Solutions for Topic 10 – Fields (AHL)

1. $\frac{3g}{4}$

2. The acceleration a of the spacecraft is $\frac{v-u}{t} = \frac{300}{600} = 0.50\ \text{m s}^{-2}$

This is also the gravitational field strength, $g = 0.50\ \text{N kg}^{-1}$

3. **a)** a conductor contains *free* electrons and insulators do not

b) electrons must move along the wire and so an electric force must act on them this is provided by the electric field

c) $55 \times 1.6 \times 10^{-19}$
$= 8.8 \times 10^{-18}$ N

d) *Similarity:*
both follow an inverse square law

Differences:
gravitational force is much weaker than electric force

electric force can be attractive or repulsive, gravity only attractive

e) **(i)** 25 N kg^{-1}

(ii) $M = \frac{25\ R^2}{G}$

$= \frac{25 \times 7.0^2 \times 10^{14}}{6.7 \times 10^{-11}}$

$= 1.8 \times 10^{27}$ kg

4. the astronaut and the spacecraft experience the same acceleration

5. **a)** work done in moving mass from infinity to a point;

b) **(i)** accurate read-offs at −12.6 and −3.2
or gain in gravitational potential $[12.6 \times 10^6 - 3.2 \times 10^6]$
$9.4 \times 10^6 \times 12 \times 10^6 = 1.13 \pm 0.05 \times 10^5$ MJ

(ii) use of gradient of graph to determine g

values substituted from drawn gradient $\left(\text{typically } \frac{6.7 \times 10^6}{7 \times 3.3 \times 10^6}\right)$

$= (0.23 \pm 0.3)$ N kg^{-1}

c) g at surface $= 4^2$ g at $4R$

and $\frac{3.7}{0.23} = 16.1$

$= 3.7$ N kg^{-1}

d) escape speed for Earth > escape speed for Mars
potential less/more negative at Earth

6. $F_X = \frac{GM}{d^2} = 90$ N

$F_Y = \frac{4GM}{(ad)^2} = \frac{4}{9} F_X = 40$ N