Sample Diagnostic Test (Physics – Paper 1 (Multiple Choice))

1. In an experiment a student hypothesizes that the frequency of sound, f, that a tense string produces is directly proportional to the square root of T i.e. f = k$\sqrt{T}$ where f is a constant. Which of the following graph could the student plot in order to determine the proportionality constant?

A Plot f^2 against T and gradient = k
B Plot f against log T and gradient = k
C Plot log f against log T and gradient = k
D Plot log f against log T and y-intercept = log k

2. Using a centimeter ruler that measures correct to the nearest mm, a student measures the horizontal length and slanted length of a ramp to be 18.0 cm and 21.2 cm, respectively. What is the upper bound for the angle of inclination?

A $\cos^{-1}(17.9/21.3)$ B $\cos^{-1}(17.95/21.25)$
C $\cos^{-1}(18.1/21.1)$ D $\cos^{-1}(18.05/21.15)$

3. An object is launched horizontally off the edge of a balcony with a speed of 15 m/s. It lands with a speed of 25 m s^{-1}. Taking g = 10 m s^{-2}, the time of fall is …

A 1 second B $\sqrt{2}$ seconds
C 2 seconds D $2\sqrt{2}$ seconds

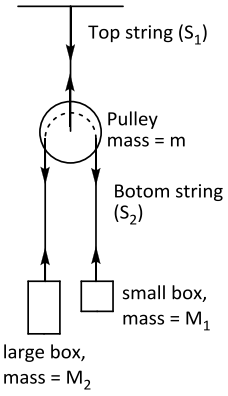
4. Balls are simultaneously dropped from a window on each equally–spaced floor of a 20-meter building. Assume that air resistance is negligible. An observer on ground floor sees the balls landing with …

A Constant time differences between all balls landing
B Longest time differences between landings of balls dropped from the lower levels
C Longest time differences between landings of balls dropped from the upper levels
D Longest time differences between landings of balls dropped from the middle levels

5. A constant force F is applied to a object with mass m starting from rest on a frictionless surface. Which answer properly describes how momentum and kinetic energy vary?

	Momentum is directly proportional to …	KE is directly proportional to …
A	t	$t^{1/2}$
B	t	t^2
C	t^2	t^2
D	t^2	t^3

6–7. Consider the following diagram: 2 masses, with $M_2 > M_1$, attached to a string (S_1), freely suspended over a pulley. The pulley is attached to the ceiling with another string (S_2). Let acceleration due to gravity be g, as usual.



6 The acceleration of the system is:

A $\frac{(M_2+M_1)g}{M_1+M_2+m}$

B $\frac{(M_2-M_1)g}{M_1+M_2+m}$

C g

D $\frac{(M_2-M_1)g}{M_1+M_2}$

7 Let the tensions along S_1 and S_2 be T_1 and T_2 respectively. What are the likely values of T_1 and T_2?

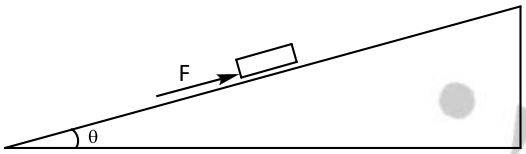
	T_1	T_2
A	$= \frac{(M_1+M_2)g}{2}$	$= 2T_1 + mg$
B	$= \frac{(M_1+M_2)g}{2}$	$< 2T_1 + mg$
C	$> \frac{(M_1+M_2)g}{2}$	$> 2T_1 + mg$
D	$< \frac{(M_1+M_2)g}{2}$	$< 2T_1 + mg$

8. A 45–kg person is standing inside an elevator which is moving downwards. The elevator is slowing down at 2 m s^{-2}. Assuming that gravity = 10 m s^{-2}, as usual, the magnitude of the reaction force between the floor of the elevator and the person is:

A 90 N B 360 N

C 540 N D 900 N

9. An object with mass m is resting on an inclination with angle θ and coefficient of static friction μ. A push, F is applied up the incline such that the force is barely enough to keep the object from sliding down the plane.



Which of the following equations of force is correct?

A $F = mg\sin\theta + \mu mg\cos\theta$

B $F + mg\sin\theta = \mu mg\cos\theta$

C $F + \mu mg\cos\theta = mg\sin\theta$

D $F + \mu mg\sin\theta = mg\cos\theta$

10. A bombshell, at rest, explodes into two unequally–sized pieces; which piece will have a higher magnitude of momentum and higher kinetic energy, respectively?

	Higher magnitude of momentum	Higher kinetic energy
A	The smaller piece	The smaller piece
B	The smaller piece	The larger piece
C	Same	The smaller piece
D	Same	The larger piece

11. Water with density ρ kg m^{-3} is ejected out of a horizontal hose with a cross–section area of A m^2, at a speed of v m s^{-1}. The force required by a person to hold the hose still is:

A $0.5\rho Av^2$

B ρAv^2

C $\rho A^2 v$

D $\frac{\rho A}{v}$

12. Consider a Hooke's law–obeying spring, with a spring constant of k N m^{-1} that is vertically suspended off a ceiling. A mass m kg is attached with zero initial speed and when the spring is unstretched. The mass is quickly let go. The mass of the spring itself is negligible.

Which of the following statements is/are true?

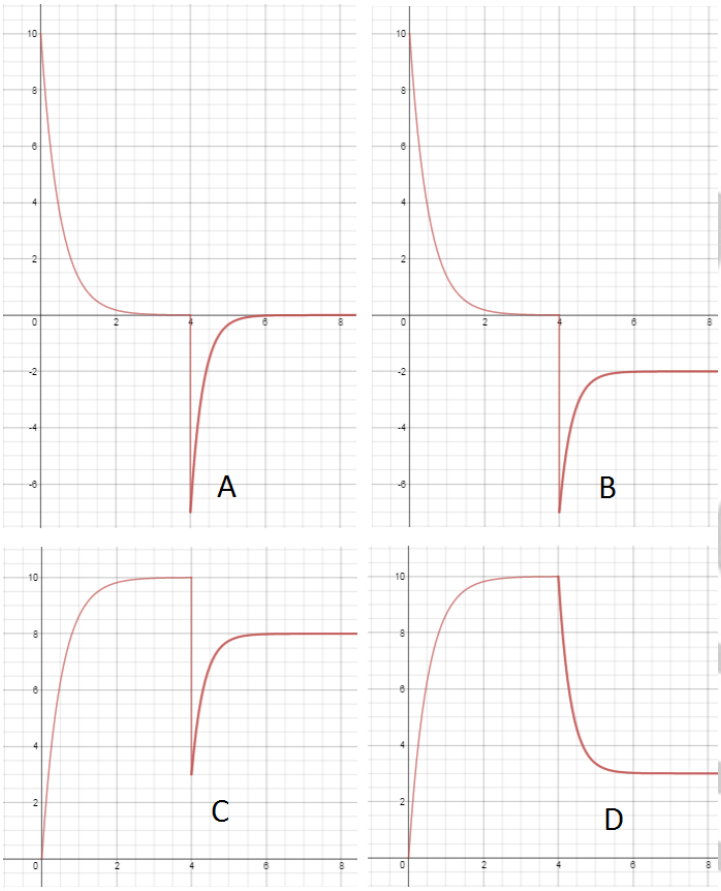
I The mass will first come to a momentary stop at a distance of x given by mg = kx.

II Some GPE is converted into KE as the mass is falling.

III Some GPE is converted into elastic PE as the mass is falling.

A I and II B I and III C II and III D I, II, and III

13. A small rock falls off a cliff, reaches terminal velocity, and hits water before reaching a new terminal velocity; which graph most accurately represents how the net force acting on the rock varies with time?



14. A 5kg object free–falls amidst negligible air resistance for 5 meters before landing inelastically — the object is in contact with the ground for 0.25 seconds as it comes to a complete stop. The average force exerted by the ground on the ball during the stop is:

A 100 N
B 200 N
C 250 N
D 500 N

15. Water is fed through an electrical heater with power P Watts at a rate of m kg s^{-1}. The specific heat capacity of water is c J kg^{-1} K^{-1}. The increase in temperature of the water is:

A Pmc
B $\frac{Pm}{c}$
C $\frac{P}{mc}$
D $\frac{Pc}{m}$

16. 1 kg of water at 0 ^{o}C (c = 4200 kJ kg^{-1}) is mixed with 1 kg of sand (c = 840 J kg^{-1} ^{o}C^{-1}) at 100 ^{o}C. The final temperature should be closest to:

A 17 ^{o}C
B 20 ^{o}C
C 25 ^{o}C
D 50 ^{o}C

17. A 80–dm^3 metal cylinder containing 700 kPa of compressed helium is used to fill 1 dm^3 balloons at a surrounding pressure of 100 kPa. How many balloons can be inflated?

A 480
B 560
C 875
D 1120

18. The internal energy, in Joules, of 160 grams of argon gas (relative atomic mass = 40) is approximately …

A $\frac{3}{2}kT$
B $6kT$
C $\frac{3}{2}RT$
D $6RT$

19–20. A water surface is experiencing a wave of speed 2.4 m/s, wavelength 1.7 meters, and an amplitude of 0.7 meters. A wooden cork floats on top of the water surface.

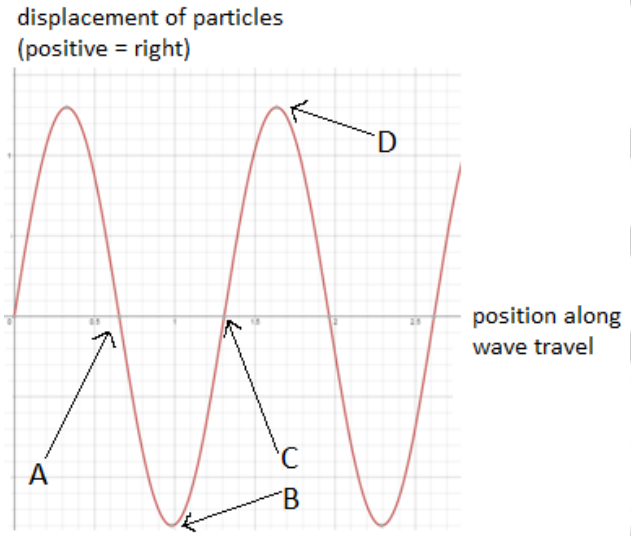
19. After 2 periods, a wavefront would have travelled:

A 1.4 meters
B 2.4 meters
C 3.4 meters
D 4.8 meters

20. After 2 periods the cork would have travelled a distance of:

A 5.6 meters
B 4.8 meters
C 3.4 meters
D 0 meters

21. Consider the following sound wave. The horizontal axis indicates position along the sound wave and the vertical axis indicates the displacement of particles at a particular instant. Which letter indicates a compression?



22. The 2nd–order diffraction pattern of light through a diffraction grating is observed to be at angular position of 15^{o}. Given that $\sin 15^{o} = 0.2588$ correct to 4 significant figures, the total number of diffraction patterns observed in this experiment should equal to:

A 7
B 8
C 11
D 15

23. The 3rd harmonic of a standing wave, set up in an open–close pipe, has a frequency of f. The 4th harmonic of the same pipe will have a frequency of:

A $\frac{5f}{4}$
B $\frac{4f}{3}$
C $\frac{7f}{5}$
D $\frac{3f}{2}$

24. A light–dependent resistor is connected to a battery with internal resistance. The light intensity is increased. How will the following quantities change?

	Resistance of LDR	Current through LDR	Voltage across LDR
A	Decrease	Increase	Decrease
B	Decrease	Increase	Increase
C	Increase	Decrease	Decrease
D	Increase	Decrease	Increase

25. A battery with EMF 18.0 Volts and internal resistance r is connected to a single light bulb. The terminal voltage is measured to be 16.0 V. What will be the terminal voltage if a second identical light bulb is connected in parallel with the original light bulb?

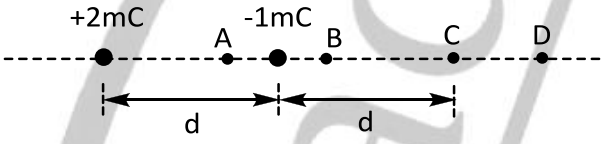
A 14.0 V
B 14.4 V
C 16.0 V
D 16.8 V

26. Two identical positively–charged spheres, M and N, are held in place, separated by 2r cm. Another positively–charged sphere P is placed at the midpoint between M and N. Sphere P is now displaced by a distance r/2 towards M. What will happen to P when it's released?

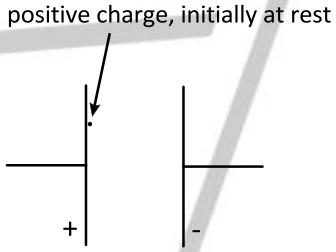
I P will undergo simple harmonic motion
II P will come to a momentary stop when it reaches the midpoint
III P will come to a momentary stop when it reaches a distance 3r/2 away from M.

A II only B III only C I and II D I and III

27. Two point charges of +2mC and –1mC are placed as shown. At which of the positions A to D will a charged particle experience no force due to these two charges?

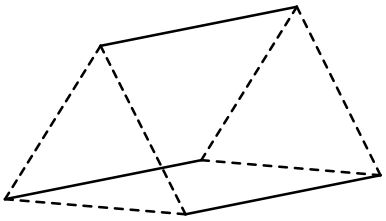


28. A positively–charged particle is placed next to the positive plate of an oppositely–charged parallel–plate setup. The initial acceleration is a and the speed at which the charge strikes the negative plate is v. The experiment is repeated, with the separation of the plate decreased to one–third of the previous value while the Voltage is maintained constant. What are the new values of a and v?



	Acceleration	Impact velocity
A	a	$\sqrt{3}$v
B	a	3v
C	3a	v
D	3a	$\sqrt{3}$v

29. Three parallel wires, with identical lengths and masses and carrying identical currents in the same direction, are placed equidistant from each other and held in place. Gravitational forces are negligible. Which of the following is **not** true?



A The magnetic field in the centre of the triangle is zero.

B The wires mutually attract each other.

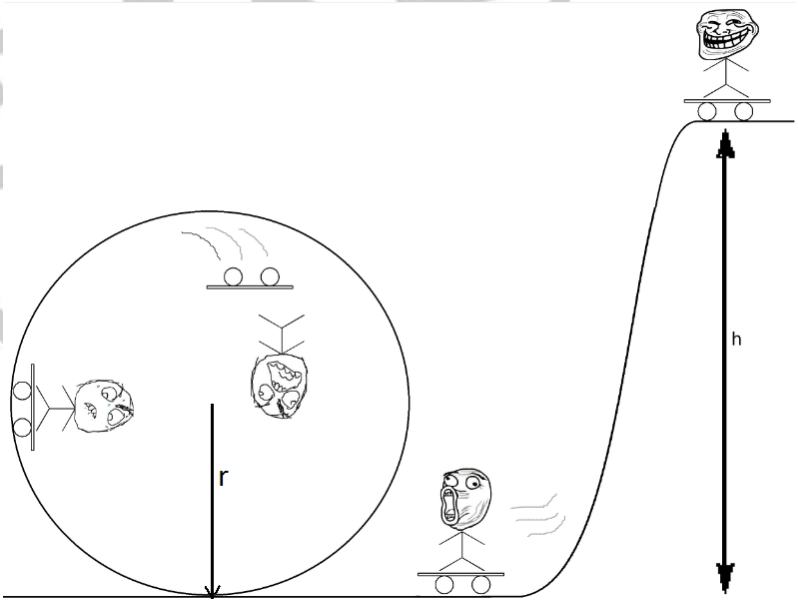
C If one wire is let go and the other two are held in place, the first wire will initially accelerate toward the midpoint between the other two wires.

D If two wires are let go and the third wire is held in place, the two wires will each initially accelerate directly at the 3rd wire.

30. A horizontal circular track has coefficients of static and dynamic frictions μ_s and μ_d, respectively. The maximum possible speed that a car can travel at, as it maneuvers a corner with radius r on a horizontal track, without skidding, is:

A $\sqrt{\mu_s gr}$ B $\sqrt{\mu_d gr}$ C $\sqrt{\frac{gr}{\mu_s}}$ D $\sqrt{\frac{gr}{\mu_d}}$

31. A group of skateboarders are attempting a vertical loop stunt on a frictionless track. The minimum height, h, at which the skateboarders must start in order to avoid eventually falling off the top of the loop is ...



A 2.5r B $2\sqrt{2}$ r C 3r D 5r

32. An asteroid with mass m is falling towards the centre of the Earth (mass = M), going from a position of r = 3R to r = 2R where R = radius of Earth. The gain in kinetic energy is given by the expression

A $\frac{GMm}{R}$

B $\frac{GMm}{6R}$

C $\frac{5GMm}{6R}$

D $\frac{5GMm}{36R}$

33. A satellite, in a circular orbit around the Earth at a radius r from the centre of the Earth and with initial kinetic energy K, is given an amount of kinetic energy K'. As a result, it is just able to escape. The value of K' equals to.....

A K

B $(\sqrt{2}-1)$K

C $\sqrt{2}$K

D 2K

34. A decay of an up quark into a down quark must be accompanied by:

A an electron and an electron neutrino

B an electron and an electron antineutrino

C a positron and an electron neutrino

D a positron and an electron antineutrino

35. A Geiger–Muller counter registers an average count of 90 decays per second when placed at a distance r from a radioactive source. The same counter is moved to a distance 3r and the average count rate becomes 34 decays per second. The radioactive source has a very long half life. The value of background radiation is closest to how many counts per second?

A 4

B 18

C 22

D 27

36. Consider the hypothetical nuclear reaction below:

$${}^{11}_{5}B + p \rightarrow {}^{12}_{6}C$$

The binding energies per nucleon for boron–11 and carbon–12 are 7.0 MeV and 7.7 MeV, respectively. The energy change for this reaction is:

A 0.7 MeV released

B 0.7 MeV absorbed

C 15.4 MeV released

D 15.4 MeV absorbed

37. Water of uniform cross–section area is stored behind a dam to height h. Half the water is released in power generation. The fraction of gravitation potential energy that remains is:

A $\frac{1}{4}$

B $\frac{1}{3}$

C $\frac{1}{2}$

D $\frac{3}{4}$

38. Glucose has an energy density of G Joules per kg. Assuming that a human is a blackbody radiator with emissivity e and surface area A, the rate of consumption of glucose, in kg s^{-1}, in order to maintain the person's body temperature at T is:

A $e\sigma AT^4G$

B $\frac{e\sigma AT^4}{G}$

C $\frac{G}{e\sigma AT^4}$

D $\frac{G}{\sigma AT^4}$

39. The amount of solar power incident from the sun to the Earth is I. Mars' radius is approximately half that of the Earth, and is 1.5 time as far away from the sun as Earth is. The amount of solar power incident on Mars is approximately:

A $\frac{I}{9}$

B $\frac{2I}{9}$

C $\frac{I}{3}$

D $\frac{4I}{9}$

40. A likely surface temperature for a star that emits violet light as its peak wavelength is:

A 1000 K

B 3000 K

C 7000 K

D 15000 K