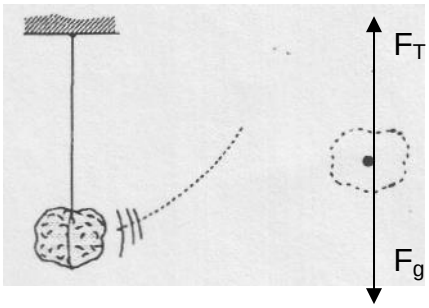
Physics 20 - Lesson 20
Vertical Uniform Circular Motion

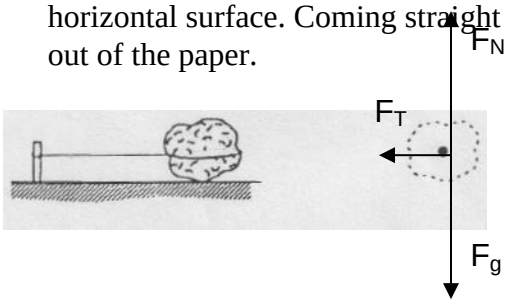
/44

1. Each free body diagram is worth 2 marks for a total of 12 marks.

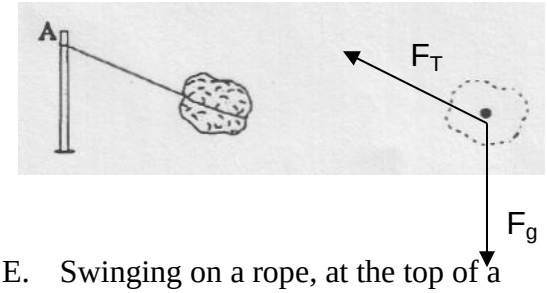
A. Swinging on a rope, at lowest position. No friction.



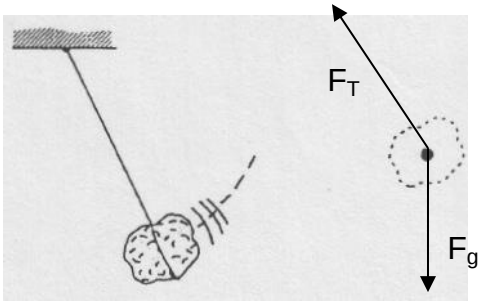
B. Tied to a post and moving in a circle at constant speed on a frictionless horizontal surface. Coming straight out of the paper.



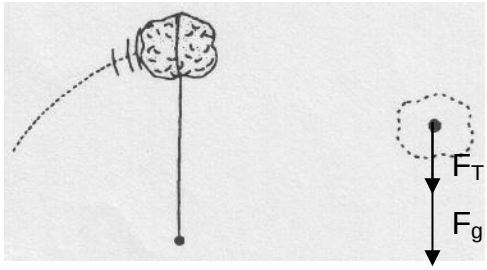
C. Tied to point A by a string. Moving in a horizontal circle at constant speed. Not resting on a solid surface. No friction. Coming straight out of the paper.



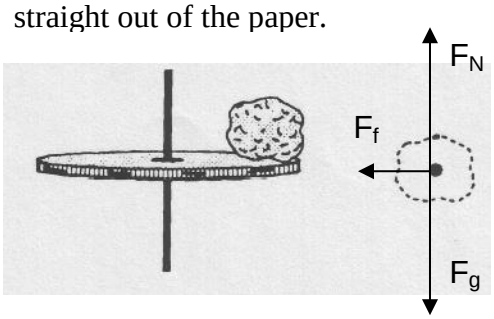
D. Swinging on a rope. No friction.



E. Swinging on a rope, at the top of a vertical circle.

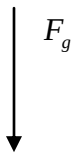


F. Riding on a horizontal disk that is rotating at constant speed about its vertical axis. Friction prevents rock from sliding. Rock is moving straight out of the paper.



2) /5

Top



$$r = \frac{7.0m}{2} = 3.5m$$

$$F_c = F_g$$

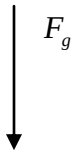
$$\frac{\cancel{m}v^2}{r} = \cancel{m}g$$

$$v = \sqrt{gr} = \sqrt{9.81\,{}^{m}\!/_{s^2}\,(3.5m)}$$

$$\boxed{v = 5.86\,{}^{m}\!/_{s}}$$

3) /4

Top



$$F_c = F_g$$

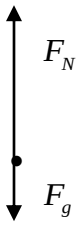
$$\frac{\cancel{m}v^2}{r} = \cancel{m}g$$

$$v = \sqrt{gr} = \sqrt{9.81\,{}^{m}\!/_{s^2}\,(0.95m)}$$

$$\boxed{v = 3.05\,{}^{m}\!/_{s}}$$

4) /8

Bottom



$$m = \frac{F_g}{g} = \frac{655N}{9.81m/s^2}$$

$$m = 66.8kg$$

$$F_c = F_n - F_g$$

$$F_c = 1960N - 655N$$

$$F_c = 1305N$$

$$F_c = \frac{mv^2}{r}$$

$$v = \sqrt{\frac{F_c r}{m}}$$

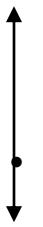
$$v = \sqrt{\frac{1305N\,(18.0m)}{66.8kg}}$$

$$\boxed{v = 18.76m/s}$$

5) /6

The maximum tension occurs at the bottom of the circle

Bottom



$$F_g = 14.7N$$

$$F_c = F_N - F_g$$

$$F_c = 186N - 14.7N$$

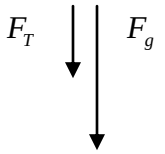
$$F_c = 171.3N$$

$$v = \sqrt{\frac{F_c r}{m}} = \sqrt{\frac{(171.3N)(1.90m)}{1.50kg}}$$

$$\boxed{v = 14.7\,m/s}$$

6) /9

Top



$m = 2.2kg$

$r = 1.0m$

$T = 0.97s$

$$F_c = \frac{m4\pi^2 r}{T^2}$$

$$F_c = \frac{2.2kg(4\pi^2)(1.0m)}{(0.97s)^2}$$

$$F_c = 92.3N$$

$$F_g = mg$$

$$F_g = 22kg(9.81 {}^{m}\!/_{s^2})$$

$$F_g = 21.6N$$

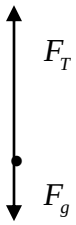
$$F_c = F_g + F_T$$

$$F_T = F_c - F_g$$

$$F_T = 92.3N - 21.6N$$

$$\boxed{F_T = 70.7N}$$

Bottom



$$F_c = F_T - F_g$$

$$F_T = F_c + F_g$$

$$F_T = 92.3N + 21.6N$$

$$\boxed{F_T = 113.9N}$$