F2 Conservation of Momentum

$^{8}/_{10}$

F2.1 Two masses, called Alfie and Beth, collide and stick together under four different circumstances, as shown in the four rows of the table below. Calculate the missing measurements:

Before collision				After collision
Alfie's mass /kg	Alfie's velocity /m s^{-1}	Beth's mass /kg	Beth's velocity /m s^{-1}	Velocity /m s^{-1}
30	+2.0	40	+1.5	(a)
60	−1.4	30	+2.8	(b)
120	+1.5	80	(c)	0.0
120	+3.0	(d)	−31	+2.0

F2.2 Charlie is driving her 20 000 kg bus. She stops at a roundabout. Percy is driving his 750 kg Corsa at 15 m s^{-1} behind her. He fails to stop and rams into the back of the bus, sticking to it. The impact releases the brakes on the bus. How fast will the combined vehicle be travelling immediately after the collision?

F2.3 A neutron (mass = 1 u) is moving at 300 m s^{-1} when it smacks into a stationary ^{235}U nucleus (mass = 235 u), and sticks to it. What will the velocity of the combined particle be?

F2.4 A 7.90 g bullet is travelling at 200 m s^{-1}. It hits a 3.00 kg sack of sand which is hanging by a rope from the ceiling. The bullet goes into the sack, and is stopped inside it by friction with the sand. How fast is the sack going immediately after the bullet has "stopped" inside it[1]? NB you must give your answer to 3 significant figures to be awarded the mark.

F2.5 A rocket (containing a space probe) is travelling at 7000 m s^{-1} in outer space. The 2000 kg probe is ejected from the front of the rocket (forwards) using a big spring. If the speed of the probe afterwards is 7200 m s^{-1}, and the rest of the rocket has a mass of 6000 kg, what is the speed of the rest of the rocket?

[1] "stopped" means stopped relative to the sand, not stopped relative to a stationary observer.

F2.6 In a strange form of billiards, the cue ball is one third the mass of the other balls, which are stripey. There is no spin, and I hit a stripey ball centrally with the cue ball (travelling at 1.4 m s^{-1}) such that the cue ball rebounds in the opposite direction with half of its initial speed. What is the speed of the stripey ball?

F2.7 I am stranded, stationary, in space, but near to my spacecraft. I detach my 30 kg oxygen cylinder, and fling it away from the spacecraft with a speed of 3.0 m s^{-1}. If my mass (without the cylinder) is 80 kg, how fast will I travel in the other direction towards my spacecraft?

$^{18}/_{20}$

F3 Units of Rotary Motion

F3.1 How big is 3 rad, when expressed in degrees?

F3.2 How many radians are there in $90°$?

Complete the questions in the table by converting the units:

	Time period /s	Frequency /Hz	Angular velocity /rad s^{-1}	Revolutions per minute (rpm)
F3.3	0.50	(a)	(b)	(c)
F3.4	(a)	(b)	3.0	(c)
F3.5	(a)	(b)	(c)	3800
F3.6	(a)	50	(b)	(c)
F3.7	2700	(a)	(b)	(c)

F3.8 A car travels 10 km. One of its wheels has a radius of 30 cm. Calculate the angle the wheel turns as the car travels this distance (answer in radians).

F3.9 An astronaut's training centrifuge has a radius of 4.0 m. If it goes round once every 2.5 s, calculate the velocity of the end of the centrifuge arm (4.0 m from the pivot).

F3.10 My washing machine has a spin speed of 1200 rpm, and a drum radius of 20 cm. Calculate how fast clothes go, when up against the side of the drum.