Edexcel AS Physics: Working as a Physicist – Calculation Practice

Praneel Physics

1. A physicist measures the mass of an object to be 2.5 kg. What is the weight of the object on Earth? **(P)**

Working and Answer:
Weight $W = mg$ where $g = 9.81\,\text{m/s}^2$.
$W = 2.5\,\text{kg} \times 9.81\,\text{m/s}^2 = 24.525\,\text{N}$
Answer: 24.53 N

2. A physicist records a temperature change of 15 °C. Convert this temperature change to Kelvin. **(P)**

Working and Answer:
Temperature change in Kelvin is the same as in Celsius.
$\Delta T = 15\,\text{K}$
Answer: 15 K

3. A force of 10 N is applied to an object, causing it to accelerate at $2\,\mathrm{m/s^2}$. What is the mass of the object? **(P)**

Working and Answer:
Using Newton's second law, $F = ma$.
Rearranging gives $m = \dfrac{F}{a} = \dfrac{10\,\mathrm{N}}{2\,\mathrm{m/s^2}} = 5\,\mathrm{kg}$
Answer: 5 kg

4. A physicist measures the distance traveled by a car to be 100 m in 5 s. What is the average speed of the car? **(P)**

Working and Answer:

Average speed $v = \dfrac{d}{t} = \dfrac{100\,\text{m}}{5\,\text{s}} = 20\,\text{m/s}$

Answer: 20 m/s

5. A spring has a spring constant of 200 N/m. If it is compressed by 0.1 m, what is the potential energy stored in the spring? **(P)**

Working and Answer:
Potential energy $PE = \frac{1}{2}kx^2$
$PE = \frac{1}{2} \times 200\,\text{N/m} \times (0.1\,\text{m})^2 = 1\,\text{J}$
Answer: 1 J

6. A physicist uses a pendulum with a length of 2 m. What is the period of the pendulum? (Use $g = 9.81\,\mathrm{m/s^2}$) **(PP)**

Working and Answer:

Period $T = 2\pi\sqrt{\dfrac{L}{g}}$

$T = 2\pi\sqrt{\dfrac{2\,\mathrm{m}}{9.81\,\mathrm{m/s^2}}} \approx 2.83\,\mathrm{s}$

Answer: 2.83 s

7. A car accelerates uniformly from rest to a speed of 25 m/s in 10 s. What is the distance traveled by the car during this time? **(PP)**

Working and Answer:

Using $d = ut + \frac{1}{2}at^2$ where $u = 0$.

First, find $a = \frac{v - u}{t} = \frac{25\,\text{m/s}}{10\,\text{s}} = 2.5\,\text{m/s}^2$.

Then, $d = 0 + \frac{1}{2} \times 2.5\,\text{m/s}^2 \times (10\,\text{s})^2 = 125\,\text{m}$

Answer: 125 m

8. A 5 kg object is lifted to a height of 10 m. Calculate the gravitational potential energy gained by the object. **(PP)**

Working and Answer:
Potential energy $PE = mgh$
$PE = 5\,\text{kg} \times 9.81\,\text{m/s}^2 \times 10\,\text{m} = 490.5\,\text{J}$
Answer: 490.5 J

9. A wave travels a distance of 300 m in 15 s. What is the speed of the wave? **(PP)**

Working and Answer:
Speed $v = \dfrac{d}{t} = \dfrac{300\,\text{m}}{15\,\text{s}} = 20\,\text{m/s}$
Answer: 20 m/s

10. A circuit has a resistance of $12\,\Omega$ and a current of $3\,\text{A}$. What is the voltage across the circuit? **(PP)**

Working and Answer:
Using Ohm's law $V = IR$
$V = 3\,\text{A} \times 12\,\Omega = 36\,\text{V}$
Answer: $36\,\text{V}$

11. A 2 kg object is moving with a velocity of $4\,\text{m/s}$. Calculate its kinetic energy. **(PPP)**

Working and Answer:
Kinetic energy $KE = \frac{1}{2}mv^2$
$KE = \frac{1}{2} \times 2\,\text{kg} \times (4\,\text{m/s})^2 = 16\,\text{J}$
Answer: $16\,\text{J}$

12. A car of mass 800 kg is traveling at a speed of 20 m/s. What is its momentum? **(PPP)**

Working and Answer:
Momentum $p = mv$
$p = 800\,\text{kg} \times 20\,\text{m/s} = 16000\,\text{kg m/s}$
Answer: 16000 kg m/s

13. A 1000 W heater is used for 2 h. How much energy does it consume in kilowatt-hours? **(PPP)**

Working and Answer:
Energy $E = P \times t$
Convert time to hours: $t = 2\,\text{h}$
$E = 1\,\text{kW} \times 2\,\text{h} = 2\,\text{kWh}$
Answer: 2 kWh

14. A 50 kg diver jumps from a height of 10 m. Calculate the speed of the diver just before hitting the water. (Assume no air resistance) **(PPP)**

Working and Answer:

Using energy conservation: $mgh = \frac{1}{2}mv^2$

$gh = \frac{1}{2}v^2$

$v = \sqrt{2gh} = \sqrt{2 \times 9.81\,\text{m/s}^2 \times 10\,\text{m}} \approx 14.14\,\text{m/s}$

Answer: $14.14\,\text{m/s}$

15. A capacitor has a capacitance of $10\,\mu$F and is charged to a voltage of $12\,$V. What is the energy stored in the capacitor? **(PPPP)**

Working and Answer:
Energy $E = \frac{1}{2}CV^2$
Convert capacitance: $C = 10 \times 10^{-6}\,\text{F}$
$E = \frac{1}{2} \times 10 \times 10^{-6}\,\text{F} \times (12\,\text{V})^2 = 0.00072\,\text{J}$
Answer: $0.00072\,\text{J}$

16. A 1500 kg car is traveling at a speed of 30 m/s. Calculate the work done to bring the car to a stop. **(PPPP)**

Working and Answer:
Work done $W = \Delta KE = KE_{initial} - KE_{final}$
$KE_{initial} = \frac{1}{2}mv^2 = \frac{1}{2} \times 1500\,\text{kg} \times (30\,\text{m/s})^2 = 675000\,\text{J}$
$KE_{final} = 0$
$W = 675000\,\text{J}$
Answer: 675000 J

17. A 2 kg object is moving in a circular path of radius 5 m with a speed of 10 m/s. Calculate the centripetal force acting on the object. **(PPPP)**

Working and Answer:

Centripetal force $F_c = \dfrac{mv^2}{r}$

$$F_c = \frac{2\,\text{kg} \times (10\,\text{m/s})^2}{5\,\text{m}} = 40\,\text{N}$$

Answer: 40 N

18. A 1000 kg satellite is in orbit at a height of 300 km above the Earth's surface. Calculate the gravitational potential energy of the satellite. (Use $g = 9.81\,\text{m/s}^2$) **(PPPP)**

Working and Answer:
Gravitational potential energy $PE = mgh$
Height $h = 300\,\text{km} = 300000\,\text{m}$
$PE = 1000\,\text{kg} \times 9.81\,\text{m/s}^2 \times 300000\,\text{m} = 2943000000\,\text{J}$
Answer: 2943000000 J

19. A 5 kg object is dropped from a height of 20 m. Calculate the speed of the object just before it hits the ground. (Assume no air resistance) **(PPPPP)**

Working and Answer:

Using energy conservation: $mgh = \frac{1}{2}mv^2$

$gh = \frac{1}{2}v^2$

$v = \sqrt{2gh} = \sqrt{2 \times 9.81\,\text{m/s}^2 \times 20\,\text{m}} \approx 19.8\,\text{m/s}$

Answer: $19.8\,\text{m/s}$

20. A 3 kg object is moving with a velocity of 15 m/s and collides with a stationary object of mass 2 kg. If the collision is perfectly inelastic, what is the final velocity of the combined mass? **(PPPPP)**

Working and Answer:
Using conservation of momentum: $m_1v_1 + m_2v_2 = (m_1 + m_2)v_f$
$3\,\text{kg} \times 15\,\text{m/s} + 2\,\text{kg} \times 0 = (3\,\text{kg} + 2\,\text{kg})v_f$
$45\,\text{kg m/s} = 5\,\text{kg} \times v_f$
$v_f = \dfrac{45\,\text{kg m/s}}{5\,\text{kg}} = 9\,\text{m/s}$
Answer: $9\,\text{m/s}$

21. A 10 kg block is pulled up a frictionless incline of 30° with a force of 100 N. Calculate the acceleration of the block. **(PPPPP)**

Working and Answer:
Net force $F_{net} = F - mg\sin\theta$
Weight component down the incline:
$mg\sin\theta = 10\,\text{kg} \times 9.81\,\text{m/s}^2 \times \sin(30°) = 49.05\,\text{N}$
Net force: $F_{net} = 100\,\text{N} - 49.05\,\text{N} = 50.95\,\text{N}$
Using $F = ma$, $a = \dfrac{F_{net}}{m} = \dfrac{50.95\,\text{N}}{10\,\text{kg}} = 5.095\,\text{m/s}^2$
Answer: $5.1\,\text{m/s}^2$