CHAPTER 10 TEST REVIEW -- MARKSCHEME

1. C

2. A

3. B

4. D

5. D

6. Gravitational potential

(a) the work done per unit mass;
in bringing a small/point mass;
from infinity to the point (in the gravitational field); 3

(b) from the graph $V_0 = 3.9\ (\pm 0.2) \times 10^7$ J kg^{-1};

$$g_0 = \frac{V_0}{R_0} = \frac{39}{5};$$

$= 7.8(\pm 2)$ N kg^{-1}; 3

(c) 2.0×10^7 m above surface is 2.5×10^7 m from centre;

ΔV between surface and 2.5×10^7m = $(3.9 - 0.80) \times 10^7$
$= 3.1(\pm 0.2) \times 10^7$ J kg^{-1};

$$v = \sqrt{\frac{2m\Delta V}{m}} = \sqrt{2\Delta V};$$

$= \sqrt{6.2 \times 10^7} = 7.9(\pm 0.2) \times 10^3$ m s^{-1}; 4

*Award **[3 max]** if the candidate forgets that the distances are from the centre (answer 3.2 $\times 10^3$ m s^{-1}), ie the candidate must show ΔV.*

7. C

8. A

9. A

10. A

11. D

12. A

13. D

14. C

15. (a) a conductor contains "free" electrons and insulators do not / *OWTTE*; 1

(b) to have a current electrons must be accelerated/move along the wire;
and so a (electric) force must act on them;
this is provided by the electric field; 3

(c) 8.8×10^{-18} N; 1

(d) *similarity:*
both follow an inverse square law;
difference:
gravitational force is always attractive/is much weaker than electric force / electric force can be repulsion/is much stronger than gravitational force; 2

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

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

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

$= 1.8 \times 10^{27}$ kg 2

16. (a) $\frac{mv^2}{r} = \frac{GMm}{r^2}$;

$E_K = \frac{1}{2}mv^2 = \frac{GMm}{2r}$;

$E_P = -\frac{GMm}{r}$ (hence magnitude o $E_K = \frac{1}{2}$ magnitude of E_P); 3

(b) (i) total energy = (KE + PE =) $-\frac{Vm}{2}$;

$= \left(-\frac{4.0 \times 10^7 \times 8.2 \times 10^2}{2} =\right) -1.6 \times 10^{10}$ J; 2

(ii) $v = \sqrt{V}$; (*or use of* $E_k = \frac{1}{2}mv^2$)

$= 6.3 \times 10^3$ m s^{-1}; 2

(iii) total energy in new orbit = $\left(-\frac{2.0 \times 10^7 \times 8.2 \times 10^2}{2} =\right) -0.82 \times 10^{10}$ (J);

energy required = $(1.6 \times 10^{-10} - 0.82 \times 10^{10} =) 7.8 \times 10^9$ J; 2

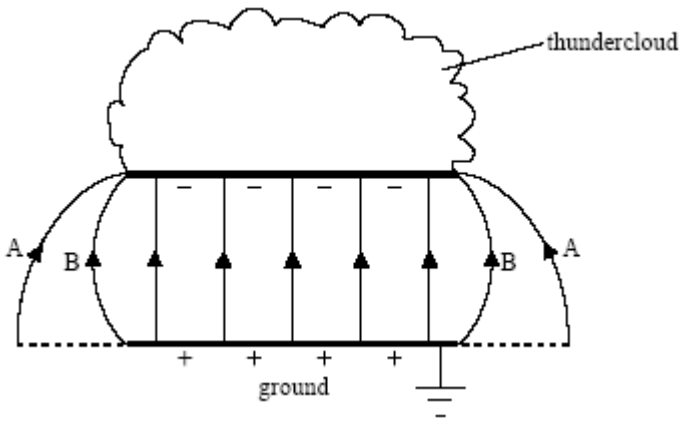
or

total energy is proportional to E_P;

so energy required = – (b)(i) ÷ 2 = 8 ***or*** 8.2×10^9 J; (*allow ECF from (b)(i))*

17. (a) force acting per unit charge;
on positive test / point charge;

(b)



lines connecting plate and ground equally spaced in the central
region of thundercloud <u>and</u> touching both plates; (*judge by eye)*
edge effects shown;
(*accept either edge effect A or B shown on diagram)*
field direction correct;

(c) (i) $\sigma = \left(\frac{35}{1.2\times10^{7}}\right) = 2.917 \times 10^{-6}$ (C m^{-2});

$E = \frac{2.917\times10^{-6}}{8.85\times10^{-12}}$

$= 3.3 \times 10^{5}$ N C^{-1} ***or*** V m^{-1}; 3

(ii) edge of thundercloud parallel to ground;
thundercloud and ground effectively of infinite length;
permittivity of air same as vacuum; 2 max

(iii) $t = \frac{Q}{I}$;

$t = \frac{35}{1800}$;

= 20 ms; 3

(iii) use of energy = p.d. × charge;
average p.d. = 1.25×10^{8} (V);
energy released =$1.25 \times 10^{8} \times 35$;
$= 4.4 \times 10^{9}$ J; 4
*Award **[3 max]** for 8.8 GJ if average p.d. point omitted.*
Allow ecf from (c)(ii).

18. (a) use of $\frac{1}{2}mv^2 = qV$;

$\frac{1}{2} \times 4 \times 1.66 \times 10^{-27} \times v^2 = 2 \times 1.6 \times 10^{-19} \times 2400$;

($v = 4.8 \times 10^{5}$ m s^{-1}) 2

(b) (i) $E = \frac{600}{0.80\times10^{-2}}$;

$= 7.5 \times 10^{4}$ V m^{-1}; (*accept unit as N C^{-1})* 2

(ii) force = (Eq =) $7.5 \times 10^{4} \times 2 \times 1.6 \times 10^{-19}$;
($= 2.4 \times 10^{-14}$ N)

acceleration = $\frac{2.4\times10^{-14}}{4\times1.66\times10^{-27}}$;

($= 3.6 \times 10^{12}$ m s^{-2}) 2
Do not penalize twice for omission of 2 in charge of α-particle.

(c) (i) $\left(\frac{2.4\times10^{-2}}{4.8\times10^{5}} =\right) = 5.0 \times 10^{-8}$ s; 1

(ii) for motion in direction of electric field

distance dropped in 50 ns = $\frac{1}{2} \times 3.6 \times 10^{12} \times (5.0 \times 10^{-8})^2$;

= 0.45 cm;
α-particle starts 0.40 cm from above plate and so hits it / *OWTTE* ; 3