2007 MOTION SAC TEST SOLUTIONS

Question 1

C

In john's frame the ball will appear to drop straight down as both he and the ball have the same horizontal velocity.

Question 2

(a) Momentum is conserved in all collisions

P (before) = p (after)

V(truck) = 9.6 m/s

(b) KE before = 2.3 x 10^5
KE after = 1.9 x 10^5

Therefore, energy lost = 3.8 x 10^4

(c) The energy lost in this collision goes mainly into heat and a small amount into sound.

Question 3

(a) Fnet = 0 since travelling at constant velocity.
F(engine) = F(friction)
= 750 + 250 = **1000N**

(b) Fnet = ma (caravan)
= T – Fr(caravan)
Where T is the tension in the tow bar

Therefore, T = ma + Fr
= 1000(3) + 250
= **3250N**

Question 4

(a) **C** *(the car at the instant is travelling in the an easterly direction as this is the direction of the tangential velocity)*

(b) **A** The centripetal acceleration acting on the car at the instant shown is towards the centre of the circle (north)

(c) $F = mv^2/r$

$= 1200 \times 400/60$

$\mathbf{= 8.0 \times 10^3\ N}$

(d) The friction acting on the car's tyres provides the centripetal force that forces the car to travel in a circle.

Question 5

(a) **C** *The projectiles follow parabolic paths*

(b)

$s = ut + 1/2\ at^2$

t = 2.5sec

c) distance = vel x time

= 15 x 2.5

= 37.5m

(d)

$u_v^2 = u_v{}^2 + 2as$ in vertical direction

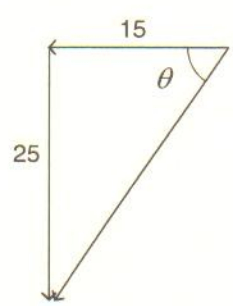
$\therefore u_v^2 = 0^2 + 2(10)(30)$

$u_v = 25\ \text{m s}^{-1}$

$v_H = 15\ \text{m s}^{-1}$

$\therefore v = \sqrt{V_v^2 + V_H^2}$

$= 29\ \text{m s}^{-1}$ at 59° from horizontal



$\tan\theta = \frac{25}{15}$

Question 6

(a)

$$F = \frac{GmM}{R^2}$$

$$= \frac{(6.67 \times 10^{-11})(7.4 \times 10^{22})(6.0 \times 10^{24})}{(3.8 \times 10^8)^2}$$

$$= 2.1 \times 10^{20} \text{ N}$$

(b)

$$F = \frac{GmM}{R^2} = \frac{m4\pi^2 R}{T^2}$$

$$\therefore T = \sqrt{\frac{4\pi^2 R^3}{GM}}$$

$$= \sqrt{\frac{4\pi^2 (3.8 \times 10^8)^3}{(6.67 \times 10^{-11})(6.0 \times 10^{24})}}$$

$$= 2.3 \times 10^6 \text{ s}$$

(c)

$$v = \frac{2\pi R}{T}$$

$$= \frac{2\pi(3.8 \times 10^8)}{(2.3 \times 10^6)}$$

$$= 1038 \text{ m s}^{-1}$$

Question 7

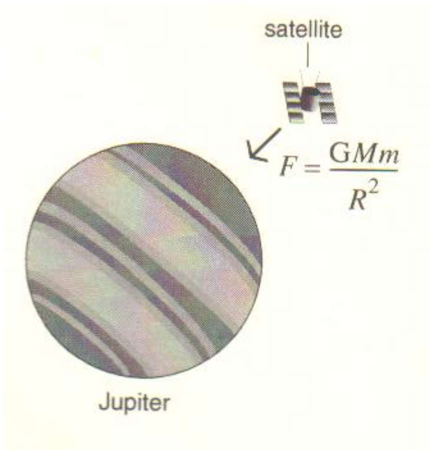
(a)

$$g = \frac{GM}{R^2}$$

$$= \frac{(6.67 \times 10^{-11})(1.9 \times 10^{27})}{(7.22 \times 10^7)^2}$$

$$= 24.3 \text{ m s}^{-2}$$

(b)



Question 8

(a)

9.8 m s^{-2}

Accept an answer in the range of 9.7 to 9.9 m s^{-2}.

(b)

radius of orbit = 6400 + 600

= 7000 km

From graph, $g = 8.2$ m s^{-2}.

Accept an answer in the range of 8.1 to 8.3 m s^{-2}.

$\therefore F = mg$

$= (1.2 \times 10^3)(8.2)$

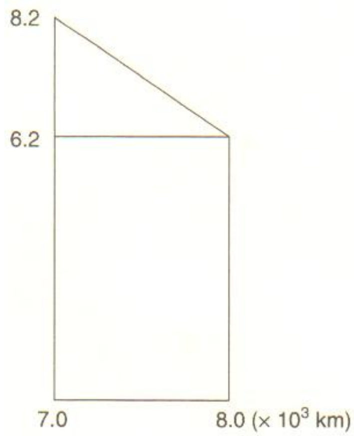
$= 9.8 \times 10^3$ N

Accept an answer in the range of 9.7×10^3 to 10×10^3 N.

(c)

In this case, energy can be represented by the mass of the space-lab times the area under the force–distance graph between 7000 km and 8000 km from the centre of the Earth. This area is approximately a trapezium as shown.

$$\text{area} = \left((6.2 \times 1.0 \times 10^6) + \frac{(8.2 - 6.2) \times (1.0 \times 10^6)}{2}\right) m$$



Using $m = 1200$ kg

$\text{area} = 8.6 \times 10^9$ J

Accept a range of ±5%.