

15 marks · one mark for each correct letter

The reason given for each answer is for learning: it is not needed in the exam.

Q	Answer	Why
1	B	Correct. Learn these words: force per unit mass, small point mass.
2	C	Correct. $F \propto m_1 m_2 / r^2$: $\times 2$ for the mass, $\div 3^2 = 9$ for the distance.
3	A	Correct. $g = GM/R^2$: $3/2^2 = 3/4$.
4	D	Correct. $GM/x^2 = G(9M)/(d-x)^2$, so $(d-x)/x = 3$ and $x = d/4$.
5	B	Correct. $g = -\Delta V/\Delta r$. At Q the gradient is zero (the tangent is horizontal), so the net field is zero.
6	C	Correct. This is Kepler's third law: $T^2 \propto a^3$.
7	A	Correct. $v = \sqrt{GM/r} \propto 1/\sqrt{r}$, and $\sqrt{1/4} = 1/2$.
8	D	Correct. $T^2 \propto r^3$, so $T \propto r^{3/2}$: $9^{3/2} = 27$.
9	B	Correct. Both are in free fall; the contact force is zero.
10	A	Correct. Work done per unit mass, from infinity to the point.
11	C	Correct. Each gives $-GM/(d/2) = -2GM/d$. Potentials are scalars: add them. $-4GM/d$.
12	D	Correct. $W = m\Delta V = m(-GM/2R + GM/R) = GMm/2R$.
13	B	Correct. The orbit is an equipotential (r is constant): $\Delta V = 0$, so $W = 0$. The force is at 90° to the motion.
14	C	Correct. $v_{\text{esc}} = \sqrt{2GM/R} \propto \sqrt{M}$: $\sqrt{2}$.
15	A	Correct. The total energy $-GMm/2r$ decreases, so r decreases; then $v = \sqrt{GM/r}$ and $E_k = GMm/2r$ increase.