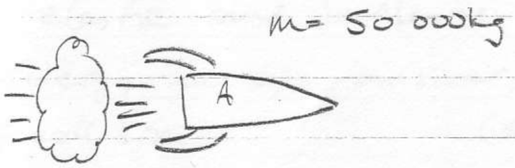
A2 Physics – Topic Test – Momentum

A2 Physics

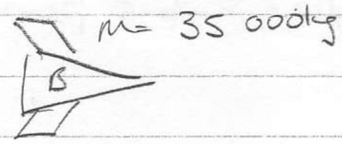
1. Rocket A is motionless in deep space, far away from the nearest Burgerking. The Captain starts the motors and fires 150kg of exhaust gas at a velocity of 12×10^3 m/s.



(a) Explain why the rocket moves forward. (Do not use the word "Burgerking" in your answer.) (2)

(b) What is the speed of the rocket at the end of the burn? (3)

2. Rocket B fires its motor for 2 minutes with a thrust of 3,600 N, and for another minute with a smaller thrust of 1200 N.

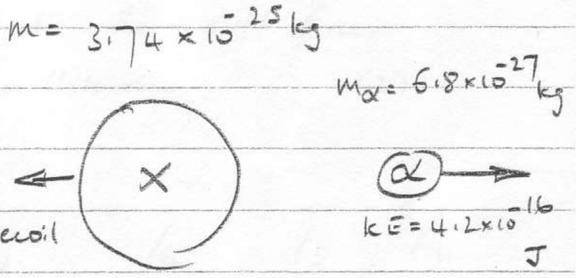


(a) Sketch the graph of motor thrust against time. (3)

(b) Calculate the velocity of rocket B at the end of the two stage "burn" (5)

(c) If the rocket applies a constant thrust, why does the acceleration steadily increase? (2)

3 A stationary radioactive nucleus X, emits an α-particle with a KE of 4.2×10^{-16} J.



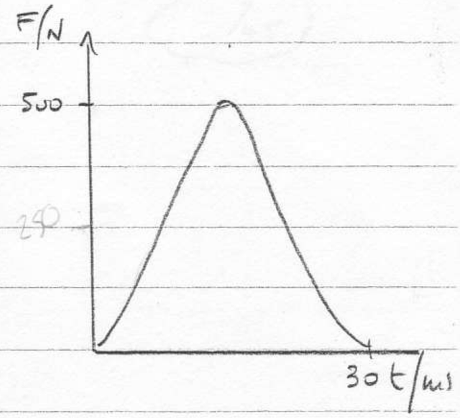
(a) Why does nucleus X recoil? (2)

(b) The paths of X and α lie on a straight line .... why? (1)

(c) What is the velocity of the α particle? (2)

(d) What is the recoil velocity of X.? (3)

4 The graph shows the force acting on a golf ball, mass 120g, as it is hit by the club.



(a) Calculate the velocity of the ball leaving the club (4)

(b) What does "Impulse" mean, and what is the impulse on the golf ball? (2)

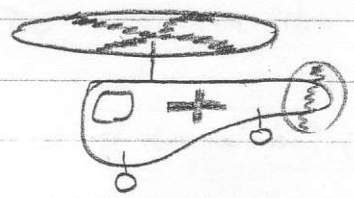
TM 02.Oct. 5. Explain the difference between "elastic" and "Inelastic" collisions – use the concept of energy in your answer

Momentum – Topic Test continued

A2 Physics

5. Explain the difference between elastic and inelastic collisions. Use the concept of energy in your answer. Give an example of each type of collision. (5)

6 The helicopter has a rotor blade with a diameter of 4.5 m, blowing air down at a velocity of 45 m/s.



Density ρ of air = 1.3 kg/m^3

a) Calculate the mass of air blown by the rotor in 1 second (3)

b) Calculate the uplift force on the helicopter (2)

c) Explain why there is an uplift force on the helicopter (2)

d) The pilot wants to increase the lift force, and increases the downdraft velocity by 50%. What is the new lift force on the helicopter? (2)

e) State and explain what happens to the lift force as the helicopter flies at higher altitudes. (2)

Q...	1.	2.	3.	4.	5.	6
	/5	/10	/8	/6	/5	/11

/45

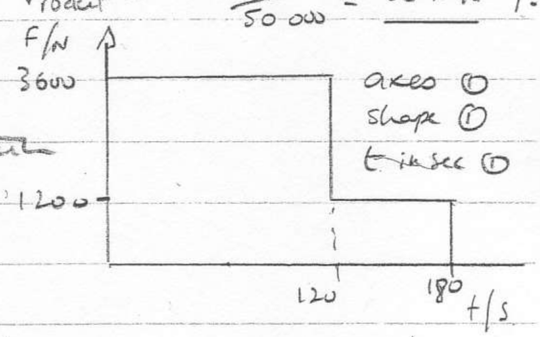
Topic Test - Momentum Answers

AL Physics

1. (a) p(whole system) = 0 all the time (1), so if gas moves ← then rocket must move → (1), so $p_{gas} + p_{rocket} = 0$ /2

(b) $p_{gas} = m v_{gas} = 150 \times 12\times10^3 = 1.8\times10^6$ Ns (1) so $V_{rocket} = \frac{1.8\times10^6}{50\,000}$ (1) $= \underline{36\text{ m/s}}$ (1) /3

(a) – 3 out of 3 →



axes (1)
shape (1)
t in sec (1)

2 (b) $F\times t$ = area under graph (1) = change in momentum

$= (3600 \times 120) + (1200 \times 60) =$

$= 432\,000$ (1) $+ 72\,000$ (1) $= 504\,000$ Ns.

$504\,000 = m_{rocket} v_{rocket}$ (1)

so $V_{rocket} = 504\,000/35\,000 = \underline{14.4\text{ m/s}}$ (1) /5

(c) 'cos the rocket mass is ↓ (1) (it's burning fuel) so a must ↑ since $a = F/m$ ← constant ← decreasing (1) /2

3 (a) Momentum of whole system = 0, so X nucleus momentum must be equal + opposite to momentum of α (1) ($\overleftarrow{p_X} = \overrightarrow{p_\alpha}$) /2

(b) If not a straight line, then there would be some resultant momentum (1)

(c) $KE = \frac{1}{2}mv^2$ (1) → $v = \left(4.2\times10^{-16} \times 2 / 6.8\times10^{-27}\right)^{\frac{1}{2}} = 351\times10^3$ (1) m/s /2

(d) $\overleftarrow{p \text{ of } X} = \overrightarrow{p \text{ of } \alpha}$ (1) .... so $\overleftarrow{m_X v_X} = \overrightarrow{m_\alpha v_\alpha}$

so V recoil of X $= 6.8\times10^{-27} \times 351\times10^3 / (\underbrace{3.74\times10^{-25} - 6.8\times10^{-27}}_{=3.67\times10^{-25}})$ (1) /3

$= \underline{6500}$ (1) m/s.

4 (a) Ft = area under graph (1) = Δp change in momentum

½ base × height (1) $= \frac{1}{2} \times 30\times10^{-3} \times 500 = \underline{7.5}$ (1) (Ns) $= m\Delta V_{ball}$

so $\Delta V_{ball} = 7.5 / 120\times10^{-3}$ (1) $= \underline{62.5}$ (1) m/s /4

(b) Impulse is $F\times t$ (1) in Ns, and here it is 7.5 Ns (1) /2

5. Elastic: no energy loss (1): KE total before = KE total after

Inelastic: energy is lost (1): usually ends up as heat (1)

because the particles/atoms are set vibrating. (1) /4

Q	1	2	3	4	5	
	/5	/10	/8	/6	/5	/33

TJN
Oct '02