Markscheme-Topic 6.1: Circular motion

1. C [1]
2. C [1]
4. D [1]
5. D [1]
6. (a) for circular motion, force required towards centre of circle / centripetal force; this provided as a result of extension of the spring; 2
   Do not give credit where candidate implies that the spring is pulled outwards by a force.
   (b) force produced by spring = 1.5 × 18 = 27 N;
   use of \( F = \frac{mv^2}{r} \);
   \[ 27 = \frac{(0.075 \times v^2)}{0.265} \];
   \( v = 9.77 \text{ m s}^{-1} \); 4 [6]
7. (a) Look for an answer on the following lines.
   the direction of the car is changing; hence the velocity of the car is changing; or since the direction of the car is changing; a force must be acting on it, hence it is accelerating; 2 max
   (b) (i) arrow pointing vertically downwards; 1
   (ii) weight;
   Do not penalize the candidate if they state “gravity”.
   normal reaction;
   Do not penalize the candidate if they state “push of the track on the marble”.
   (iii) loss in PE = 0.05 × 10 × (0.8 – 0.35);
   = gain in KE = \( \frac{1}{2} mv^2 \);
   to give \( v = 3.0 \text{ m s}^{-1} \);
   or use of \( v = \sqrt{2gh} \) to give \( v = 4.0 \text{ m s}^{-1} \) at point B;
   and then use of \( v^2 – u^2 = 2gh \) with \( v = 4.0 \text{ m s}^{-1} \) and \( h = 0.35 \text{ m} \);
   to get \( u = 3.0 \text{ m s}^{-1} \); 3 max
   Do not penalize the candidate if \( g = 9.8 \text{ m s}^{-2} \) is used.
   (iv) recognize that resultant force = \( \frac{mv^2}{r} \);
   \[ = \frac{(0.05 \times 9.0)}{0.175} = 2.6 \text{ N} \];
(a) The angular speed of the body is calculated as \( \omega = \theta / t \),

Here \( \theta = 180 \) degrees = \( \pi \) radians. (since the boy has completed half the circular track)
or 1 radian = 57.296 degrees.
t = 20 seconds.

So \( \omega = \theta / t \)
\( \omega = 180 / 20, \)
\( \omega = 9 \) degree/s
\( \omega = 0.157 \) radians/s.

(b) Now to find his Linear speed, we need to convert the radians in meters and then using the relation of Linear and angular speed we can find the Linear speed of the boy.
\( V = r \omega \)
\( = 15 / 2 \) meters \( \times 0.157 \) radians/s.
\( V = 1.1775 \) m/s.
Markscheme-Topic 6.2: Newton’s law of gravitation

1. C
   [1]

2. C
   [1]

3. B
   [1]

4. C
   [1]

5. C
   [1]

6. C
   [1]

7. D
   [1]

8. B
   [1]

9. (a) (i) from satellite towards centre of Earth;
   (ii) tangent to circle at satellite in correct direction;
   (no labels, [1 max])
   2

   (b) direction of motion is changing / force acts on satellite;
   and changing direction means changing velocity / any further detail;
   2

   (c) work done is product of force and distance moved in direction of force;
   force is always normal to direction of motion;
   hence no work done;
   (accept argument based on changes in \( E_k \) and \( E_p \))
   3

10. (a) the force exerted per unit mass;
    on a point (small) mass;
    2

   (b) (i) use of \( g = \frac{F}{m} \) and \( F = G \frac{Mm}{R^2} \);
       combine to get \( g = G \frac{M}{R^2} \);
       2

   (ii) \( M = \frac{gR^2}{G} \);
       substitute to get \( M = 1.9 \times 10^{27} \) kg;
       2
11. (a) (i) (deceleration due to) gravitational pull of Earth;  1

(ii) \( a = \frac{\Delta v}{\Delta t} = \frac{5100 - 5370}{600}; \)

\( a = -0.45 \text{ms}^{-2}; \)  2

(iii) \( ecf \ from \ (ii): \)

\( E = \frac{F}{m}; \)

\( E = a; \)

\( E = -0.45 \text{Nkg}^{-1}; \)  3

Accept \( \text{ms}^{-2} \) as correct units.

12. (a) gravitation / gravity;  1

(b) gravitational force = \( \frac{GM_1M_2}{(R_1 + R_2)^2}; \)

centripetal force = \( \frac{M_1R_1 \times 4\pi^2}{T^2}; \)

gravitational force provides centripetal force

\( \frac{GM_1M_2}{(R_1 + R_2)^2} = \frac{M_1R_1 \times 4\pi^2}{T^2}; \)

\( T^2 = \frac{R_1(R_1 + R_2)^2 \times 4\pi^2}{GM_2}; \)  3

(c) from formula, \( \frac{R_1}{M_2} \) is a constant;

\( \text{so if } R_1 \text{ is smaller } \Rightarrow M_2 \text{ is smaller } / M_1 \text{ is larger}; \)  2

*Do not award second mark if no reasoning given or argument is fallacious.*