S4 Physics Practice Paper: kinematics and v-t graphs, Newton laws and friction, inclines and connected bodies, momentum and collisions, circular motion, work and energy, power, resistance and power bills, sound, refraction and the critical angle (100 marks)

Level: S4 | Subject: Physics | 75 minutes | 100 marks | 24 questions | answer key

Section A - Kinematics: Uniform Acceleration and Graphs (18 marks)

Answer all questions and show your working. (Take g = 10 m/s2, ignore air resistance.)

#	Question	Answer	Marks
1	A car starts from rest and accelerates uniformly at 2.5 m/s2 for 8.0 s. Find (a) its final velocity; (b) the distance travelled in 8.0 s.	(a) v = at = 2.5 x 8.0 = 20 m/s; (b) s = 1/2 a t^2 = 0.5 x 2.5 x 64 = 80 m	5
2	A ball is thrown vertically upwards at 15 m/s. Find (a) the time to reach the highest point; (b) the maximum height; (c) its displacement 2.0 s after release.	(a) t = u/g = 15/10 = 1.5 s; (b) h = u^2/2g = 225/20 = 11.25 m; (c) s = ut - 1/2 g t^2 = 30 - 20 = 10 m	5
3	The v-t graph of a car shows: 0 to 4.0 s velocity rises uniformly from 0 to 12 m/s; 4.0 to 10.0 s stays at 12 m/s; 10.0 to 14.0 s falls uniformly to 0. Find (a) the total displacement in 14.0 s; (b) the average velocity.	(a) displacement = 24 + 72 + 24 = 120 m; (b) average velocity = 120/14.0 = 8.57 m/s	4
4	A stone falls freely from a roof 45 m high. Find (a) the time of fall; (b) the speed on landing.	(a) t = sqrt(2 x 45/10) = 3.0 s; (b) v = gt = 30 m/s	4

Section B - Forces, Newton Laws and Friction (18 marks)

Answer all questions and show your working. (Take g = 10 m/s2.)

#	Question	Answer	Marks
5	A 5.0 kg object on a smooth horizontal surface experiences a net horizontal force of 20 N. Find its acceleration. If instead a 25 N force is applied while a friction of 5.0 N opposes the motion, find the new acceleration.	(a) a = F/m = 20/5.0 = 4.0 m/s2; (b) a = (25 - 5.0)/5.0 = 4.0 m/s2	5
6	A 30 kg crate rests on horizontal ground. The coefficient of friction is 0.40. Find (a) the maximum static friction; (b) the friction acting on the crate when pushed with 100 N; (c) the acceleration when pushed with 200 N.	(a) f = 0.40 x 300 = 120 N; (b) 100 N is below the 120 N limit, so the crate stays at rest and friction = 100 N; (c) a = (200 - 120)/30 = 2.67 m/s2	5
7	A 4.0 kg object slides down a frictionless incline of 30 degrees. Find (a) its acceleration along the incline; (b) the normal force from the incline.	(a) a = g sin30 = 5.0 m/s2; (b) N = mg cos30 = 4.0 x 10 x 0.866 = 34.6 N	4
8	Two blocks of 3.0 kg and 5.0 kg on a smooth horizontal table are joined by a light string. A horizontal pull of 16 N acts on the 5.0 kg block. Find (a) the acceleration; (b) the tension in the string.	(a) a = 16/8.0 = 2.0 m/s2; (b) T = 3.0 x 2.0 = 6.0 N	4

Section C - Momentum, Collisions and Circular Motion (16 marks)

Answer all questions and show your working.

#	Question	Answer	Marks
9	A 0.20 kg ball hits a wall perpendicularly at 8.0 m/s and rebounds at 8.0 m/s. The contact time is 0.040 s. Find (a) the change in momentum of the ball; (b) the average force exerted by the wall.	(a) dp = 0.20 x (8.0 + 8.0) = 3.2 kg m/s away from the wall; (b) F = 3.2/0.040 = 80 N	4
10	A 2.0 kg object moving at 6.0 m/s collides with a stationary 4.0 kg object and they stick together. Find (a) the common velocity; (b) the kinetic energy lost.	(a) v = 12/6.0 = 2.0 m/s; (b) lost KE = 36 - 12 = 24 J	4
11	An object moves in a circle of radius 2.0 m with a period of 4.0 s. Find (a) its speed; (b) its centripetal acceleration (take pi = 3.14).	(a) v = 2 x 3.14 x 2.0/4.0 = 3.14 m/s; (b) a = 3.14^2/2.0 = 4.93 m/s2	4
12	A 800 kg car goes round a flat bend of radius 50 m. The maximum friction between the tyres and the road is 4,000 N. Find (a) the maximum safe speed in m/s; (b) this speed in km/h.	(a) v = sqrt(4000 x 50/800) = sqrt(250) = 15.8 m/s; (b) 15.8 x 3.6 = 56.9 km/h	4

Section D - Work, Energy and Power (16 marks)

Answer all questions and show your working. (Take g = 10 m/s2.)

#	Question	Answer	Marks
13	A 40 kg person runs up a staircase to a platform 5.0 m high in 8.0 s. Find (a) the work done against gravity; (b) the average power.	(a) W = mgh = 40 x 10 x 5.0 = 2000 J; (b) P = 2000/8.0 = 250 W	4
14	A 2.0 kg object slides down a slope 5.0 m high and reaches the bottom at 8.0 m/s. Find (a) the loss in gravitational potential energy; (b) the kinetic energy at the bottom; (c) the work done against friction.	(a) dEp = 2.0 x 10 x 5.0 = 100 J; (b) Ek = 0.5 x 2.0 x 64 = 64 J; (c) work against friction = 36 J	4
15	A force of 100 N acts at 30 degrees above the horizontal and moves a crate 10 m horizontally. Find the work done by the force (cos30 = 0.866).	W = F d cos(theta) = 100 x 10 x 0.866 = 866 J	4
16	A pump lifts 300 kg of water per minute to a tank 10 m high. If the efficiency is 60%, find (a) the useful output power; (b) the input power.	(a) P = 300 x 10 x 10/60 = 500 W; (b) input = 500/0.60 = 833 W	4

Section E - Electricity: Resistance, Power and Bills (18 marks)

Answer all questions and show your working.

#	Question	Answer	Marks
17	A 12 V battery of negligible internal resistance is connected to a 4.0 ohm and a 6.0 ohm resistor in series. Find (a) the total resistance; (b) the current; (c) the voltage across each resistor.	(a) R = 10 ohm; (b) I = 12/10 = 1.2 A; (c) 4.8 V and 7.2 V	5
18	A 4.0 ohm and a 12 ohm resistor are connected in parallel across a 6.0 V supply. Find (a) the equivalent resistance; (b) the total current; (c) the current in each resistor.	(a) 1/R = 1/4 + 1/12 = 1/3 so R = 3.0 ohm; (b) I = 2.0 A; (c) 1.5 A and 0.5 A	5

19	An electric kettle is rated 220 V, 2000 W. It heats 1.5 kg of water from 20 C to 100 C (specific heat capacity of water 4200 J/kg/K, no heat loss). Find (a) the energy required; (b) the time needed.	(a) E = 1.5 x 4200 x 80 = 5.04 x 10^5 J; (b) t = 504000/2000 = 252 s = 4.2 min	4
20	A 1500 W air conditioner runs 6.0 hours a day for 30 days. If electricity costs $1.2 per kWh, find (a) the monthly energy used; (b) the monthly cost.	(a) E = 1.5 x 6.0 x 30 = 270 kWh; (b) 270 x 1.2 = $324	4

Section F - Waves and Light: Sound, Refraction, Lenses and TIR (14 marks)

Answer all questions and show your working.

#	Question	Answer	Marks
21	A sound has frequency 500 Hz in air where its speed is 340 m/s. Find (a) its wavelength in air; (b) its wavelength in water where the speed is 1500 m/s.	(a) wavelength = 340/500 = 0.68 m; (b) 1500/500 = 3.0 m	4
22	Light travels from air into water (refractive index 1.33) at an angle of incidence of 40 degrees. Find the angle of refraction (sin40 = 0.643).	sin r = 0.643/1.33 = 0.483, so r = 28.9 degrees	4
23	An object is placed 30 cm in front of a convex lens of focal length 10 cm. Find (a) the image distance; (b) the magnification and describe the image.	(a) 1/v = 1/10 - 1/30 = 2/30 so v = 15 cm; (b) m = 0.50, inverted, diminished, real	3
24	Light travels in glass of refractive index 1.5. Find the critical angle at the glass-air boundary (sin c = 1/n).	sin c = 1/1.5 = 0.667, so c = 41.8 degrees	3