Exam Papers Answers:

Sample Paper 1:

Q1. (a) (i) $v = 30\ m/s$ (ii) $20\ m/s$

Q2. (a) (ii) $32.5\ mins$ (iii) $\frac{2}{45}\ m/s^2$ (b) (i) 4.907% (ii) $D_n = 1.004D_{n-1} - A$

(iii) $250A + (120000 - 250A)(1.004)^n$ (iv) €936.50

Q3. (a) (ii) $T = \left(\frac{3k}{k+4}\right)mg$ (iii) $R = \left(\frac{3k}{k+4}\right)mg$ (b) (i) $\frac{x^3}{9}(3\ln x - 1) + c$ (ii) $160\ J$

Q4. (a) $15°$ or $75°$ (b) (i) $10.1\ m$ (ii) $15.4\ m$

Q5. (a) 2 days Classical, 1 day App Maths (33%) (b) (i) $36.87°$ (ii) $\sqrt{\frac{12}{5}gr}$ or $\frac{14\sqrt{3r}}{5}$ or $4.85\sqrt{r}$

Q6. (a) (i) $\frac{u}{4}, \frac{5u}{4}$ (ii) $0.93\ m/s$ (b) (i) $v = 2.5(1 - e^{-10t})$ (ii) $0.35\ m$

Q7. (a) (i) $k = \frac{1}{108}$ (ii) $u = \frac{3}{2}\ m/s$ (b) (i) $v = \frac{u}{(4ntu^n+1)^{\frac{1}{n}}}$ (ii) $v = \frac{u}{\sqrt{1+24u^2}}$

Q8. (a) (i) $v = \frac{12}{7}\ m/s$ (ii) $e = \frac{6}{7}$

Sample Paper 2:

Q1. (a) $25\ m$ (b) (ii) $39.8\ m$

Q2. (a) (i) €2700 (ii) €2600; Sell at end of years 1, 2, 3, 4

(b) (i) $v_a = \sqrt{\{\left(\frac{1-e}{2}\right)u\cos\alpha\}^2 + \{u\sin\alpha\}^2}$, $v_b = \left(\frac{1+e}{2}\right)u\cos\alpha$

Q3. (a) $0.228\ m$ (b) (i) $1.96\ m/s^2$ (ii) $0.33\ s$

Q4. (a) (i) $22.5°$ (ii) $165.9\ m$ (iii) $46.79\ m/s$

(b) (i) $v = 80e^{-\frac{1}{100}t}$ (ii) $s = 8000(1 - e^{-\frac{1}{100}t})$ (iii) $v = 80 - \frac{1}{100}s$

Q5. (a) (i) $\frac{u(3-2e)}{5}, \frac{u(3+8e)}{5}$ (b) (i) $P_{n+1} = 0.15P_n + 3000$

(ii) $\frac{60000}{17} + \frac{365000}{17}(0.15)^n$ (iii) 3602 (iv) 3529

Q6. (a) (ii) $a = (-\omega^2 r\cos\omega t)\vec{\imath} + (-\omega^2 r\sin\omega t)\vec{\jmath}$ (b) (ii) $f = 0.5$

Q7. (a) $36.87°$

Q8. (a) (i) $49\ s$ (ii) $31.25\ s$ (b) (i) $7\sqrt{2}\ m/s$ (ii) $\alpha = 80.41°$

Sample Paper 3:

Q1. (a) (i) $u_n = 600(2)^n - 7(5)^n$ (ii) $n = 5$ (b) (i) $20\ s$ (ii) $480\ m$ (iii) $420\ m$

Q2. (a) (i) $20\ m/s$ (ii) $1.6\ m/s^2$ (iii) $10\ s$ (iv) $\frac{400}{3}\ m$ (b) (i) $SBFGT$ (ii) €21000

Q3. (a) (i) $3.36\ N$ (ii) $1.4\ m/s$

Q4. (a) (ii) $49\ m/s$ (b) (ii) $5\ m/s$ (iii) $107.5\ m$

Q5. (a) (i) 0.63 (b) (i) $u_n = -5(2)^n + 6(3)^n$ (ii) 38086

Q6. (a) (i) $\frac{u(8e-1)}{3}, \frac{u(1+4e)}{3}$

Q7. (a) (i) $1\ s$ (ii) $0.65\ m$ (iii) $30.87\ m/s$ (b) (i) $k = 0.07324$ (ii) $28.8\ days$

Q8. (a) $420\ m/s$ (b) (i) $7200\ m$ (ii) $2931.75\ m$ (iii) $0.54\ m/s^2$

SEC HL Sample Paper 2020:

Q1. (a) (ii) $\begin{pmatrix} 0 & 2 & 0 \\ 1 & 1 & 2 \\ 1 & 1 & 0 \end{pmatrix}$ (b) (i) $u_2 = 6, u_3 = 9$ (ii) $u_{n+2} = u_{n+1} + u_n$ (iii) $u_n = 2.171\left(\frac{1+\sqrt{5}}{2}\right)^n + 0.829\left(\frac{1-\sqrt{5}}{2}\right)^n$ (iv) 5 *older ones*

Q2. (ii) *Disagree* (iii) *Agree* (v) *AEIL* (vi) 25 *days* (vii) 5 *days* (viii) *Morning of July* 11*th*

Q3. (a) $s = ut + \frac{1}{2}at^2 + s_o$ (b) (i) 1.5 s (iii) 16 m

Q4. (a) (i) $\frac{1}{e^2}$ (ii) $e^{10}H_0$ (b) (ii) $e = 0.577, \theta = 75°$

Q5. (a) (i) $ACGJLN, 72\ km$ (ii) 140 km (b) (i) $R = \frac{1200.e^{1200kt}}{11+e^{1200kt}}$ (ii) 0.000443

Q6. (i) $\vec{s} = r\cos\omega t\,\vec{i} + r\sin\omega t\,\vec{j}$ (ii) $\vec{v} = -\omega r\sin\omega t\,\vec{i} + \omega r\cos\omega t\,\vec{j}$ (v) $v_{max} = \sqrt{\mu g r}\ m/s$

Q7. (a) (i) $W = \frac{kx^2}{2}$ (ii) 0.47 m (b) (iii) $T = 1.17\ N, a = 1.9\ m/s^2$

Q8. (a) (i) $P_n = (\frac{24000-100B}{3})(1.03)^n + \frac{100}{3}B$ (ii) $P = \frac{e^{0.03n}(240-B)+B}{0.03}$ (iii) *Model* 1: 12512, *Model* 2: 12642 (v) 240

SEC HL Paper 2023:

Q1. (a) (ii) $BCAB$ or $BCDFB$..... (b) (i) $s(t) = 2(1 - e^{-t} - 2e^{-t})$ (ii) 1.6017

Q2. (a) *Cheapest* $= XAEDJMY$, €11450 (b) $P = \frac{4-8e}{5}\vec{i} + \frac{16}{5}\vec{j}, Q = \frac{4+4e}{5}\vec{i} + 3.2\vec{j}$

Q3. (iv) 8 *complete revolutions* (v) 1.5876 s

Q4. (iii) $v = \sqrt{\frac{1272e^{-2s}-147}{5}}$ (iv) 1.1 m (vi) $\frac{dv}{ds} = \frac{29.4-v^2}{v}$

Q5. (a) (ii) 1.14 m/s^2 (b) 08: 23

Q6. (i) $u_2 = 7, u_3 = 20$ (ii) $u_n = \frac{1}{4}(-1)^n + \frac{3}{4}(3)^n$ (iii) 44287 (iv) $v_n = \frac{1}{8}(3)^n - \frac{1}{8}(-1)^n + \frac{1}{8}n + 1$ (v) 7387

Q7. (a) (i) *Min Weight* $=$ 101 (ii) 137 *mins* (b) (i) $N = 2000 - 1750e^{-kt}$ (ii) $k = 0.20879$

Q8. (i) 28 m/s (ii) 110.53 m (iii) $\vec{p} = 28.68\vec{i} - 4.47\vec{j}, \vec{Q} = -12.32\vec{i} + 5.6\vec{j}$ (iv) −378.3696 (v) 15.57°

Q9. (iii) $AEJL$ or AEK *including* 2 *dummies* (v) D, E, F *or* G

Q10. (a) (i) $U_1 = 180, U_2 = 186$ (ii) $U_{n+1} = 1.2U_n - 30$ (iii) $U_n = 25(1.2)^n + 150$ (iv) 373 (b) (iii) $k = 5$

SEC HL Deferred Paper 2023:

Q1. (a) (i) $\begin{pmatrix} 2 & 7 & -2 \\ -9 & 10 & 8 \\ 7 & 1 & 2 \end{pmatrix}$ (b) (ii) $v = \sqrt{lg\sin\theta\tan\theta}$ (iii) $T = 2\pi\sqrt{\frac{l\cos\theta}{g}}$

Q2. (a) (ii) *Dijsktra's*, $ABDEG$, 174 ms (b) (i) $E_n = (101 - \frac{20C}{3})(1.15)^n + \frac{20C}{3}$ (ii) 16 (iii) $\frac{dE}{dn} = 0.15E - C$

Q3. (i) $c = \frac{3}{2}, d = \frac{9}{16}$ (ii) 420 *billion* (iii) $G_n = 200\left(\frac{3}{4}\right)^n + 40n\left(\frac{3}{4}\right)^n + 640, G_6 = 718$ *billion*

Q4. (i) $P = 10e^{0.08t}$ (ii) 52 *weeks* (iv) $P = \frac{20Ke^{0.08t}}{K-20+20e^{0.08t}}$ (v) 95

Q5. (i) 5 s (ii) $v = \frac{1}{k}((g + 20k)e^{-kt} - g)$ (iii) 1.82 s (iv) $\frac{dv}{dt} = g - kv$

Q6. (a) (i) 40.33 m (ii) 376.44 m (b) *Optimal*: $XBDFY$, €60,000

Q7. (ii) $\frac{u\sqrt{10}}{3}\vec{i} + 0\vec{j}$ (iii) $W = \frac{kx^2}{2}$ (iv) $x = \frac{u}{3}\sqrt{\frac{10m}{k}}\ m$

Q8. (ii) $a = 2.19\ m/s^2, T = 47.14\ N$ (iii) 1.32 m/s (iv) $-7.24\ m/s^2$ (v) 0.52 m

Q9. (iv) $AEIM$ (v) 16 *hours* (vi) *No*

Q10. (ii) 48.19° (iii) 3.13 m/s (iv) 0.46 s (v) 2.08 m

SEC HL Paper 2024:

Q1. (a) $\begin{pmatrix} -1 & -1 & 2 \\ 13 & 2 & -3 \\ -6 & 11 & 6 \end{pmatrix}$ (b) (i) $586\ km$ (b) (ii) $751\ m$ (c) $6.41s\ or\ 3.59s$

Q2. (a) (ii) $5.37°$ (b) (ii) $\frac{343}{11}N\ or\ 31.18N$

Q3. (a) $\frac{\pi^2-4}{8}\ m/s\ or\ 0.73\ m/s$ (b) (i) $\overrightarrow{V_a} = -eu\cos\alpha\,\vec{i} + u\sin\alpha\,\vec{j}, \overrightarrow{V_B} = eu\cos\alpha\,\vec{i} + u\sin\alpha\,\vec{j}$

Q4. (ii) $R = \frac{m{v_1}^2 - 13.4mg + 20.1mg\cos\alpha}{6.7}$ (iii) $v_2 = \sqrt{{v_1}^2 - 13.4g}$ (vi) $v = \frac{1}{k}\left(g + k(\sqrt{{v_1}^2 - 13.4g})\right)e^{-kt} - \frac{g}{k}$

Q5. (a) (i) $\frac{u-9eu}{5}, \frac{u+6eu}{5}$ (ii) $0 < e < \frac{1}{9}$

Q6. (a)(i) $P_{n+1} = 1.0012P_n - x$ (ii) $P_n = \left(13500 - \frac{250x}{3}\right)(1.012)^n + \frac{250x}{3}$ (iii) 148 (iv) 13602

(b) (i) $v = \sqrt{4\ln(\frac{2}{2-s})}$ (ii) $0.806\ m/s$

Q7. (a) (i) $\frac{7}{4\cos\alpha}\ s$ (ii) $\alpha = 58.12°\ or\ 35.96°$ (b) (ii) $10.22\ m/s$ (iv) 0.315

Q8. (a)(i) $XCDIY\ giving\ €6000\ profit$

Q9. (i) $M_2 = 395, M_3 = 578.75$ (ii) $M_n = 172.5(\frac{3}{2})^n + 27.5(-\frac{1}{2})^n$ (iii) $3602.8125\ kg$ (iv) $P_n = 175.25(\frac{3}{2})^n + 26.95(-\frac{1}{2})^n - \frac{4}{5}(2)^{n+2}$ (v) $3458\ kg$

Q10. (a) (i) $Finishing\ Time = 21\ days$ (ii) $BEJLM$ (b) $85.175\ s$

SEC HL Paper 2025:

Q1. (a)(i) $\begin{pmatrix} 2 & 2 & 1 \\ 1 & 1 & 1 \\ 3 & 1 & 0 \end{pmatrix}$ (ii) $\begin{pmatrix} 9 & 7 & 4 \\ 6 & 4 & 2 \\ 7 & 7 & 4 \end{pmatrix}$ (iii) Number of walks of length 2 between nodes (b) (ii) $21.23\ N$

(iii) $2.86\ rads/s$ (iv) $1.17\ m$

Q2. (ii) $v = \sqrt{16 + 2as}$ (iv) $v = \sqrt{408e^{\frac{-1}{20}s} - 392}$ (v) $0.8\ m$ (vi) $v = 14\sqrt{2}\tan(0.2 - \frac{7\sqrt{2}}{20}t)$

Q3. (a) (i) 0.208 (ii) $4.47\ m/s^2$ (b) (i) $56\ m$ (ii) Kruskal's

Q4. (ii) $1.57\ m/s, 1.71\ m/s$ (iv) $0.3 - 0.3\cos\theta$ (v) $v = \sqrt{5.88\cos\theta - 2.96}$ (vi) $32.24°$

Q5. (a) (ii) $g\sin\beta - \frac{g\cos\beta}{2}, g\sin\beta - \frac{2g\cos\beta}{5}$ (iii) $40.1°$

Q6. (a) (i) €29,100, 2/1/2 or 2/2/1 or 1/2/2 (b) (i) $13\ J$ (ii) $1.35\ m$

Q7. (i) $61\ km$ (b) (i) $61.44°, 40.79°$ (ii) $4.77\vec{i} - 2.05\vec{j}$ (iii) $0.94\ m$

Q8. (a) (i) $U_{n+2} - 3U_{n+1} + 2U_n = 0$ (ii) Homogeneous (iii) $u_n = 7(2)^n - 2$ (iv) 207

(b) (i) $P(t) = e^t(t^2 - 2t + 2) + 2198$ (ii) 4721

Q9. (a) (i) $1.82\ m/s^2$

Q10. (a) (i) 3435, 5258.75 (ii) $S_n = 2416(\frac{5}{4})^n - 425(-1)^n + 30n + 25$ (iii) $Yes, S_{12} = 35117.43$

(b) $36.6\ m/s$