

## Exam Papers Answers:

### Sample Paper 1:

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

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

(iii)  $250A + (120000 - 250A)(1.004)^n$  (iv)  $\text{€}936.50$

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)  $160 \text{ J}$

Q4. (a)  $15^\circ$  or  $75^\circ$  (b) (i)  $10.1 \text{ m}$  (ii)  $15.4 \text{ m}$

Q5. (a) 2 days Classical, 1 day App Maths (33%) (b) (i)  $36.87^\circ$  (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)  $0.93 \text{ m/s}$  (b) (i)  $v = 2.5(1 - e^{-10t})$  (ii)  $0.35 \text{ m}$

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

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

### Sample Paper 2:

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

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

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

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

Q4. (a) (i)  $22.5^\circ$  (ii)  $165.9 \text{ m}$  (iii)  $46.79 \text{ m/s}$

(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)  $a = (-\omega^2 r \cos \omega t)\vec{i} + (-\omega^2 r \sin \omega t)\vec{j}$  (b) (ii)  $f = 0.5$

Q7. (a)  $36.87^\circ$

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

### Sample Paper 3:

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

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

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

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

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)  $1 \text{ s}$  (ii)  $0.65 \text{ m}$  (iii)  $30.87 \text{ m/s}$  (b) (i)  $k = 0.07324$  (ii)  $28.8 \text{ days}$

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

**Sample Paper 4:**

Q1. (a) (i)  $\frac{u(1-15e)}{4}, \frac{u(1+9e)}{4}$  (b)  $x \sin^{-1} 2x + \frac{1}{2}\sqrt{1-4x^2} + c$

Q2. (a) (ii)  $\sqrt{\frac{8gR}{5}}$  or  $3.96\sqrt{R}$  (b) (i)  $P_n = 20 + 5(-0.8)^n$  (ii)  $P_2 = 23.2$  billion,  $P_3 = 17.44$  billion (iv) 20 billion

Q3. (a) (ii) ADEHI, 80 days (iii) B (3), C(5), D(4), G(3) (iv) 3 workers (b) (i) 8 s (ii) 313.6 m

Q4. (a) (ii) 40.66 m (b)  $\frac{g}{5}, \frac{g}{5}, \frac{2g}{5}$

Q5. (a) (i)  $\begin{pmatrix} 0 & 1 & 1 \\ 0 & 1 & 3 \\ 2 & 0 & 0 \end{pmatrix}$  (ii)  $\begin{pmatrix} 6 & 3 & 5 \\ 6 & 7 & 9 \\ 4 & 2 & 6 \end{pmatrix}$  (iii) 5 walks: (ABBC  $\times$  3, ACAC  $\times$  2) (b) (ii)  $k = 7$

Q6. (a) 9.84 m (b) (i)  $V_n = (500 + 125n)(0.8)^n + 100n - 200$  (ii) False - will continue to increase

Q7. (a) 2.56 s (b) (i)  $T = \frac{8mg}{5}$  (ii)  $h = 0.0136$  m (iii)  $R = \frac{6mg}{5}$

Q8. (a) (i)  $-22.5^\circ, 67.5^\circ$  (ii) 6.47 s, 2.68 s (b) (i)  $5u, \sqrt{17}u$  (ii)  $67.17^\circ$

**Sample Paper 5:**

Q1. (a) (ii)  $\frac{210}{17}$  m (b) 6.26 m/s

Q2. (a) (i) 87.5 m, 90 m (b) (ii)  $k = 0.0785$  (iii) 3.7 hrs

Q3. (a) (i)  $a = \frac{g}{3+m}$  (ii)  $m = 2$  (b)  $u_n = (2)^n + (5)^n + n^2$

Q4. (a) (i)  $r = \tan^{-1} t - 0.67$  (ii)  $y = -2.7$  (b) (ii)  $\frac{u\sqrt{3}(1+7e)}{6(1+e)}$

Q5. (a) (ii) 62.5 m (b)  $\frac{1}{13}e^{2x}(2 \cos 3x + 3 \sin 3x) + c$

Q6. (a) (i)  $\frac{u(3-7e)}{2}, \frac{u(3+7e)}{2}$  (b) (ii) Route: ACEGI, No. of Bags = 64

Q7. (a) (ii) 2.46 m (iii) 1.88 m/s (b) (i)  $v = \sqrt{2gr}$  (ii)  $d = \frac{r}{\mu}$  (iii) 5 m

Q8. (a) (i)  $a = 2, b = -10, c = 15$  (ii) 6 m/s<sup>2</sup> (iii) 2.67 m (b) (i) ADGF, 460 m (ii) ABEGF, 470 m

**Sample Paper 6:**

Q1. (a) (ii)  $\frac{0.134u^2}{g}$  or  $0.014u^2$  or  $\frac{(2-\sqrt{3})u^2}{2g}$  (b) (i)  $x = (P - 40n)e^{\frac{t}{40}} + 40n$  (ii) 4.99 years

Q2. (a) (ii)  $\frac{3g}{11}$  m/s<sup>2</sup> (iii)  $\frac{40mg}{11}, \frac{16mg}{11}$

Q3. (a) (i)  $\frac{u(5-4e)}{3}, \frac{u(5+8e)}{3}$  (ii)  $I = \frac{8mu}{3}(1+e)$  (iii)  $k = \frac{16}{3}$  (b) (i)  $\begin{pmatrix} 1 & 2 & 0 \\ 2 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}$  (ii)  $\begin{pmatrix} 9 & 12 & 2 \\ 12 & 4 & 5 \\ 2 & 5 & 0 \end{pmatrix}$  (iii) 12

Q4. (a) (ii) BD, AC, DF, BC, DE, Length = 18 km (iv) (B, D), (D, F), (B, C), (A, C), (D, E)

(b) (i)  $0^\circ, 71.6^\circ$  (ii)  $\sqrt{\frac{2h}{g}}, \sqrt{\frac{20h}{g}}$

Q5. (a) (i) 47.04 m (ii) 33.32 m/s (b) (i)  $P_n = 2975(0.5)^n - 1775(0.9)^n + 800n + 2000$  (ii) 9384

Q6. (a) (ii)  $T = \frac{8mg}{8+m}$  (iii)  $m = 8$  (b) (ii)  $d = \frac{3u^2}{2a}$

Q7. (a) (i)  $v = 5t + 8e^{-t} - 6$  (ii) 1.35 m/s (iii) 0.73 m

(b) (i)  $\sqrt{\left\{\frac{2}{5}u \cos \alpha\right\}^2 + \left\{4u \sin \alpha\right\}^2}, \sqrt{\left\{\frac{7}{5}u \cos \alpha\right\}^2 + \left\{-u \sin \alpha\right\}^2}$  (ii)  $38.66^\circ$

Q8. (a)  $k = 2$  (b)  $s = \frac{4d}{27}$

**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 11th

Q3. (a)  $s = ut + \frac{1}{2}at^2 + s_0$  (b) (i) 1.5 s (iii) 16 m

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

Q5. (a) (i) ACGJLN, 72 km (ii) 140 km (b) (i)  $R = \frac{1200 \cdot e^{1200kt}}{11 + e^{1200kt}}$  (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)  $v_{max} = \sqrt{\mu gr}$  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<sup>2</sup>

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

**SEC OL Sample Paper 2020:**

Q1. (a) (i)  $\vec{b} = 9\vec{i} + 12\vec{j}, \vec{c} = 5\sqrt{3}\vec{i} - 15\vec{j}$  (ii) -102.06 (iii)  $k = 3$

(b) (i) 3.7 m/s (ii) 9.13 N (iii)  $T = 28.73$  N

Q2. (a) (ii) 860 s (iii) B or D (b) (ii) BFIL (iii) 47 mins (iv) G: 6 mins

Q3. (a) (i)  $P_n = (92307.69)(1.052)^n + 57692.31$  (ii) €182,813.92 (iii) Cormac by €3073.71

(b) (i)  $x = 3, -1$  (ii)  $u_n = 5(3)^n + 3(-1)^n$  (iii) 1820 cars

Q4. (i)  $20.38\vec{i} + 17.71\vec{j}$  (ii)  $24.07 \frac{m}{s}, E32.15^\circ N$  (iii) 1.81 s (iv) 16 m (v) 3.323 s

Q5. (a) (i)  $P = -\frac{1}{4}\vec{i}, Q = \frac{11}{4}\vec{j}$  (ii)  $\frac{165}{8}mJ$  or 20.625mJ

(b) (i)  $R_n = 160(0.7)^n$  (ii) 18.82 cm (iii) 489.41 m (iv)  $R_{n+1} = R_n$

Q6. (ii) 2g N (iii)  $\frac{18g}{5}$  N (iv) 1.77 m/s

Q7. (a)  $\begin{pmatrix} 0 & 1 & 0 & 0 \\ 1 & 1 & 1 & 1 \\ 0 & 1 & 0 & 2 \\ 0 & 1 & 2 & 0 \end{pmatrix}$  (b)  $\begin{pmatrix} 4 & 2 \\ -2 & 2 \end{pmatrix}$  (c) ABGIJ, 148 passengers

Q8. (i) 11 m/s (iii)  $5t + 0.2t^2$  (iv)  $4t + 0.3t^2$  (v) 50 s (vi) 52 s

**SEC HL Paper 2023:**

Q1. (a) (ii) BCAB or BCDFB..... (b) (i)  $s(t) = 2(1 - e^{-t} - 2e^{-2t})$  (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<sup>2</sup> (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) *Dijkstra'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)  $a = 2.19 \text{ m/s}^2, T = 47.14 \text{ N}$  (iii) 1.32 m/s (iv)  $-7.24 \text{ m/s}^2$  (v) 0.52 m

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

Q10. (ii)  $48.19^\circ$  (iii) 3.13 m/s (iv) 0.46 s (v) 2.08 m