Unit 1: Kinematics, Forces & Systems (10 questions)

1. **Multi-segment motion**
   A car drives 20 m east, then 12 m west, then 5 m east. What are its total distance travelled and net displacement?

A. 37 m distance; 13 m east
B. 13 m distance; 37 m east
C. 33 m distance; 5 m west
D. 33 m distance; 13 m east

2. **Scaling of maximum height**
   A ball thrown straight up reaches maximum height (h). Ignoring air resistance, how high will it rise if its initial speed is doubled?

A. (2h)
B. (3h)
C. (4h)
D. (h)

3. **Projectile range and launch angle**
   Two projectiles are fired at the same speed (v) but angles 30° and 60° above the horizontal. They land at the same elevation from which they were launched. Their horizontal ranges are

A. longer for 30°
B. longer for 60°
C. the same for both angles
D. different only if their masses differ

4. **Effect of changing acceleration and time**
   An object under constant acceleration travels a distance (d) in time (t). If the acceleration is tripled and the time is halved, the new distance is

A. (d)
B. (d)
C. (d)
D. (d)

5. **Steep versus gentle incline**
   Two identical blocks start from rest atop frictionless ramps of the same vertical height but different lengths (one steep, one gentle). Which has the greater speed at the bottom?

A. The block on the steep ramp
B. The block on the gentle ramp
C. Both have the same speed
D. Depends on their masses

6. **Static friction under increasing force**
   A 10-kg crate rests on a horizontal floor. The coefficient of static friction is 0.40 and the

coefficient of kinetic friction is 0.30. A horizontal force is gradually increased from zero. When the applied force is 25 N, the friction force on the crate is

A. 25 N
B. 30 N
C. 39 N
D. zero

7. **Pulley with friction**
   Two blocks are connected by a light string over a frictionless pulley. Block A (2.0 kg) rests on a rough horizontal table with coefficient of kinetic friction 0.10. Block B (3.0 kg) hangs freely. What is the magnitude of the acceleration of the system? (Use (g=9.8;^2).)

A. 1.1 m/s^2
B. 3.0 m/s^2
C. 5.5 m/s^2
D. 9.8 m/s^2

8. **Safe speed on a flat curve**
   A car travels around a level curve of radius (r) with coefficient of static friction (). If the curve's radius is quadrupled while () remains the same, how does the maximum safe speed change?

A. unchanged
B. halved
C. doubled
D. quadrupled

9. **Comparing power output**
   Person A (60 kg) climbs a 5.0-m flight of stairs in 4.0 s. Person B (80 kg) climbs the same flight in 5.0 s. Which person produces the greater power and by what factor (approximate)?

A. A produces more; factor ≈1.3
B. A produces more; factor ≈1.7
C. B produces more; factor ≈1.07
D. B produces more; factor ≈1.7

10. **Mass versus weight in deep space**
    An 80-kg astronaut drifts in deep space far from any significant gravitational field. Which statement is true?

A. Both mass and weight are zero.
B. Mass is 80 kg and weight is zero.
C. Mass is zero and weight is 80 N.
D. Mass is 80 kg and weight is 80 N.

Unit 2: Momentum, Energy, Rotation & Fluids (8 questions)

11. **Elastic collision calculation**
A 2-kg cart moving at 3 m/s collides elastically with a 1-kg cart initially at rest on a frictionless track. What are their speeds after the collision (speeds to the right positive)?

A. 1 m/s (2-kg cart); 4 m/s (1-kg cart)
B. 4 m/s (2-kg cart); 1 m/s (1-kg cart)
C. 2 m/s (2-kg cart); 2 m/s (1-kg cart)
D. Both come to rest

12. **Energy loss in a perfectly inelastic collision**
A ball of mass (m) moving at speed (v) collides head-on with and sticks to a stationary ball of mass (2m). What fraction of the initial kinetic energy is lost in the collision?

A. ()
B. ()
C. ()
D. ()

13. **Bullet–block interaction**
A 10-g bullet moving at 400 m/s passes completely through a 5-kg block at rest on a frictionless surface and emerges at 300 m/s. What is the block's speed just after the bullet emerges?

A. 0.10 m/s
B. 0.20 m/s
C. 0.40 m/s
D. 2.0 m/s

14. **Spring compression from a drop**
A block of mass (m) is released from height (h) above an ideal horizontal spring of constant (k). When the block hits and compresses the spring, the maximum compression (x) is

A. (x=)
B. (x=)
C. (x=)
D. (x=)

15. **Work done lifting at constant speed**
A crate of weight (W) is lifted vertically upward a distance (h) at constant speed by a rope exerting tension (T). The work done by the net force on the crate is

A. (+Wh)
B. (-Wh)
C. zero
D. ((T-W)h)

16. **Conservation of angular momentum**
A uniform disk of mass (m) and radius (R) rotates freely with angular speed (). A thin

ring of the same mass and radius is gently dropped onto it and they stick together. The final angular speed is

A. (,)
B. (,)
C. (,)
D. ()

17. **Who wins the race?**
A smooth ramp allows three objects of equal mass and radius to roll/slide down without slipping from the same height: a frictionless sliding block, a solid cylinder and a thin hoop. Which order describes their arrival times from first to last?

A. Hoop, cylinder, block
B. Block, cylinder, hoop
C. Cylinder, hoop, block
D. Cylinder, block, hoop

18. **U-tube with two liquids**
A U-tube contains water (density 1000 kg/m^3) in one arm and oil of unknown density in the other. The water column is 0.15 m high, and the oil column is 0.18 m high. If the pressure at the bottom of both arms is equal, the density of the oil is closest to

A. 625 kg/m^3
B. 830 kg/m^3
C. 900 kg/m^3
D. 1100 kg/m^3

Unit 3: Electrostatics & Magnetism (8 questions)

19. **Symmetry and net force**
Two identical positive charges are fixed 2 m apart. A small positive test charge is placed exactly midway between them. The net electric force on the test charge is

A. zero
B. directed toward one of the charges
C. perpendicular to the line connecting the charges
D. dependent on the size of the test charge

20. **Location of zero field between two charges**
Two point charges, (+3q) and (-2q), are separated by a fixed distance on a straight line. At a point along this line where the net electric field is zero, the point will be

A. midway between the charges
B. closer to the (+3q) charge
C. closer to the (-2q) charge
D. not exist because the charges are of opposite sign

21. **Helical motion in a magnetic field**
A charged particle enters a uniform magnetic field at an angle of 30° to the field lines.

Its resulting path is a helix. Which component of the particle's velocity remains constant?

A. The component perpendicular to the field
B. The component parallel to the field
C. Both components change periodically
D. Its speed varies sinusoidally

22. **Finding the electric field for zero deflection**
A proton travels east at (2.0^6;) in a region where a 0.10 T magnetic field points upward (out of the page). To make the proton's path undeflected, what should be the magnitude and direction of a uniform electric field?

A. (2.0^5;) south
B. (2.0^5;) north
C. (2.0^5;) east
D. (0.1;) north

23. **Changing fields in a velocity selector**
A velocity selector uses crossed electric and magnetic fields to allow particles of a specific speed to pass straight through with no deflection. If the electric field magnitude is quadrupled while the magnetic field stays the same, what must be done to maintain zero deflection?

A. Nothing; the original speed still works.
B. The particle speed must be halved.
C. The particle speed must be quadrupled.
D. The particle charge must be increased.

24. **Magnetic field around a straight wire**
A long straight wire carries current (I) into the page. At point (P), 2 cm from the wire, the magnetic field has magnitude (B_1). At point (Q), 4 cm from the wire, the field magnitude is (B_2). What is (B_1/B_2)?

A. 1/2
B. 2
C. 4
D. 8

25. **Effects of doubling speed in circular motion**
A proton moves in a circle of radius (R) in a uniform magnetic field. If its speed is doubled, how do the radius and period of its circular motion change?

A. Both radius and period double.
B. Radius doubles; period stays the same.
C. Radius doubles; period halves.
D. Radius stays the same; period doubles.

26. **Equalising charges on identical spheres**
Two identical isolated metal spheres A and B carry charges of +6(Q) and –2(Q),

respectively. They are connected by a conducting wire and then separated. What is the final charge on each sphere?

A. +2(Q) on each
B. +3(Q) on A and +1(Q) on B
C. +4(Q) on A and 0 on B
D. +6(Q) on A and –2(Q) on B

Unit 4: Waves & Optics (6 questions)

27. **Distance to an image in a plane mirror**
A person stands 2.0 m in front of a plane mirror. The distance between the person and their image is

A. 1.0 m
B. 2.0 m
C. 4.0 m
D. cannot be determined

28. **Refraction from water into air**
A light ray in water (index (n=1.33)) is incident on the water–air interface at 40°. The angle of refraction in air is closest to

A. 32°
B. 40°
C. 59°
D. 66°

29. **Fringe spacing in a double-slit experiment**
Two slits 0.50 mm apart produce an interference pattern on a screen 1.0 m away using light of wavelength 500 nm. The distance between adjacent bright fringes on the screen is

A. 0.10 mm
B. 0.50 mm
C. 1.0 mm
D. 2.0 mm

30. **Effect of slit width on diffraction**
In single-slit diffraction, what happens to the width of the central bright maximum on the screen if the slit width decreases while wavelength and screen distance remain fixed?

A. narrower
B. wider
C. unchanged
D. shifted sideways

31. **Thin-film constructive interference**
A thin soap film (index (n=1.33)) in air is illuminated by normally incident white light.

It appears green with wavelength 550 nm. For constructive reflection from both surfaces, which film thickness (measured in nanometres) is most likely?

A. 103
B. 206
C. 413
D. 550

32. **Orientation of fields in an electromagnetic wave**
An electromagnetic wave propagates in vacuum along the (x)-direction. Its electric field oscillates along the (y)-axis. Which statement about the associated magnetic field is correct?

A. The magnetic field also oscillates along the (y)-axis and is in phase with the electric field.
B. The magnetic field oscillates along the (z)-axis and is in phase with the electric field.
C. The magnetic field oscillates along the (z)-axis and lags the electric field by 90°.
D. The magnetic field oscillates along the (x)-axis and is out of phase with the electric field.

Unit 5: Relativity (3 questions)

33. **Muon decay and time dilation**
Muons created in the upper atmosphere travel toward Earth at 0.998 (c). Their half-life at rest is 2.2 μs. Without relativistic time dilation, how far would a muon travel before decaying?

A. 0.66 km
B. 3.3 km
C. 10.4 km
D. 34.8 km

34. **Twin paradox calculation**
A spaceship journeys to a star 6 light-years away at 0.60 (c) and then returns at the same speed. According to observers on Earth, the trip takes 20 years. How much younger will the travelling twin be when they reunite?

A. 2 years
B. 4 years
C. 5 years
D. 8 years

35. **Length contraction**
A rod has a proper length of 10 m. It moves past an observer at 0.80 (c). What length does the observer measure?

A. 10 m
B. 8 m
C. 6 m
D. 4 m

Answer key

Q#	Answer
1	A
2	C
3	C
4	A
5	C
6	A
7	C
8	C
9	C
10	B
11	A
12	C
13	B
14	A
15	C
16	B
17	B
18	B
19	A
20	C
21	B
22	B
23	C
24	B
25	B
26	A
27	C
28	C
29	C
30	B
31	A
32	B
33	A
34	B
35	C