

Each Question is worth up to 2 points

1. What value of A satisfies the expression $A^{-6/8} = 0.001$?

Answer is: **10,000**

Q1, pg. 5-10; A1, pg 5-14

2. If the \log_{10} of 4 is $0.703x$, what is the \log_{10} of $1/4$?

Answer is: **-0.703x**

Q11, pg. 5-11; A11, pg 5-15

3. Two students are working independently on a problem. Their respective probabilities of solving the problem are $1/3$ and $3/4$. What is the probability that at least one of them will solve the problem?

Answer is: **5/6**

Q2, pg. 6-7; A2, pg 6-10

4. A cat has a litter of seven kittens. If the probability is 0.52 that a kitten will be female, what is the probability that exactly two of the seven will be male?

Answer is: **0.184**

Q5, pg. 6-7; A5, pg6-10

Rounding off to 0.18 is acceptable for one point.

5. Evaluate dy/dx for the following expression.

$$y = e^{-x} \sin(2x)$$

Answer is: **$e^{-x}(2 \cos(2x) - \sin(2x))$**

Q4, pg. 7-7; A4, pg7-11

6. Find dy/dx for the parametric equations given.

$$x = 2t^2 - t$$

$$y = t^3 - 2t + 1$$

Answer is: $\frac{dy}{dx} = \frac{3t^2 - 2}{4t - 1}$

Q25, pg. 7-10; A25, pg7-14

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7. Solve the following differential equation.

$$y'' + 4y' + 4y = 0$$

$$y(0) = 1$$

$$y'(0) = 0$$

Answer is: $y = (1 + 2x)e^{-2x}$

Q1, pg. 8-7; A1, pg8-9

8. What is the Laplace transform of $\sin t \cos t$?

Answer is:

$$\frac{1}{s^2 + 4}$$

Q6, pg. 8-7; A6, pg8-11

9. What is the complete solution to the following differential equation?

$$y' + 8y = 16$$

$$y(0) = 5$$

Answer is: $y(x) = 3e^{-8x} + 2$

Q18, pg. 8-9; A18, pg8-14

10. Find the general solution of the following differential equation.

$$(x^2 + 9) \left(\frac{dy}{dx} \right) = xy$$

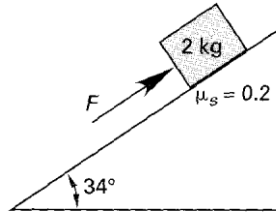
Answer is: $y = C\sqrt{x^2 + 9}$

Q20, pg. 8-9; A20, pg8-14

$y = 0$ is also an acceptable answer for full credit

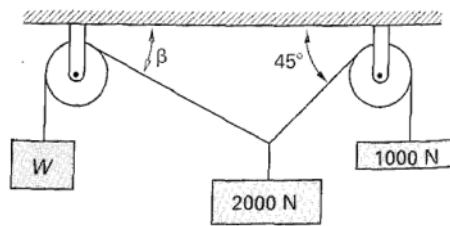
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11. A 2 kg block rests on a 34° incline. If the coefficient of static friction is 0.2, how much additional force, F , must be applied to keep the block from



Answer is: **7.7N** Q5, pg. 12-7; A5, pg 12-10
 Give or take up to .1 is also acceptable for 1 point

12. The system shown is in static equilibrium. Find W .



Answer is: **1472N** Q1, pg. 12-6; A1, pg 12-9

13. The velocity (in m/s) of a falling ball is described by the equation $v = 32 + t + 6t^2$. What is the acceleration at time $t = 2$ s?

Answer is: **25 m/s²** Q1, pg. DE-V1; A1, pg DE-V3

14. A child keeps a 1kg toy airplane flying horizontally in a circle by holding onto a 1.5 m long string attached to its wing tip. The string is always in the plane of the circular flight path. If the plane flies at 10 m/s, what is the tension in the string?

Answer is: **66.7N** Q11, pg. 15-7; A11, pg 15-10
 Give or take up to .1 is also acceptable for 1 point

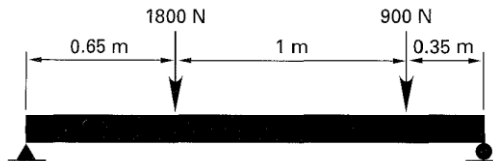
15. A car travels around an unbanked 50 m radius curve without skidding. The coefficient of friction between the tires and road is 0.3. What is the car's maximum speed?

Answer is: **43.67 km/h** Q4, pg. 16-6; A4, pg 16-9
 Give or take up to .1 is also acceptable for 1 point

16. A hockey puck traveling at 30 km/h hits a massive wall at an angle of 30° from the wall. What are its final velocity and deflection angle if the coefficient of restitution is 0.63?

Answer is: **19.99°** Q5, pg. 17-6; A5, pg 17-8
 Give or take up to .1 is also acceptable for 1 point

17. Referring to the simply supported beam shown below, what is the maximum bending moment?



Answer is: **892 N·m** Q3, pg. 20-7; A3, pg 20-9

18. The length, l , of a column divided by r is one of the terms in the equation for the buckling of a column subjected to compression loads. What does r stand for in the l/r ratio?

Answer is: **least radius of gyration** Q1, pg. 21-3; A1, pg 21-5

19. What is the mass of 0.01 gram-moles of Na_2SO_4 ?

Answer is: **1.421 g** Q4, pg. DE-XI-1; A4, pg DE-XI-3
 Give or take up to .01 is also acceptable for 1 point



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MESA OLYMPICS
LEVEL 3 KEY
APRIL 17, 2010

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Name 3 _____
Name 4 _____

20. How much water must be added to 100 mL of a 0.75 molar solution of KCl to make a 0.04 molar solution?

Answer is: **1.775 L** Q12, pg. DE-XI-2; A12, pg DE-XI-5
Give or take up to .01 is also acceptable for 1 point

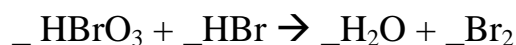
21. Vitamin C has the molecular formula of $C_6H_8O_6$. How many gram-moles are in 23 g of vitamin C?

Answer is: **0.13 mol** Q5, pg. 33-9; A5, pg 33-12

22. The half-life of radioactive carbon is approximately 5700 years. If a sample is found to 7000 atoms after 6000 years, how many atoms were present initially?

Answer is: **$N_0 = 14518$ atoms** Q15, pg. 33-10; A15, pg 33-13

23. Balance the following reaction.



Answer is: **$\text{HBrO}_3 + 5\text{HBr} \rightarrow 3\text{H}_2\text{O} + 3\text{Br}_2$** Q1, pg. 34-7; A1, pg 34-9

24. A solution is adjusted from pH 8 to pH 9. The relative concentration of the hydrogen $[\text{H}^+]$ ion has changed by a factor of what?

Answer is: **$\frac{1}{10}$ or $\frac{10^{-9}}{10^{-8}}$** Q4, pg. 34-8; A4, pg 34-10

25. Without your knowledge, an old classmate applies to the company you work for. Knowing that you recently graduated from the same school, the director of engineering asks your opinion and shows you the application and resume that your friend submitted. It turns out that your friend has exaggerated his participation in campus organizations, even claiming to have been an officer in an engineering society that you are sure he was never in. On the other hand, you remember him as being a highly intelligent student and believe that he could really help the company. How should you handle the situation?

Answer is: see below, for best answer Q14,pg.DE XVI-3;A14, pg DE XVI-5

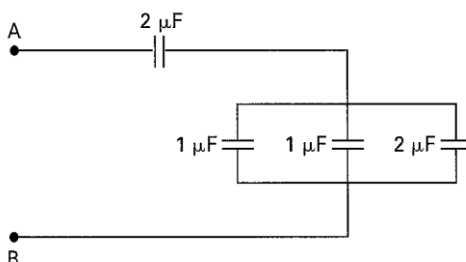
An engineer's is ethically obligated to be truthful. You should recommend the applicant, but qualify your recommendation by pointing out that you think he may have exaggerated some details on his resume. This answer is about truth-other answers that focus on truth are accepted for full credit.

26. While working to revise the design of the suspension for a popular car, an engineer discovers a flaw in the design currently being produced. Based on a statistical analysis, the company determines that although this mistake is likely to cause a small increase in the number of fatalities seen each year, it would be prohibitively expensive to do a recall to replace the part. Accordingly, the company decides not to issue a recall notice. What should the engineer do?

Answer is: see below, for best answer Q15,pg.DE XVI-3;A15, pg DE XVI-5

An engineer's highest obligation is to the public's safety. The engineer should notify the National Transportation Safety Board, providing enough details for them to initiate a formal inquiry. This answer is about safety-other answers that focus on safety are accepted for full credit.

27. Find the equivalent capacitance between terminals A and B.

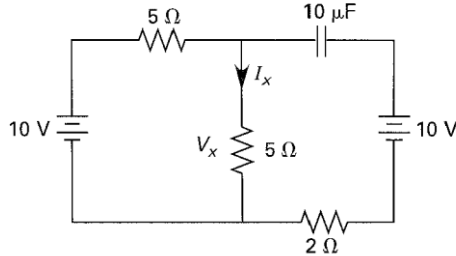


Answer is: 1.33 μF

Q1, pg. 40-9; A1, pg 40-14

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28. What are the voltage across and current through the $5\ \Omega$ resistor in the center leg?



Answer is: **5 V; 1 A**

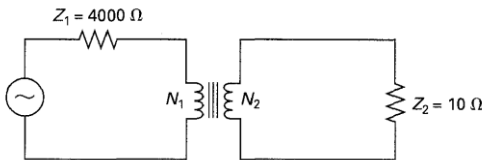
Q2, pg. 40-9; A2, pg 40-14

29. The reactances of a 10 mH inductor and a $0.2\ \mu\text{F}$ capacitor are equal when the frequency is?

Answer is: **3559 Hz or 3.56 kHz**

Q1, pg. 41-9; A1, pg 41-11

30. What is the turns ratio ($N_1:N_2$) for maximum power transfer in the following circuit?



Answer is: **$N_1:N_2 = 20:1$**

Q7, pg. 41-9; A7, pg 41-13

31. Data are being collected automatically from an experiment at a rate of 14.4 kbps. How long will it take to completely fill a diskette whose capacity is 1.44 MB?

Answer is: **13.98 minutes**

Q9, pgDE XIV-3; A9, pgDE XIV-5

Give or take up to .20 is also acceptable for 1 point

32. Before being used, programs must generally be 'loaded into memory'. What storage component does this 'memory' refer to?

Answer is: **RAM (random access memory)**

Q10, pgDE XIV-3; A10, pgDE XIV-5