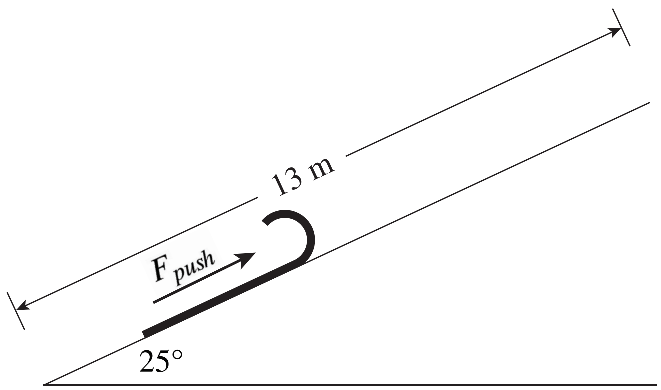
Physics 12
Resource Exam B
Scoring Guide

1. **(6 marks)**

A 25 kg sled is pushed 13 m up a $25°$ ramp at a constant speed as shown. The energy loss due to the frictional force between the ramp and the sled is 590 J.



a) What is the total work done in moving the sled up the ramp?

$W = \Delta E_p + \Delta E_h$

$W = mgh + E_h$ } ← **1 mark**

$W = 25 \times 9.8 \times \ell \times \sin 25° + E_h$ ← **1 mark**

$W = 25 \times 9.8 \times 13 \times \sin 25° + 590$ ← **1 mark**

$W = 1346 + 590$ ← **1 mark**

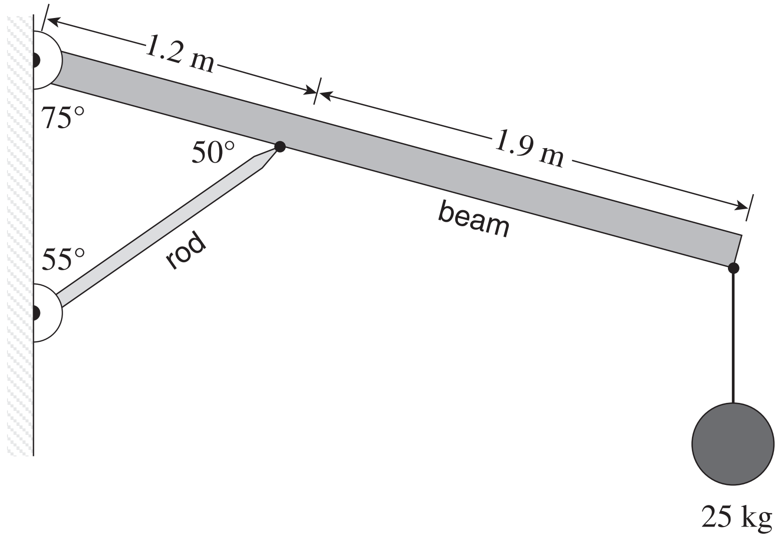
$W = 1900\text{ J}$ ← **1 mark**

b) The ramp in part 1 is then lowered to a smaller angle. Explain using principles of physics why more work is done to move the sled to the same vertical height as in part 1.

The sled has to travel further along the lower angled ramp, against an increased frictional force, to reach the same vertical height (1/2 mark). This would result in a greater production of heat energy (1 mark) and hence would require a greater input of total energy since potential energy remains constant (1/2 mark).

2. **(5 marks)**

A 3.1 m-long uniform 15 kg beam is held in place by a rod and supports a 25 kg mass as



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

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

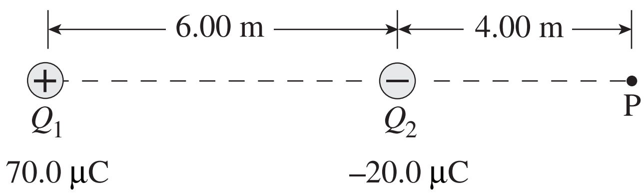
$$F_{rod}(\sin 50°)(1.2 \text{ m}) = (15 \text{ kg})(9.8 \text{ m/s}^2)(\sin 75°)(1.55 \text{ m}) + (25 \text{ kg})(9.8 \text{ m/s}^2)(\sin 75°)(3.1 \text{ m}) \quad \leftarrow \textbf{2 marks}$$

$$F_{rod}(0.919) = 220.09 + 733.62 \quad \leftarrow \textbf{1 mark}$$

$$F_{rod} = 1.0 \times 10^3 \text{ N} \quad \leftarrow \textbf{1 mark}$$

3. **(5 marks)**

Point P is located on the horizontal line that passes through the two charges shown below.



Determine the size and direction of the electric field at point P.

$E_p = E_1 + E_2$ ← **2 marks**

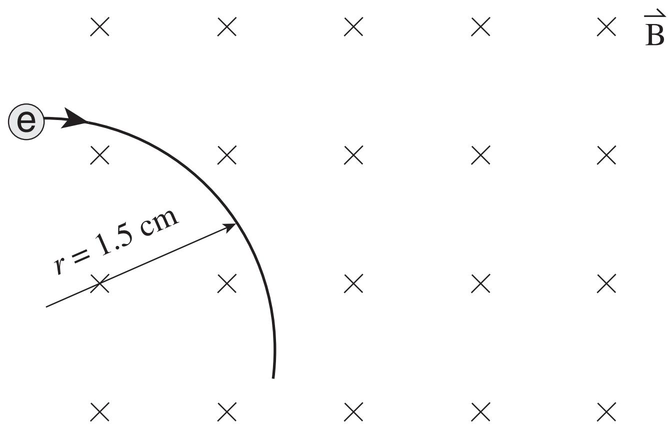
$E_p = \frac{(k70\times10^{-6})}{10.0^2} + \frac{(-k20\times10^{-6})}{4.0^2}$ ← **1 mark**

$E_p = 6300 + (-11\,250)$ ← **1 mark**

$E_p = 4.95\times10^3$ N/C (left) ← **1 mark**

4. **(5 marks)**

An electron with a kinetic energy of 5.2×10^{-16} J enters a magnetic field causing it to trav[el in a] circular path of radius 1.5 cm.



What is the strength of the magnetic field?

$$E_k = \frac{1}{2}mv^2 \qquad \leftarrow \tfrac{1}{2}\ \textbf{mark}$$

$$v = \left(\frac{2E_k}{m}\right)^{\frac{1}{2}}$$

$$= \left(\frac{2\cdot 5.2\times10^{-16}}{9.11\times10^{-31}}\right)^{\frac{1}{2}} \qquad \leftarrow \tfrac{1}{2}\ \textbf{mark}$$

$$= 3.38\times10^{7}\ \text{m/s} \qquad \leftarrow \tfrac{1}{2}\ \textbf{mark}$$

$$F_c = F_B \qquad \leftarrow \tfrac{1}{2}\ \textbf{mark}$$

$$\frac{mv^2}{R} = qvB \qquad \leftarrow 1\ \textbf{mark}$$

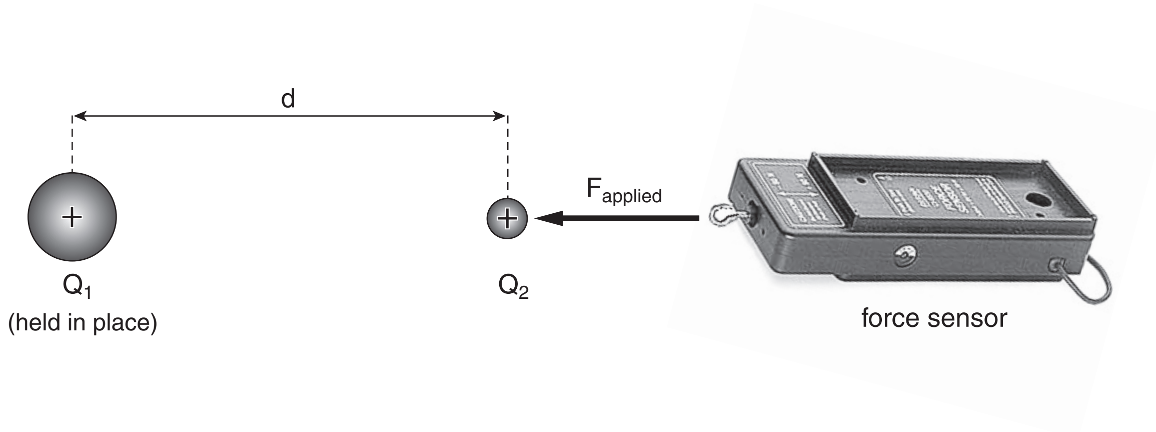
$$B = \frac{mv}{Rq} \qquad \leftarrow \tfrac{1}{2}\ \textbf{mark}$$

$$= \frac{9.11\times10^{-31}\cdot 3.38\times10^{7}}{1.5\times10^{-2}\cdot 1.60\times10^{-19}} \qquad \leftarrow 1\ \textbf{mark}$$

$$= 1.3\times10^{-2}\ \text{T} \qquad \leftarrow \tfrac{1}{2}\ \textbf{mark}$$

5. **(5 marks)**

A charge Q_2 is pushed towards a fixed charge Q_1. A sensor is used to measure the repul force being experienced by Q_2.



The distance between the charges and the readings on the force sensor are recorded for several different positions. In order to produce a linear plot of the data, the original measurements are adjusted as shown in the table below.

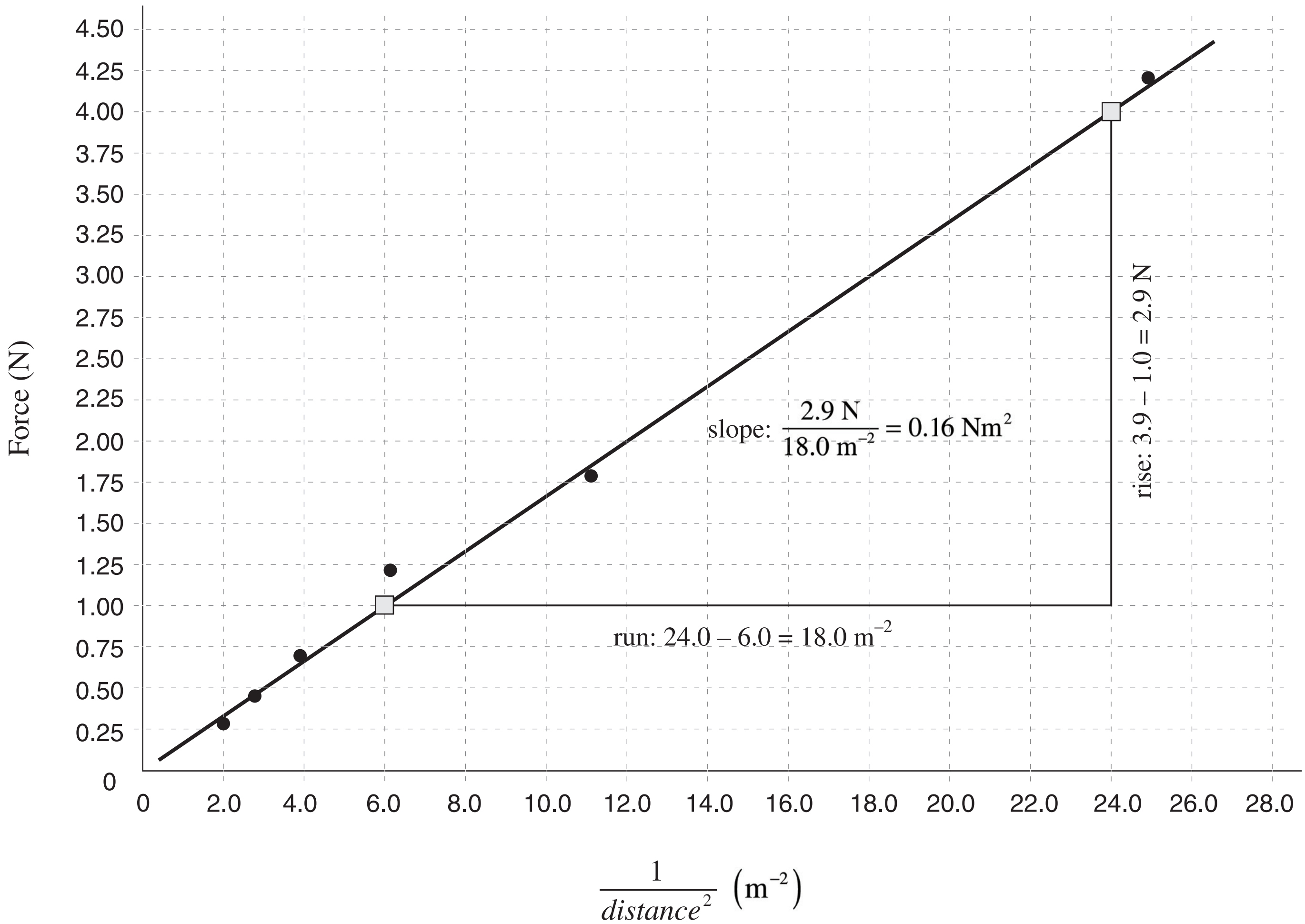
Adjusted Data

FORCE (N)	$\frac{1}{distance^2}$ (m^{-2})
4.2	25.0
1.8	11.1
1.2	6.2
0.7	4.0
0.4	2.8
0.3	2.0

a) Construct a linear plot of the adjusted data and determine the slope of the best fit line (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.*



$slope = 0.16\text{ Nm}^2$ ← **1 mark**

b) Given that Q_2 has a charge that is three times larger than Q_1, use the slope from part calculate the magnitude of charge Q_1.

$$F = kQ_1Q_2\left(\frac{1}{d^2}\right)$$

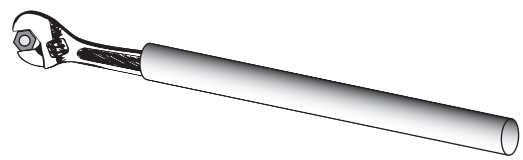
$$y = mx + b \qquad \therefore slope = kQ_1Q_2$$

$$0.16 = \left(9.00\times10^9\right)\left(Q_1\right)\left(3Q_1\right)$$

$$\therefore Q_1 = 2.4\times10^{-6}\ \text{C}$$

6. **(4 marks)**

A student is unable to loosen a nut by using a wrench. The student then attaches a pipe o
end of the wrench (see diagram).



Using principles of physics, explain why the student is now able to loosen the nut.

The student is only able to exert a certain maximum amount of force to generate torque to loosen the nut (1 mark). There is insufficient torque generated at the end of the wrench to loosen this nut (1 mark). Since torque is a combination of force and lever arm length the student needs to increase the lever arm length (1 mark) to be able to generate enough torque to overcome the frictional forces holding the nut in place (1 mark)