Section A: Answer all questions

A1. a. Determine the Highest Common Factor and Lowest Common Multiple of the following set of numbers

7350, 6860, 2700 — 4 marks

b. Use a valid technique to show your answers are correct. — 2 marks

See video https://mybaseline.org/maths1/index.php/SE2017QA1

7350	2		3			5		7	7	
6860	2	2				5		7	7	7
2700	2	2	3	3	3	5	5			
HCF	2					5				
LCM	2	2	3	3	3	5	5	7	7	7

a. HCF(7350, 6860, 2700) = 10
   LCM(7350, 6860, 2700) = 926100
b. HCF: Divide each number by your HCF and show there are no extra common factors.
c. LCM: Divide your LCM by each number and show there are no extra common factors.

A2. Express the following in terms of powers of prime numbers:

a. $\frac{4^{-3} \times 4^{4}}{4^{3} \times 4^{6}}$ — 3 marks

b. $\frac{2^{3} \times 6^{6}}{4^{-3} \times 5^{2}}$ — 3 marks

See video https://mybaseline.org/maths1/index.php/SE2017QA2

a. 4^-8
b. 2^15 3^6 5^-2

A3. Show the following numbers in binary, decimal and hexadecimal:

$1111\ 1100_b$, 215_d, $C4_h$ 6 marks

Binary	Decimal	Hexadecimal
$1111\ 1100_b$	252	FC
1101 0111	215_d	D7
1100 0100	196	$C4_h$

A4. Expand the following expressions giving your answer in decreasing powers of x.

a. $(2x - 4)^2(x + 6)$ 3 marks

b. $(5x + 3)^3$ 3 marks

a. $4x^3 + 8x^2 - 80x + 96$
b. $125x^3 + 225x^2 + 135x + 27$

A5. Carry out the following algebraic division.

a. $\dfrac{20x^3 + 47x^2 + 36x + 9}{4x + 3}$ 4 marks

b. Prove that your answer is correct. 2 marks

a. $5x^2 + 8x + 3$
b. Multiply answer by $4x + 3$

A6. Factorise the following cubic polynomial

a. $18x^3 + 66x^2 + 38x + 6$ 4 marks

b. Show that you answer is correct 2 marks

See video https://mybaseline.org/maths1/index.php/SE2017QA6

a. $2(3x + 1)(3x + 1)(x + 3)$
b. Either insert one of your roots to ensure y = 0 or multiply the factors back together.

A7. Solve the simultaneous equations to find the points of intersection.

a. i. $y = -x^2 + 9x + 15$ 4 marks

ii. $y = 5x + 3$

b. Prove that your answer is correct. 2 marks

a. (6, 33) and (-2, -7)
b. Put the values back into the equations

A8. Separate the following into partial fractions

a. $\dfrac{-4x - 18}{-5x^2 + 23x - 12}$ 4 marks

b. In the simplest manner prove your answer is correct. 2 marks

a. $\dfrac{6}{-5x + 3} + \dfrac{2}{x - 4}$
b. Show A(x – 4) + B(-5x + 3) = -4x - 18

A9. a. Transform the expression $6\sin\theta + 12\cos\theta$ to the form $r\sin(\theta + \phi)$ giving ϕ in the range 0 to π. 4 marks

b. Sketch $r\sin(\theta + \phi)$. 2 marks

a. r = 13.416, ϕ = 1.107 rad
b. Graph

A10. Given $A = \begin{bmatrix} -3 & 2 \\ 7 & 5 \end{bmatrix}$, $B = \begin{bmatrix} 1 & 4 \\ 2 & -3 \end{bmatrix}$ and $C = \begin{bmatrix} 7 \\ -6 \end{bmatrix}$ find the following:

a. $A - B$ 1 mark

b. $|C|$ 1 mark

c. $|B|$ 1 mark

d. $B \times A$ 2 marks

e. $A \times C$ 1 mark

a. $\begin{bmatrix} -4 & -2 \\ 5 & 8 \end{bmatrix}$

b. Not possible

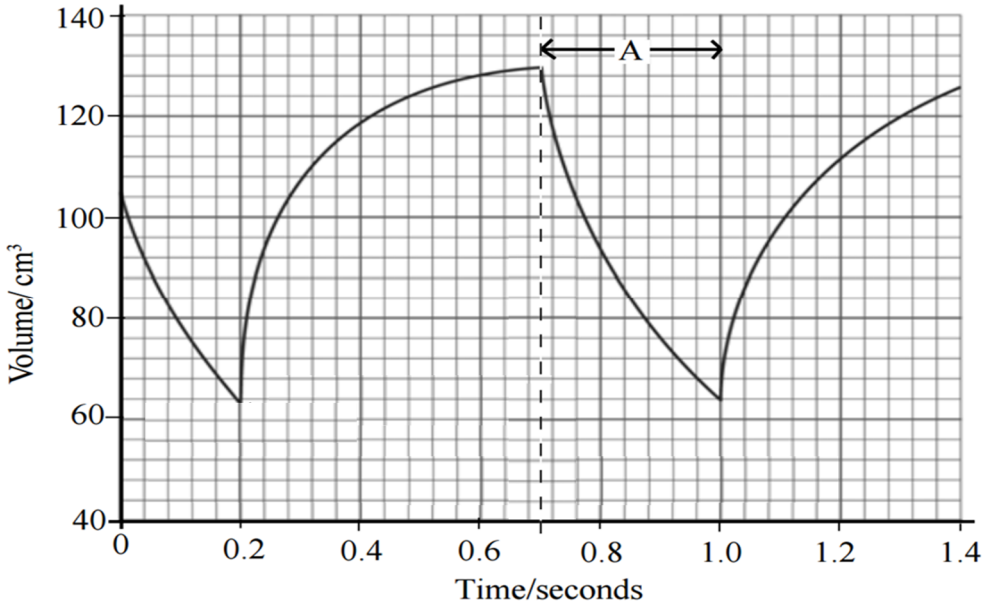
c. -11

d. $\begin{bmatrix} 25 & 22 \\ -27 & -11 \end{bmatrix}$

e. $\begin{bmatrix} -33 \\ 19 \end{bmatrix}$

Section B: Answer 2 questions

B1. The following graph show changes in the volume of blood in the right ventricle as the heart beats.



- Stroke volume (SV) is the volume of blood pumped from the ventricle per beat.
- Heart Rate (HR) is the number of beats per minute.
- Cardiac Output = Stroke Volume × Heart Rate

a. The line A shows when blood is leaving the ventricle. Explain, in terms of blood pressure, why blood does not flow back into the atrium during this part of the cycle.

4 marks

b. Draw a line on the graph to show one complete cardiac cycle.

4 marks

c. Draw a line on the graph to show the period in one cardiac cycle when the muscle in the wall of the ventricle is relaxed.

4 marks

d. Using your answer to part b. calculate the number of times the heart would beat in one minute. Show your workings.

4 marks

e. Calculate the volume of blood pumped out by the heart in one minute (cardiac output) in dm^3. Show your workings.

4 marks

See video https://mybaseline.org/maths1/index.php/SE2017QB1

B2. a. Explain, with examples what is meant by **significant figures**. 4 marks

b. Give the number of significant figures in each of the following

i. 3.08000 2 marks

ii. 0.00418 2 marks

iii. 7.09×10^{-5} 2 marks

c. The following data were collected from experiments. Calculate the final value giving your answer to the correct number of significant figures.

$$\frac{561.0 \times 34{,}908 \times 23.0}{21.888 \times 75.2 \times 120.00}$$

10 marks

See video https://mybaseline.org/maths1/index.php/SE2017QB2

B3. a. Find the units of the molar gas constant R using the ideal gas equation

$$pV = nRT$$

given that p is measured in kg m^{-1} s^{-2}, V in m^3, n in mol and T in K.

10 marks

b. The Arrhenius equation, given below, describes the relationship between the rate of a reaction k and the temperature T

$$k = Ae^{\left(\frac{-E_a}{RT}\right)}$$

where E_a, R and A are all constants.

Given the activation energy $E_a = 52.0\ kJ\ mol^{-1}$, the gas constant $R = 8.31\ JK^{-1}mol^{-1}$ and $A = 1.00$ what is the rate of the reaction k when the temperature $T = 241\ K$?

10 marks

a. Rearrange the equation so that $R = pV/nT$

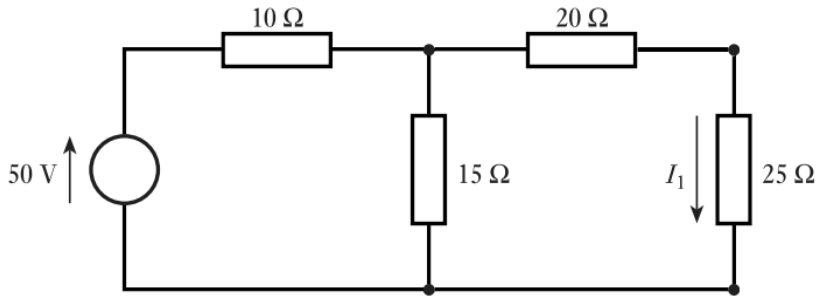
Next, replace variables with consistent units

$$R = \text{kg}\ m^{-1}s^{-2}\ m^3/(mol\ K)$$
$$R = \text{kg}\ m^2s^{-2}mol^{-1}K^{-1}$$

b.
$$k = Ae^{-E_a/RT}$$
$$= 1.00.\ e^{-52000/(8.31\times241)}$$
$$= 5.29 \times 10^{-12}$$

Give your answer to 3 significant figures because that is the least precise value in the question.

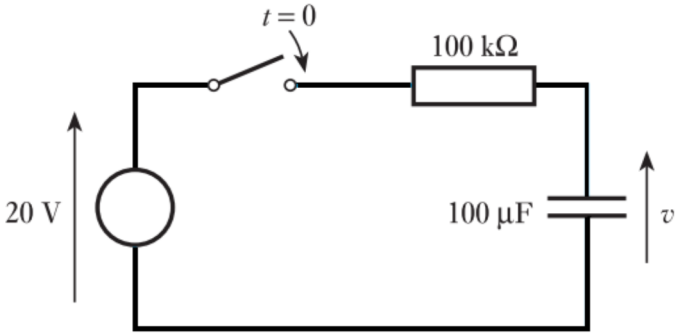
B4. a. Calculate the current I_1 in the following circuit.



10 marks

b. The switch in the following circuit is closed at $t = 0$. The voltage across the capacitor V_c is given by $V_c = V(1 - e^{-t/RC})$ where t is time, R is the resistance and C is the capacitance.

i. Calculate the voltage on the capacitor at $t = 25$ s.
ii. How can you increase the rate at which the capacitor charges?



10 marks

a. Resistance for parallel section = 45/4=11.25Ω
Total resistance = 21.25Ω, Total current = 50/21.25 = 2.35A
Voltage drop over 10Ω resistor = 10x2.35 = 23.5V
so I_1 = (50-23.5)/45 = 0.59A

b. i V_{25} = 18.36V
ii Decrease the resistance

B5. a. A prescription specifies the dose to be 2g of a specific pharmaceutical mixture. Your stock of the mixture is labelled 500mg in 10ml where 500mg is the stock strength and 10ml is the stock volume.

How much mixture should you administer?

10 marks

b. A dehydrated person is prescribed 1.5L of rehydration fluid over a 10 hour period? Your equipment delivers 20 drops per mL.

What drip rate will supply the prescription?

10 marks

a. 40ml,
b. 50 drops per minute

B6. a. Solve the following simultaneous equations using Cramer's method

$$2x + 4y + 6z = 22$$
$$3x - 3y + 4z = 4$$
$$2x + 5y + 5z = 19$$

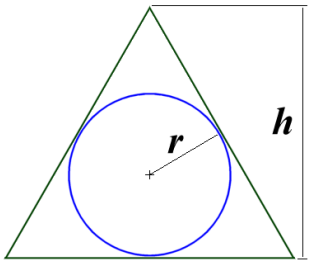
12 marks

b. Show that your answers are correct. 8 marks

See video https://mybaseline.org/maths1/index.php/SE2017QB6
for standard determinants
or https://mybaseline.org/maths1/index.php/SE2017QB6b
which uses the method of diagonals.

B7. a. An equilateral, triangular frame is made to fit around a ball of radius r.

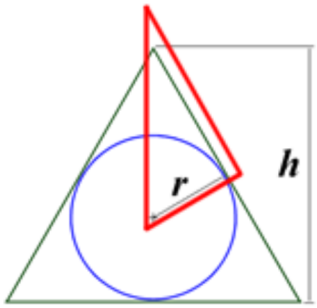
Show that the height h of the frame is equal to $3r$.



16 marks

b. How would you confirm the answer is correct? 4 marks

a.



Look at the red triangle. It is rotated to make easier to visualise. The angle between a radius and a tangent is 90º The angle opposite the radius is half of 60º.

$sin(30) = r/h_1$ so $h_1 = r/\sin(30) = 2r$.

The centre of the ball is at height r so $h = r + 2r = 3r$

b. Draw a circle, radius r, with it's centre where the vertical line from the apex crosses the circumference. The circle should go through the triangle and the centre of the ball.

B8. a. The manufacturer of a board game printed $18,500,000,000,000 of toy money in 1990. If this this toy money were distributed equally among the world's population, estimated to be 5.3 billion in 1990, how much would each person get?

8 marks

b. If the toy money was distributed so that the poorest person got the most, the richest person got nothing and there is a linear variation between the two how much would the person in the middle get?

12 marks

a. $\$1.85 \times 10^{13} / 5.3 \times 10^{9} = \$3490.57$

b. The amount of money remains the same, the richest gets nothing and the variation is linear so the distribution is triangular with an area of $\$1.85 \times 10^{13}$ and a base of 5.3×10^{9}.

The area of a triangle is base x height / 2 so the poorest get $6981.14

END OF QUESTIONS

END OF PAPER