Fall 2008 RED Barcode Here

Physics 105, sections 1 and 2

Final Exam Please write your CID_____

Colton 2-3669

4 hour time limit. No notes. No books. No calculators. 100 points total, all problems equal weight.

Constants:

$g = 9.8$ m/s^2 → **but you may use 10 m/s^2 in nearly all cases**

$G = 6.67 \times 10^{-11}$ N·m^2/kg^2

$k_B = 1.381 \times 10^{-23}$ J/K

$N_A = 6.022 \times 10^{23}$

$R = k_B \cdot N_A = 8.314$ J/mol·K

$\sigma = 5.67 \times 10^{-8}$ W/m^2·K^4

Mass of Sun = 1.991×10^{30} kg

Mass of Earth = 5.98×10^{24} kg

Radius of Earth = 6.38×10^{6} m

Radius of Earth's orbit = 1.496×10^{11} m

Density of water: 1000 kg/m^3

Density of air: 1.29 kg/m^3

Young's modulus of steel: 20×10^{10} N/m^2

Linear exp. coeff. of copper: 17×10^{-6} /°C

Linear exp. coeff. of steel: 11×10^{-6} /°C

Specific heat of water: 4186 J/kg·°C

Specific heat of ice: 2090 J/kg·°C

Specific heat of steam: 2010 J/kg·°C

Specific heat of aluminum: 900 J/kg·°C

Latent heat of melting (water): 33×10^{5} J/kg

Latent heat of boiling (water): 2.26×10^{6} J/kg

Thermal conduct. of aluminum: 238 J/s·m·°C

sin(30°) = 0.5

cos(30°) ≈ 0.866

tan(30°) ≈ 0.577

π ≈ 3.14

Conversion factors

1 inch = 2.54 cm

1 m^3 = 1000 L

1 atm = 1.013×10^{5} Pa = 14.7 psi

$$T_F = \frac{9}{5}T_C + 32$$

$$T_K = T_C + 273.15$$

Other equations

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Surface area of sphere = $4\pi r^2$

Volume of sphere = $(4/3)\pi r^3$

$$v_{ave} = \frac{v_i + v_f}{2}$$

$$v = v_o + at$$

$$x = x_o + v_o t + \frac{1}{2}at^2$$

$$v_f^{\,2} = v_o^{\,2} + 2a\Delta x$$

$w = mg$, $PE_g = mgy$

$F = -kx$, $PE_s = ½ kx^2$

$f = \mu_K N$ (or $f \le \mu_S N$)

$P = F_{//} \cdot v = Fv\cos\theta$

$F\Delta t = \Delta p$

Elastic: $(v_1 - v_2)_{bef} = (v_2 - v_1)_{after}$

arc length: $s = r\theta$

$v = r\omega$

$a_{tan} = r\alpha$

$a_c = v^2/r$

$$F_g = \frac{GMm}{r^2}, \; PE_g = -\frac{GMm}{r}$$

$I_{pt\ mass} = mR^2$

$I_{sphere} = (2/5)\, mR^2$

$I_{hoop} = mR^2$

$I_{disk} = (1/2)\, mR^2$

I_{rod} (center) = $(1/12)\, mL^2$

I_{rod} (end) = $(1/3)\, mL^2$

$$L = r_\perp p = rp_\perp = rp\sin\theta$$

stress = F/A; strain = $\Delta L/L$

Y = stress/strain

$$P = P_0 + \rho gh$$

$$VFR = A_1 v_1 = A_2 v_2$$

$$P_1 + \frac{1}{2}\rho v_1^{\,2} + \rho g y_1 = P_2 + \frac{1}{2}\rho v_2^{\,2} + \rho g y_2$$

$$\Delta L = \alpha L_0 \Delta T$$

$$\Delta V = \beta V_0 \Delta T; \; \beta = 3\alpha$$

$$KE_{ave} = \frac{1}{2} m v_{ave}^{\,2} = \frac{3}{2} k_B T$$

$$Q = mc\Delta T; \; Q = mL$$

$$\frac{\Delta Q}{\Delta T} = kA\frac{T_2 - T_1}{L}$$

$$P = e\sigma A T^4$$

$|W_{on\ gas}|$ = area under P-V curve = $P\Delta V$ (constant pressure)

$$U = \frac{3}{2}Nk_B T = \frac{3}{2}nRT$$ (monatomic ideal gas)

$Q_h = |W_{net}| + Q_c$

$$e = \frac{|W_{net}|}{Q_{added}} = 1 - \frac{Q_c}{Q_h}$$

$$e_{\max} = 1 - \frac{T_c}{T_h}$$

$$\omega = \sqrt{\frac{k}{m}}, \; T = 2\pi\sqrt{\frac{m}{k}}$$

$$\omega = \sqrt{\frac{g}{L}}, \; T = 2\pi\sqrt{\frac{L}{g}}$$

$$v = \sqrt{\frac{T}{\mu}}, \; \mu = m/L$$

$$v = \sqrt{\frac{Y}{\rho}}, \; v = \sqrt{\frac{B}{\rho}}$$

v_{air} = 343 m/s at 20° C

$$\beta = 10\log\left(\frac{I}{I_0}\right) \quad I_0 = 10^{-12} \text{ W/m}^2$$

$$f' = f\,\frac{v \pm v_0}{v \pm v_S}$$

$$f_n = n\frac{v}{2L} \quad n = 1,2,3,...$$

$$f_n = n\frac{v}{4L} \quad n = 1,3,5,...$$

Write your work on the exam pages if you wish. Of course also **record your final answers on the bubble sheet**. You will likely not get this exam booklet back, but please put your CID at the top of this page just in case.

Problem 1. A 5 kg block hangs without vibrating at the end of a spring (k = 400 N/m) that is attached to the ceiling of an elevator car. The car is rising with an upward acceleration of 3 m/s^2 when the acceleration suddenly ceases. What is the angular frequency of oscillation of the block after the acceleration ceases? ______ rad/s

a. $\sqrt{\dfrac{400}{3}}$

b. $\sqrt{\dfrac{400}{5}}$

c. $\sqrt{\dfrac{400}{9.8}}$

d. $\sqrt{\dfrac{400}{5 \cdot 3}}$

e. $\sqrt{\dfrac{400}{3 \cdot 9.8}}$

f. $\sqrt{\dfrac{400}{5 \cdot 9.8}}$

g. $\sqrt{\dfrac{400}{3 \cdot 5 \cdot 9.8}}$

1. w=√k/m=√400/5

Choice B

Problem 2. An object is moving back and forth in simple harmonic motion. Where is the acceleration of that object greatest?

a. at the midpoint of the motion
b. at the end points of the motion
c. same value at every point

2. Choice B (where the force is the greatest)

Problem 3. A stereo speaker emits sound waves with a power output of 100 W. Find the intensity 10 m from the source. (Assume that the sound is emitted uniformly in all directions from the speaker.) ________ W/m^2

a. $\dfrac{1}{20\pi}$

b. $\dfrac{1}{4\pi}$

c. $\dfrac{1}{2\pi}$

d. 2π

e. 4π

f. 20π

3. I=P/A=100/(4π10^2)=~~100~~/(4π~~100~~)=1/4π Choice B

Problem 4. For the previous problem, the intensity level (in decibels) at that same distance is closest to:

a. 80 dB
b. 90
c. 100
d. 110
e. 120
f. 130
g. 140 dB

4. dB=10log(I/10^{-12})=10log((1/12)/(10^{-12}))≈10log(.1/10^{-12})
= 10log(10^{11})=110 Choice D

Problem 5. You hear a sonic boom:

a. Whenever an aircraft flies overhead faster than the speed of sound.
b. Only when an aircraft above you first exceeds the speed of sound ("breaks the sound barrier")

5. Choice A

Problem 6. Two students play with an extra-long Slinky. The student on the left end sends waves to the other student by shaking her end back and forth. After the waves die down, both students take a step backwards and try it again. How will the speed of the waves now compare to the previous waves?

a. They will be faster
b. They will be slower
c. They will go the same speed

6. Wave speed is higher with more tension Choice A.

For the next four problems, please use 300 m/s as the speed of sound in air.

Problem 7. A boy is listening to two speakers that oscillate identically. He is 10 m from the first, and 11.5 m from the second. What is the lowest frequency of sound that will give him an intensity minimum at this location due to interference effects?

a. Less than 90 Hz
b. 90 - 110
c. 110 - 130
d. 130 - 150
e. 150 - 170
f. 170 - 190
g. Higher than 190 Hz

7. destructive interference: $\Delta L=\lambda/2 \rightarrow 1.5=\lambda/2 \rightarrow \lambda=3$ m
$f=v/\lambda=300/3=100$ Hz Choice B

Problem 8. The fundamental frequency of the trumpet I brought to class is very close to 150 Hz. How long would its uncoiled length be? (Not including any length added by valves.)

a. Less than 0.6 m
b. 0.6 - 0.9
c. 0.9 - 1.2
d. 1.2 - 1.5
e. 1.5 - 1.8
f. Longer than 1.8 m

8. fundamental: $L=\frac{1}{2}\lambda \rightarrow \lambda=2L$, also $\lambda=v/f \rightarrow 2L=300/150 \rightarrow L=1$ m Choice C

Problem 9. An ambulance emitting a 1 kHz sound passes you going 20 m/s. You are driving at 10 m/s in the same direction as the ambulance. What frequency do you hear as the ambulance drives away from you? ______ Hz

a. $1000\left(\frac{300-10}{300-20}\right)$
b. $1000\left(\frac{300-10}{300+20}\right)$
c. $1000\left(\frac{300+10}{300-20}\right)$
d. $1000\left(\frac{300+10}{300+20}\right)$

e. $1000\left(\frac{300-20}{300-10}\right)$
f. $1000\left(\frac{300-20}{300+10}\right)$
g. $1000\left(\frac{300+20}{300-10}\right)$
h. $1000\left(\frac{300+20}{300+10}\right)$

9. Doppler: $f' = f\,(v \pm v_0)/(v \pm v_s)$. Choose numerator to increase f (since observer is moving towards source). Choose denominator to decrease f (since source is moving away from observer)
$f' = 1000((300+10)/(300+20))$ Choice D

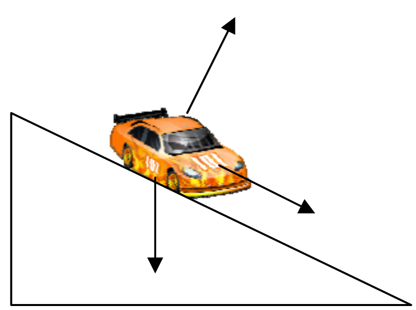
Problem 10. Two identical strings under 200 N of tension are sounding tones with fundamental frequencies of 600 Hz. The peg of one string slips slightly, and the tension in it drops to 180 N. How many beats per second will be heard? _______ beats/sec

a. $\left|300-300\sqrt{\frac{180}{200}}\right|$
b. $\left|300-300\sqrt{\frac{200}{180}}\right|$
c. $\left|300-300\left(\frac{180}{200}\right)\right|$
d. $\left|300-300\left(\frac{200}{180}\right)\right|$
e. $\left|600-600\sqrt{\frac{180}{200}}\right|$
f. $\left|600-600\sqrt{\frac{200}{180}}\right|$
g. $\left|600-600\left(\frac{180}{200}\right)\right|$
h. $\left|600-600\left(\frac{200}{180}\right)\right|$

10. It is easier to do this with ratios, but here's how I did it in my HW solutions:
$f\lambda = v$; also $v = \sqrt{T/\mu} = \sqrt{TL/m}$
fundamental: $\lambda = 2L$
$f \cdot 2L = \sqrt{TL/m}$
$\sqrt{mL} = 1/2f\sqrt{T}$
Use this equation with original condition:
$\sqrt{mL} = 1/(2(600)) \cdot \sqrt{200}$
Now use it with new condition:
$\sqrt{mL} = 1/(2(f_{new})) \cdot \sqrt{180}$
$[1/(2(600)) \cdot \sqrt{200}] = 1/(2(f_{new})) \cdot \sqrt{180}$
$f_{new} = 600\sqrt{(180/200)}$
$f_{beat} = |\Delta f| = |600 - 600\sqrt{(100/200)}|$

Problem 11. A toy car on a ramp is given a quick upward push. As a result of the push, the car travels up the ramp a bit, then rolls back down again. As the car is moving up the ramp, the net force on it is:

a. Up the ramp, and increasing in magnitude
b. Up the ramp, and decreasing in magnitude
c. Up the ramp, and constant
d. Zero
e. Down the ramp, and increasing in magnitude
f. Down the ramp, and decreasing in magnitude
g. Down the ramp, and constant



11. The net force is down the ramp (that's why we choose the tilted axes). Gravity and

normal forces are not changing, so the net force is not changing either. Choice G

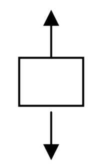
Problem 12. You drop a 3 kg stone down a 20 m well. How fast is it going when it hits the bottom?
a. 5-15 m/s
b. 15-25
c. 25-35
d. 35-45
e. 45-55 m/s

12. ~~m~~gh= ½~~m~~v^2 v=√2gh=√2(10)(20) =√(20*20)=20 Choice B

Problem 13. You slide a block of ice down a 45° ramp. There is no friction between the ice and the ramp. The acceleration of the ice block down the ramp will be _____ the normal acceleration of gravity, 9.8 m/s^2.
a. greater than
b. less than
c. equal to

13. Choice B. (To be precise, when you divide force of gravity into components, you'll find acceleration down the ramp is *g* sin45°)

Problem 14. An elevator is being lifted up an elevator shaft at *a constant speed* by a steel cable. All frictional effects are negligible. In this situation, forces on the elevator are such that:



a. the upward force by the cable is greater than the downward force of gravity.
b. the upward force by the cable is equal to the downward force of gravity.
c. the upward force by the cable is smaller than the downward force of gravity.
d. none of the above (the cable does not supply an upward force on the elevator)

14. Constant speed: no acceleration. Therefore sum of forces = 0. Choice B

Problem 15. A sled moving to the right on level ground is slowing down. What direction is the net force on the sled?
a. up
b. left
c. right
d. up and left
e. up and right
f. none of the above (zero net force)

15. Acceleration is to the left because it's slowing down. Therefore the net force must also be to the left. Choice B

Problem 16. The force required to maintain an object at a constant speed in free space is equal to _____
a. the force required to stop the object
b. the mass of the object
c. the momentum of the object
d. the weight of the object
e. zero

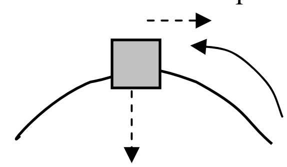
16. Newton's 1st Law. Choice E

Problem 17. How much time is required for a 60 W light bulb to dissipate 10 Joules of electrical energy?
a. 1/36 s
b. 1/12
c. 1/6
d. 1
e. 6

17. P=E/t
t=E/P=10J/60W=1/6 s
Choice C

f. 12
g. 36 s

Problem 18. A car is going around a corner while slowing down, as shown (top view). The net acceleration at the position shown is closest to what direction in the picture? ("up" = "towards the top of the page")



a. down
b. down and left
c. down and right
d. left
e. right
f. up
g. up and left
h. up and right

18. Going in a circle: centripetal acceleration is down. Slowing down: tangential acceleration is to the right. Combine the two, and you have Choice C

Problem 19. What are the units of L (angular momentum)?

a. $kg{\cdot}m^2$
b. $kg{\cdot}m/s$
c. $kg{\cdot}m/s^2$
d. $kg{\cdot}m^2/s$
e. $kg{\cdot}m^2/s^2$
f. m/s
g. m/s^2
h. m^2/s^2

19. $L=I\omega=(kgm^2)(1/s)$ …or… $L=rp=(m)(kgm/s)$. Either way, you get Choice D

Problem 20. A small ferry boat is 4 m wide and 5 m long. When a truck drives onto it, the ferry boat sinks an additional 3 cm into the river. What is the weight of the truck?

a. Less than 5900 N
b. 5900 - 6100
c. 6100 - 6300
d. 6300 - 6500
e. 6500 - 6700
f. 6700 - 6900
g. More than 6900 N

20. Buoyancy force is up; weight is down. They balance. Any additional weight must be exactly compensated for by additional buoyant force.
$\rho Vg=(1000)(4*5*.03)(10)=1000*20*.3=1000*6=6000$ Choice B
Note: if you used g = 9.8 (and did the problem correctly), you would have gotten 5880 as your answer. If you did that, please let me know ASAP.

Problem 21. The salty water in the Great Salt Lake is denser than regular water. Where is the pressure greater, one meter beneath the surface of the Great Salt Lake or one meter beneath the surface of a regular swimming pool?

a. the Great Salt Lake
b. the swimming pool
c. same pressure

21. $P=P_0+\rho gh$. If ρ is greater, P is greater. Choice A

Problem 22. Friction in a fluid is characterized by:

a. Buoyancy

b. Internal energy
c. Pressure
d. Temperature
e. Viscosity

22. Choice E

Problem 23. A "bimetallic strip" with copper on the left side and steel on the right is heated with a propane torch. Which way will the strip curve?

a. To the left
b. To the right
c. Neither; it will stay straight

23. From page 1 of exam, $\alpha_{copper} > \alpha_{steel}$. Copper will expand more, causing it to curve to the right. Choice B

Problem 24. Suppose we have two jars of gas: one of helium and one of neon. If both jars have the same volume, and the two gases are at the same pressure and temperature, which jar contains the greatest number of gas molecules? (The mass of a neon molecule is greater than the mass of a helium molecule.)

a. jar of helium
b. jar of neon
c. same number

24. PV=nRT. Same P, same V, same T→ same n. Choice C

Problem 25. You put one end of a rod in a fire and the other end in a tub of water. Which kind of rod will heat the water the fastest?

a. short and fat
b. long and fat
c. short and thin
d. long and thin

25. $\frac{\Delta Q}{\Delta T} = kA\frac{T_2 - T_1}{L}$ **. Most heat flow happens if A is big and L is small. Choice A**

Problem 26. A 600 kg car accelerates from rest (with constant acceleration) and travels 225 meters in 30 seconds. The forward force on the car during this time is:

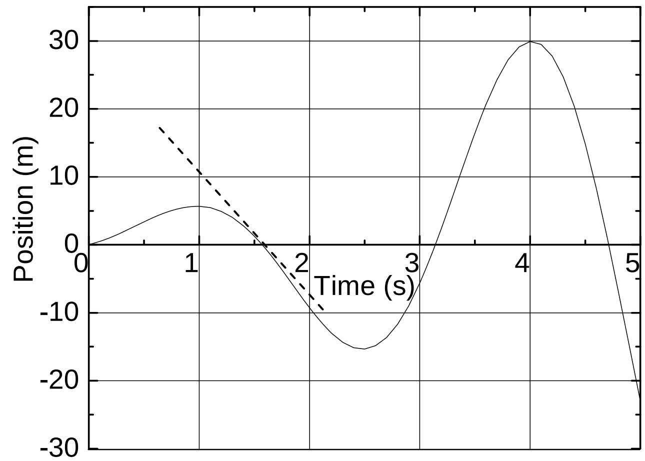
a. less than 150 N
b. 150-250
c. 250-350
d. 350-450
e. 450-550
f. more than 550 N

26. $x=1/2at^2$
$225=1/2a(30)^2$
450/900=a
a= 1/2

F=ma
F=600(1/2)=300 N
Choice C

Problem 27. An object's position vs. time is plotted. What is its instantaneous velocity at 1.5 seconds?

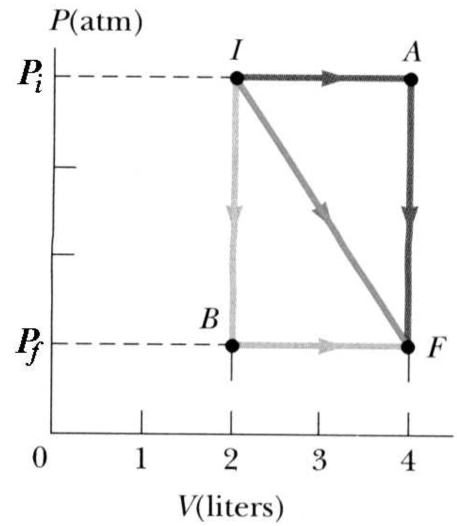
a. 0 m/s
b. –8
c. –17
d. –44
e. –70 m/s



27. instant velocity = slope of tangent line at 1.5 s
Slope = rise/run
…by my dashed line estimate…
Slope = (-7.5-11)/1=-18.5
Choice C

Problem 28. A gas can be taken from state I to state F through three different processes as shown: (a) via state A, (b) via state B, and (c) in a straight line to F. See the given P-V diagram. In which process does the gas do the most amount of work?

a. via A
b. via B
c. straight-line to F
d. same for all three



28. Most work = most area under curve. Choice A

Problem 29. For the same situation: in which process is the change in internal energy, ΔU, the largest?

a. via A
b. via B
c. straight-line to F
d. same for all three

29. They start and end at same points; therefore ΔU is identical for all paths. Choice D

Problem 30. A woman pulls a 12 kg suitcase horizontally to get it moving. Between the suitcase and the floor, $\mu_s = 0.5$ and $\mu_k = 0.25$. To get it to start moving, how much force must the woman use?

a. less than 25 N
b. 25 - 35
c. 35 - 45
d. 45 - 55
e. 55 - 65
f. more than 65 N

30. She must counteract the static friction. f=μN=μmg → (.5)(12)(10)=60 N Choice E

Problem 31. A baseball player, mass *m*, running at speed *v*, slides to stop himself. If the friction coefficient between player and ground is μ, how far does he travel before stopping?

a. $\frac{v}{2mg}$

b. $\frac{vg}{2\mu m}$

c. $\dfrac{vg}{\mu m}$

d. $\dfrac{v^2}{2\mu g}$

e. $\dfrac{v^2}{4\mu g}$

f. $\dfrac{v^2}{\mu g}$

g. $\dfrac{v^2}{2\mu mg}$

31. $E_{bef} + W = E_{aft}$
KE - (friction)d=0
$1/2mv^2=\mu mgd$
$d=1/2\ v^2/\mu g$
Choice D

Problem 32. A heat engine performs 600 J of work in each cycle and has an efficiency of 33%. For each cycle of operation, how much energy is expelled (wasted) as heat?

a. Less than 1250 J
b. 1250 - 1450
c. 1450 - 1650
d. 1650 - 1850
e. 1850 - 2050
f. More than 2050 J

32. $e=W_{net}/Q_h$
$.33=600/Q_h$
$Q_h=600/.33=1800$
$Q_c=Q_n-|W_{net}|$
=1800-600=1200
Choice A

Problem 33. "Lift force" on an airplane wing is generated (in large part) by the air flowing faster above the wing than below it. How will the lift force compare for the same airplane speed when an airplane is at a high elevation, where the density of air is less?

a. It will be less than the lift force at lower elevations
b. It will be more than the lift force at lower elevations
c. It will be the same as the lift force at lower elevations

33. This type of life comes from Bernoulli effect, difference in pressures: $P_1+1/2\rho v^2$+~~ρgh~~=$P_2+1/2\rho v^2$+~~ρgh~~
Therefore $\Delta P=1/2\rho(v_1^2-v_2^2)$. Less ρ → less pressure difference between top and bottom of wing
Choice A

Problem 34. You want to measure the spring constant of a hanging spring. You add a 0.5 kg mass to the spring and let the spring slowly stretch out so that the mass eventually hangs without moving at a distance of 20 cm below where it started. What is the spring constant *k*?

a. less than 10 N/m
b. 10 - 19
c. 19 - 28
d. 28 - 37
e. 37 - 46
f. 46 - 55
g. more than 55 N/m

34. Not moving: forces in equilibrium. mg=kx k=mg/x=(.5*10)/2=5/.2=25 Choice C

Problem 35. You want to measure the spring constant of a second hanging spring a different way. You add a 0.5 kg mass to the spring and release the mass so that it starts oscillating up and down. At the lowest point of the first oscillation, the mass has stretched the spring out to a distance of 33 cm below its initial equilibrium position. What is the spring constant *k*?

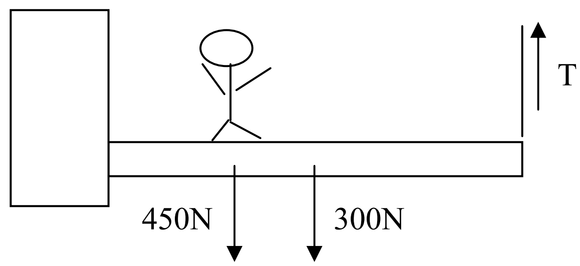
a. less than 10 N/m
b. 10 - 19

c. 19 - 28
d. 28 - 37
e. 37 - 46
f. 46 - 55
g. more than 55 N/m

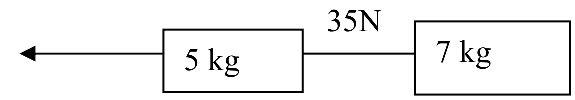
35. Conservation of energy: initial potential of gravity = final potential of spring (not moving at start or at end, so no kinetic).
mgh = 1/2kx^2; h and x refer to same distance so they cancel
mg = 1/2kx
k=2mg/x=2(.5*10)/.33=10/.33=30 Choice D

Problem 36. A man weighing 450 N stands 2 m from the left end of a plank weighing 300 N that is 6 m long. It pivots on its left end, where it is anchored to the wall. On the right it is supported by a cable. What is the tension in the vertical cable at the right end?

a. Less than 275 N
b. 275 - 285
c. 285 - 295
d. 295 - 305
e. 305 - 315
f. More than 315 N



36. sum of torques about left end = 0
2(450)+3(300) - 6T = 0
900+900=6T T=300 Choice D



Problem 37. What is the tension in the rope pulling the 5 kg box to the left if the tension in the rope between the two boxes is 35 N? (There is no friction.)

a. less than 38 N
b. 38 - 43
c. 43 - 48
d. 48 - 53
e. 53 - 58
f. more than 58 N

37. Use Newton 2 on right box, then N2 on both together
ΣF_7=7a → 35=7a → a=5 $\Sigma F_{both}=m_{tot}a$ → T=12*5=60 Choice F

Problem 38. A small block (mass = 0.3 kg) rests on a rotating turntable. The coefficient of static friction between the two objects is 0.1. The block is 0.2 m from the center of the turntable. As the turntable rotates, what is the maximum speed that the block can move along its circular path without slipping off the turntable? _____ m/s

a. $\sqrt{0.1\times0.2\times9.8}$
b. $\sqrt{0.1\times0.3\times9.8}$
c. $\sqrt{0.2\times0.3\times9.8}$
d. $0.1\times0.2\times9.8$
e. $0.1\times0.3\times9.8$
f. $0.2\times0.3\times9.8$

38. Centripetal acceleration is occurring; only inward/outward force is friction.

$\sum F=mv^2/r$ $\mu \cancel{m}g=\cancel{m}v^2/r$ $v=\sqrt{\mu rg}=\sqrt{(.1)(.2)(9.8)}$ Choice A

Problem 39. A 200 kg man stands in the middle of a frozen pond of radius 10 m. He is unable to get to the other side because of lack of friction between his shoes and the ice. To overcome this difficulty, he throws his 2 kg physics textbook horizontally towards the north shore, at a speed of 5 m/s. How long does it take him to reach the south shore?

a. Less than 270 s
b. 270 - 350
c. 350 - 430
d. 430 - 510
e. 510 - 590
f. More than 590 s

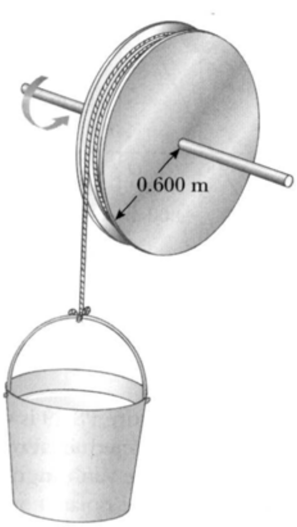
39. momentum is conserved: $p_{bef} = p_{aft}$ $\rightarrow 0 = (mv)_{man} - (mv)_{book} \rightarrow 200v=2v \rightarrow v=.05$ m/s
$v=x/t \rightarrow t=x/v = 10/.05 = 10/(1/20)=200$ s Choice A

Problem 40. You are on Planet Xarthon that has a mass of 2× that of the earth, and a radius 2× as big. If you throw a ball at the surface, you will find that $g_{Xarthon}$ is ___ g_{earth}.

a. 1/8 ×
b. 1/4
c. 1/2
d. the same as
e. 2
f. 4
g. 8 ×

40. force of gravity = GMm/r^2; force of gravity also = mg
$GMm/r^2=mg \rightarrow g = GM/r^2$
$g_x/g_e=GM_xr_x^2/(G(M_e/r_e^2)) = (M_x/M_e) \times (r_e/r_x)^2 = 2(1/2)^2 =1/2$ Choice C

Problem 41. A cylindrical 6 kg reel with a radius of 0.600 m and a frictionless axle, starts from rest and speeds up uniformly as a 5 kg bucket falls into a well, making a light rope unwind from the reel (see figure). The bucket starts from rest and falls for 4 meters. How fast is it going at the end? Use g = 10 m/s^2. ______ m/s

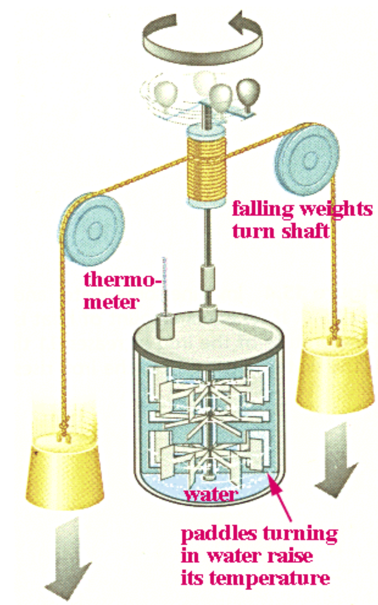


a. $\sqrt{30}$
b. $\sqrt{40}$
c. $\sqrt{50}$
d. $\sqrt{60}$
e. $\sqrt{70}$
f. $\sqrt{80}$
g. $\sqrt{90}$

41. conservation of energy: $m_1gh=1/2m_1v^2+1/2I\omega^2$
Note that $I=1/2m_2R^2$ for cylinder;
Note that $\omega=v^2/R^2$ (and the R^2 cancels with the R^2 from I)
$m_1gh=(1/2m_1+1/4m_2)v^2$
$v=\sqrt{m_1gh/(1/2m_1+1/4m_2)} = \sqrt{(5*10*4)/(.5*5+.25*6)} = \sqrt{200/(2.5+1.5)} = \sqrt{200/4} = \sqrt{50}$ Choice C

Problem 42. Joule's machine is used with 3 kg of water on the inside. The two 5 kg falling weights start 1 m off the ground; when they hit the ground, they are moving at 2 m/s. How much will the temperature of the water increase during the process? The very light paddles have negligible kinetic energy as does the (non-random) swirling motion of the water. Assume the walls of the container are perfectly insulated. Use $g = 10\ m/s^2$. ΔT = ________ ° C

a. 3/(2×4186)
b. 15/(2×4186)
c. 60/(2×4186)
d. 10/(3×4186)
e. 20/(3×4186)
f. 80/(3×4186)
g. 100/(3×4186)



42. Conservation of energy: all unaccounted for kinetic/potential energy goes into heating up the water

$mgh - 1/2mv^2 = Q = m_w c\Delta T$

$(10)(10)(1) - 1/2(10)(2)^2 = 3(4186)\Delta T$

$100 - 20 = 3(4186)\Delta T$

$\Delta T = 80/3(4186)$ Choice F