**DYNAMICS WORKSHEET 1 – FORCES**

**Solutions are supplied at the end of this worksheet.**

1. Explain the difference between “mass” and “weight”.
2. Define the term “normal reaction force”?
3. State in words Newton’s Laws of Motion and provide any associated equations. You MUST know these off by heart.
4. An unbalanced force of 48N west is applied to a 4 kg cart. Calculate the cart’s acceleration. (12ms-2 west)
5. A 2200 kg car, travelling at 25 m/s south, comes to a stop in 10 s. Calculate (a) the car’s acceleration and (b) the unbalanced force required to cause that acceleration. (2.5 ms-2 north & 5500 N north)
6. A particular pressure on the accelerator of a 4-wheel drive van of mass 2000 kg, travelling along a smooth, level road supplies sufficient force from the engine to accelerate the van at 5 ms-2. When this same van travels through soft sand, the same pressure on the accelerator results in a constant velocity of the van. Determine the force due to friction acting on the van in the soft sand. (1 x 104N)
7. The driver’s handbook in a particular country states that the minimum safe distance between vehicles on the road is the distance a vehicle can travel in 2 s at constant speed. Assume that a 1200 kg car is travelling south at 72 km/h when the truck ahead crashes into a northbound truck and comes to a sudden stop.

	1. If the car is at the required safe distance behind the truck, what is the separation distance between the car and the truck in metres? (40m)
	2. If the average braking force exerted by the car is 6400 N north, how long would it take the car to stop? (3.75s)
	3. What additional data would you need to obtain to determine whether or not the car would be involved in a collision? Assume that the car diver has a reaction time of 0.1s.
8. The diagram below shows a spring balance connected via two inextensible strings to two identical masses.



What will be the reading (in newtons) on the spring balance? Explain.
9. When you walk, you apply a force backwards on the earth. Likewise, the earth applies a force to you of equal magnitude but in the opposite direction. So, you move forward.

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A 67kg woman starts running along a straight, level path. With each stride she applies 1500N force backwards on the Earth.

	1. State the magnitude and direction of the force applied by the Earth on the woman with each stride she takes.
	2. Name the Law of Physics you used to determine your answer to (a).
	3. Determine the size of the acceleration of the woman produced with each stride.
	4. Calculate the magnitude of the acceleration of the Earth caused by the woman with each stride she takes. (Mass of Earth is 5.97 x 1024 kg)
	5. Compare the two accelerations calculated in parts (c) & (d).

**SOLUTIONS TO WORKSHEET 1**

**Note:** For questions 1, 2 & 3, please refer to the relevant sections of the Dynamics Notes on this website.

1. a = F/m and so a = 48/4 and therefore a = 12 ms-2 west.

	1. a = (v – u) / t
	 a = (0 – 25) / 10 = - 2.5 ms-2, or 2.5 ms-2 north
	2. F = ma = 2200 x -2.5 = - 5500 N = 5500 N north
2. Force produced by engine when car is on road, F = ma = 2000 x 5
 = 10,000 N

In sand, the van travels at constant speed, even though same pressure applied to accelerator. Net force on van in sand is zero.

⸫ Friction force applied by sand = 10,000 N = 1 x 104 N opposing motion of van.

	1. Mass of car, m = 1200 kg
	Velocity of car, u = (72 x 1000)/3600 = 20 m/s south.

	So, safe distance of car behind truck = speed x time
	 = 20 x 2
	 = 40 m
	2. Braking force, F = 6400 N

	Acceleration of car, a = F/m = 6400 / 1200 = 5.33 ms-2, north

	So, taking south as positive, acceleration of car = - 5.33 ms-2

	Since a = Δv/Δt = (v – u) / Δt

	⸫ - 5.33 = (0 – 20) / Δt

	⸫ Δt = 3.75 s

	It takes the car 3.75 s to stop.
	3. We would need to know how far the car travels in the 3.75 s it takes to come to rest. We would need to add to that distance, the distance moved by the car at constant speed while the driver reacts and applies the brakes (20 m/s x 0.1 s = 2 m). We would also need to know the exact distance the truck ended up in front of the car.
3. Reading on spring balance = weight of the 3 kg mass = 3 x 9.8 = 29.4 N

The 3 kg mass on the RHS of the balance is like your hand when you hold the balance vertically to measure a weight. In that case, your hand supplies 3 kg force (29.4 N) upwards to hold the balance at rest, while the 3 kg mass whose weight you are measuring pulls the spring downwards. When the 3 kg mass comes to rest, the balance will read 3 kg force (29.4 N), provided the spring balance is properly calibrated.

	1. 1500 N in direction of motion of woman
	2. Newton’s Third Law
	3. From F = ma, a = F/m = 1500 / 67 = 22.4 ms-2
	4. a = F/m = 1500 / 5.97 x 1024 = 2.5 x 10-22 ms-2
	5. Clearly, the acceleration produced on the woman is much greater than that produced on the Earth (by a factor of almost 1023). Although the same sized forces are applied to both the Earth and the woman, the Earth’s much greater mass results in a much smaller resultant acceleration.