

SKILLS CHECK – A LEVEL MECHANICS ANSWERS

QUESTION 1

$$\begin{aligned}R + T\sin 30 &= 200g & F &= 200 \times 2.2 \\Fr &= 0.3(200g - T\sin 30) & &= 440 \text{ N} \\T\cos 30 - 0.3(200g - T\sin 30) &= 440 \\T(\cos 30 + 0.3\sin 30) &= 1028 \\T &= 1010 \text{ N (3 s.f.)}\end{aligned}$$

QUESTION 2

$$\begin{aligned}u &= 4.9 \text{ ms}^{-1} \\a &= -9.8 \text{ ms}^{-2} \\v &= 0 \text{ ms}^{-1} \\v^2 &= u^2 + 2as \\0 &= 24.01 - 19.6s \\s &= 1.225 \text{ m} \\ \text{Max height} &= 3.025 \text{ m} & \text{Bounce height} &= 2.12 \text{ m}\end{aligned}$$

QUESTION 3

$$\begin{aligned}5 - 0.4g &= 0.4a \\a &= 2.7 \text{ ms}^{-2} \\mg - 5 &= 2.7m \\m(g - 2.7) &= 5 \\m &= 0.704 \text{ kg}\end{aligned}$$

QUESTION 4

$$\begin{aligned}\text{From A : } -1 \times 40g + 2.25T_B &= 0 \\T_B &= 174 \text{ N (3sf)} \\ \text{From B : } 1.25 \times 40g - 2.25T_A &= 0 \\T_A &= 218 \text{ N (3 sf)}\end{aligned}$$

QUESTION 5

$$\begin{aligned}u &= 3i - 2j \\a &= i + 2j \\t &= 4 \\s &= ut + \frac{1}{2}at^2 \\s &= 12i - 8j + 8i + 16j \\&= 20i + 8j & \text{Magnitude} &= \sqrt{20^2 + 8^2} \\& & &= 4\sqrt{29} \\& & &= 21.5 \text{ m}\end{aligned}$$

WEEK 1

SKILLS CHECK - A LEVEL MECHANICS ANSWERS

QUESTION 1

° Working in 'j' only

$$u = U \sin \theta$$

$$a = -g$$

$$v = 0$$

$$v^2 = u^2 + 2as \quad 0 = U^2 \sin^2 \theta - 2gs$$

$$s = \frac{U^2 \sin^2 \theta}{2g}$$

QUESTION 2

$$80 - F_r = 30 \times 2.2$$

$$F_r = 80 - 66 \\ = 14 \text{ N}$$

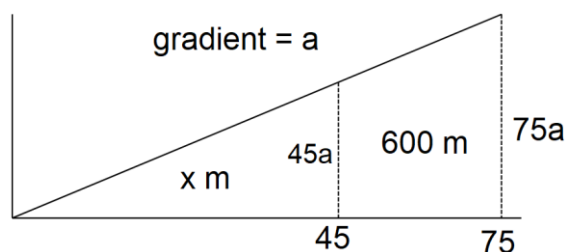
QUESTION 3

$$x = \frac{45^2 a}{2} \quad x + 600 = \frac{75^2 a}{2}$$

$$\frac{45^2 a}{2} + 600 = \frac{75^2 a}{2}$$

$$5625a - 2025a = 1200$$

$$a = \frac{1}{3} \quad x = 337.5 \text{ m (338m)}$$



QUESTION 4

$$v = 6 + 24t^2 - 3t^3$$

$$a = 48t - 9t^2$$

$$a > 0$$

$$3t(16 - 3t) > 0$$

$$0 < t < \frac{16}{3}$$

QUESTION 5

From A

$$-4 \times 50 - 2.5 \times 40 + 8 \times T_B = 0$$

$$T_B = 37.5 \text{ N}$$

From B

$$4 \times 50 + 5.5 \times 40 - 8 \times T_A = 0$$

$$T_A = 52.5 \text{ N}$$

WEEK 2

SKILLS CHECK - A LEVEL MECHANICS ANSWERS

QUESTION 1

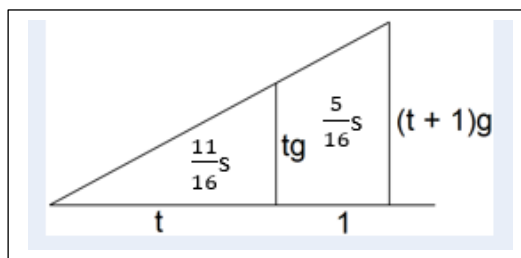
$$t^2g = \frac{11}{16}s \quad (t+1)^2g = s$$

$$t^2g = \frac{11}{16}(t+1)2g$$

$$16t^2 = 11t^2 + 22t + 11$$

$$5t^2 - 22t - 11 = 0$$

$$t = 4.85 \quad s = 168 \text{ m}$$



QUESTION 2

$$R = 10g\cos\theta \text{ N}$$

$$Fr = 2.5g\cos\theta \text{ N}$$

$$10g\sin\theta - 2.5g\cos\theta = 0$$

$$\tan\theta = \frac{1}{4}$$

$$\theta = 14.0^\circ$$

QUESTION 3

$$6g - T = 6a$$

$$T - 10 = 5a$$

$$6g - 10 = 11a$$

$$a = 4.44 \text{ ms}^{-2}$$

QUESTION 4

$$T_A = 1.2T_B \text{ Let } x = \text{distance from b}$$

From A $10T_B - 5 \times 40 - 20(10-x) = 0$

$$10T_B + 20x = 400$$

From B $5 \times 40 + x - 10 \times 1.2T_B = 0$

$$12T_B - 20x = 200$$

$$22T_B = 600 \quad T_B = 27.27 \quad x = 6.36 \text{ m}$$

QUESTION 5

$$\mathbf{r} = (2t^2 - 3t)\mathbf{i} + (t^3 - 2t)\mathbf{j}$$

$$\mathbf{v} = (4t - 3)\mathbf{i} + (3t^2 - 2)\mathbf{j}$$

$$\mathbf{a} = 4\mathbf{i} + 6t\mathbf{j}$$

$$|\mathbf{a}| = \sqrt{4^2 + 24^2}$$

$$= \sqrt{592}$$

$$= 24.3 \text{ ms}^{-2}$$

SKILLS CHECK - A LEVEL MECHANICS ANSWERS

QUESTION 1

$$r = 5t + 3\sin t + 4\cos t \text{ m}$$

$$v = 5 + 3\cos t - 4\sin t \text{ ms}^{-1}$$

Max values occurs when $3\cos t - 4\sin t$ is maximum

$$3\cos t - 4\sin t = R(\cos(t + \theta))$$

$$R\cos\theta = 3 \quad R\sin\theta = 4$$

$$R = \sqrt{3^2 + 4^2}$$

$$R = 5 \quad \text{max value of } 3\cos t - 4\sin t = 5 \quad \text{Max velocity} = 10 \text{ ms}^{-1}$$

QUESTION 2

$$r_1 = 2i - 5j$$

$$v = i + 3j \text{ ms}^{-1}$$

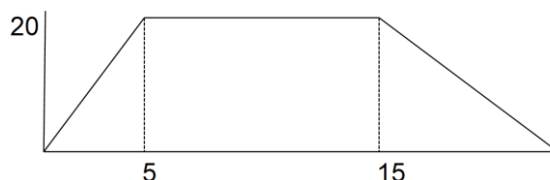
Displacement when $t = 5$ is $5i + 15j$

$$\begin{aligned} \text{Displacement from the origin} &= 2i - 5j + 5i + 15j \\ &= 7i + 10j \end{aligned}$$

$$\begin{aligned} \text{Distance from origin} &= \sqrt{7^2 + 10^2} \\ &= \sqrt{149} \\ &= 12.2 \text{ m} \end{aligned}$$

QUESTION 3

$$\begin{aligned} s &= \frac{1}{2} \times 20 \times 5 + 200 + \frac{1}{2} \times 13\frac{1}{3} \times 20 \\ &= 383\text{m} \end{aligned}$$



QUESTION 4

$$u = 10\cos 40^\circ i + 10\sin 40^\circ j \text{ ms}^{-1}$$

$$a = -9.8 \text{ ms}^{-2}$$

$$s_i = 4 \text{ m}$$

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

$$4 = 10\cos 40^\circ t + 0$$

$$t = 0.522$$

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

$$= 10\sin 40^\circ \times 0.522 - 4.9 \times 0.522^2$$

$$= 2.02 \text{ m} \quad \text{Height} = 3.62 \text{ m}$$

QUESTION 5

$$R + 25\sin 30 = 6g$$

$$R = 46.3 \text{ N}$$

$$Fr = 25\cos 30$$

$$Fr = 21.7 \text{ N}$$

$$\text{Coefficient of friction} = 0.469$$

SKILLS CHECK - A LEVEL MECHANICS ANSWERS

QUESTION 1

$$R = 6g\cos 22^\circ \text{ N}$$

$$= 54.5 \text{ N}$$

$$Fr = 6g\sin 22^\circ \text{ N}$$

$$= 22.0 \text{ N}$$

$$\text{Coefficient of friction} = 0.404$$

QUESTION 2

$$u = (8i + 24j) \text{ ms}^{-1}$$

$$a = -9.8j \text{ ms}^{-2}$$

$$s = xi + 0j$$

Working in j

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

$$0 = 24t - 4.9t^2$$

$$t(24 - 4.9t) = 0$$

$$t = 0 \quad t = 4.898\text{s}$$

$$s_i = 8 \times 4.898 \\ = 39.2 \text{ m}$$

QUESTION 3

$$F = 0.2g - 1.5 \text{ N}$$

$$= 0.46$$

$$F = ma$$

$$a = 2.3\text{ms}^{-2}$$

$$u = 0$$

$$t = 3 \quad s = 0 + \frac{1}{2} \times 2.3 \times 9 \\ = 10.4\text{m}$$

QUESTION 4

$$v = (3 - 2t)i + (2t - 1)j$$

$$r = (3t - t^2 + 4)i + (t^2 - t)j$$

Traveling due south then $3 - 2t = 0 \quad t = 1.5 \text{ s}$

$$r = (3t - t^2 + 4)i + (t^2 - t)j$$

$$r = 6.25i + 0.75j$$

$$|r| = 6.29 \text{ m}$$

QUESTION 5

$$\text{Force} = 3i + 2j + 4i - 3j$$

$$= 7i - j$$

$$F = 0.4a$$

$$0.4a = 7i - j$$

$$a = 17.5i - 2.5j$$

$$|a| = 17.7 \text{ ms}^{-2}$$

WEEK5

SKILLS CHECK - A LEVEL MECHANICS ANSWERS

QUESTION 1

$$u = 10$$

$$s = 25$$

$$v = 0$$

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

$$0 = 10^2 + 50a$$

$$a = -2\text{ms}^{-2}$$

$$F = -4 \text{ N}$$

$$R = 19.6 \text{ N}$$

$$\text{Coefficient of friction} = 0.204$$

QUESTION 2

$$r = (2t - 5)\mathbf{i} + (2\sin t - 3\cos t)\mathbf{j}$$

$$v = 2\mathbf{i} + (2\cos t + 3\sin t)\mathbf{j}$$

Max velocity occurs where $(2\cos t + 3\sin t)$ is at its maximum

$$2\cos t + 3\sin t = R\cos(t - \theta)$$

$$R = \sqrt{2^2 + 3^2}$$

$$= 3.61$$

$$\text{Maximum velocity} = 2\mathbf{i} + 3.61\mathbf{j}$$

$$|v| = 4.13 \text{ ms}^{-1}$$

QUESTION 3

Let x = distance of the support from A

$$50g \times x = (5 - x) \times 40g + (10 - x) \times 60g$$

$$50x = 200 - 40x + 600 - 60x$$

$$150x = 800$$

$$x = 5.33\text{m}$$

QUESTION 4

$$60 \times 0.8 - F \times 1$$

$$F = 48 \text{ N}$$

QUESTION 5

$$F = ma$$

$$-3g\sin 18^\circ = 3a$$

$$a = -3.03\text{ms}^{-2}$$

$$u = 4 \text{ ms}^{-1}$$

$$s = 0$$

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

$$0 = 4t - 1.515t^2$$

$$t(4 - 1.515t) = 0 \quad t = 2.64 \text{ s}$$

WEEK 6

SKILLS CHECK - A LEVEL MECHANICS ANSWERS

QUESTION 1

Let d be the distance from the centre of the seesaw to the second child

$$1.75 \times 35g = 42dg$$

$$d = 1.49 \text{ m}$$

Distance between the children = 3.21 m

QUESTION 2

$$R = mg \cos 40^\circ$$

$$F = mg \sin 40^\circ$$

$$\text{Coefficient of friction} = \frac{mg \sin 40^\circ}{mg \cos 40^\circ}$$

$$= 0.839$$

QUESTION 3

(Working in 'j')

$$u = 1.5 \sin 40^\circ \text{ ms}^{-1}$$

$$a = -9.8 \text{ ms}^{-2}$$

$$s = -1.7 \text{ m}$$

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

$$v^2 = (1.5 \sin 40^\circ)^2 - 2 \times 9.8 \times -1.7$$

$$v_j = 5.85 \text{ ms}^{-1}$$

QUESTION 4

$$T - 5g \sin 30^\circ = 5a$$

$$3g - T = 3a$$

$$3g - 5g \sin 30^\circ = 8a$$

$$a = 0.613 \text{ ms}^{-2}$$

QUESTION 5

$$F_1 = 2i + 6j - k$$

$$F_2 = i - 2j + 4k$$

$$F_3 = i - j + 2k$$

$$F = 4i + 3j + 5k$$

$$8a = 4i + 3j + 5k$$

$$a = \frac{1}{2}i + \frac{3}{8}j + \frac{5}{8}k$$

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

$$r = \frac{1}{2} \times 4^2 \times \left(\frac{1}{2}i + \frac{3}{8}j + \frac{5}{8}k \right)$$

$$|r| = \sqrt{4^2 + 3^2 + 5^2}$$

$$= 7.07 \text{ m}$$

WEEK 7