NSAA 2017
Section 1

Model Solutions

1. $\frac{(\sqrt{12}+\sqrt{3})^2}{(\sqrt{12}-\sqrt{3})^2} = \frac{12+3+2\sqrt{3}\sqrt{12}}{12+3-2\sqrt{3}\sqrt{12}}$

$= \frac{15+2\sqrt{36}}{15-2\sqrt{36}}$

$= \frac{15+12}{15-12}$

$= \frac{27}{3} = 9 \Rightarrow F.$

2. $2x^2 \geq 15 - x$

$2x^2 + x - 15 \geq 0$

$(2x-5)(x+3) \geq 0.$

both brackets ≤ 0 or both ≥ 0.

$x \leq -3$ or $x \geq 2.5$

$\Rightarrow E.$

3. $y = 3\left(\frac{x}{2} - 1\right)^2 - 5$

$y + 5 = 3\left(\frac{x}{2} - 1\right)^2$

$\left(\frac{x}{2} - 1\right)^2 = \frac{y+5}{3}$

$\frac{x}{2} - 1 = \pm\sqrt{\frac{y+5}{3}}$

$\frac{x}{2} = 1 \pm \sqrt{\frac{y+5}{3}}$

$x = 2 \pm 2\sqrt{\frac{y+5}{3}} \Rightarrow B.$

4. $P = 2x + 5y \quad Q = 3x + 2y$

$3P = 6x + 15y \quad 2Q = 6x + 4y$

$\Rightarrow 3P - 2Q = 15y - 4y$

$\Rightarrow 11y = 3P - 2Q \Rightarrow y = \frac{3P-2Q}{11}$ = price of pear $\Rightarrow G.$

5. $P \propto Q^2$

$P = kQ^2 \Rightarrow 2 = k(4)^2$

$k = \frac{2}{16} = \frac{1}{8}$.

$Q = \frac{C}{R} \Rightarrow 2 = \frac{C}{5} \Rightarrow C = 10$.

$P = \frac{1}{8}Q^2 = \frac{1}{8}\frac{C^2}{R^2} = \frac{100}{8R^2} = \frac{25}{2R^2}$. E.

6. $f_{n+1} > 99 - n^2$

$n^2 + f_{n+1} > 99$

$n^2 + f_n - 98 > 0$

$(n+14)(n-7) > 0$

$n > 7$ as $n > 0$

$\Rightarrow$ smallest $n = 8$.

$\Rightarrow$ C.

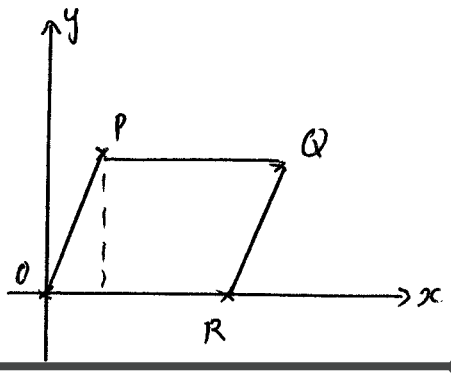
7. $2 - \frac{x^2(9x^2-4)}{x^3(2-3x)} = 2 - \frac{(9x^2-4)}{x(2-3x)} = 2 - \frac{(3x-2)(3x+2)}{x(2-3x)}$

$= 2 + \frac{3x+2}{x}$

$= \frac{5x+2}{x}$

$= 5 + \frac{2}{x}$. D.

8.



$OR = \frac{3a}{2} \Rightarrow PQ = \frac{3a}{2}$.

$P_x = Q_x - \frac{3a}{2}$

$= 2a - 3a/2 = \frac{a}{2}$.

$P_y = Q_y = a+1$

area $= OR \times (a+1)$

$= \frac{3a}{2}(a+1) = 9.$

$a(a+1) = \frac{2}{3} \cdot 9$

$a^2 + a - 6 = 0$

$(a+3)(a-2) = 0.$

$\Rightarrow a = 2.$

Hence $P\left(\frac{2}{2}, 2+1\right)$

$P(1, 3)$

$\Rightarrow B.$

9. $2^{3+2x} \cdot 4^x \cdot 8^{-x}$

$= 2^{3+2x} (2^2)^x (2^3)^{-x}$

$= 2^{3+2x} 2^{2x} 2^{-3x}$

$= 2^{3+2x+2x-3x}$

$= 2^{3+x} = 4\sqrt{2} = \sqrt{2}^5 = 2^{\frac{5}{2}}$

$3 + x = \frac{5}{2}$

$x = -0.5 \Rightarrow D.$

10.

	French	German	Spanish	T
Girls	x		$35-y$	$3x$
Boys		$2y$	y	
T			35	100
			~~35~~	~~100~~

Girls Spanish $= 35 - y$.

Girls german $= 3x - x - (35 - y)$

$= 2x + y - 35$.

Total German $= 2x + y - 35 + 24$

$= 2x + 3y - 35$

$\Rightarrow$ F.

11. Exterior angles for n sides $= \frac{360}{n}$.

$\Rightarrow \frac{360}{n} - \frac{360}{n+3} = 4.$

$360\left(\frac{1}{n} - \frac{1}{n+3}\right) = 4$

$90\left(\frac{(n+3)-(n)}{n(n+3)}\right) = 1$

$90\left(\frac{3}{n(n+3)}\right) = 1$

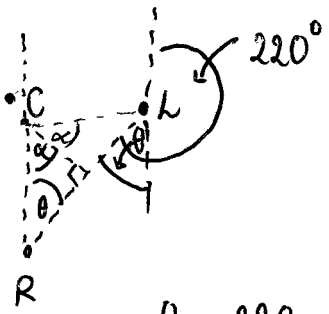
$\frac{270}{n(n+3)} = 1$

$n(n+3) = 270$

$n^2 + 3n - 270 = 0$

$(n+18)(n-15) = 0 \Rightarrow n = 15$, as $n > 0$. $\Rightarrow$ C.

12.



$\theta = 220 - 180$

$= 40°.$

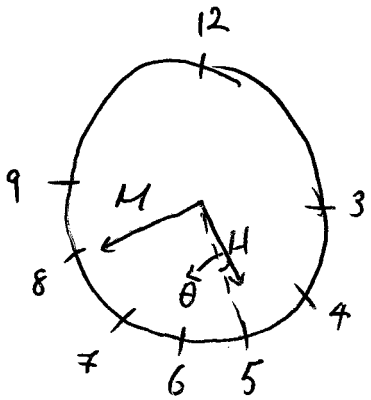
$\Rightarrow$ bearing $= 180 - 2\alpha$

$= 180 - 2(90 - \theta)$

$= 080$

$\Rightarrow$ B.

13.



as 40 minutes past hour, hour hand, H, has $\frac{1}{3}$ of the arc between 4 and 5 left to travel.

$\Rightarrow \theta = \frac{1}{3} \times$ angle between 4 and 5

$= \frac{1}{3} \times \frac{360}{12} = 10°.$

$\Rightarrow$ angle between hour and minute hand $= 3 \times \frac{360}{12} + 10$

$= 100°$ $\Rightarrow$ B.

Note: angle between consecutive hour markings on the clock $= \frac{360}{12} = 30°.$

14. 70% profit. let P = net profit (£)

C = cost (£)

$\frac{P}{C} = 0.70$

$\Rightarrow P = 0.7C$

$P + C = 6.80$

$1.7C = 6.80$

$\Rightarrow C = 4$

$\Rightarrow P = 2.8.$

as dimension all go down by scale factor 2, volume falls by $2^3 = 8$ times.

$\Rightarrow$ C of smaller cake $= \frac{4}{8} = 0.5$

$\Rightarrow$ cost of 6 smaller cakes $= 0.5 \times 6 = £3.$

Profit $= £6.50 - £3 = £3.50 \Rightarrow$ D.

15. $P(1^{st} \text{ male}) = \frac{x}{x+4}$ $P(2^{nd} \text{ male, given } 1^{st} \text{ male}) = \frac{x-1}{(x-1)+4}$

$P(\text{both male}) = \frac{x}{x+4} \cdot \frac{x-1}{x+3}$ $= \frac{x-1}{x+3}.$

$= \frac{x^2 - x}{x^2 + 4x + 3x + 12} = \frac{1}{3}$

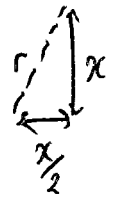
$\Rightarrow \frac{3x^2 - 3x}{x^2 + 7x + 12} = 1$

$3x^2 - 3x = x^2 + 7x + 12$

$2x^2 - 10x - 12 = 0 \Rightarrow (2x + 2)(x - 6) = 0$

$x = 6$ as $x > 0 \Rightarrow$ C.

16.



radius of circle $= \sqrt{\frac{x^2}{4} + x^2}$ by pythagorean theorem

$= \sqrt{\frac{5}{4}x^2}$

$= \frac{\sqrt{5}}{2}x.$

$\Rightarrow$ area of Semicircle $= \frac{\pi r^2}{2} = \frac{\pi \cdot \frac{5x^2}{4}}{2} = \frac{5\pi x^2}{8}.$

$\Rightarrow$ area Shaded $= \frac{5\pi x^2}{8} - x^2$

$= x^2\left(\frac{5\pi}{8} - 1\right)$

$= x^2\left(\frac{5\pi - 8}{8}\right) \Rightarrow$ F.

17. area of ring Shape

$= \pi R^2 - \pi r^2$

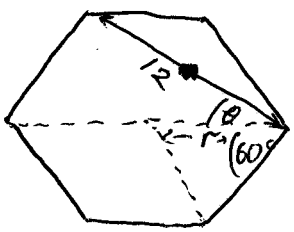
$= \pi(5^2 - 4^2)$

$= 9\pi.$

$\Rightarrow$ Volume of tube $= 9\pi \times 16 = 144\pi \text{ cm}^3.$

mass = density x volume $= 8 \times 144\pi = 1152\pi$ g. $\Rightarrow$ G.

18.



$r\cos\theta = \frac{12}{2}$

$r = \frac{6}{\cos\theta} = \frac{6}{\cos(90-60)} = \frac{6}{\cos 30^\circ} = 4\sqrt{3}.$

$\left(= \frac{6}{\sqrt{3}/2} = \frac{12}{\sqrt{3}} = \frac{12\sqrt{3}}{3} = 4\sqrt{3}\right)$

area of equilateral triangle $= \frac{1}{2} r^2 \sin 60^\circ$

$= \frac{1}{2} \cdot 4^2 \sqrt{3}^2 \cdot \frac{\sqrt{3}}{2}$

$= 12\sqrt{3}$.

$\Rightarrow$ hexagon area $= 6 \times 12\sqrt{3} = 72\sqrt{3}$. $\Rightarrow$ E.

(six equilateral triangles fit into one hexagon).

19. Decelerating means velocity decreasing. The distance travelled is the area under the graph from $t = 110s$ to $t = 130s$ because this is the only section of the graph where deceleration takes place.

The area is a trapezium.

$$A = \frac{20+30}{2} \times (130 - 110) = 25 \times 20 = 500m. \Rightarrow B.$$

20. For Statement 2, this means the volume of a fixed mass increases (as the density decreases) hence it is the equivalent statement to number 3. These are then both correct because the hotter the water becomes the less dense it gets. These hotter parts rise and then cool at the top where the surrounding water is cooler. This is the cause of convection currents.

The mass of the water does not change during the process and hence Statement 1 is incorrect. Only 2 and 3 are right.

Answer is G.

21. The only two that could be detected are sound waves and visible light.

Sound waves have a frequency of, say, around 5000Hz,

$$\text{So } \lambda = \frac{c}{f} = \frac{300}{5000} = 0.06\ m \Rightarrow \text{on the order of } 10^{-1}m.$$

They are longitudinal hence wave 2 are sound waves.

Visible light is electro - magnetic and has wavelengths between 400nm and 700nm hence they are on the order of $10^2 \times 10^{-9} = 10^{-7}$ m. Thus, the waves are wave 4.

E.

22. The current, $I = \frac{\Delta Q}{\Delta t}$ (average) $= \frac{60C}{30s} = 2A$.

By Ohms law, $V = IR$ for this resistor and the resistance is constant.

$10 = 2 \times R \Rightarrow R = 5.0\,\Omega$. E

23. Total used to lift car $= mg\Delta h = 1200 \times 10 \times 1.0 = 12000J$.

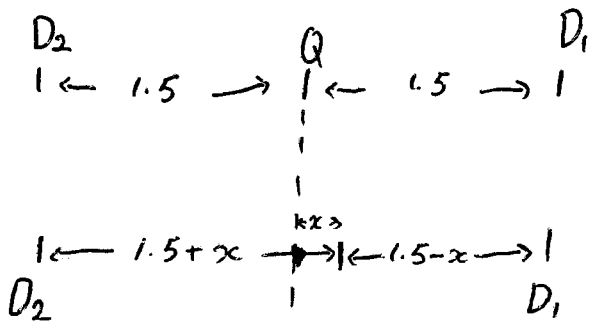
Total output from Motor $= 0.75 \times 28000 = 21000J$.

So, amount left over $= 21000 - 12000 = 9000J$.

But, $28000 - 21000J$ $(= 0.25(28000))$ is lost in the motor.

Hence total lost $= 9000 + 7000 = 16000 = 16kJ \Rightarrow$ D.

24. D_1 and D_2 are the detectors:



Δt = time difference = 0.

$t_2 = \frac{1.5+x}{c}$ $t_1 = \frac{1.5-x}{c}$ $\Rightarrow \Delta t = t_2 - t_1 = \frac{1.5+x-(1.5-x)}{c}$

$$= \frac{1.5 - 1.5 + 2x}{c} = \frac{2x}{c} = 4.0 \times 10^{-10}\ s.$$

$$2x = 3.0 \times 10^{8} \times 4.0 \times 10^{-10}$$

$$= 12.0 \times 10^{-2}$$

$$\Rightarrow x = 6.0 \times 10^{-2}\ m = 6\ cm \Rightarrow D.$$

25. Conservation of baryons (or nucleons) $\Rightarrow 1 + 239 = W + Y + Z$

$$240 = W + Y + Z$$

$$\Rightarrow Z = 240 - (W + Y)$$

So, B correct.

26. Energy required to lift mass as output = $mg\Delta h$

$$= 20 \times 10 \times 6.0$$

$$= 1200\ J$$

Energy input $= \frac{1200}{0.8} = \frac{5 \times 1200}{4} = 1500\ J.$

Power $= \frac{1500\ J}{5s} = 300\ W.$

Power $= I \times V$

$$I = \frac{300\ W}{12\ V} = 25\ A \Rightarrow F.$$

27. ~~Because~~ Option A is not possible because for the atomic mass to be P, it means no alpha particles have ~~decayed~~ been released. Therefore only β particles have been released. However, the atomic number will increase for each β-particle released. Hence the atomic number of the nuclide should have increased by the conservation of charge.

B is possible: $^{P}_{Q}X \rightarrow {}^{P}_{Q+1}A + {}^{0}_{-1}\beta$

C is possible: $^{P}_{Q}X \rightarrow {}^{P}_{Q+2}A + 2\,{}^{0}_{-1}\beta$

D is possible: $^{P}_{Q}X \rightarrow {}^{P}_{Q+3}A + 3\,{}^{0}_{-1}\beta$

E is possible: $^{P}_{Q}X \rightarrow {}^{P-4}_{Q-2}A + {}^{4}_{2}\alpha$

F is possible: $^{P}_{Q}X \rightarrow {}^{P-4}_{Q-1}A + {}^{4}_{2}\alpha + {}^{0}_{-1}\beta$

G is possible: $^{P}_{Q}X \rightarrow {}^{P-4}_{P-4-Q}A + {}^{4}_{2}\alpha + 2\,{}^{0}_{-1}\beta$

H is possible: $^{P}_{Q}X \rightarrow {}^{P-4}_{Q+1}A + {}^{4}_{2}\alpha + 3\,{}^{0}_{-1}\beta$.

${}^{n}_{n}A$ is a nuclide part of the way through the decay from X to Y.

28. $V \propto r^3$

$\rho = \frac{m}{V}$ So as the mass of the atom and nucleus can be treated as equal here, we have $\rho \propto \frac{1}{r^3}$.

Hence $\frac{\rho_{atom}}{\rho_{nucleus}} = \left(\frac{r_{nucleus}}{r_{atom}}\right)^3 = \left(\frac{1}{3.0 \times 10^4}\right)^3 = \left(3.0 \times 10^4\right)^{-3}$.

$\Rightarrow$ A.

29. The wavelength is $2(x_2 - x_1)$.

We know $v = f\lambda = \frac{\lambda}{T}$ where T = time period.

$T = \frac{3}{2}(t_2 - t_1)$

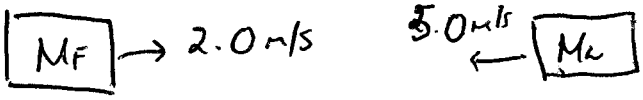
Hence, $v = \frac{2(x_2 - x_1)}{\frac{3}{2}(t_2 - t_1)} = \frac{3(x_2 - x_1)}{(t_2 - t_1)}$ $\Rightarrow$ E.

30. $P = IV$

$I = P/V = \frac{150}{12} = 12.5\,A.$

$Q = I\Delta t = 12.5 \times 20 \times 60 = 250 \times 60 = 15000\,C$ $\Rightarrow$ C.

31.



Mass of freight train, M_F

$= 3(130) + 7(30)$

$= 600$ Tonnes.

Mass of passenger train, M_L:

$2(70) + n(10)$

$= 10n + 140$ tonnes

By the principle of conservation of linear momentum:

$\xrightarrow[+ve]{}: \quad 2.0M_F - 5.0M_L = 0$

$20(600) - 5.0(10n + 140) = 0$

$1200 - 50n - 700 = 0$

$50n = 500$

$n = 10 \Rightarrow C.$

32. $\frac{200}{5} = 40.$ Units: $\frac{kg\ ms^{-1}}{ms^{-1}} = kg$ ✓

$\frac{200}{5} = 40.$ Units $\frac{J}{m} = \frac{Nm}{m} = N = kg\ ms^{-2}$ ✗

$\frac{200}{5} = 40.$ Units $\frac{kg\ m^{-3}}{m^3} = kg\ m^{-6}$ ✗

$\frac{200}{5} = 40.$ Units $\frac{N}{ms^{-2}} = \frac{kg\ ms^{-2}}{ms^{-2}} = kg$ ✓.

So 1 and 4 give 40 kg. $\Rightarrow C.$

33. K.E. is constant and is equal to: $\frac{1}{2}mv^2 = \frac{1}{2} \cdot 72 \cdot 5^2$

$= 36 \times 25$

$= (72 + 18) \times 10$

$= 900\,J$ ✗

$\Rightarrow$ Statement 1 is wrong.

Each second GPE falls by $mg\Delta h = 72 \times 10 \times 5$

$= 360 \times 10$

$= 3600\,J$

Hence Second Statement is correct.

Third Statement is wrong.

Force	Paired force
Weight (i.e force of gravity)	Pull on Earth by parachutist's mass.
Air resistance	Force on air due to parachutist.

Hence only 2 is correct $\Rightarrow$ 2.

34. X has decayed by $3/4$ and if total initial number of X was N_X, the number that became Z is $\frac{3N_X}{4}$.

Y has decayed by $7/8$ and if total initial number of Y was N_Y, the number that became Z is $\frac{7N_Y}{8}$.

So, fraction which

are now $= \dfrac{\frac{7}{8}N_Y + \frac{3}{4}N_X}{N_Y + N_X}$

$= \dfrac{7/8 + 3/4}{2}$ as initial quantities are equal.

$= \dfrac{13}{16}$

35. M_X is the mass of car X. V_X is the speed of car X.
M_Y is the mass of car Y. V_Y is the speed of car Y.

$M_X = \frac{4}{5} M_Y$ and $V_X = 1.5 V_Y$.

$$\frac{1}{2} M_X V_X^2 = \frac{1}{2} \cdot \frac{4}{5} M_Y \times 1.5^2 V_Y = \frac{9}{5} \cdot \frac{1}{2} M_Y V_Y^2$$

$\Rightarrow \frac{9}{5}$ times kinetic energy of car Y

$= 1.80. \Rightarrow \bar{E}$

36. $P = I^2R = 12$

$I^2 = \dfrac{12}{R} = \dfrac{12}{12} = 1 \Rightarrow I = 1A$ through 12Ω resistor.

Current through 4.0Ω is $4.0 - 1.0 = 3.0A$. (as 4.0A is sum of both currents).

$\Rightarrow$ Power $= I^2R = 3.0^2 \times 4.0 = 36W \Rightarrow E$.

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37.

1 Yes, as $^{16}_{8}O^{2-}$ has 10 electrons and $^{24}_{12}Mg^{2+}$ has 10 electrons

2 No, as $^{32}_{16}S^{2-}$ has $32-16=16$ neutrons and $^{18}_{8}O$ has $18-8=10$ neutrons

3 Yes as the sum of the number of electrons in $^{16}_{8}O^{2-}$ and $^{18}_{8}O$ is $10+8=18$ and the number of electrons in $^{32}_{16}S^{2-}$ is 18

Answer is F

38.

Oxidation is the loss of electrons

1 Ca is oxidised to Ca^{2+} as it loses 2 electrons

2 Cl is reduced to Cl^- by gaining 1 electron

3 C is oxidised from +2 in CO to +4 in CO_2 by gaining 2 electrons

4 Nothing is reduced or oxidised

Answer is B

39.

1 It does turn blue litmus paper red as it is an acid

2 This happens as it is an acid.

$$2CH_3COOH + NaCO_3 \rightarrow (CH_3COO)_2Na + H_2O + CO_2$$

3 Yes, as they are both monoprotic acids

Answer is H

40.

All actions will increase the initial rate of reaction.

1 Increasing the pressure would increase the yield in Q, as there are more gaseous moles on the left hand side but decrease the yield in R as there are less gaseous moles on the left hand side, so the equilibrium would shift in the backwards direction to reverse the change

2 Increasing the temperature would decrease the yield in Q as it is an exothermic reaction so the equilibrium would shift in the backwards direction. It would increase the yield in R as this is an endothermic reaction

3 A catalyst does not increase or decrease the yield

Answer is A

41.

1 Sweet 1 and 2 both contain additive S but only sweet 1 has R

2 NO, the Rf value for iv (0.4) is double that for spot iii (0.2)

3 Yes, as 7/10 = 0.7

Answer is D

42.

Atomic number is 20 = Ca (group 2)

∴ XO

Ca is a metal and O is a nonmetal so it has ionic bonding

Answer is C

43.

The equation is:

$$CuCl_{2\,(aq)} + Li_3PO_{4\,(aq)} \rightarrow Cu_3(PO_4)_{2\,(s)} + LiCl_{(aq)}$$

The balanced equation is:

$$3CuCl_{2\,(aq)} + 2Li_3PO_{4\,(aq)} \rightarrow Cu_3(PO_4)_{2\,(s)} + 6LiCl_{(aq)}$$

Ionic equation (all aq compounds split into ions):

$$3Cu^{2+}_{(aq)} + 6Cl^-_{(aq)} + 6Li^+_{(aq)} + 2PO_4^{3-}{}_{(aq)} \rightarrow$$

$$Cu_3(PO_4)_{2\,(s)} + 6Li^+_{(aq)} + 6Cl^-_{(aq)}$$

$$3Cu^{2+}_{(aq)} + 2PO_4^{3-}{}_{(aq)} \rightarrow Cu_3(PO_4)_{2\,(s)}$$

Answer is D

44.

1 Yes as Li is oxidised to +2 and H is reduced from +1 to 0

2 $2Li + 2H_2O \rightarrow 2LiOH + H_2$ $\frac{7}{7} = 1$ $0.5 \times 2 = 1$g of H_2

3 Yes as Li(OH) is an alkali

4 Yes as there are 2 moles of each $\frac{14}{7} = 2$ moles $\frac{36}{18} = 2$ moles

Answer is D

45.

Reduction occurs at the cathode.
Oxidation occurs at the anode.

The only two reduction equations at the cathode are A and D.
A and D both show an oxidation reaction in the anode column, but an element cannot be reduced at one electrode and oxidised at another, and chlorine needs to be oxidised so chlorine gas can be given off.

Answer is D

46.

Moles of F: $\frac{57}{19} = 3$

Moles of C: $81 - 57 = 24$, $\frac{24}{12} = 2$

Empirical is: C_2F_3

Molecular is: C_4F_6

Answer is E

47.

Find the volume of the product.

1 $\frac{56}{12+16} = \frac{56}{28} = 2$

$2 \times 24 = 48 dm^3$ of CO_2

2 $\frac{36}{18} = 2$

$2 \times 24 = 48$
$1 \times 24 = 24$
$72 dm^3$ of H_2 and O_2

3 $\frac{30}{14+16} = \frac{30}{30} = 1$ $1 \times 24 = 24 dm^3$ of NO_2

Answer is E

48.

Finding the limiting reagent

$\frac{1.2}{24} = 0.05$ moles of Mg

$1 \times 0.04 = 0.04$ moles of H_2SO_4 ←

Experiment Q:

The limiting reagent is now Mg as there are 0.08 moles of H_2SO_4.

This means there are now 0.05 moles of H_2 instead of 0.04, so the volume of H_2 produced will be more than P but not double

⇒ Line is 2

Experiment R

The limiting reagent is H_2SO_4 at 0.02 moles.

This means there are now 0.02 moles of H_2, so half as much H_2 produced

⇒ Line is 5

Answer is D

49.

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

?	436×3	391×6
	$= 1308$	$= 2346$

$1308 + x - 2346 = -93$ (remember -ve as energy released!)

$1308 + x = 2253$

$x = 945\ kJmol^{-1}$

Answer is E

50.

1 True, as reduction takes place at the cathode (-ve electrode)

2 False:
Electrolysis of $PbCl_2$

$\frac{20}{207} \approx 0.1$

$0.2 \times 24 = 4.8 dm^3$ of $Cl_2(g)$

$\frac{20}{1} = 10$

$10 \times 24 = 240 dm^3$ of $H_2(g)$

3 False, as in the electrolysis of NaCl, $H_2(g)$ is produced at the -ve electrode

Answer is B

51.

moles of $AgNO_3$

$0.1 \times 0.05 = 0.005$ moles

equal mass of Zn

$\frac{0.005}{2} = 0.0025$ moles

$0.0025 \times 65 = 0.1625$
$= 0.163g$

Answer is A

52.

$$\frac{(62.93 \times x) + (64.93 \times (100 - x))}{100} = 63.55$$

(x: percentage of ^{63}Cu; (100 − x): percentage of ^{65}Cu)

$62.93x + 6493 - 64.93x = 6355$

$-2x = -138$

$x = 69\%$

$100 - 69 = 31\%$

Answer is D

53.

moles of CO_2:

$\frac{8.8}{44} = 0.2$ moles

$0.2 \times 100 = 20g$

This leaves B, C and D.

moles of HCl in each:

B $0.1 \times 2 = 0.2$ moles

C $0.2 \times 2 = 0.4$ moles ← minimum number of moles required as there are 2HCl

E $0.4 \times 1 = 0.4$ moles

C will be faster than E because although they have the same number of moles it is in a smaller volume so more concentrated resulting in successful collisions being more likely, increasing the rate of reaction. Answer is C

54.

$\frac{0.05}{50\,000} = 1 \times 10^{-6}$ nm

$= 1 \times 10^{-15}$ m

= 1 femtometre

Answer is D

m ←÷10 dm ←÷10 cm ←÷10 mm ←÷1000 μm ←÷1000 nm

NSAA 2017 section 1: PART D Biology

55.

Oxygen debt: the amount of oxygen needed to oxidise lactic acid to CO_2 and H_2O

1 No, because P's line has not returned to normal lactic acid levels whereas Q's line has, indicating that the lactic acid is broken down more quickly

2 No, because P's line reaches higher lactic acid levels than Q's line despite both beginning at the same lactic acid concentration

3 No, as they have a larger oxygen debt due to increased lactic acid build up

Answer is A

56.

- Most mutations have no effect (neutral) because they can be checked and repaired before protein synthesis happens.
- In the mutations that have an effect, more are likely to be harmful as a random change is more likely not produce an effect that provides an advantage in the environment and instead is likely to affect it negatively because the environment is specific.

*or occur in an intron

Answer is B

57.

Frequency of occurance = $\frac{\text{number of quadrats the species occur in}}{\text{number of quadrats}}$

$X \rightarrow \frac{9}{10} = 0.9$

$Y \rightarrow \frac{7}{10} = 0.7$ ←

$Z \rightarrow \frac{8}{10} = 0.8$

Answer is C

58.

1 Yes, they have the same number of genes but some are switched off in the specialised cell

2 Yes, because they are a female

3 No, it divides to produce 1 new stem cell and 1 specialised body cell

Answer is E

59.

1 Intra=within a population, so you would be removing species from within the population, decreasing the size

2 This may not benefit the population, it may lead to increase in another population which could be competitors for other resources or predators

3 A decrease in the organisms rate of reproduction will not increase the size of the population

Answer is A

60.

cell has an external wall: fungi, bacteria

cell uses enzymes to release energy: fungi, bacteria, animals

membrane bound structure with DNA: animals, fungi

Answer is D

61.

cactus → rat

$150\,000 \times \frac{1}{10} = 15000$

rat → rattlesnake

$15000 \times \frac{1}{10} = 1500$

Energy lost

$15000 - 1500 = 13500$

Answer is B

62.

1 No, they are genetically identical as they are produced by asexual reproduction

2 They are produced by budding

3 Yes, as bacteria do not have nuclei so DNA is found either in plasmids or the nucleoid

Answer is D

63.

C1 - the motor running means all sides of the plant feel the effects of gravity equally, so the plant will grow horizontally

C2 - the motor being stationary means the root will grow down as it is positively gravitrophic so will grow in the direction of gravity

Answer is G

64.

As the first children include one with the disease and two without, those not affected must be carriers.

Father is dominant

	R	R
R	RR	RR
r	Rr	Rr

0% chance of the child having the condition

$0 \times 0.5 = 0$

↳ chance of being a girl

Father is heterozygous

	R	r
R	RR	Rr
r	Rr	rr

25% chance of the child having the condition

$0.25 \times 0.5 = 0.125$

Answer is B

65.

The water potential inside the glass tube is lower than the water potential in the beaker as it is pure water compared to the sucrose solution.

As a result of osmosis, water moves from an area of high water potential to low water potential, resulting in an increase of the height of level P.

The water potential in the glass tube will always be lower due to the sucrose - the height will always increase

Answer is C

66.

Only mitosis occurs when number of chromosomes before and after the numbered stages are the same

↳ spores to adult plant stage P

adult plant stage P to gametes

Answer is C

67.

1 Yes as all 16 discs were floating in the shortest time indicating that the most oxygen had been produced in the shortest time and therefore the rate of photosynthesis was greatest

2 NO, at 5 minutes 25% of the discs had floated

3 Yes, as the reciprocal of the time indicates rate and using the fist 4 discs means the rate is more accurate as they underwent photosynthesis when sodium hydrogen carbonate was in excess and the light was not obstructed (as it might be when more discs are floating). It also gives the initial rate

Answer is F

68.

1 Enzymes are proteins so work optimally at a specific pH, as a result of the hydrogen and ionic bonds which are affected by the concentration of H^+ ions

2 Amylase is an enzyme that breaks down starch, so in a higher concentration it will break down more leaving a larger diameter

3 Temperature affects enzymes as they are proteins so depend on their tertiary structure - the bonds that make up this can be broken by heat.

Answer is H

69.

P - the distance from the light source would decrease as the auxins in the tip would move to the shaded side causing cell elongation here so it grows towards the light source

Q - there would be no change in distance as the tip is removed - this is where auxin is which is a plant hormone that contributes to phototropism

R - the same response as P would be observed as the tip is still exposed so a phototrophic response will be seen here, and the distance from the light source will decrease

Answer is A

70.

1 Yes, if the mutation at 4 is a substitution as the mutation at 20 is an insertion of A (or substitution)

ATG ?GA GAC ATG TTA AGG TAG

1 2 3 4 5 6

2 Yes, because if the substitution was for A it would still code for Arg

3 Yes, if there is a substition at 4 for G

ATG GGA GAC ATG TTA AGG TGG GAC CCC CGA GTC

met gly asp met leu arg leu asp pro arg val

Answer is H

71.

1 No, as the water temp rises the oxygen required for survival increases (dependent factor)

2 Yes, as indicated by the negative correlation seen in graph 2

3 This information is not provided by the graphs

Answer is C

72.

	H	h
H	HH	Hh
h	Hh	hh

normal - 3:1

1 They may have only produced 3 offspring, which resulted in this ratio, a 4th offspring may have resulted in the normal ratio

2 If the recessive condition was lethal then all offspring would have the same phenotype and there would not be the 2:1 ratio

3 This could explain the ratio as it means the only possible genotypes are Hh and hh, and the offspring is twice as likely to be Hh than hh according to the punnett square, resulting in the ratio of 2:1

Answer is F

73. $(3+\sqrt{3})^2 = 9 + 6\sqrt{3} + 3 = 12 + 6\sqrt{3}$

$(6-2\sqrt{3})^2 = 36 - 24\sqrt{3} + 4(3) = 48 - 24\sqrt{3}$.

$$\frac{(3+\sqrt{3})^2}{(6-2\sqrt{3})^2} = \frac{12+6\sqrt{3}}{48-24\sqrt{3}} = \frac{6(2+\sqrt{3})}{624(2-\sqrt{3})} = \frac{6(2+\sqrt{3})^2}{24(2-\sqrt{3})(2+\sqrt{3})}$$

$$= \frac{6(4+4\sqrt{3}+3)}{24(4-3)}$$

$$= \frac{1}{4}(7+4\sqrt{3})$$

$$\Rightarrow 1 - \left(\frac{3+\sqrt{3}}{6-2\sqrt{3}}\right)^2 = 1 - \frac{7}{4} - \frac{4\sqrt{3}}{4}$$

$$= -\frac{3}{4} - \sqrt{3} \Rightarrow E.$$

74. Let M_y be the moment caused by the weight of the horizontal section of the crane.

Initially, moments about P CW: $2000(10) - 400(10) - M_y = 0$

$M_y = 20000 - 4000 = 16000\,Nm$.

Then, moments about P CW (after counter weight moves a distance x to the right):

$2000(10+x) - 400(15) - M_y = 0$.

$2000(10+x) = 16000 + 6000$

$= 22000$.

$\Rightarrow 10 + x = 11\ m$.

$x = 1.0\ m$. $\Rightarrow$ B.

75. $2\sin x + 1 = 0$

$\sin x = -\frac{1}{2}$

$x = 210°$ (by Symmetry because we were using the results that $\sin 30° = \frac{1}{2}$ and $\sin 180° = 0$).

$2\cos(420°) = 2 \times \cos 60° = 1$. ✓ So $210°$ is x.

No other Solutions to $2\sin x + 1 = 0$ is range $0 \leq x° \leq 210°$ as we just found that $210°$ is the first.

But for $2\cos 2x = 1$ we can have $x = 30°, 150°$

Hence there are three values of x being $30°, 150°, 210°$.

$\Rightarrow C$.

76. Constant Speed in a Straight line means not accelerating and hence no resultant force by Newtons Second law. $\Rightarrow$ C.

77. $3^{(2x+1)} - 6(3^x) = 0$

$(\div 3)$ $3^{2x} - 2(3^x) = 0$

$(\div 3^x)$ $3^x - 2 = 0$

↗ $x = \log_3 2$. $\Rightarrow$ B.

(never 0 So no problem dividing by it.)

78. Using Constant acceleration formulae:

$$v^2 = u^2 + 2as$$

$$v^2 = 40^2 - 2(14.4)(20)$$

$$= 1600 - (28.8)(20)$$

$$= 1600 - 576$$

$$= 1024.$$

$$\Rightarrow v = \sqrt{1024} = 32 \text{ m/s}.$$

$$\Rightarrow \textcircled{D}.$$

79. $y = x^3 + px^2 + qx + 6$

$$\frac{dy}{dx} = 3x^2 + 2px + q$$

$$\left.\frac{dy}{dx}\right|_{x=2} = 3(2)^2 + 4p + q = 0 \qquad \left.\frac{dy}{dx}\right|_{x=4} = 3(4)^2 + 8p + q = 0$$

$$\Rightarrow 4p + q = -12. \qquad \Rightarrow 8p + q = -48$$

$$\Rightarrow (8p + q) - (4p + q) = -48 + 12$$

$$4p = -36$$

$$p = -9$$

$$q = -48 + 8(9)$$

$$= 24.$$

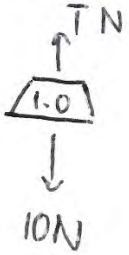
Check $\frac{d^2y}{dx^2} = 6x + 2p$ when $x = 2$, $\frac{d^2y}{dx^2} = -18 + 12 = -6 < 0$

Hence a maximum.

when $x = 4$, $\frac{d^2y}{dx^2} = -18 + 24 = 6 > 0$ hence a minimum

$\Rightarrow$ D.

80. Apply Newtons second law to the load:



$\Rightarrow 10 - T = 0$ (we know it is in equilibrium because the block remains stationary and the string is in-extensible.)

$T = 10N$.

As the string is light and the pulley is smooth, the force meter reading is the tension.

Hence the force meter will read 10N.

$\Rightarrow$ F.

81. $\frac{dy}{dx} = 6(2+3x)^5 \cdot 3$

$= 18(3x+2)^5$.

Coefficient of x^3: $18(3x)^3 \cdot (2)^2 \times {}^5C_3$

$= 10 \times 4 \times 18 \times 27$

$= 40 \times 18 \times 27$

$= 40 \times (540 - 54)$

$= 40 \times 486$

$= 19440 \Rightarrow$ E

82. Work energy principle

$\Delta KE = \frac{1}{2}m\Delta(v^2) = mg\Delta h - WD$ (work done against resistive forces)

$\Rightarrow \frac{1}{2}(0.1)(8^2 - 0) = (0.1)(10)(4) - WD$

$\frac{64}{20} = 4 - WD$

$WD = 4 - 3.2 = 0.80J$

$\Rightarrow$ A.

83.

$S_\infty = \frac{a}{1-r} = \frac{1}{1 - \frac{1}{2}\sin(2x)}$

$= \frac{2}{2 - \sin(2x)}$

$\Rightarrow \frac{2}{2 - \sin(2x)} = \frac{4}{3}$

$2 - \sin(2x) = 3/2$

$\sin(2x) = 1/2$

but, $\pi \leq x \leq 2\pi$, $2\pi \leq 2x \leq 4\pi$,

$\Rightarrow 2x = 2\pi + \pi/6, 2\pi + 5\pi/6$

$\Rightarrow 2x = \frac{13\pi}{6}, \frac{17\pi}{6}$

$x = \frac{13}{12}\pi, \frac{17}{12}\pi$. $\Rightarrow$ A.

84. By the Symmetry of the Stones motion, it speed downwards when it passes the top of the cliff on the way down is 13 m/s.

Using constant acceleration formula:

$$S = ut + \frac{1}{2}at^2$$

$$6.0 = 13t + \frac{1}{2}(10)t^2$$

$$\Rightarrow 5t^2 + 13t - 6.0 = 0$$

$$(5t - 2)(t + 3) = 0$$

$t > 0$ So $t = \frac{2}{5} = 0.40\ s \Rightarrow$ A.

85.

$$u_3 = pu_2 + 3$$

$$= p(pu_1 + 3) + 3$$

$$= p^2u_1 + 3p + 3$$

$$u_4 = pu_3 + 3 = -7$$

$$\Rightarrow p^3u_1 + 3p^2 + 3p + 3 = -7$$

$$2p^3 + 3p^2 + 3p + 10 = 0$$

By guessing, $p = -2$.

$$(p + 2)(2p^2 - p + 5) = 0$$

$$\downarrow$$

$$b^2 - 4ac = 1 - 4(2)(5) < 0$$

So only Solution is $p = -2$.

Then, $u_1 = 2$, $u_2 = -1$, $u_3 = 5$, $u_4 = -7$ $\Rightarrow$ Sum $= -1$. $\Rightarrow$ C.

86. kinetic energy is equal to the work done by the force of the bowstring by the work energy principle.

Area under graph $= \frac{192 \times 0.4}{2}$

$= 192 \times \frac{1}{5}$

$= \frac{190}{5} + \frac{2}{5}$

$= 38.4\text{J}.$

Maximum height is when all this kinetic energy becomes gravitational potential energy.

$mg\Delta h = 38.4$

$0.024 \times 10 \times \Delta h = 38.4$

$\Delta h = \frac{3.84}{0.024}$

$= \frac{3.84}{24} \times 1000$

$= \frac{1.92}{12} \times 1000$

$= 160\text{m}.$

$\Rightarrow$ B.

87. Because we have the x on the denominator we should consider for $x > 0$; $x < 0$ to ensure inequality signs are in the correct direction.

$x > 0$:

$x^3 - 6x^2 + 9x - 4 > 0 \times x$

$x^3 - 6x^2 + 9x - 4 > 0$

$(x-1)(x^2 - 5x + 4) > 0$

$(x-1)(x-1)(x-4) > 0$

$(x-1)^2(x-4) > 0$

$\Rightarrow x > 4$.

$x < 0$:

$x^3 - 6x^2 + 9x - 4 < 0$

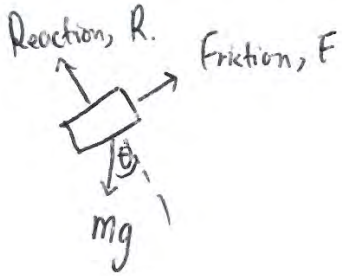
$(x-1)^2(x-4) < 0$

$x < 4$ but as $x < 0$, as assumed, we must say $x < 0$.

Hence we have: $x > 4, x < 0 \Rightarrow A$.

88.

Work out coefficient of friction, μ:



Newtons second law ↑:

$R - mg\cos 20° = 0$

Newtons second law ↙:

$mg\sin 20° - F = 0$

Friction is limiting:

$mg\sin 20° - \mu R = 0$

$\mu = \frac{mg\sin 20°}{R} = \frac{mg\sin 20°}{mg\cos 20°} = \tan 20°$.

Now, when $\theta = 25°$:

Newtons second law ↙:

$mg\sin 25° - F = ma$

$ma = mg\sin 25° - \mu R = mg\sin 25° - \tan 20°(mg\cos 25°)$

$\Rightarrow a = g\sin 25° - g\cos 25°\tan 20° = g(\sin 25° - \cos 25°\tan 20°)$.

=> Answer in H.

89. perpendicular when gradients m_1, m_2 obey: $m_1 = -\frac{1}{m_2}$.

So, $2p^2 - p = -\frac{1}{p-2}$

$(2p^2 - p)(p-2) = -1$

$\Rightarrow 2p^3 - p^2 - 4p^2 + 2p + 1 = 0$

$2p^3 - 5p^2 + 2p + 1 = 0$

$(p-1)(2p^2 - 3p - 1) = 0$ (by trying $p=1$, and it solved the equation, then factorising).

$p = 1$

or $2p^2 - 3p - 1 = 0$

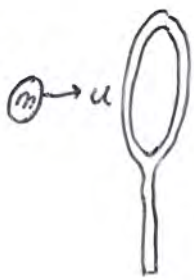
$p = \frac{3 \pm \sqrt{9+8}}{4} = \frac{3 \pm \sqrt{17}}{4}$ $\left(\sqrt{17} \approx \sqrt{16} = 4\right)$

$\approx \frac{3 \pm 4}{4}$

$= \frac{7}{4}$ or $-\frac{1}{4}$

=> largest value $\approx 7/4 = 1.75$. => B.

90.



$\Delta p = F \Delta t$ → true direction.

$= -F(t_2 - t_1)$.

$p = p_0 + \Delta p = mu - F(t_2 - t_1)$. But as ball moves to the left $|p| = F(t_2 - t_1) - mu$ => B.