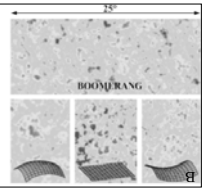
3. If I observe a galaxy with an apparent velocity of recession of 1500 km/s, and Hubble's constant is 75 km/s/Mpc, how far away is the galaxy?
   A. 2 Mpc; about 6.5 million light years
   B. 5 Mpc; about 16 million l.y.
   C. 10 Mpc; about 33 million l.y.
   D. 20 Mpc; about 67 million l.y.
   E. 200 Mpc; about 670 million l.y.

D

2. Which direction in the sky would you look to see the big bang?
   A. you won't see it in any direction
   B. I don't know: some random (but fixed) direction?
   C. depends on time of year (where sun is in sky)
   D. it's in every direction you look
   E. sideways

D

3. Which one is a match?
   A. left picture
   B. middle picture
   C. right picture
   D. none of the above
   E. all look okay to me



B

4. When we say the universe is flat, we mean:
   A. The angles inside a triangle add to 180°
   B. Parallel lines remain parallel forever
   C. Space is infinite in extent
   D. None of the above
   E. All of the above

E

5. How many planets total (including around other stars) have we identified thus far?
   A. Just the 8 (9 with Pluto) in our solar system
   B. Something like 15: some around other stars
   C. A little over 60
   D. Almost 300
   E. Over 100,000

D

1. If the nucleus is 10^{-5} times the size of the atom's electron cloud, how big would an electron cloud be if the nucleus were the size of a sand grain (1 mm)?
   A. 0.1 meters
   B. 1 meter
   C. 10 meters
   D. 100 meters
   E. 1 km

D

2. Why do different elements have different chemical behaviors?
   A. they just do, man
   B. the properties of the electron cloud dictate behavior
   C. the number of neutrons in the nucleus determine behavior
   D. the number of protons in the nucleus determine behavior
   E. the total number of nucleons (protons plus neutrons) determines behavior

B

3. Collections of three quarks are called baryons (protons, neutrons belong). The baryon called the Delta particle is made of three up quarks. What is its charge?
   A. No way I can know this
   B. +2/3
   C. +2
   D. +3
   E. -2

C

1. A yellow car is heading East at 100 km/h and a red car is going North at 100 km/h. Do they have the same speed? Do they have the same velocity?
   A. same speed, same velocity
   B. same speed, different velocity
   C. different speed, same velocity
   D. different speed, different velocity

B

2. A 16-lb bowling ball in a bowling alley in Del Mar heads due north at 10 m/s. At the same time, a purple 8-lb ball heads due north at 10 m/s in an alley in La Jolla. Do they have the same speed? Same velocity?
   A. same speed, same velocity
   B. same speed, different velocity
   C. different speed, same velocity
   D. different speed, different velocity

A

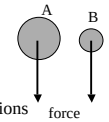
3. A sprinter who is running a 200 meter race covers the second 100 meters in less time than it takes to cover the first 100 meters. Why?
   A. Drafting takes hold once up to speed
   B. The more upright posture produces less air drag
   C. The runner's metabolism kicks in for the second half
   D. The runner spends the first half accelerating

D

4. If you are driving East and apply the brakes to stop your car, in what direction are you accelerating?
   A. you're not accelerating
   B. accelerating to the east
   C. accelerating to the west
   D. the direction is indeterminate

C

1. If identical forces act on two objects, where object A is twice as massive as object B, how do their accelerations compare?
   A. same accelerations
   B. A accelerates twice as much as B
   C. B accelerates twice as much as A
   D. A and B accelerate in different directions



C

2. If I double the mass of an object, by what factor must I change the applied force to maintain a certain acceleration?
   A. the force stays the same
   B. you must double the force
   C. you must cut the force in half
   D. there is no set rule for this

B

3. If one force pulls an object to the East, while a second force of equal magnitude pulls it to the West, what is the object's acceleration?
   A. It will slip out to the north or south
   B. It will accelerate to the east
   C. It will accelerate to the west
   D. It will not accelerate under balanced forces

D

4. If you observe a 1000 kg car accelerating forward at 2 m/s^2, what is the force acting on the car?
   A. there is not necessarily a force
   B. 500 Newtons toward front of car
   C. 1000 Newtons toward back of car
   D. 2000 Newtons toward back of car
   E. 2000 $kg \cdot m/s^2$ toward front of car

E

5. If something is accelerating at 4 m/s^2 in the direction **opposite** its velocity, and it starts with a velocity of 20 m/s, how long will it take to be going only 8 m/s in the original direction?
   A. it won't: it'll be speeding up
   B. 1 second
   C. 2 seconds
   D. 3 seconds
   E. 4 seconds

D

1. A ball falls from rest for 4 seconds. Neglecting air resistance, during which of the 4 seconds does the ball's speed increase the most?
   A. the increase is the same in each second
   B. the increase is greatest in the first second
   C. the increase is greatest in the second second
   D. the increase is greatest in the third second
   E. the increase is greatest in the fourth second

A

2. If you drop a ball from a height of 4.9 m, it will hit the ground 1 s later. If you fire a bullet exactly horizontally from a height of 4.9 m, how long will it take to hit the ground?
   A. less than one second
   B. also exactly 1 second
   C. something longer than one second
   D. never, if fired perfectly horizontally

B

3. If you throw a ball upward with a velocity of 20 m/s, how long will it take to reach its maximum height?
   A. there's no way to know this with the given info
   B. 0.5 seconds
   C. 1.0 seconds
   D. 2.0 seconds
   E. 3.0 seconds

D

4. How high will the ball from the previous problem travel to reach the top of its trajectory?
   A. 2 meters
   B. 5 meters
   C. 10 meters
   D. 20 meters
   E. 40 meters

D

5. If I have four forces pulling in the cardinal directions of north, south, east, and west with forces measuring 10, 20, 5, and 15 Newtons, respectively, how much net force is on the particle?
   A. impossible to say
   B. 5 Newtons to south
   C. 10 Newtons to west
   D. about 14 Newtons to southwest
   E. don't know the number, but to northeast

D

1. Which of the following does not derive from of Newton's laws of motion?
   A. things like to stay in their present state of motion
   B. momentum is unchanged by collisions of particles
   C. you cant push something without it pushing back
   D. it's hard to get heavy things to move
   E. All are consistent

B

2. If the earth's gravity exerts 2 Newtons of force on a falling apple, how much force does the apple exert on the earth?
   A. zero Newtons if it is falling (neglecting air)
   B. a very small amount depending on mass ratio
   C. zero Newtons until it rests on the ground, at which point it's 2 N
   D. 2 Newtons at all times, no matter what

D

3. If a 100 kg satellite in low earth orbit exerts about 1000 N on the earth, how much does the satellite accelerate; how much does earth accelerate?
   A. satellite is weightless and does not accelerate; nor does earth
   B. satellite accelerates about 10 m/s^2; earth not at all
   C. satellite accelerates about 10 m/s^2; earth WAY less (but not zero)
   D. satellite and earth both accelerate about 10 m/s^2

C

4. Given that frictional force is μ times the normal force, and $0 < \mu < 1$; what is the most frictional force a crate of mass, m, can have on a smooth surface?
   A. there is no limit
   B. there will be no friction on a smooth surface
   C. max force is m kilograms
   D. max force is m Newtons
   E. max force is mg Newtons

E

5. What is the ratio of projected areas for two balloons if one is twice the diameter of the other?
   A. 1:1, same area
   B. 2:1, bigger one is twice the area
   C. 4:1, bigger one is four times the area
   D. 8:1, bigger one is 8 times the area

C

6. If $F_{drag} = 0.65Av^2$, and the ratio of areas is 4:1 for the two balloons, what is the ratio of drag forces if the velocity is the same?
   A. 1:1
   B. 2:1
   C. 4:1
   D. 8:1

C

7. Since the balloons are identical in mass, terminal velocity will have $F_{drag} = mg$ for both. What will the ratio of velocities be, if $A_1v_1^2 = A_2v_2^2$? (areas 4:1)
   A. 1:1 (same velocity)
   B. 1:2 (smaller twice as fast)
   C. 1:4 (smaller four times as fast)
   D. 2:1 (larger twice as fast)
   E. 4:1 (larger four times as fast)

B

1. Which takes more work: lifting a piano 1 m onto the tailgate of a truck, or pushing the same piano up a (frictionless) ramp to the same tailgate?
   A. Same work either way
   B. Straight lift is less work: shorter distance
   C. Ramp is less work: less force is required
   D. Not enough information to say for sure

A

2. How much energy must I put into raising a 20 kg box of books onto a shelf 2 m off the floor?
   A. 20 J
   B. 40 N
   C. 40 N·m
   D. 200 N·m
   E. 400 J

E

3. How much kinetic energy will a 1 kg ball have at the ground if dropped from a 20 m building?
   A. I need the velocity to figure this out
   B. 20 J
   C. 200 J
   D. 20 N·m
   E. 200 N

C

4. How much kinetic energy does a 50 kg runner (110 lbs) have if sprinting at 10 m/s?
   A. 250 J
   B. 500 J
   C. 2500 J
   D. 5000 J
   E. kinetic energy is not measured in Joules (J)

C

2. How much power does it take to lift a 20 kg box of books 2 meters high in 2 seconds?
   A. 20 W
   B. 40 W
   C. 80 W
   D. 200 W
   E. 400 W

D

3. In a head-on collision, a dump truck collides with a Prius, both traveling the same speed. In what direction does the combined mangled mess move after the collision?
   A. The speeds are the same, so the velocities cancel and leave the mess at zero speed/direction
   B. The mess will move in the dump truck's original direction
   C. The mess will move in the Prius' original direction

B

4. A 100 kg ogre clobbers a stationary 50 kg figure skater while trying to learn to ice-skate. If the ogre is moving at 6 m/s before the collision, at what speed will the tangled pile be sliding afterwards?
   A. 0 m/s
   B. 3 m/s
   C. 4 m/s
   D. 6 m/s

C

5. If a figure skater is turning once per second with arms outstretched, then reduces their moment of inertia (I) by a factor of two, what happens to the rotation speed?
   A. doubles, to 2 turns per second
   B. stays the same: no new mass is added
   C. cut in half: one turn every two seconds
   D. skater looses balance and falls every time

A

1. During which part of a roller coaster ride do you feel heaviest: at the bottom of a dip or at the crest of a hill?
   A. I have the same mass all the time, so feel the same weight
   B. I feel heaviest at the bottom of a dip
   C. I feel the heaviest at the crest of a hill
   D. I feel heaviest at the end of the ride when it's time to get out of the seat

B

2. If you're in an elevator with an upward acceleration rate of 1 m/s^2 and you normally weigh 100 pounds, how much will you weigh (standing on a scale)?
   A. 90 lbs
   B. 99 lbs
   C. 100 lbs
   D. 101 lbs
   E. 110 lbs

E

3. If I let go of the string when the ball is in front of me (going clockwise as seen from above), which way does the ball go?
   A. to our right; your left
   B. toward us; straight out in front of you
   C. to our left; your right
   D. away from us; toward your back
   E. it will just drop straight down when you let go

C

4. What acceleration is needed to keep a car going around a corner with radius 10 m, if the speed is 10 m/s (22 mph)?
   A. 0.1 m/s^2 = 0.01g
   B. 1 m/s^2 = 0.1g
   C. 10 m/s^2 = 1g (tires/friction probably won't hold)
   D. 100 m/s^2 = 10g (tires/friction incapable of this)
   E. 1000 m/s^2 = 100g (tires/friction incapable of this)

C

1. What fraction of the energy that we use in the U.S. do you think comes from fossil fuels (coal, petroleum, natural gas)?
   A. 30%
   B. 50%
   C. 75%
   D. 85%
   E. 95%

D

2. The Watt-hour is a unit of energy (may have heard of killowatt-hour, kWh, before). This is one watt for one hour, or 30 W for 2 minutes. How many J are in a Wh?
   A. 1 J
   B. 60 J
   C. 60×60 = 3600 J
   D. 60×60×24 = 86,400 J
   E. huh?

C

3. If your body's metabolism runs at 100 W, then you use how many watt-hours of *energy* in a day?
   A. 100 W in 24 hours is about 4 W/h
   B. 24 Wh
   C. 100 Wh
   D. 240 Wh
   E. 2,400 Wh = 2.4 kWh

E

4. If you do 100 W of output power (a lot!), your body actually consumes energy at a rate of 400 W due to inefficiency. If you keep this up for 3 hours, how many Wh of exercise have you done?
   A. 400 W in 3 hours is 133 W/h
   B. 3 Wh
   C. 300 Wh
   D. 400 Wh
   E. 1200 Wh = 1.2 kWh

E

5. If it takes 2000 Calories to provide 2.4 kWh of metabolic energy, how much *more* must you eat to cover 1.2 kWh of exercise?

A. 400 Calories
B. 1000 Calories
C. 1200 Calories
D. 2000 Calories

B