s

c) 15.4 m/s

d) 17.8 m/s

e) 41.4 m/s

momentum is conserved

$m_A v_A + m_B v_B = (m_A + m_B) v_{final}$

$v_{final} = 38.6 m/s$

26) Imagine that it is possible to take a 2 kg mass and raise it straight up off the Earth's equator on a huge tower that stretches beyond the Earth's atmosphere into space. If the top of the tower is 160.0 km directly above a point on the Earth's equator, what would the mass weight at the top of the tower? For comparison, on the surface of the Earth, the mass weighs 19.7 Newtons.

a) 0 N
b) 19.22N
c) 19.7N
d) 18.75N
e) 20.1 N

Newton's law of gravitation states that the gravitational force between two masses goes as the square of the distance between them. For a 2 kg mass on the surface of the Earth, $r=R_E$, and the force is 19.7 N. For the mass 160 km above the surface of the Earth, $r=R_E+1.6X10^3$ km. The force at 160 km then is

f) $\frac{r_E^2}{r_E^2+(1.6X10^5 m)^2}$

*g) times the weight at the surface of the Earth, i.e. 0.95*19.7N=18.75N*

Match the SI unit with the corresponding quantity. (In the next 5 problems, each unit is used once. Fill in the correct bubble for the unit corresponding to distance for question 4, for mass for question 5, etc)

a Newton
b m/s^2
c meter
d kilogram
e second

27) distance **c**

28) mass **d**

29) acceleration **b**

30) force **a**

31) time **e**

32) Which of the following is a characteristic of pseudoscience?

a) proponents do not exploit the controversies and inadequacies in a competing theory
b) all facts are considered and discussed
c) the hypothesis is not at risk. If data does not agree with the hypothesis, then the data is assumed to be wrong
d) proponents publish in scientific journals
e) proponents admit they are given a fair chance to present their results

33) Which of the following quantities is a vector quantity?

a) distance
b) position
c) mass
d) speed
e) time

34) What was the major problem Galileo had to solve in his experiments on meauring the motion of falling objects?

a) the studies were prohibited by the church

b) he was not able to find a tower high enough to conduct his experiments

c) the mathematics that he had available weren't sophisticated enough for the needed calculations

d) the motion was occuring too quickly to be accurately measured

e) he wasn't able to measure the lengths accurately enough

That's why he had to use a ramp rather than to try to measure directly the falling bodies.

35) Through his precise experiments, Antoine de Lavoisier demonstrated that

a) momentum is conserved
b) that the momentum of an object depended linearly on the velocity
c) the potential energy of a system always equalled the kinetic energy
d) mass is conserved in chemical reactions
e) $E=mc^2$

Match the term below with its definition (each term will be used only once):

36) Speed **b**
37) Acceleration **e**
38) Mass **c**
39) Velocity **a**
40) Momentum **d**

a) the speed and direction of an object

b) magnitude of the rate of change of position

c) property of an object which determines the amount of acceleration for an applied force
d) force is the rate of change of this quantity
e) rate of change of velocity