

# Solution

PHYS-205A-001

(Final Exam)

Spring 2024

①

## Problem 1

$$[x] = [3A t^2] = [5B t^4]$$

$$[A] = L T^{-2}$$

$$[B] = L T^{-4}$$

$$\left[\frac{A}{B}\right] = \frac{L T^{-2}}{L T^{-4}} = T^2$$

## Problem 2

radially inward, towards the center.

## Problem 3

$$\int_i^f m \vec{a} \cdot d\vec{v} = \int_i^f m d\vec{v} \cdot \vec{v} = \Delta K$$

$$K = \frac{1}{2} m v^2$$

## Problem 4

$$\tau = N R \sin(180) = 0. \quad (\text{it passes through the axis.})$$

## Problem 5

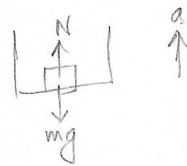
$$ma = -mg + N$$

$$\downarrow$$
$$= 0$$

$$N = mg$$

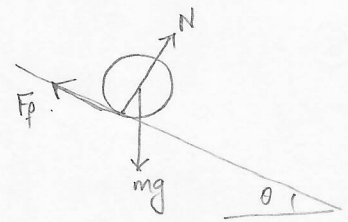
$$= (75)(9.8)$$

$$= 740 \text{ Newton}$$



### Problem 6

$$m\vec{a} = m\vec{g} + \vec{N} + \vec{F}_f$$



x:  $ma = mg \sin \theta - F_f$  — (i)

y:  $0 = -mg \cos \theta + N$  — (ii)

torque:  $I\alpha = 0 + 0 + F_f R$  — (iii)

(iii)  $\Rightarrow (\frac{1}{2}mR^2)\alpha = F_f R \Rightarrow F_f = \frac{1}{2}ma$  — (iv)

Using (iv) in (i)

$$ma = mg \sin \theta - \frac{1}{2}ma$$

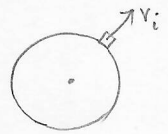
$$\frac{3}{2}ma = mg \sin \theta$$

$$\Rightarrow a = \frac{2}{3}g \sin \theta = \frac{2}{3}(9.8) \sin 30^\circ = 3.3 \frac{m}{s^2}$$

### Problem 7

$$\frac{1}{2}m v_i^2 - \frac{GMm}{R} = \frac{1}{2}m v_f^2 - \frac{GMm}{r_f}$$

$\downarrow \Rightarrow 0$                        $\downarrow \Rightarrow \infty$



$$\frac{1}{2}m v_E^2 = \frac{GMm}{R}$$

$$v_E = \sqrt{\frac{2GM}{R}}$$

$$v_E = \sqrt{\frac{2(6.7 \times 10^{-11})(6.0 \times 10^{24})}{(6.4 \times 10^6)}} = 11 \times 10^3 \frac{m}{s}$$