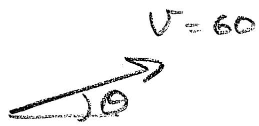
# PH405 Exam Review #1

## Multiple Choice Questions

1. D




**x**

$v_i = 60\cos 30$

$d_x = ?$

$t =$

$d = v_i t$

$= (60 \cos 30)6.12$

$d = 318$

**y**

$v_i = 60 \sin 30$

$d_y = 0$

$a = -9.8$

$t =$

$d = v_i t + \frac{1}{2} a t^2$

$-v_i t = \frac{1}{2} a t^2$

$t = \frac{-2v_i}{a} = \frac{-2(60 \sin 30)}{-9.8}$

$t = 6.12$

2. C

**x**

$v_i = 10$

$d = ?$

$t =$

$d = v_i t$

$= 10(2)$

$= 20$

**y**

$v_i = 0$

$d = -20$

$a = -9.8$

$t = ?$

$d = \cancel{v_i t} + \frac{1}{2} a t^2$

$t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2(-20)}{-9.8}} = 2$

3. C

vertical velocity is zero
therefore, the velocity is only the horizontal component

$v = 20 \cos 30 = 17$

4. A

acceleration due to gravity is ALWAYS 9.8 $m/s^2$ down.

5. C

the telescope is moving with a horizontal velocity and is accelerating downwards with gravity.

6. C

$\rightarrow a +$

$M_A g \leftarrow \boxed{A+B} \rightarrow M_B g$

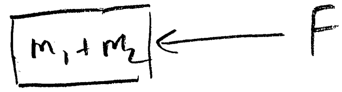
$\Sigma F = ma$

$-m_A g + m_B g = (m_A + m_B) a$

$$a = \frac{(-m_A + m_B)\, g}{m_A + m_B}$$

$$= \frac{(-.4 + .6)}{(.4 + .6)} 9.8 = 1.96 \, m/s^2$$

7. C




$\Sigma F = ma$

$F = (m_1 + m_2) a$

$a = \frac{F}{m_1 + m_2}$ $\quad m_1 = m$, $m_2 = 2m$

$= \frac{F}{m + 2m}$

$a = \frac{F}{3m}$

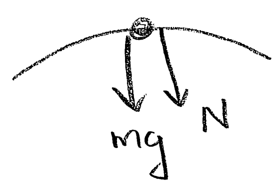
8. B

9. A

$F_c = \frac{mv^2}{r}$

$= \frac{1000(25)^2}{50} = 12500$

10. B




$mg + N = \frac{mv^2}{r}$

$N = 0$

$mg = \frac{mv^2}{r}$

$v = \sqrt{gr}$

11. D

$$F = G\frac{m_1 m_2}{r^2} \qquad m_1 = m_2$$

$$m = \sqrt{\frac{r^2 F}{G}} = \sqrt{\frac{(.5)^2 (6.67\times10^{-7})}{(6.67\times10^{-11})}}$$

$$m = 50\,kg$$

12. A

$$F = G\frac{m_1 m_2}{r^2} = \frac{6.67\times10^{-11}(5.98\times10^{24})(1500)}{(6.38\times10^{6} + 3000)^2}$$

$$= \frac{5.98\times10^{17}}{4.07\times10^{13}}$$

$$= 1.48\times10^{5}$$

13. A

$$\frac{G m_1 m_2}{r^2} = \frac{m v^2}{r} \qquad v = \frac{2\pi r}{T}$$

$$\frac{G m_2}{r} = \frac{4\pi^2 r^2}{T^2}$$

$$T = \sqrt{\frac{4\pi^2 r^3}{G m}} = \sqrt{\frac{4\pi^2 (6.38\times10^{6})^3}{6.67\times10^{-11}(5.98\times10^{24})}}$$

$$T = 5069.8\ s$$

14. B

$$W = Fd\cos\theta$$

$$= 50(10)\cos 35^\circ = 409.576$$

15. D

Word is the area under the curve.

$$\text{trapezoid} = \frac{1}{2}h(b_1 + b_2)$$

$$= \frac{1}{2}(30)(3 + 5) = 120$$

$$\text{trapezoid} = \frac{1}{2}h(b_1 + b_2)$$

$$= \frac{1}{2}(-10)(5 + 1) = -30$$

$$\text{total area} = 120 - 30 = 90\text{ J}$$

16. B

$$W = Fd \qquad F = ma \qquad v_f^2 = v_i^2 + 2ad$$

$$W = (-31250)(10) \qquad F = 1000(31.25) \qquad a = \frac{-v_i^2}{2d}$$

$$-3.13\times10^5\text{ J} \qquad = 31250\text{ N} \qquad = \frac{-(25)^2}{2(10)}$$

$$a = -31.25$$

17. A

$$K = U$$

$$\frac{1}{2}mv^2 = \frac{1}{2}kx^2 \qquad F = kx$$

$$k = \frac{F}{x} = \frac{20}{.05} = 400\text{ N/m}$$

$$v = \sqrt{\frac{kx^2}{m}}$$

$$= \sqrt{\frac{400(.05)^2}{10\times10^{-3}}} = 10$$

18. B

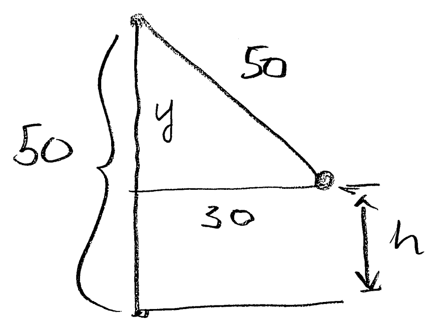
$$U = \frac{1}{2}kx^2$$
$$= \frac{1}{2}(60)(.1)^2 = 0.3$$

19. C

$$U = K$$
$$mgh = \frac{1}{2}mv^2$$
$$h = \frac{v^2}{2g} = \frac{(9.8)^2}{2(9.8)} = 4.9$$

20. D

$$mgh = \frac{1}{2}mv^2$$
$$v = \sqrt{2gh}$$
$$= \sqrt{2(9.8)(.1)}$$
$$v = 1.4 \text{ m/s}$$




$$50^2 = 30^2 + y^2$$
$$y = 40 \text{ cm}$$
$$h = 10$$

21. C

$$K - W = 0$$
$$\frac{1}{2}mv^2 = Fd$$
$$F = \frac{mv^2}{2d} = \frac{(20\times10^{-3})(60)^2}{2(.2)} = 180$$

22. B $U_i + \cancel{K_i} - W_f = K_f + \cancel{U_f}$

$$mgh - W_f = \frac{1}{2}mv^2$$

$$v = \sqrt{\frac{2(mgh - W_f)}{m}} = \sqrt{\frac{2(60(9.8)50 - 6.0\times10^3)}{60}}$$

$v = 27.9$

23. C $P = \frac{W}{t} = \frac{Fd}{t} = Fv = 10(5) = 50$

24. C $F = k\frac{q_1 q_2}{r^2} = \frac{(9\times10^9)(2\times10^{-6})(4\times10^{-6})}{(.015)^2}$

$= 320N$

25. D $E = \frac{\Delta V}{d} = \frac{10 - -5}{.1} = 150\ V/m$

26. D $R_1 = \rho\frac{L}{A}$

$$R_2 = \rho\frac{(2L)}{(.5A)} = 4\rho\frac{L}{A} = 4R_1$$

27. B Voltmeter in parallel B, C

Ammeter in series. B

28. B

$R_2$ + $R_4$ are in series therefore

$I_2 = I_4$

The equivalence of $R_2$ and $R_4$ = $40\Omega$ $(R_{2,4})$

Therefore the Voltage across $R_{2,4}$ is

$V = IR = .05(40) = 2V$

$V_3$ is parallel with $R_{2,4}$ and therefore has a voltage drop of 2V

29. B

The voltage drop across $R_1$ + $R_3$ must be the voltage across the battery.

The current in $R_3 = \frac{V}{R_3} = \frac{2}{20} = 0.1\,A$

the current through $R_1$ splits into $R_3$ and $R_2$

therefore, $I_1 = I_2 + I_3 = .05 + .1 = .15A$

The voltage drop across $R_1$ is then

$V = IR = .15(20) = 3\,V$

so the voltage across the battery is $3 + 2 = 5V$

30. A

$\phi = BA\cos\theta$

$= (1.5\times10^{-5})(\pi(.2)^2)\cos 35$

$= 1.5\times10^{-6}\ Wb$

31. D definition of Lenz's law

32. D

$$\mathcal{E} = -N\frac{\Delta\phi}{\Delta t} = \frac{-N \Delta B A \cancel{\cos\theta}}{\Delta t}$$

$$= \frac{-200(0-.5)(.18)^2}{8}$$

$$= 0.405\ V$$

33. C definition of a transformer.

34. C

$$\frac{I_s}{I_p} = \frac{N_p}{N_s}$$

$$\frac{14}{2} = \frac{100}{N_s} \qquad N_s = \frac{2(100)}{14} = 14.28$$

$$= 14$$

35. A

$$\frac{V_p}{V_s} = \frac{N_p}{N_s}$$

$$\frac{120}{6} = \frac{5000}{N_s} \qquad N_s = \frac{6(5000)}{120} = 250$$

## Sample Free Response Questions

1. An arrow is fired horizontally at the center of a target 20 m away. The arrow leaves the bow with a speed of 30 m/s.

   (a) Calculate the length of time for the arrow to reach the target.

   x

   $v_i = 30$

   $d = 20$

   $t = ?$

   $d = v_i t$

   $t = \frac{d}{v_i} = \frac{20}{30} = \underline{0.67 s}$

   (b) Calculate the displacement of the arrow from the center of the target.

   y

   $v_i = 0$

   $a = -9.8$

   $d = ?$

   $t = 0.67$

   $d = \cancel{v_i t} + \frac{1}{2}at^2$

   $d = \frac{1}{2}(-9.8)(0.67)^2$

   $d = \underline{-2.2 m}$

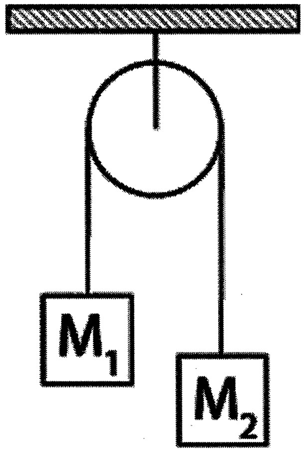
   or

   $\underline{2.2 m \text{ down}}$

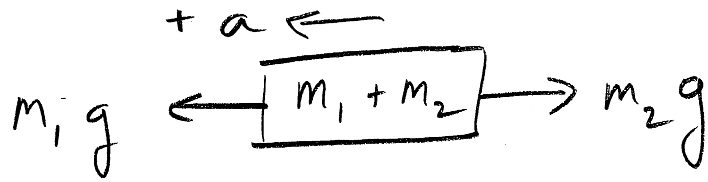
   (c) Explain what you would do so that you hit the center of the target.

   Since the arrow falls 2.2 m, you must aim the arrow at a point 2.2 m above the center of the target.

2. Two masses are attached across a frictionless pulley as shown.



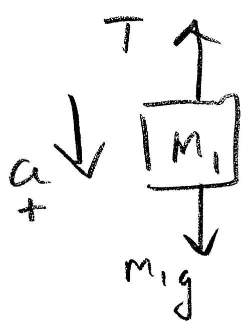

$M_1$ is 10 kg and $M_2$ is 5 kg. Calculate the tension in the rope.




$$m_1 g - m_2 g = (m_1 + m_2) a$$

$$a = \frac{(m_1 - m_2) g}{m_1 + m_2} = \frac{(10 - 5)\, 9.8}{10 + 5} = 3.27\ m/s^2$$

$\left(3.33 \text{ for } g = 10\right)$




$$m_1 g - T = m_1 a$$

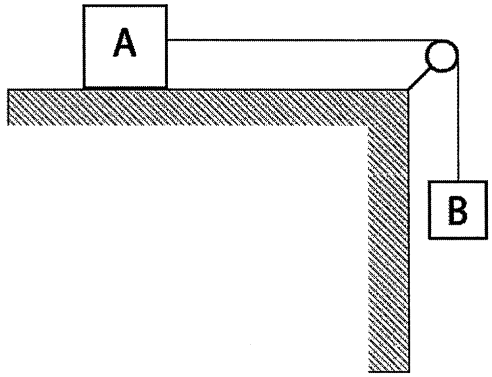
$$T = m_1 g - m_1 a$$

$$= 10(9.8) - 10(3.27)$$

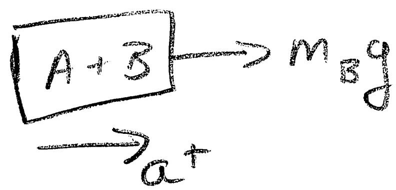
$$T = 65.3 = \underline{65 N}$$

$\left(67 \text{ for } g = 10\right)$

3. Blocks A and B are connected by a string over a frictionless pulley as shown.

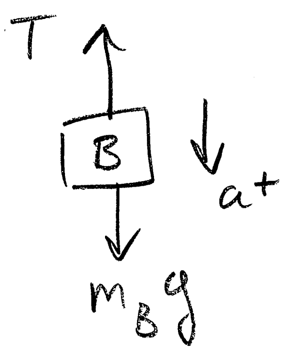



Block A has a mass of 15 kg and is on a frictionless table. Block B has a mass of 5 kg. Calculate the tension in the string joining the blocks.




$$m_B g = (m_A + m_B) a$$

$$a = \frac{m_B g}{m_A + m_B} = \frac{5(9.8)}{15 + 5} = 2.45 \text{ m/s} \quad (2.5 \text{ for } g = 10)$$




$$m_B g - T = m_B a$$

$$T = m_B g - m_B a$$

$$= 5(9.8) - 5(2.45)$$

$$T = 36.75 = \underline{37\text{ N}}$$

$$(38\text{ N for } g = 10)$$

4. A 0.1 kg ball attached to a string of negligible mass is rotated horizontally in a circle with a radius of 0.5 m. The ball revolves 10 times in 5 seconds.

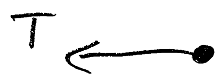
(a) Calculate the centripetal force on the ball.

$F = \frac{mv^2}{r}$ $\quad v = \frac{2\pi r}{T}$ $\quad T = \frac{5}{10} = .5\,s$

$= \frac{m 4\pi^2 r^{\not 2}}{\not r\, T^2} = \frac{.1(4)\pi^2(.5)}{(.5)^2}$

$= 7.896 = \underline{8\,N}$

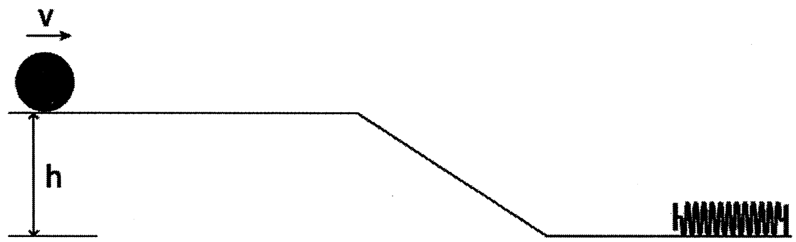
(b) Calculate the force of tension in the string.




The only force acting on the ball is the force of tension. Therefore,

$\underline{T = 8\,N.}$

5. A ball rolls down a ramp and compresses a spring as shown.




The ball has an initial velocity of 10 m/s and the height, h, is 0.5 m.

(a) Calculate the velocity of the ball at the bottom of the ramp (before it reaches the spring).

$K_i + U_i = K_f$

$\frac{1}{2} m v_i^2 + mgh = \frac{1}{2} m v_f^2$

$v_f = \sqrt{2\left(\frac{1}{2} v_i^2 + gh\right)}$

$v_f = \sqrt{2\left(\frac{1}{2}(10)^2 + 9.8(.5)\right)}$

$v_f = 10.5 \text{ m/s} = \underline{10 \text{ m/s}}$ (10 m/s for $g = 10$)

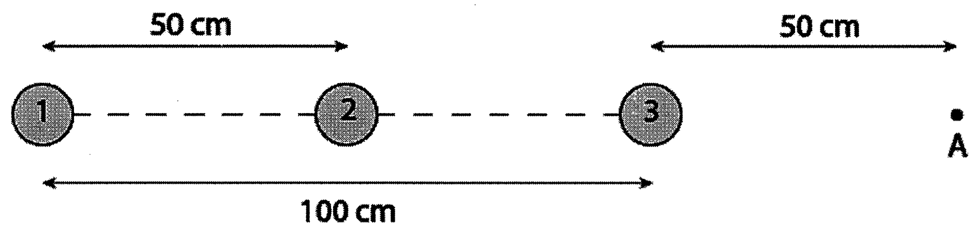
(b) The ball continues along the flat surface and compresses the spring (k = 200 N/m) 20 cm from its equilibrium position. Calculate the mass of the ball.

$\frac{1}{2} m v_f^2 = \frac{1}{2} k x^2$

$m = \frac{kx^2}{v_f^2} = \frac{200(.2)^2}{(10.5)^2}$

$m = \underline{0.07 \text{ kg}}$

6. Three charges are placed in a line.




$q_1 = 10.0$ nC
$q_2 = -5.0$ nC
$q_3 = 5.0$ nC

$$F = \frac{kq_1q_2}{r^2}$$

(a) Calculate the net electrostatic force on charge $q_3$.

$$F_{13} = \frac{9\times10^9(10\times10^{-9})(5\times10^{-9})}{(1)^2} = 4.5\times10^{-7} \text{ right}$$

$$F_{23} = \frac{9\times10^9(5\times10^{-9})(5\times10^{-9})}{(.5)^2} = 9\times10^{-7} \text{ left}$$

$$F_{net} = 4.5\times10^{-7} - 9\times10^{-7} = -4.5\times10^{-7}\text{ N}$$

or

$4.5\times10^{-7}$ N left

(b) Calculate the net electric potential at point A. $V = \frac{kq}{r}$

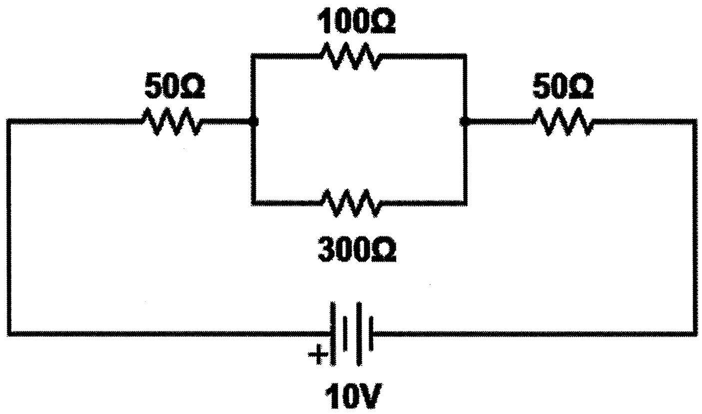
$$V_1 = \frac{9\times10^9(10\times10^{-9})}{(1.5)} = 60\text{V}$$

$$V_2 = \frac{9\times10^9(-5\times10^{-9})}{(1)} = -45\text{V}$$

$$V_3 = \frac{9\times10^9(5\times10^{-9})}{(.5)} = 90\text{V}$$

$V_{net} = 60-45+90$
$= 105$ V

7. Consider the following circuit.




(a) Calculate the equivalent resistance of the circuit.

100 is in parallel with 300 $\frac{1}{R_{eq}} = \frac{1}{100} + \frac{1}{300}$ $R_{eq} = 75\Omega$

50, 50, 75 in series. $R_{eq} = 50 + 50 + 75 = \underline{175\Omega}$

(b) Calculate the voltage drop across the 100 Ω resistor.

$I = \frac{V}{R} = \frac{10}{175} = 0.057\text{ A} = I_{75}$

$V_{75} = IR = 0.057(75) = 4.3\text{V}$

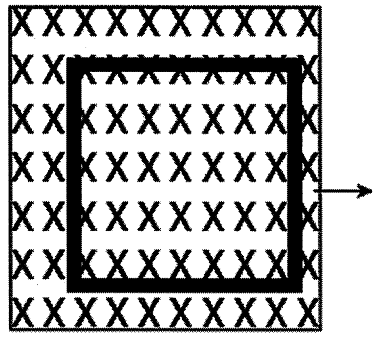
Since 100 + 300 are in parallel.

$V_{100\Omega} = \underline{4.3\text{V}}$

(c) Calculate the current flowing through the 100 Ω resistor.

$I = \frac{V}{R} = \frac{4.3}{100} = \underline{0.043\text{ A}}$

8. A square coil of 100 loops is positioned perpendicular to a magnetic field of 0.5 T going into the page. The length of one side of the coil is 10 cm.



The loop is quickly and uniformly pulled from the field (moving perpendicular to the magnetic field) to a region where the magnetic field drops abruptly to zero. It takes 1.0 s for the whole coil to reach the field-free region. Calculate the induced EMF.

$$\mathcal{E} = -\frac{N\Delta\phi}{\Delta t} \qquad \phi = BA\cos\theta$$

$$= -\frac{N\Delta B A}{\Delta t} = \frac{-100(0-.5)(.1)^2}{1}$$

$$= 0.5\ V$$

9. 10 MW of power must be transmitted from a substation to a subdivision 10 km away.

(a) Explain why the power company will transmit the power at a high voltage.

The power loss is less at high voltages.

(b) The power is transmitted at a voltage of 33 kV. The total resistance of the power lines is 0.12Ω. Calculate the power loss.

$P = IV$

$I = \frac{P}{V} = \frac{10 \times 10^6}{33 \times 10^3} = 303\ A$

$P_{loss} = I^2R$

$= 11019 = \underline{11\ kW}$