

# SKILLS CHECK – A LEVEL MECHANICS ANSWERS

QUESTION 1

$$R + T\sin 30 = 200g$$

$$Fr = 0.3(200g - T\sin 30) = 440 \text{ N}$$

$$T\cos 30 - 0.3(200g - T\sin 30) = 440$$

$$T(\cos 30 + 0.3\sin 30) = 1028$$

$$T = 1010 \text{ N (3 s.f.)}$$

$$F = 200 \times 2.2$$

QUESTION 2

$$u = 4.9 \text{ ms}^{-1}$$

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

$$v = 0 \text{ ms}^{-1}$$

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

$$0 = 24.01 - 19.6s$$

$$s = 1.225 \text{ m}$$

$$\text{Max height} = 3.025 \text{ m} \quad \text{Bounce height} = 2.12 \text{ m}$$

QUESTION 3

$$5 - 0.4g = 0.4a$$

$$a = 2.7 \text{ ms}^{-2}$$

$$mg - 5 = 2.7m$$

$$m(g - 2.7) = 5$$

$$m = 0.704 \text{ kg}$$

QUESTION 4

$$\text{From A : } -1 \times 40g + 2.25T_B = 0$$

$$T_B = 174 \text{ N (3sf)}$$

$$\text{From B : } 1.25 \times 40g - 2.25T_A = 0$$

$$T_A = 218 \text{ N (3 sf)}$$

QUESTION 5

$$u = 3i - 2j$$

$$a = i + 2j$$

$$t = 4$$

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

$$s = 12i - 8j + 8i + 16j$$

$$= 20i + 8j$$

$$\text{Magnitude} = \sqrt{20^2 + 8^2}$$

$$= 4\sqrt{29}$$

$$= 21.5 \text{ m}$$

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

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

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

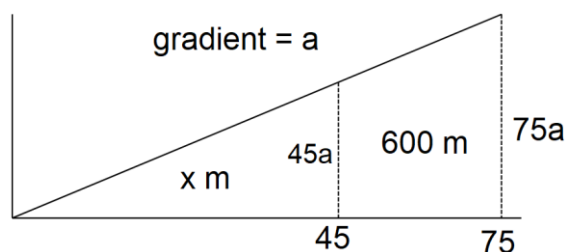
QUESTION 3

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

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

$$5625a - 2025a = 1200$$

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



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

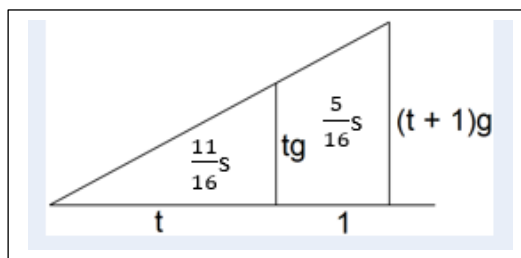
$$t^2g = \frac{11}{16}s \quad (t+1)^2g = s$$

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

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

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

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



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

$$r_1 = 2i - 5j$$

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

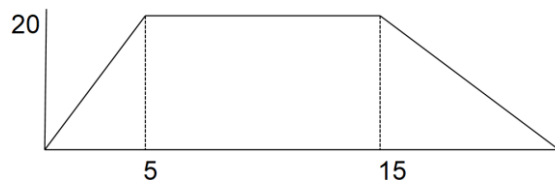
Displacement when  $t = 5$  is  $5i + 15j$

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

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

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

$$\begin{aligned}R &= 6g\cos 22^\circ \text{ N} \\ &= 54.5 \text{ N} \\ F_r &= 6g\sin 22^\circ \text{ N} \\ &= 22.0 \text{ N} \\ \text{Coefficient of friction} &= 0.404\end{aligned}$$

QUESTION 2

$$\begin{aligned}u &= (8i + 24j) \text{ ms}^{-1} \\ a &= -9.8j \text{ ms}^{-2} \\ s &= xi + 0j \\ \text{Working in } j \\ s &= ut + \frac{1}{2}at^2 \\ 0 &= 24t - 4.9t^2 \\ t(24 - 4.9t) &= 0 \\ t = 0 \quad t &= 4.898\text{s} \quad s_i = 8 \times 4.898 \\ &= 39.2 \text{ m}\end{aligned}$$

QUESTION 3

$$\begin{aligned}F &= 0.2g - 1.5 \text{ N} \\ &= 0.46 \\ F &= ma \\ a &= 2.3\text{ms}^{-2} \\ u &= 0 \\ t = 3 \quad s &= 0 + \frac{1}{2} \times 2.3 \times 9 \\ &= 10.4\text{m}\end{aligned}$$

QUESTION 4

$$\begin{aligned}v &= (3 - 2t)i + (2t - 1)j \\ r &= (3t - t^2 + 4)i + (t^2 - t)j \\ \text{Traveling due south then } 3 - 2t &= 0 \quad t = 1.5 \text{ s} \\ r &= (3t - t^2 + 4)i + (t^2 - t)j \\ r &= 6.25i + 0.75j \\ |r| &= 6.29 \text{ m}\end{aligned}$$

QUESTION 5

$$\begin{aligned}\text{Force} &= 3i + 2j + 4i - 3j \\ &= 7i - j \\ F &= 0.4a \\ 0.4a &= 7i - j \\ a &= 17.5i - 2.5j \\ |a| &= 17.7 \text{ ms}^{-2}\end{aligned}$$

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