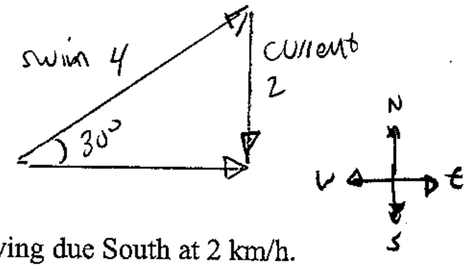
# SOLUTIONS




**Physics 160 Final Exam 10 answer multiple choice, 40 QUESTIONS.**
**Do the "easy" questions first.**
**Then, do the ones that take longer.**
**When you have only a few minutes left, GUESS!**

1. You wish to swim across a river, from the west side to the east side, flowing due South at 2 km/h. You can swim at 4 km/h. What direction should you aim to reach a point directly East of you?
(a) due N (b) 30° E of N (c) NE **(d) 30° N of E** (e) due E

2. A child on a merry-go-round, radius r, circles once every T seconds. What is her average velocity in one rotation?
**(a) 0** (b) r/T (c) 2r/T (d) 2πr/T (e) T/2πr (f) none of these

$v_{avg} = \frac{\Delta x}{\Delta t}$

3. What is her average speed?
(a) 0 (b) r/T (c) 2r/T **(d) 2πr/T** (e) T/2πr (f) none of these

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4. A projectile is launched with speed v at an angle of 60° above the horizontal. What is the speed of the projectile at the peak of its flight? (Ignore air resistance.)
(a) 0 (b) v/4 **(c) v/2** (d) v (e) 2v (f) none of these

$V = V_{x_0} = V\cos 60° = \frac{V}{2}$

5. For this same projectile, what is the peak height?
(a) 0 (b) $\frac{v^2}{4g}$ (c) $\frac{v^2}{2g}$ **(d) $\frac{3v^2}{8g}$** (e) $\frac{3v^2}{g}$ (f) none of these

$\frac{1}{2}mv_i^2 = \frac{1}{2}mv_f^2 + mgh \quad v_f = v_i/2. \quad v_f^2 = v_i^2/4$

$\frac{1}{2}\cdot\frac{3}{4}v_i^2 = gh \quad h = \frac{3v^2}{8g}$

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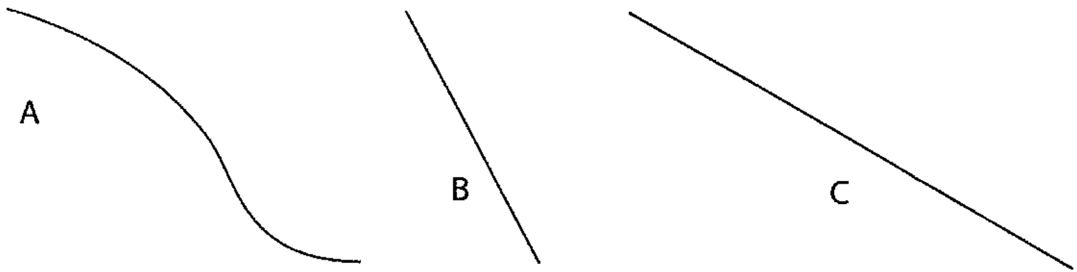
6. A motorcyclists wishes to jump a river. He has a **horizontal** takeoff at speed v, toward the opposite bank, which is a height h lower. How much time does he spend in flight? (Ignore air resistance.)
(a) $\sqrt{2hg}$ (b) $\sqrt{\frac{h}{2g}}$ (c) $\sqrt{\frac{h}{g}}$ **(d) $\sqrt{\frac{2h}{g}}$** (e) $\sqrt{\frac{g}{2h}}$ (f) more information is required

$\frac{1}{2}gt^2 = h \quad t = \sqrt{\frac{2h}{g}}$

7. What minimum takeoff speed does he need to cross the river, of width w?
(a) $\sqrt{\frac{hg}{w}}$ (b) $\sqrt{\frac{w^2h}{2g}}$ (c) $\sqrt{\frac{w^2g}{h}}$ **(d) $\sqrt{\frac{w^2g}{2h}}$** (e) $\sqrt{\frac{w^2h}{g}}$ (f) none of these

$w = vt \quad v = \frac{w}{t} = w\sqrt{\frac{g}{2h}}$

8. Blocks are allowed to slide down 3 different ramps, having the same total height. In the absence of friction, which block is moving fastest at the bottom? (The blocks never leave the ramps.)
(a) A (b)B (c) C (d) all move at the same speed (e) more information is needed

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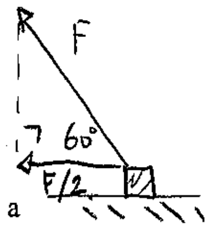
9. A constant pulling force F is applied to an initially stationary block of mass m sitting on a frictionless surface. The force is applied upward, at an angle of 60° above horizontal. What is the speed of the block if the force is applied for a time t? $F_x t = \Delta p = mv, \quad F_x = F/2.$




a) $\frac{F}{m}$ (b) $\frac{F \cdot t}{m}$ (c) $\frac{F \cdot t}{2m}$ (d) $\frac{m}{F \cdot t}$ (e) $\sqrt{\frac{F \cdot t}{2m}}$ (f) none of these

10. How fast is the block moving if (instead) the force is applied while the block moves through a distance x? $F_x \cdot x = \frac{1}{2} mv^2$

a) $\frac{F \cdot x}{m}$ (b) $\sqrt{\frac{F \cdot x}{m}}$ (c) $\sqrt{\frac{F \cdot x}{2m}}$ (d) $\sqrt{\frac{2F \cdot x}{m}}$ (e) $\sqrt{\frac{2m}{F \cdot x}}$ (f) none of these

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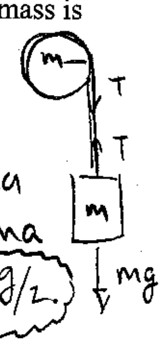
11. A mass m hangs by a massless rope, which is wrapped around a massless, hollow cylinder pulley of radius r. If the mass is dropped, what is the tension in the rope?

a) 0 (b) $\frac{mg}{2}$ (c) $mg$ (d) $2mg$ (e) $\sqrt{\frac{mg}{2}}$ (f) none of these

12. If the hollow cylindrical pulley also has mass m, what is the tension in the rope after the mass is dropped? $Tr = mr^2 \cdot \frac{a}{r} \Leftrightarrow \tau = I\alpha \quad \Rightarrow \quad T = ma$




a) 0 (b) $\frac{mg}{2}$ (c) $mg$ (d) $2mg$ (e) $\sqrt{\frac{mg}{2}}$ (f) none of these

$mg - T = ma$

$mg - ma = ma$

13. In problem 12, what is the magnitude of the angular acceleration of the pulley?

$a = g/2$

a) 0 (b) $\sqrt{\frac{mg}{2}}$ (c) $\frac{g}{r}$ (d) $\frac{g}{2r}$ (e) $\sqrt{\frac{2g}{r}}$ (f) none of these

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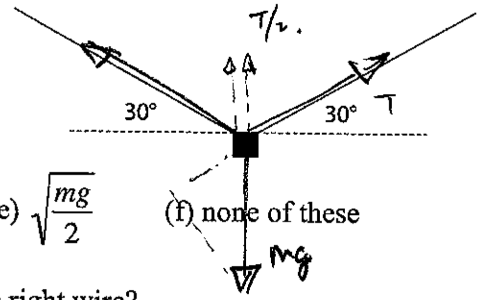
$\alpha = \frac{a}{r} = \frac{g}{2r}.$

14. A block of mass m hangs from two wires as shown, each 30° above horizontal. What is the tension in each wire?




$2 \cdot \frac{T}{2} = mg$

a) 0 (b) $\frac{mg}{2}$ (c) $mg$ (d) $2mg$ (e) $\sqrt{\frac{mg}{2}}$ (f) none of these

15. The left wire suddenly breaks. What is the tension in the right wire?

must give no net radial force since $mv^2/r = 0$.

a) 0 (b) $\frac{mg}{2}$ (c) $mg$ (d) $2mg$ (e) $\sqrt{\frac{mg}{2}}$ (f) none of these

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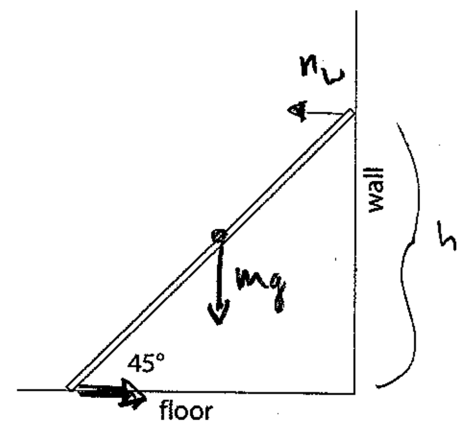
16. A ladder of mass m leans against a wall at a 45° angle. In order for the ladder to remain stable:




a) there must be friction with the floor
b) there must be friction with the wall
c) there must be friction with BOTH the floor and the wall
d) there is no need for friction at all

17. Assume there is friction with the floor, but *not* with the wall. What is the direction of the frictional force the floor exerts on the ladder?

a) left (b) right (c) upward (d) downward

18. Assume the mass of the ladder is uniformly distributed, and that the static friction coefficient is more than sufficient to keep the ladder from slipping. What is the magnitude of the frictional force in #17 (choose any correct answer.)

$n_w \cdot h = mg \cdot \frac{h}{2}$ Balance torques! $n_w = mg/2$.

a) $\mu_s mg$ (b) $\frac{mg}{2}$ (c) $mg$ (d) $2mg$ (e) $4mg$ (f) ∞

↑ No! $f \leq \mu_s mg$.

19. Now take $\mu_s = 0.5$. Assuming the ladder does not break, how heavy could a person be who could stand on the middle rung of the ladder (half way up) without causing the ladder to slip?

a) 0 (b) $\frac{mg}{2}$ (c) $mg$ (d) $2mg$ (e) $4mg$ (f) ∞

20. With $\mu_s = 0.5$, and assuming the ladder does not break, how heavy could a person be who could stand on the top rung of the ladder (at the very top) without causing the ladder to slip?

a) 0 (b) $\frac{mg}{2}$ (c) $mg$ (d) $2mg$ (e) $4mg$ (f) ∞

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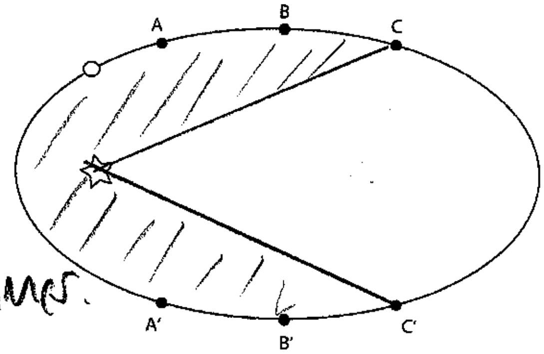
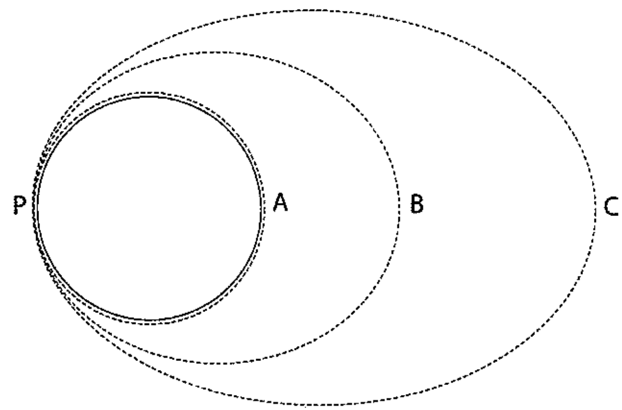
Part II.

21. A planet around a star is in an elliptical orbit with a period of one year, right. How much of the orbit would be covered in a half a year?




(a) A to A'
(b) B to B'
(c) C to C'  EQUAL AREAS IN EQUAL TIMES.

22. Consider several satellite orbits which approach very close to the surface of a planet (which has no atmosphere.) For which orbit is the speed of the satellite fastest at point P?




(a) orbit A (circular orbit)
(b) orbit B
(c) orbit C
(d) All would have the same speed at P

23. If the planet has mass M and the radius of the circular orbit is r (which is essentially the radius of the planet itself), what is the speed of a satellite in a circular orbit, at point P?

a) $\sqrt{\frac{GM}{2r}}$  (b) $\sqrt{\frac{GM}{r}}$  (c) $\sqrt{\frac{2GM}{r}}$  (d) $\sqrt{GMr}$  (e) $\sqrt{2GMr}$

24. Suppose a satellite in orbit C above has a maximum height of 3r *above the surface* of the planet, and a minimum height that is just barely above the surface. What is the ratio of the speed at the highest point to the speed at the lowest point? EQUAL areas in equal times

a) 1/5  (b) 1/4  (c) 1/3  (d) 1/2  (f) 1  (g) 0

$\frac{1}{2}mv_p^2 - \frac{GMm}{r} = \frac{1}{2}mv_c^2 - \frac{GMm}{4r}$

$v_p = 4v_c$

25. Use energy conservation to find the speed of the satellite in orbit C when it is at P.

a) $\sqrt{\frac{GM}{2r}}$  (b) $\sqrt{\frac{GM}{r}}$  (c) $\sqrt{\frac{8GM}{5r}}$  (d) $\sqrt{\frac{4GM}{3r}}$  (e) $\sqrt{\frac{4GM}{r}}$  (f) $\sqrt{\frac{16GM}{3r}}$

$\frac{1}{2}\frac{15}{16}v_p^2 = \frac{3GM}{4r}$

26. Does gravitational force from the earth (your weight) go up or down as you go down in a deep mine? Assume a uniform density for the earth.
a) it goes up (you are heavier down closer to the center of the earth)
b) it goes down (you are lighter closer to the center of the earth)  No gravity in spherical shell!
c) it is unchanged

27. A 100 kg cart has a 100 kg sandbag in it. It is attached to a spring and moves back and forth in SHM. At the middle point of its motion, the sandbag falls out. The amplitude of the motion
a) increases
b) decreases   energy lost
c) remains the same

28. By what factor does the amplitude change?   $U = \frac{1}{2}kx^2$.
a) smaller by ½   b) smaller by $1/\sqrt{2}$   c) no change   d) larger by $\sqrt{2}$   e) larger by 2

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29. A uniform rod is suspended at one end. What is the angular frequency of oscillation, ω, if it is deflected a small amount?

a) $\sqrt{\frac{L}{g}}$   (b) $\sqrt{\frac{2L}{g}}$   (c) $\sqrt{\frac{3L}{g}}$   (d) $\sqrt{\frac{g}{L}}$   (e) $\sqrt{\frac{2g}{L}}$   (f) $\sqrt{\frac{3g}{2L}}$   $\omega = \sqrt{\frac{mgd}{I}} = \sqrt{\frac{mg\,L/2}{\frac{1}{3}mL^2}}$

30. The rod is set into oscillation by being struck with a bit of putty at its middle, which sticks to it. Is the **period** of oscillation (a) longer (b) shorter (c) the same as the bare rod?

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31. Arctic sea ice **floats** on the artic ocean. Assuming that the artic ocean is 1/20th of the worlds ocean area, and that the sea ice is on average 20 m thick, by how much would mean sea level rise if all the artic sea ice melted?
(a) 0   (b) 1 cm   (c) 10 cm   (d) 1 m   (e) 10 m

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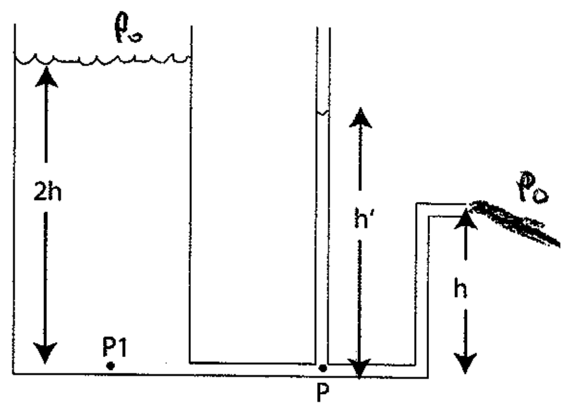
In the water tank and spigot system shown, the middle tube and the tank at the left are open at the top. Water is spurting out the spigot at the right.




32. What is the total pressure at point P1? Take the density of water to be ρ and atmospheric pressure to be $P_0$. *Pay attention to what h is!*
(a) $P_0$
(b) $P_0 + \rho gh$
(c) $P_0 + 2\rho gh$
(d) $P_0 - 2\rho gh$
(e) 0

$P_0 + \rho gh + \frac{1}{2}\rho v^2 = \text{const.}$

33. What is the speed of the water coming out the nozzle?
(a) $\sqrt{gh}$   (b) $\sqrt{2gh}$   (c) $2\sqrt{gh}$   (d) $\sqrt{\frac{g}{2h}}$   (e) $\sqrt{\frac{g}{2}}$

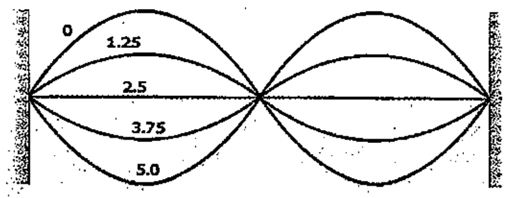
34. What is the pressure at point P?
(a) $P_0$   (b) $P_0 + \rho gh$   (c) $P_0 + 2\rho gh$   (d) $P_0 - 2\rho gh$   (e) 0

$P_1 = P + \frac{1}{2}\rho v^2 \quad v^2 = 2gh$ (from 33)

$P_1 = P + \rho gh = P_0 + 2\rho gh \quad P = P_0 + \rho gh.$

35. What is the height h' of the fluid column in the center? (Note: the cartoon may *not be correct!*)
(a) h' > 2h
(b) h' = 2h
(c) 2h> h' > h
(d) h'=h
(e) h' < h
(f) cannot be determined.

36. A standing wave on a 1 m wire is shown at five successive timepoints. The time shown is in milliseconds (ms.) Maximum displacement occurred at 0 ms and 5 ms, with no maxima in between.




What harmonic is the string vibrating in?

a) $1^{st}$ (fundamental) (b) $2^{nd}$ (c) $3^{rd}$ (d) $4^{th}$ (e) cannot determine

37. What is the period?
a) 1.25 ms (b) 2.5 ms (c) 5 ms (d) 10 ms (e) 20 ms

38. What is the wavelength?
a) 0.25 m (b) 0.5 m (c) 1 m (d) 2 m (e) 4 m

39. What is the total mass of the wire, if the tension is 100 N?
a) 0.0002 kg (b) 0.01 kg (c) 0.3 kg (d) 0.6 kg (e) 1 kg (f) 11 kg

40. If a light bulb gives light of intensity 4 $W/m^2$ at a distance of 1 m, what is the intensity at a distance of 2 m (in $W/m^2$) ?
a) ¼ (b) ½ (c) 1 (d) 2 (e) 4

*Merry Christmas, Happy Hanukkah!*