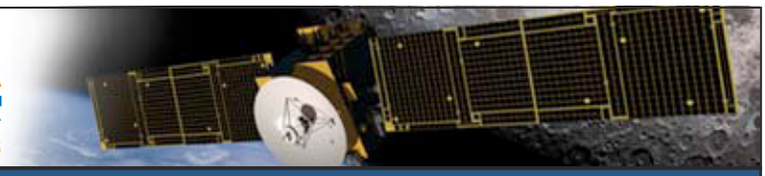
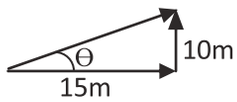
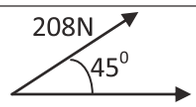
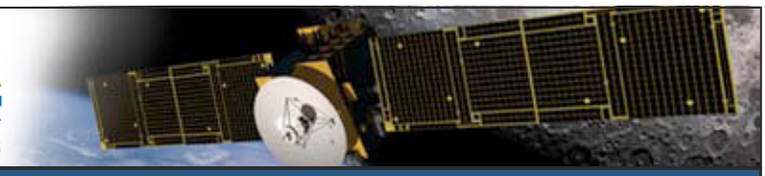
STAWA
SCIENCE TEACHERS' ASSOCIATION OF WESTERN AUSTRALIA
EXPLORING PHYSICS STAGE 3



Motion and Forces in a Gravitational Field: Set 1

Set	Number	Solution
1	1	Velocity is a vector quantity. It contains information about the magnitude and direction of a quantity. Performing mathematics with vectors must includes the direction; 20 m s^{-1} East followed by 20 m s^{-1} West does not have the same consequence as 20 m s^{-1} North followed by 20 m s^{-1} East.
	2a	18 m N 56° E $s_p = \sqrt[2]{(15^2) + (10^2)}$ s_p= 18m tan Θ= 10/15 Θ= 34° N of E or N 56° E 
	2b	22 m N 63° W $s_b = \sqrt[2]{(20^2) + (10^2)}$ s_b = 22 m tan Θ= 20/10 Θ= 64^0 N of W
	3	294 N Resolve 1 side horizontally 208 N × cos 45^0 = 147 N There are 2 sides: 147 N × 2 = 294 N 
	4	3.8 m s^{-1} at 23° to rip $v_s = \sqrt[2]{1.5^2 + 3.5^2}$ V_s = 3.8 m s^{-1} tan Θ= 1.5/3.5
	5a	42°
	5b	3.4 m s^{-1} at 53° to the bank $v_c = \sqrt[2]{2.7^2 + 2^2}$ tan Θ= 2.7/2
	5c	30 m Horizontally: time = 40m/2.7 ms^{-1} = 14.8s In 14.8s vertically 14.8s × 2 ms^{-1} = 30m
	6a	9.2 km Displacement East = 6km, Displacement South = 7km $d_s = \sqrt[2]{6^2 + 7^2}$ = 9.2 km
	6b	N 41° W tan Θ= 6/7
	7	5.5 m s^{-1} away from the player Δ_v= 0 − 5.5 = −5.5, minus sign indicates opposite direction to original movement – so away from player
	8	47 m s^{-1} toward the opponent 90 km h^{-1} = 25 m s^{-1}, 80 km h^{-1}=22 m s^{-1} Take motion towards the opponent as positive Δ_v= −25 − 22 = −47 m s^{-1}
	9	32 m s^{-1} at 51° to the final velocity Resolve h Δv_h =20 $\cos 45^0$ –(-25$\cos 45^0$) = 31.81 Resolve v Δv_v = -20 $\sin 45^0$ - (-25$\sin 45^0$) = 3.53 $\Delta v = (31.81^2 + 3.53^2)^{0.5}$ = 32m s^{-1}. tanΘ= 3.53/31.81 Θ = 6° But this is to horizontal, add to 45°, change in velocity 51°
	10	212 N in the forward direction Each skater is pulling at an angle of 45^0. Resolve for 1 skater: 150N ×$\sin 45^0$ = 106 N. 2 skaters so total in forward direction = 212 N



Motion and Forces in a Gravitational Field: Set 1

Set	Number	Solution
1		Resolve horizontally $\Delta v_h = 30 \cos 45^o - -30 \cos 45^0 = 42.4$ m s^{-1} Resolve vertically $\Delta v_v = -30 \sin 45^o - -30 \sin 45^0 = 0$ So only change in velocity is horizontally, along a line bisecting initial and final velocities. Initial & final velocities are at 90° to each other, so Δv is at 45° to initial & final velocities 42 m s^{-1} at 45° to both initial and final velocities
	12a	Position 1: 427 N toward the Earth Use towards moon as positive Resultant force F = -480N + 53.2 N = -427N, so towards Earth
	12b	$F = (359^2 + 13.1^2)^{0.5} = 359$N $\tan \Theta = 13.1/359$ $\Theta = 2.10^0$ Position 2: 359 N at 2.10° to the line joining the Earth and the asteroid
	13	Resolve horizontally: $v_h = 45$ m s$^{-1} \times \sin 18^o = 43$ m s^{-1} 43 m s^{-1}
	14	$v = (1.4^2 + 1.1^2)^{0.5}$ $\tan \Theta = 1.1/1.4$ 1.78 m s^{-1} N 38.2° E
	15a	Resolve horizontally for 1 person $F_h = 600 \times \cos 12^o = 587$ N 2 people so total force parallel to track is 1.17×10^3 N
	15b	Resolve vertically $F_v = 600 \times \sin 12^0 = 125$N 125 N
	16	Rate to rise, resolve vertically: 25 m s^{-1} $\times \sin 35^0 = 14$ m s^{-1}, Rate towards pin, resolve horizontally; 25 m s$^{-1} \times \cos 35^0 = 20$ m s^{-1}
	17	Gravity is 'diluted' down the plane; $a = g \sin \Theta = 9.8 \times \sin 25^0 = 4.14$ m s^{-2} down the slope
	18	35 km h^{-1} = 9.72 m s^{-1} Resolve vertically: $v_v = 9.72 \times \sin 30^0 = 4.86$ m s^{-1} t = s/v = 12 m/4.86 m s^{-1} =2 .5 s
	19	Resolve towards boat $F_{min} = 250$ N $\times \sin 45^o = 177$ N 177 N perpendicular to, and toward, the path of the boat
	20a	Horizontal motion: t = v/s t = 45 m/13 m s^{-1} = 3.5 s
	20b	Vertically s = v × t = 8.5 m s^{-1} × 3.5 s = 30 m
	21 a	When the plank is horizontal all the force applied acts vertically. When the plank is inclined a proportion of the force acts horizontally.
	21b	$T_{max} = 166g$ $166g = 197g \cos \Theta$ $\Theta = 32.6°$
	22	Resolve all horizontally 220 N × cos 30° = 191 N 180 N × cos 12° = 176 N 170 N × cos 10° = 167 N 200 N × cos 25° = 181 N Resolve all vertically +220 N × sin 30° = 110N +180 N × sin 12° = 37N -170 N × sin 10° = -30N -200 N × sin 25° = -85N Resultant horizontally = 715N away from boat, vertically 32 N towards top of page $F_r = (715^2 + 32^2)^{0.5} = 716$N $\tan \Theta = 32/715$ 716 N at 2.7° to the left of the boat's path