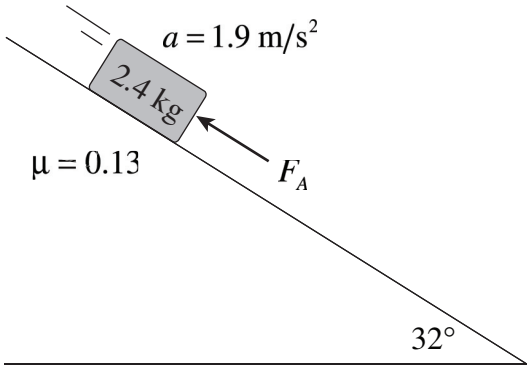
Physics 12

Resource Exam A

Scoring Guide

1. **(5 marks)**

A 2.4 kg block is sliding **down** a $32°$ incline with an acceleration of $1.9\ \text{m/s}^2$ as shown. The coefficient of friction between the block and the incline is 0.13.



What is the applied force, F_A, acting parallel to the incline?

$F_{net} = F_{||} - F_{fr} - F_A$ ← **1 mark**

$ma = mg\sin\theta - \mu mg\cos\theta - F_A$ ← **1 mark**

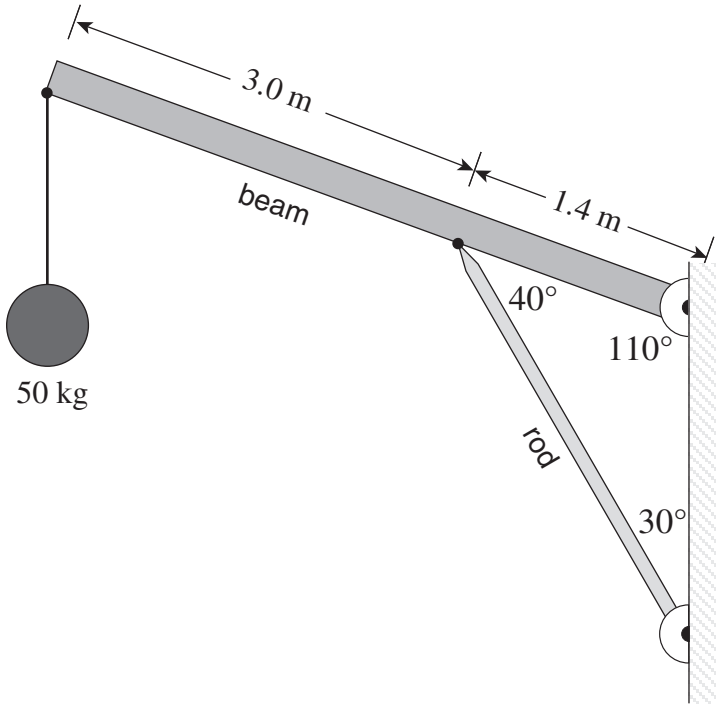
$F_A = 2.4 \times 9.8 \times \sin 32° - 0.13 \times 2.4 \times 9.8 \times \cos 32° - 2.4 \times 1.9$ ← **1 mark**

$F_A = 12.5 - 2.6 - 4.6$ ← **1 mark**

$F_A = 5.3\ \text{N}$ ← **1 mark**

2. **(5 marks)**

A 4.4 m-long 30 kg beam is held in place by a thin rod and supports a 50 kg mass as sho



What is the force exerted by the rod on the beam?

$$\tau_{rod} = \tau_{beam} + \tau_{mass} \quad \leftarrow \textbf{1 mark}$$

$$F_{rod}(\sin 40°)(1.4\text{ m}) = (30\text{ kg})(9.8\text{ m/s}^2)(\sin 70°)(2.2\text{ m}) + (50\text{kg})(9.8\text{ m/s}^2)(\sin 70°)(4.4\text{ m}) \quad \leftarrow \textbf{2 marks}$$

$$F_{rod}(0.8999) = 608 + 2026 \quad \leftarrow \textbf{1 mark}$$

$$F_{rod} = 2.9 \times 10^3\text{ N} \quad \leftarrow \textbf{1 mark}$$

3. **(6 marks)**

A 1.5 kg rock above the surface of planet Gleem drops off a ledge and falls 20 m in 4.1 s. The radius of the planet is 5.5×10^6 m .

a) Determine the mass of planet Gleem.

$$d = v_i \cdot t + \frac{1}{2}at^2$$

$$-20 = 0 \cdot t + \frac{1}{2}a(4.1)^2$$

$$a = -2.38 \text{ m/s}^2 \qquad \leftarrow \textbf{2 marks}$$

$$F_g = F_{net} = ma$$

$$Gm_p m_{rock} / r^2 = m_{rock} \cdot a$$

$$Gm_p / \left(5.5\times10^6\right)^2 = 2.38$$

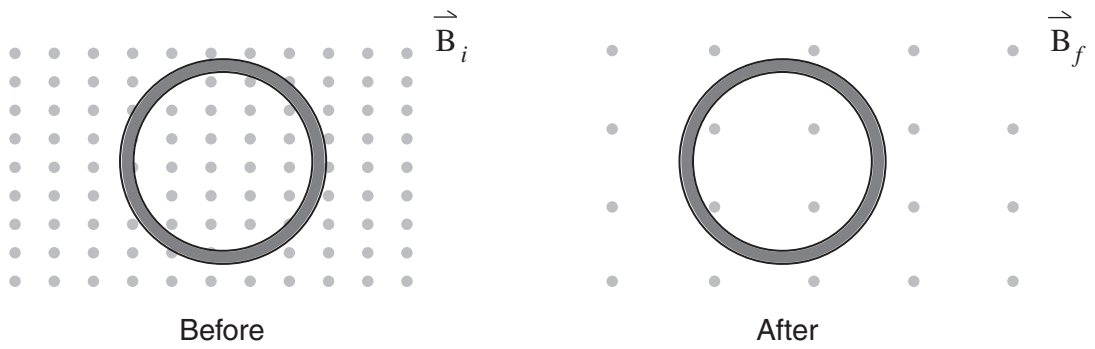
$$m_p = 1.1\times10^{24} \text{ kg} \qquad \leftarrow \textbf{2 marks}$$

b) The planet Gleem 2 has the same radius of Gleem $\left(5.5\times10^6 \text{ m}\right)$ but has a smaller mass. Explain, using principles of physics, why it takes more time for a rock to fall 20 m on Gleem 2.

Smaller mass (with the same radius) results in a smaller F_g, and therefore a smaller F_{net} and acceleration. A smaller acceleration means a longer time to fall the 20 m distance. (2 marks)

4. **(5 marks)**

The "Before" diagram shows a coil at one instant in a changing magnetic field. The "After" diagram shows the coil at a slightly later time.



Using the following data table calculate the average induced emf in the coil.

Coil radius:	0.15 m
Number of turns:	250
B_f :	0.25 T
B_i :	1.50 T
Δt :	0.50 s

$$\mathcal{E} = -N\frac{\Delta\Phi}{\Delta t} \qquad \leftarrow \textbf{1 mark}$$

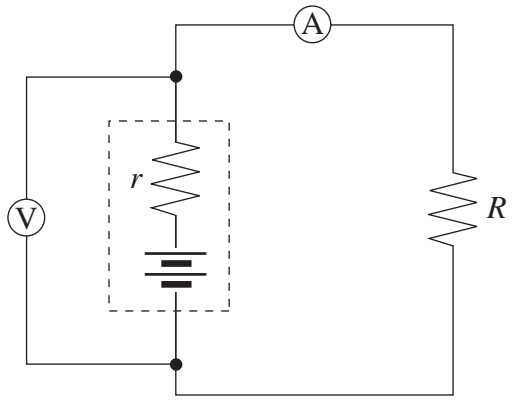
$$= -250 \cdot \frac{\left(\pi \cdot 0.15^2 \cdot 0.25 - \pi \cdot 0.15^2 \cdot 1.50\right)}{0.50} \qquad \leftarrow \textbf{2 marks}$$

$$= 250 \cdot \frac{(0.0177 - 0.106)}{0.50} \qquad \leftarrow \textbf{1 mark}$$

$$= 44 \text{ V} \qquad \leftarrow \textbf{1 mark}$$

5. **(5 marks)**

A battery with internal resistance r is connected to a variable resistor R as shown.
An ammeter and voltmeter are used to record the terminal voltage and current through the ba
as the variable resistor is adjusted.



The readings on the voltmeter and ammeter are recorded in the table below.

Circuit Measurements

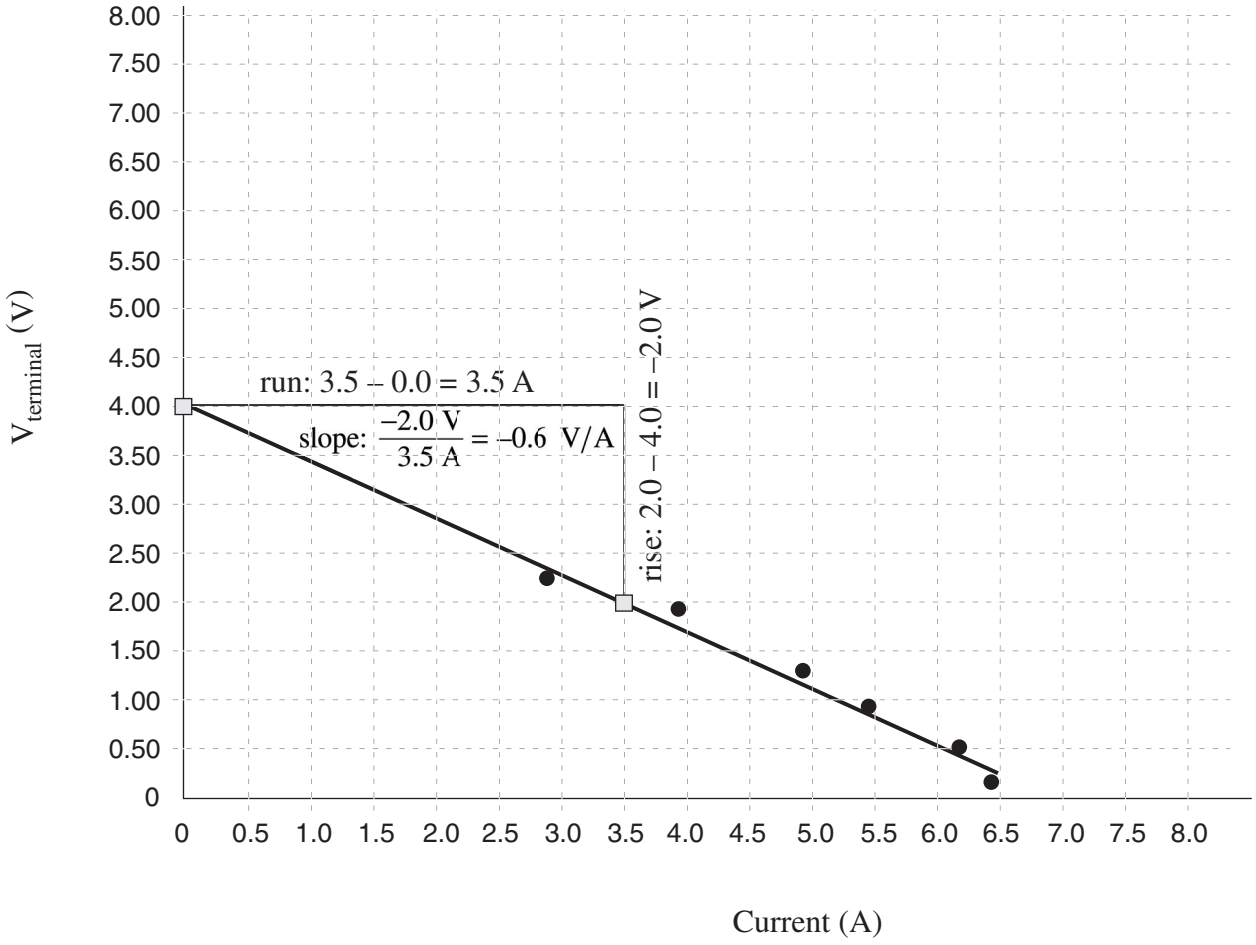
$V_{terminal}$ (V)	CURRENT (A)
0.2	7.0
0.6	6.2
0.9	5.4
1.3	4.9
1.9	3.9
2.3	2.8

a) Construct a linear plot of the data then determine the slope and *y*-intercept of the best-
(including appropriate units).

(2 marks)

**Note that hand-drawn best-fit lines are not precise; the range of acceptable values for the slope and y-intercept to be determined by the marking team.*

Linear Plot of the Data



slope $= -0.6$ V/A $(\text{or } \Omega)$ $\quad$ *y*-intercept = 4.0 V $\quad \leftarrow$ **1 mark**

b) Use the slope and *y*-intercept from part a) to determine the internal resistance and em… …ry.

$V_T = \mathcal{E} - IR_i$

$\therefore V_T = -R_i I + \mathcal{E}$

$y = mx + b$ $\quad \therefore slope = -R_i \quad \therefore R_i = 0.6\ \Omega$

y-intercept $= \mathcal{E}$ $\quad \therefore \mathcal{E} = 4.0$ V $\quad \leftarrow$ **2 marks**

6. **(4 marks)**

A satellite in a stable circular orbit around Earth is brought down to a new lower stable circular orbit. Explain, using principles of physics, why the centripetal acceleration of the satellite is greater in the new lower altitude orbit.

Since the satellite is now closer to Earth's centre the gravitational force between the satellite and Earth has increased (2 marks). Since F_g is providing the centripetal force, the increase in F_g means that F_c and therefore the centripetal acceleration have increased. (2 marks)