①

a) For no friction the ball accelerates until the spring is uncompressed.
∴ The maximum speed is reached at 5.00 cm from the start.

b) When the spring force just equals the friction force, the ball will stop speeding up. This occurs when

$$F_f = F_s$$
$$0.032 = kx$$

$$x = \frac{0.032}{8} = .004 \text{ m} = 0.400 \text{cm}$$

THIS IS AT $5.00 - 0.400 = \underline{4.60 \text{ cm}}$ FROM the start

c) P.E. (SPRING) − W(FRICTION) = K.E. (BALL)

$$\frac{1}{2}kx^2 - F_f d = \frac{1}{2}mv^2$$

$$\frac{1}{2} \times 8.00 \times (.05)^2 - .032 \times .15 = \frac{1}{2} \times 5.30 \times 10^{-3}\ v^2$$

$$0.01 - .0048 = 2.65 \times 10^{-3}\ v^2$$

$$v^2 = 1.962$$

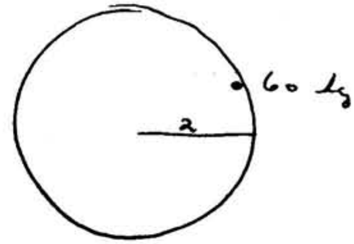
$$\boxed{v = 1.40 \text{ m s}^{-1}}$$

②

a) Angular momentum is conserved. $L(\text{initial}) = 0$

$$L_w = |\vec{r} \times \vec{p}| = r m v$$
$$= 2 \times 60 \times 1.5$$
$$= 180 \ \text{kg m}^2 \text{s}^{-1}$$

clockwise



$$L_f = L_i = 0$$
$$L_f = L_w + L_t$$
$$\therefore L_t = 180 \ \text{kg m}^2 \text{s}^{-1} \quad \text{counter clockwise}$$
$$\text{But} \quad L_t = I \omega_t = 500 \omega_t$$
$$\therefore \omega_t = \frac{180}{500} = 0.36 \ \text{rad s}^{-1}$$

b) For the woman $v = \omega_w r$ $\therefore \omega_w = \frac{v}{r} = \frac{1.5}{2} = 0.75$ rad

Work done = KE woman + KE of turntable

$$= \frac{1}{2} m v^2 + \frac{1}{2} I \omega^2$$
$$= \frac{1}{2} \times 60 \times (1.5)^2 + \frac{1}{2} 500 \times (0.36)^2$$
$$= 67.5 + 32.4 = 99.9 \text{ J}$$

c) $\frac{\omega_w}{\omega_t} = \frac{.75}{.36} = 2.08333$ ∴ after the turntable has made 1 rev. the woman has made 2.0833 rev.

The angle between her initial and final position vectors is $(2.0833 - 2)\text{rev} \times 360° \frac{\text{deg}}{\text{rev}} = \underline{\underline{30.0°}}$

(3) LET M BE THE MASS OF THE EMPTY ROCKET

LET M_A BE THE MASS OF FUEL A

LET M_B BE THE MASS OF FUEL B

FOR TYPE A FUEL

$$X = 0 + v_e \ln\left(\frac{M + M_A}{M}\right) = v_e \ln\left(\frac{2M}{M}\right) = v_e \ln 2 \quad (1)$$

FOR TYPE B FUEL

$$X = 0 + 2 v_e \ln\left(\frac{M + M_B}{M}\right) \quad (2)$$

USING (1) & (2)

$$\cancel{v_e} \ln 2 = 2 \cancel{v_e} \ln\left(\frac{M + M_B}{M}\right)$$

$$\ln\left(\frac{M + M_B}{M}\right) = \frac{\ln 2}{2}$$

$$\ln\left(\frac{M + M_B}{M}\right) = 0.3466$$

$$\frac{M + M_B}{M} = e^{0.3466}$$

$$1 + \frac{M_B}{M} = 1.414$$

$$\frac{M_B}{M} = 0.414$$