TW

Topic Test — Linear Dynamics (1.6) — Force and momentum

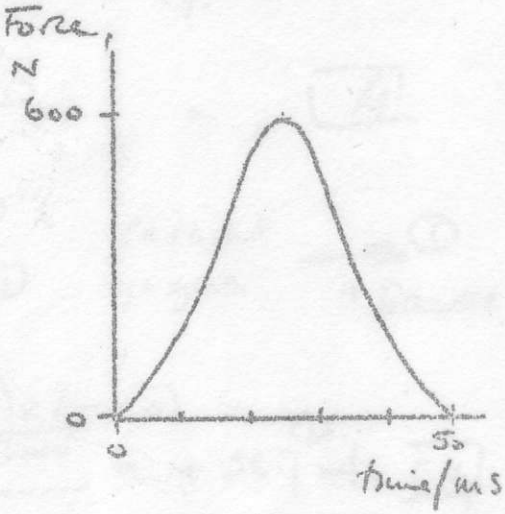
A Physics

1. Give Newton's second law in both forms, involving....
   (a) momentum
   (b) acceleration

   ② + principle of Cons. of Mom.

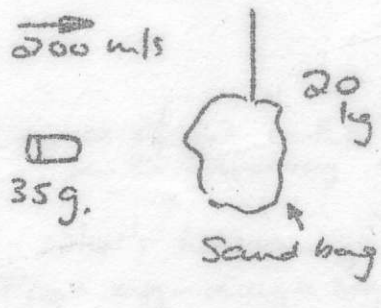
   If you have given the meaning of symbols, and their units — don't repeat yourself.

2. The graph shows how the force on a golf ball varies when the golfer hits it. The mass of the ball is 120 g.
   Estimate the speed of the ball when it leaves the club head. ④



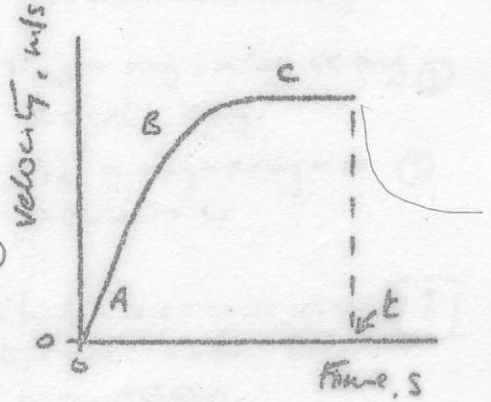
3. The rocket, mass 3000 kg, is stationary in space. The rocket motor is started, and ejects exhaust gas at a rate of 20 kg/s for 5 sec, and at a speed of 800 m/s relative to the capsule.
   What is the rocket's forward velocity after this? ④

4. In a firing range the bullets are fired into a hanging sandbag.
   What is the sandbag's velocity just after the bullet has hit it and become embedded? ④



5. A skydiver jumps out of a plane and freefalls without opening the parachute.
   (a) Describe + explain what is happening at A, B and C in the graph. 3×② = ⑥
   (b) At time t, the parachute is opened. Copy the graph and add to it to show how the velocity changes after time t. ②

TW 1.9



⑧

Test – Linear Dynamics – 1.5 ANSWERS A-Physics

1. (a) Force ∝ rate of change of momentum $F = (mv - mu)/t$
(b) Force ∝ acceleration $F = ma$ ½

2. $Ft = (mv - mu) = \Delta p$ momentum change (1)
= area under graph (1)
= ½ × 50 × 10⁻³ × 600 = 15 (1) Ns approx
$\Delta p = mv - mu = 15$ and $u = 0$ m/s
so $v = 15/m = 15/0.12 = 125$ (1) m/s (1) [4]

3 Momentum of related system is constant (1) r = rocket g = gas → (1) + forwards
$\therefore p_{before} = p_{after} + p_{gas\ exhausted} = 0$ (1)
$M_r v_r + m_g v_g = 0$ so $v_r = -\frac{(5 \times 20) \times (-800)}{3000} = +26.7$ (1) m/s [4]

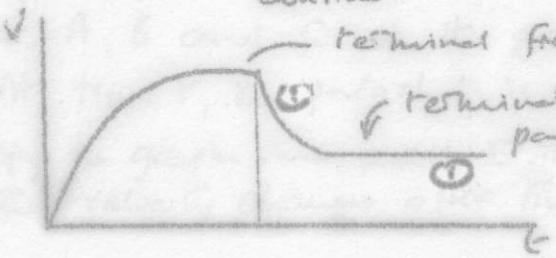
or... $F_{on\ gas} = m_{gas}(v-u)/t = (5 \times 20) \times 800/1 = 16{,}000$ N
∴ Force on rocket = 16,000 N forwards. $a = F/m = 16{,}000/3000 = 5.3$
after 5 sec $v_{rocket} = u + at = 26.7$ m/s

4 p of system = constant (1)
$p_b + p_s = p_{b+s}$ (1)
$m_b v_b + (m_s v_s) = 0 = m_{b+s} v_{b+s}$ (1)
so $v_{b+s} = m_b v_b / m_{b+s} = 0.35$ (1) m/s.
($v_{b+s} = 0.349$ m/s if you include the mass of the bullet in the sandbag)

S = Sandbag
b = bullet

5(a)

place	speed	wind resistance	what's happening?
A	0 – small	V. small	$F_{res} = mg - drag = mg$ acceleration $a \approx g$ (1)
B	large	large	$F_{res} = mg - drag \ll mg$ (1) accel. $\ll g$
C	large, constant	large	$F_{res} = mg - drag = 0$ (1) accel = 0



Parachute increases drag. Velocity decreases till again mg = drag. accel = 0 at low velocity [3]